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PART - I OF II

PARTICIPANT TRAINING PLAN
IRRIGATION SYSTEMS MANAGEMENT PROJECT 391-0467

"THE EFFECTIVE, EFFICIENT DELIVERY AND UTILIZATION OF PAKISTAN'S WATER RESOURCES PROVIDE THE MEANS FOR REALIZING THE NATION'S IRRIGATED AND WATERED AGRICULTURAL PRODUCTION POTENTIAL. THE KEY TO ATTAINING THIS GOAL IS PERSONNEL, WITH A SINGLE PHILOSOPHY AND PURPOSE IN MIND, FUNCTIONING IN A UNIFIED AND DIRECTED EFFORT AT ALL LEVELS - PLANNING, ADMINISTRATION, MANAGEMENT, RESEARCH AND ON-FARM APPLICATION

DECEMBER . 1983
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FOREWORD

This - "Participant Training Plan" - is submitted under the terms of contract 391-0467-S-00-3035-00 dated September 13, 1983 between the Contractor and the United States of America Agency for International Development, USAID/Islamabad.

The objective of the contract was to identify training options for strengthening the capabilities of personnel in Federal and Provincial Government of Pakistan institutions who are involved in the planning, design and maintenance of irrigation systems and the utilization of water delivered by these systems to support irrigated agriculture. The objective will be reached, in part, through an extensive incountry and external participant training program. As defined in the Contractors scope of work, emphasis has been placed on the external participant training portion. The planning and implementation of incountry training and on-the-job aspects of the program will in large part be supported by the members of four expatriate advisory teams (Engineering, Equipment Management, Planning/Management, and Research) provided as a part of the technical assistance provided under the Irrigation Systems Management Project. The "Plan" supports internal training through the training of trainers and short course incountry offerings from external institutions.

The overall training plan support of the Irrigation Systems Management (ISM) Project consists of three basic types of training: vocational, technical and planning/management. The training plan considers both external training (degree, medium and short term) and incountry training. The development of this training plan was a joint effort wherein the contractor assisted USAID/Pakistan and the concerned Government of Pakistan (GOP) institutions, Ministry of Water and Power, Provincial Irrigation Departments (PIDs), Water and Power Development Authority (WAPDA), and

other supporting and relevant institutions, define and develop a course of action for the life of project (Fiscal year 1983 - Fiscal year 1989) within the limits of the resources provided under the project.

As per the terms of Contract, the Contractor, during the period of September 19, 1983 - December 5, 1983 under took the following course of action -

A. September 19 - 23, 1983 - Conferred with:

- Agency for International Development (AID/W), Office of Technical Resources; Asia Bureau, Office of Agriculture; Water Resources Division, Bureau for Science and Technology; Office of International Training, Bureau for Science and Technology; BIFAD support Office, Board for International Food and Agriculture Development (BIFAD)
- United States Department of Agriculture (USDA), Office of International Cooperation and Development (OICD), International Training Division
- Partners for International Education and training

The purpose to -

1. Identify potential institutions for degree training;
2. Identify courses/seminars for short-term training;
3. Ascertain availability of on-the-job training (OJT) sites;
4. Procure appropriate catalogues and materials; and,
5. Brief organizations on the projected training requirements.

B. September 26 - October 7, 1983 - On-sites visits with

- Bureau of Reclamation (BUREC)
  International Training Office,
  Denver, Colorado
- Colorado State University,
  Fort Collins, Colorado
- University of Idaho,
  Moscow, Idaho

- Washington State University,
  Pullman, Washington
- University of California,
  Davis, California
- Utah State University,
  Logan, Utah

The purpose of the visits and conferences to ascertain each institution's capability or receptiveness to -

1. Formulate programs specific to Pakistan's requirements;
2. Modify Master Degree thesis requirements (if desirable) vis-a-vis special problems and incorporate OJT as part of study program;
3. Allow Ph. D. candidates to conduct thesis field work in Pakistan; and,
4. Acquaint institutions with general training requirements under the ISM project.

C. October 13 - December 5, 1983 - Develop in Pakistan in close cooperation and accord with the GOP and USAID/Pakistan, a course of action supportive to Pakistan's training needs. This was accomplished through -

1. A survey of present and projected staffing requirements and level of training;
2. The identification of training shortfalls;
3. An assessment of candidate availability;
4. Ascertain the in-country support requirements i.e. English Language Training (ESL), research support, selection criteria, post training placement; and,
5. Preparation of the training plan which will include identification of training desciplines, time frame, documentation requirements and placement.

December 4, 1983

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SECTION I - PAKISTAN OVERVIEW

WATER AVAILABILITY AND AGRICULTURAL PRODUCTION - A CRITICAL RELATIONSHIP CONTROLLED BY MAN

Pakistan is more richly endowed with land resources than water resources. Improved water availability and management are indispensable to productive agriculture and, therefore, to satisfactory national economic growth and development. Only a very small percentage of water that enters the Indus River and its tributaries escapes to the sea, yet vast areas of fertile irrigable land lie either unirrigated or receive far less irrigation water than is required to maximize crop production because the water which is available is not efficiently nor effectively utilized to the extent possible.

This situation, coupled with the need to increase agricultural production, points to the importance of making optimum use of available water resources for irrigation. This must be accomplished by integrated management of all parts of the system, including watershed, surface and groundwater storage, delivery, and on-farm use.

A. THE AGRICULTURAL SECTOR

Agriculture is the largest sector in Pakistan, accounting for about 32 percent of GDP, employing some 56 percent of the labor force, and contributing approximately 50 percent of export earnings. Irrigation is the single most important factor in agriculture, bringing lands under cultivation which would otherwise, because of insufficient rain, be left uncultivated or, if cultivated, produce less.

Irrigated lands account for 75 percent of total cropped acreage and 90 percent of the production of the major crops. On the average, yields on irrigated lands are higher than those in rainfed areas. However, crop yields, even in the irrigated areas, are low, measuring less than half of estimated potential yields. Cropping intensity, which under irrigated conditions should range from 130 to 150 percent, averages about 100 percent for the Indus Plain. While factors such as inadequate funding for research, less than totally effective extension programs, and less than optimum availability of off-farm inputs contribute to this phenomenon. Inefficient and ineffective water management is considered to be the principal constraint.

Improved seed accompanying the "Green Revolution" led to higher yields and diverted attention from the need to improve management of water. It is important to note that the inherent potential of these higher fertilizer responsive seeds has not been realized due to lack of adequate control of the water supply.

The water delivered by the canal system is not utilized productively. Yields per acre, one measure of productivity of water in the system, are low. For many crops, average yields are less than those achieved by other countries under rainfed conditions. The policy framework has not provided consistent support and incentives for economic uses of water delivered. For example, even though the GOP has initiated a policy of eliminating the fertilizer subsidy and has increased product prices, water rates are low. Frequently, the amount of water available to farmers is below optimum and timing of water deliver does not match crop needs.

Today it is recognized that improving the management of water for irrigation can no longer be ignored. While additional construction opportunities exist and may be required, it is agreed that a major effort is now needed to manage water so that it can be delivered to farmer's field in a way to achieve optimum yields.

B. THE INDUS IRRIGATION SYSTEM

1. Historical Review

An extensive irrigation system was developed in Pakistan in the last half of the 19th and first half of the 20th centuries. Management practices established early on are still followed. Efforts prior to Pakistan's independence in 1947 were directed mainly toward the expansion and improvement of the physical irrigation works. At independence primary attention was largely given to completion of the Indus Basin Project, under which required civil works were provided to compensate for the loss of river flows from India. Since, 1955, in a series of five year plans, the GOP has undertaken, with the assistance of numerous donors: (a) projects to further regulate the uncontrolled river flows in the Indus Basin, including the construction of the Mangla and Tarbela dams; link canals for intra-basin transfer of waters of major tributaries; and major barrages (diversion dams); (b) improvements of canal systems which supply water to irrigated land; (c) development of groundwater through expanded public and private tubewell programs; and, (d) a program to address salinity and waterlogging problems through a series of Salinity Control and Reclamation Projects (SCARPS). Despite these massive investments over many years, Pakistan's system is not yet designed to fully maximize agricultural output.

2. Physical Characteristics

Pakistan has the world's largest contiguous irrigation system with a history spanning 3,000 years. The Indus River and its major tributaries supply an irrigation network comprised of three major reservoirs with 15.3 million acre feet total live storage capacity, 19 barrage/headworks, 12 link canals, and 43 canal commands. The total length of the canal system is about 40,000 miles, feeding a network of approximately 89,000 water-courses. Nine thousand miles of surface,drains constructed to

to alleviate waterlogging and to control stormwater runoff, have been build over the years. The Indus system also includes over 13,000 publically installed tubewells and about 200,000 private tubewells, which annually pump about 34 million acre feet. The contiguous system commands 34.5 million acres.

3. Current Problems

Pakistan's irrigation system suffers from neglect of both infrastructure maintenance and the institutional framework which shapes public and private sector behaviour and performance. The causes of this situation are multiple, but inadequate budgetary allocations, outmoded policies and procedures, and insufficient training for professional staff are the primary constraints.

a. Deteriorated Canals and Drains

Canals and drains are in badly deteriorated condition due primarily to the absence of adequate and timely maintenance. Silt deposits have raised the beds of the channels, encroaching on the designed freeboard. Embankments, subjected to continuous stress from water flow, wind and rain erosion, and human and animal abuse, have deteriorated. These problems are compounded by canals carrying quantities of water much greater than their designed capacity. The end result, canal breaches with locational floods and interruption of downstream service to large farming areas, is a serious threat to the irrigation system, the lifeblood of Pakistan.

b. Financial Constraints

The ability to carry out maintenance is inhibited, for the most part, by financial constraints. As the system has grown and aged, the burden of operating and maintaining it has produced a severe financial burden on provincial governments. In periods of

high inflation, budgetary allocations have remained almost constant, resulting in a decline in real terms. In addition, the cost of maintaining publically-owned tubewells has made additional demands on these scarce resources. While staffing levels have been maintained, funds for operation and maintenance have not been adequate to keep up with requirements dictated by time and use.

Revenue generated by the system has not kept pace with either rising costs or agricultural income. In addition, the revenue collected by the provinces becomes part of a provincial general fund which is allocated yearly for all provincial recurring budgets. This practice places the Provincial Irrigation Departments (PIDs) in direct competition for funds with education, health, and other provincial bodies. It is estimated, moreover, that even if the current level of water charges were earmarked for direct use by the PIDs, the resulting revenue would fall well below the amounts needed to cover the required cost of an adequate operation and maintenance program.

c. Waterlogging and Salinity

Irrigation systems often bring with them the dangers of waterlogging and salinity, caused by rising water tables and the deposit of salts following evaporation. Vast areas of the Indus system are threatened by this phenomenon. The problem is particularly serious due to minimal slope conditions in the lower region of the Indus basin where as little as one foot of drop in three miles is found.

In 1960, the GOP embarked on a program to address salinity and waterlogging problems through a series of Salinity Control and Reclamation Projects (SCARPs). By 1980, in six SCARP areas, 12,000 public tubewells had been installed in fresh groundwater zones and 1,300 in saline zones. An estimated 200,000 smaller private tubewells have come into use in the same areas. These tubewells provide relief to rising water tables, and, in fresh zones, tubewells complement surface water supplies for irrigation. A 1978 survey conducted by the Water and Power Development Authority (WAPDA)

showed improvement in soil salinity conditions compared to similar study undertaken in the early 1960's. The improvement was largely attributed to the leaching effects of increased water supplies. Drainage channels are an integral part of a campaign to combat waterlogging and salinity as well as a means to carry off storm-water. Drains, however, have traditionally had last claim on resources for maintenance, and many are clogged with silt and vegetation.

d. Deficient Water Policies and Practices

The set of policies governing water and roles of federal and provincial institutions in formulating and implementing water policy is a product of over eighty years of history. The present canal system has its genesis under the British Colonial Government and was constructed with two primary objectives: to obtain revenue from the sale of waste lands and to alleviate chronic famines by resettling farmers from poor areas. These objectives were best achieved by spreading available water over a large area and providing a relatively "sparse" supply to the areas served. This original allocation policy of "water spreading" has more or less continued through the years and has become accepted as a fact within the social, political and administration contact of the different regions and the user population.

While the situation has not remained totally static, the current situation can be described as follows:

(i) Despite the addition of storage capacity (most recently Tarbela), the emphasis remains on the engineering aspects of water transport rather than water delivery to meet agricultural needs;

(ii) The institutional responsibility and concern for water delivery ends at the final canal outlet (mogha). The institutional vaccum relative to water use below the "mogha" in the irrigated area has only, within the last several years, been

addressed by the Provincial Agricultural Departments who do not have the needed resources to assume this responsibility. A bifurcation of institutional responsibility exists between water delivery and utilization.

(iii) Water rights are product of historical accidents, determined by piecemeal allocations as each canal came on stream. These rights still adhered to in many areas bear little relationship to water requirements; and,

(iv) The simultaneous use of surface water and tubewell pumpage, including publicly-owned tubewells under the SCARP program is not well planned often resulting in wastage of water.

The combined effect of these policies and practices is that farmers have no control over their water supply. Amounts available at the final canal outlets vary with season and the overall level of water in the canals. Generally, farmers at head reaches receive ample, even excessive supplies, while those at the tail end receive considerably less. Wherever his position along the canal, the farmer must schedule his production regime to a somewhat uncertain water supply, rather than scheduling water to meet production needs.

(v) The formulation and implementation of water policy and operational responsibilities are shared by several federal and provincial bodies. This multifarious system of planning and operations has contributed to the overall problems related to effective delivery and efficient end-use of Pakistan's water resources utilized by irrigated/watered agriculture.

The Ministry of Water and Power, the principal federal body in the water sector, is charged with rationalizing overall water and power policy and investment programs. A semi-autonomous body, the Water and Power Development Authority (WAPDA), which falls under the Ministry of Water and Power, is the planning and

executing agency for major civil works. It is also the operating agency for the Tarbela and Mangla Dams, the Chasma Barrage, and the Chasma-Jhelum link canal. Specialized technical units within WAPDA are dedicated to: overall planning and systems analysis; hydrologic studies; surveys and research on water and agriculture; flood prediction; and, design and construction of major works.

Provincial governments have a role in formulating national water policy through consultations with the Ministry of Water and Power. Water charges are levied, collected, and become part of general revenues under provincial agencies. The Provincial Irrigation Departments (PIDs) are charged with operation and maintenance of the irrigation system within each province. Provincial Agricultural Departments provide extension services to water users as well as manage a special program for watercourse rehabilitation and maintenance.

C. WATER MANAGEMENT OUTSIDE THE INDUS SYSTEM

Areas outside of the Indus System must not be neglected if Pakistan's water resources are to be thoroughly and equitably utilized. Large tracts of Pakistan in all provinces lie outside canal irrigated areas, necessitating, other irrigation techniques and technologies. Research and development of these "other" irrigation practices have largely been ignored.

It is becoming increasingly clear that water management problems associated with dryland agriculture are, in many cases, directly related to the integrity of the Indus System. Better utilization of arable land promises not only increased agricultural production and income for inhabitants of these areas but also serves as a means of protecting the watershed and controlling periodic floods. The capability to make optimum use of water resources for agricultural production in all areas must be addressed.

D. POLICY OPTIONS AND DIALOGUE OPPORTUNITIES

The policy framework for the water sector is undergoing significant changes. As a result of a major study in 1979 by WAPDA which was financed by the United Nations Development Program (UNDP), with the IBRD as executing agent, the Government of Pakistan has defined a master plan and overall framework for interventions in the agricultural sector. The study entitled the "Revised Action Programme for Irrigated Agriculture" (RAP), has been accepted in principle by the Government of Pakistan, and implementation of several identified policies is proceeding.

The water policies outlined in the RAP flow from the basic policy stance that: "all agricultural-related investments and policies should be directed to the improvement of agricultural production and should not be focused on the independent development of inputs for agricultural production; and that the costs of development should be borne by the beneficiaries with the Government facilitating the financing of the investments."

The study highlights the need for immediate rehabilitation of canals and drains, management improvement, and a shift from "water disposal" to "water management". While new capital additions to the system are generally considered necessary, such as increased storage and new drains to reduce or eliminate the constant threat of waterlogging and salinity, the thrust of the new policy guidelines is directed towards improved management of the system with an increased role for the private sector.

SECTION II - ORGANIZATIONS

ORGANIZATIONS ORIENTED TOWARD THE DELIVERY AND UTILIZATION OF IRRIGATION WATER

The development of a "training plan" for one or more organizations within the WATER-AGRO SYSTEM must take into account, if only for the purposes of clarifying the respective roles, the sum of organizations directly or indirectly involved. In Pakistan, a large and diverse array of public sector agencies are involved in one manner or another in the planning, allocation, management, delivery and utilization of water from surface and undergound sources for purposes of irrigated and watered agriculture. These organizations include:

Federal Government:

1. Ministry of Water and Power, Islamabad.
2. Pakistan Water & Power Development Authority, (WAPDA), Lahore.
3. Ministry of Food, Agriculture and Cooperatives (Water Management Cell), Islamabad.

Provincial Government:

1. Irrigation & Power Department, Government of Punjab, Lahore.
2. Irrigation & Power Department, Government of Sind, Karachi.
3. Irrigation & Public Health Engineering Department, Government of the Northwest Frontier Province, (NWFP), Peshawar.
4. Irrigation & Power Department, Government of Baluchistan, Quetta.

The following agencies impart training and or carry out

research in Irrigation Water Management:

1. WAPDA, Lahore.
2. Provincial Irrigation Departments (PIDs).
3. Ministry of Science & Technology, Islamabad.
4. Ministry of Food, Agriculture & Cooperatives, Islamabad.
5. Ministry of Education (Federal & Provincial).

a. Nadirshah Eduljee Dinshah University (NED), Karachi.
b. Sind University of Engineering & Technology, Jamshoro.
c. Punjab University of Engineering & Technology (Center of Excellence in Water Resources), Lahore.
d. University of Faizalabad, Faizalabad.
e. The NWFP University of Engineering & Technology, Peshawar.
f. Sind University of Agriculture, Tandojam.
g. The NWFP Agricultural University, Peshawar.

A. IRRIGATION WATER - SURFACE

1. Provincial Irrigation Departments (PIDs)

Provincial Irrigation & Power Departments have the front line responsibility for irrigation, drainage and flood protection. They are responsible within each respective province for providing fair and equitable distribution of water for irrigation and for operation and maintenance of the vast network of public works - barrages, headworks, and other structures of irrigation channels and link canals spread throughout the province.

They undertake any additions, alterations or remodelling required to keep the system in healthy equilibrium or 'regime'. In addition, they are responsible for the upkeep of surface drains and the operation and maintenance of tubewells installed to fight salinity and waterlogging. They are also responsible for design, construction, maintenance and operation of flood protection bunds. They have primary responsibility for flood fighting activities. They operate most of discharge measurement stations on main rivers below the rim stations and send flood flow information to the Flood Warning Centres. Funds for major flood protection, irrigation and

drainage works are received from Federal Government but funds for maintenance and operation of existing works come from Provinces' own resources.

In the process they also perform the following functions:

- Collection and collation of field data needed for planning various projects. The projects with various feasible alternatives are prepared alongwith the tentative cost estimates;
- Evaluation and appraisal of reports for detailed scrutiny, planning and project preparation, and to present the projects to the Planning Development Board for approval;
- To submit annual and five-year development plans, together with budgetary proposals for financial allocation to each project for the consideration of the Provincial Finance Department, and the Planning and Development Board;
- Regulation of water supplies for equitable distribution, supervision and implementation of warabandi and assessment of public revenues and other taxes recoverable from the irrigators, or beneficiaries of drainage and flood control programs;
- Implementation of approved water projects. Also to undertake both basic and applied research into various technical aspects of land and water resources management; and
- Creation of appropriate institutions and making other arrangements to ensure the best possible operation and management of engineering facilities constructed under a project. Remodelling and renovation of existing systems to improve their operational efficiency and their economic use.

2. WAPDA

WAPDA was set up by an ordinance issued in February, 1958 which was amended in March, 1959 to cover transfer of the electricity department to it. The Charter of duties of WAPDA includes investigations, planning and execution of schemes in the following

fields:

- Irrigation, Water Supply and Drainage.
- Prevention of Water-logging and reclamation of Water-logged and saline areas.
- Flood Control.
- Inland Navigation.
- Generation, Transmission and Distribution of Power.
- Operation-Control of Mangla Dam, Tarbela Dam and Chasma Barrage alongwith Chasma-Jhelum Link.

3. Civil Department

Apart from the major irrigation network, a large number of small irrigation canals, commonly called civil canals, are located in the Peshawar, Malakand, Hazara and D.I. Khan Divisions and Provincially Administered Tribal Areas. These are mostly inundation canals and although funds are provided for the construction and repair etc., to these canals by the Provincial Government - Irrigation Department these are under the Administrative control of the Civil Department.

B. IRRIGATION WATER - UNDERGROUND SOURCES

1. WAPDA

Public tubewell projects are planned, designed and constructed by WAPDA. Also WAPDA operates these tubewells initially for a period of one or two years and then hands over the Provincial Irrigation Department. Besides, the SCARP tubewells undertaken by WAPDA, public tubewells are also installed on a limited scale in different areas by the Irrigation Department to mitigate shortage of canal water or to provide alternative source to the areas served from the canal commands.

2. Private Sector

There is no private organization maintaining a pool of private tubewells. However, some farmers are installing and running

their own tubewells so as to supplement the surface water supplies or to have tubewell irrigation exclusively. The various Agricultural Departments assist in the development of tubewells by renting equipment for boring and provide supervision to a limited extent. The major cost is borne by the farmer.

C. WATER-SHED MANAGEMENT

Attention to the importance and value of water-shed management was initiated in Pakistan in the mid 1950s and has been approached on a project by project basis by the Federal and Provincial Governments, Forest Departments and WAPDA. The major emphasis has been toward projects designed to prolong the useful life of reservoirs (Mangla, Tarbela and Murree-Kahuta areas) through improved methods of land-use and implementation of water-shed management practices in catchment areas. The various practices being followed include afforestation of denuded lands, construction of control structures, silt trap storage, spillways, check dams, retaining walls, diversion channels, development of range lands and erosion control on cultivated fields. This aspect of water management and control is jointly undertaken by WAPDA and Federal and Provincial Forestry Departments.

D. DRAINAGE

1. WAPDA

Installation of tubewells was initially started in the Public sector when these were installed in useable groundwater areas primarily for drainage to reduce water-logging and the associated salinization of soils. However, due to useability of groundwater for irrigation, all sweet water public tubewell projects serve as water supply projects in addition to their role of drainage.

The SCARP (Salinity Control and Reclamation Project) tubewells are planned, designed and installed by WAPDA. According to the policy decision of Government of Pakistan, the completed tubewells, after the initial operation of one or two years by WAPDA, are to be taken over and operated by Provincial Irrigation Departments.

2. Provincial Irrigation Departments

The majority of the existing surface drains were excavated or developed by the Provincial Irrigation Departments. The operation and maintenance of these systems is being carried out by these departments.

E. FLOOD CONTROL

1. PIDs

The operation and maintenance of the flood protection works is essentially the responsibility of Provincial Irrigation Departments. Assistance is, however, provided by other Agencies during the flood fighting operations. The Provincial Flood Commissioners or their equivalent have been in existence for quite sometime for the purpose of flood forecasting and warning. The flood warnings are issued to various formations. The evacuation and relief measures are generally handled by the Civil Administration under the guidance of Flood Relief Commissioner. In case of calamaties Armed Forces as well as para-military organizations like Rangers etc. are called for help.

2. Federal Flood Commission

The Federal Flood Commission was established in Jan., 1977 and comprises representatives of the Provincial Irrigation Departments, Central Planning Division, Cabinet Division (Disaster Relief Cell), Ministry of Communications, Ministry of Railways, Meteorological Department, WAPDA, Pakistan Army and Irrigation Drainage and Flood Control Research Council. The

Chairman of Federal Flood Commission is the Chief Engineering Advisor in the Federal Ministry of Water & Power. The statutory responsibilities of the Federal Flood Commission are:

- Preparation of Flood Protection Plan for the country;
- Approval of flood control/protection schemes prepared by Provincial Governments and Federal Agencies;
- Recommendations regarding principles of regulations of reservoirs for flood control;
- Review of damage to flood protection works and review of plans, restoration and reconstruction works;
- Measures for improvement of flood forecasting and flood warning system;
- Preparation of a research program for flood control and protection;
- Standardization of designs and specifications for flood protection works; and
- Evaluation and monitoring of progress of implementation of National Flood Protection Plan.

3. Central Flood Committee

National policy with respect to flood management is determined by the Central Flood Committee. The Committee is organized under the Cabinet Division and is chaired by the Secretary-General, Finance and Coordination. Membership of the Committee includes secretaries of the ministries of Finance, Water & Power, Communications and Agriculture, and Additional Secretary, Central Planning Division.

4. Provincial Flood Commission

Flood Commissions have been established in Punjab and Sind Provinces because of the devastating floods experienced in these provinces in the past.

a. Sind Province

The Institution in Sind is called the Indus River Commission and comprises Senior Irrigation Engineers with the

Irrigation Minister as Chairman. The Indus River Commission is primarily concerned with preparation and implementation of flood protection plans, fixing priorities and design criteria for structures and arrangements for flood fighting in Sind.

b. Punjab Province

The Punjab Flood Commission comprises representatives of the Punjab Irrigation Department, Punjab Highway Department, Pakistan Meteorological Department, Pakistan Army, WAPDA, Pakistan Railways and Pakistan Broadcasting Corporation. The Provincial Relief Commissioner acts as the Chairman. The orientation of the Punjab Flood Commission is primarily towards flood warning, flood fighting, rescue and relief, and coordination.

5. WAPDA

WAPDA's flood related activities have generally, been limited to reservoir operation, participation in flood fore-casting and warning and collection of hydro-meterological data.

6. Pakistan Meteorological Department

A streamflow forecasting unit of this department is the key agency in the flood warning centres that function during the flood season at Lahore and Karachi. The Unit is responsible for developing flood forecasting and flood routing procedures, supply forecasts of flood discharges at key locations and developing seasonal water supply forecasts.

F. HYDROLOGIC DATA COLLECTION

Pakistan is divided basically into two hydrological regions:

- The flat alluvial plains of the Indus Basin with an extensive canal irrigation system. This region is faced with water-logging, salinity, alkalinity, aggradation of river beds, drainage, congestion and flood problems.

- The region of coastal drainage and desert streams (Karachi Division and most of Quetta and Kalat Divisions). This region is arid and the lands remain largely uncultivated and sparesly populated because of a shortage of water.

In Pakistan a number of organizations are carrying out observations in the field of hydrology or akin areas. These include:

1. Pakistan Meteorological Department

Pakistan WAPDA was established in 1958. It is charged among other things with the responsibility for the wise and orderly development of water resources. The surface water Hydrology Project was established to supplement the work already being done by the Pakistan Meteorological Department. The total number of stations maintained by this Department is 196. This includes 67 stations for stream gauging 45 for evaporation, wind speed and temperature. The number of stations to observe the solar radiations is only 7. The other 69 stations are confined only to observe precipitation and temperature. 8 snow pack gauges are also maintained by the department at heights varying from 7750 to 10,600 above sea level.

2. WAPDA

Prior to independence, Pakistan had a small number of stations mostly for rainfall and temperature measurements. However, there were some gauge and discharge measuring stations at important points. After the establishment of Pakistan Meteorological Department, in 1950, these stations were given into its jurisdiction. This Department soon set up stations to observe snowfall, precipitations, temperature, humidity, pressure, wind speed, solar radiation and evaporation.

3. PIDs - Directorates of Hydrology

These Directorates maintain 228 stations which include gauge sites, gauge and discharge sites, rainfall stations,

evaporation and temperature sites. The number of stations collecting this data is as follows:

1)	Gauge Sites	51
2)	Gauge & Discharge Sites	123
3)	Rainfall Stations	46
4)	Evaporation Stations	5
5)	Temperature Stations	3
	Total:	228

The Directorate of Hydrology exist in the provinces of Sind, Punjab and NWFP.

4. Forest Department

Sixty-four (64) observation sites are maintained for only rainfall data collection.

G. TRAINING

1. Provincial Irrigation Departments

There is no formal staff development program for employees of the PIDs. However, when engineers are employed by the provincial departments, they undergo an informal in-service training program organized by the division to which they are assigned. Such programs generally include the method of maintaining and running Head Works, Barrages, Dams, Canals, booking of irrigation/crops in fields,preparation of estimates, execution of works, checking of works, accounting procedures etc.

2. On-Farm Water Management Training and Research Institute, Lahore

The On-Farm Water Management Training Institute (Agriculture) provides training in precision land levelling techniques, watercourse design, improvement and irrigation

extension services to the following functionaries:

a) On-Farm Water Management Field Teams.
b) Private Contractors.
c) Field Staff of the Extension Wing of Agriculture Department.
d) Progressive Farmers.
e) Farm Operators.
f) Bankers.

In addition to classroom training, on-the-job training and theory application is carried out by the trainees on a seventy-four (74) acre demonstration - training-cum-research farm. Trainees, as a part of the training program, design improved watercourse programs for the private sector.

3. Academic Institutions

Seven universities, within Pakistan's higher education system, provide the bulk of college graduates entering service in the public sectors of irrigation and agriculture. The seven academic institutions impacting most directly on the irrigation and agriculture sectors include:

a. Nadirshah Eduljee Dinshah (NED) University of Engineering & Technology, Karachi

Profile - Emphasis is placed on civil (structural), mechanical, and electrical engineering. Of the faculty (125), 26 are in civil, 39 in mechanical and 28 in electrical engineering. Bachelor and Masters Degrees are awarded. The University wishes to expand its staff and curricula offering in water resource use and management.

b. Sind (Mehran) University of Engineering & Technology, Jamshoro

Profile - Emphasis is placed on various engineering disciplines. Of the faculty (111), 28 are in civil 19 in industrial, 8 in mining, 11 in chemical, 15 in electrical and 2 in hydraulics/irrigation. A Bachelor degree is awarded.

c. Punjab University of Engineering & Technology, Lahore

Profile - Of the faculty (308), 50 are in civil, 48-mechanical, 46-electrical and 16-chemical engineering. Bachelor, Masters and Docturate degrees are awarded. The Center of Excellence in Water Resources Development is located adjacent to the University. The Center's orientation is in the areas of hydraulics, irrigation engineering and hydrology. Graduate study is offered by the Center. Only nine of the approved twenty professional positions are filled at this time.

d. The NWFP University of Engineering & Technology, Peshawar

Profile - The University offers a Bachelor of Science of Engineering in Civil, Electrical, Mechanical, Agricultural Engineering, and Mining. Eighty-six of the alloted 106 positions are staffed. The University desires to develop a Master of Science - Water Resource and Structure Engineering but lacks staff to develop the program.

e. University of Agriculture, Faisalabad

Profile - The University's orientation is toward agriculture, animal husbandry, veterinary science and rural sector development. The faculty specialities cover most disciplines akin to and directly supporting agricultural production and development in its broadest context. Of the faculty (418), 9 are in irrigation and drainage, 6-farm machinery and power, 20-food and fiber technology, 18-extension and education, 34-soils and crops, 15-horticulture, 30-plant protection, 21-rural sociology, 33-livestock production and 69-veterinary science. Bachelor, Masters and D.V.M. degrees are awarded.

f. Sind Agriculture University, Tandojam

Profile - The University's program is oriented toward general agriculture, agricultural engineering and animal husbandry and veterinary science. Of the faculty (172), 82 are located in the faculty of agriculture, 38-faculty of animal husbandry and veterinary science, and 28 in the faculty of agricultural engineering. Of the later, 11 are in the field of farm power and machinery, 7-farm buildings and structures, and 10-irrigation and drainage. Bachelor, Master and D.V.M. degrees are awarded.

g. The NWFP Agricultural University, Peshawar

Profile - The NWFP Agricultural University was established as a University in its own right in early 1981 when the agricultural faculty of the University of Peshawar was split off from the University of Peshawar to form a separate institution. The present faculty (91) orientation is largely crop production with a small livestock component, however, future plans call for additional emphasis in water management and utilization at the farm level.

H. RESEARCH ORGANIZATIONS

A large number of organizations and institutions in Pakistan support research and/or accumulating data and information on the access, management, physical control, transport, distribution, drainage and utilization of surface and ground water supporting irrigated and watered agriculture. The efforts are dissipated, uncoordinated and there is a lack of trained personnel in the specific areas of endeavor in a number of instances. Superb work was observed in a number of instances but here again personnel were somewhat removed from new developments within their fields because of the lack of an opportunity for exposure to technical updating.

1. Irrigation Research Institute, Punjab, Lahore

The Irrigation Research Institute, located at Lahore is the leading research organization in the country in the field of hyd-aulics. It has conducted research studies since 1924, and has done commendable work in the development of hydraulics, irrigation, drainage and reclamation. It has made a major contribution to the understanding of the problem of waterlogging and salinity and finding suitable solutions. Considerable work in this institute has been done on the canal seepage and lining, evaporation, and evapo-transpiration.

2. Directorate of Land Reclamation, Punjab, Lahore

The Directorate of Land Reclamation originally a part of the Irrigation Research Institute was established in 1945 and is conducting research on problems relating to suitability of water for irrigation, reclamation of saline and alkali soils, consumptive use of water, drainage of land, irrigation practices, effect of salinity on crop yields and fixing standards for soil and ground water salinity.

3. Mona Reclamation Experimental Project (WAPDA)

The object of Mona Reclamation Experimental Project, established in 1965, is to derive information from operational research under SCARPS and to develop methods and procedures to achieve effective use of land and water, the reclamation of saline land and agricultural development. This institute is also engaged in the ground water hydrologic studies, management of water supplies, tubewell operation, maintenance and rehabilitation and in determining optimum cropping input-output relationship.

4. Irrigation, Drainage and Flood Control Research Council

The Irrigation, Drainage and Flood Control Research Council established in 1964 is conducting research in the field of irrigation, drainage, hydraulics, tubewells, reclamation and flood control. Since its establishment, it has given priority to the studies of waterlogging and salinity because of the vital importance of the subject. The aims, objects and functions of the Council are:

a) To organize, coordinate and promote research in the various fields of hydraulics, irrigation, drainage, reclamation, tubewells and flood control;

b) To set up national research Institutes in the fields mentioned in (a) above;

c) To make grants-in-aid for specific schemes to universities and other research institutions in Pakistan;

d) To establish and award research scholarships and fellowships in aforementioned subjects within the sphere of the works of the council;

e) To collect and disseminate information on matters relating to the activities of the council and publish scientific papers, reports and periodicals;

f) To accept fees, donations, endowments and gifts for furthering the objects concerning the activities of the council;

g) To establish library and museum in respect of subjects concerning the activities of the Council;

h) To take out patents and arrange utilization of research processes or designs developed in the institutes;

i) To undertake any further activities to promote generally the objects of the council;

j) To establish scientific liaison with other national and international organizations connected with the scientific activities of the council; and

k) to prepare budget and maintain accounts and other relevant records for the approval of the Federal Government in accordance with such general directions as may be issued from time to time.

5. Directorate of Hydrology and Research, Sind

This Directorate was established in 1955-56 as a part of the then West Pakistan Government as an integral part of the Irrigation Research Institute Lahore, with the objectives of carrying out observations of daily discharge, gauges, sediment load in the Indus River and to check the design of hydraulic structures constructed in Sind Region. At present, is functioning under the Sind Government. This organization has meagre facilities and nominal staff. Some basic research studies in the field of Hydraulics sponsored by the I.D.F.C.R. Council are being carried out in this Directorate.

6. Central Monitoring Organization of WAPDA (CMO)

To monitor the technical performance of the Salinity Control and Reclamation Projects (SCARPs) this organization was

set up in the late sixties. The aim was to evaluate the design criteria of the projects and to feed back their results in the planning stage. Hydrology, tubewell performance, water quality, soils, agriculture and agricultural economics of the SCARP areas in operation are the main aspects of studies being carried out by this organization. The activities were, however, originally spread over the whole country, but now are restricted to the northern areas only. A separate organization has been formed recently to monitor the projects in the southern zone.

In 1964, before the creation of C.M.O., an experimental Project called Mona Reclamation Experimental Project (M.R.E.P.) was created. The M.R.E.P. is now a part of C.M.O. The objects of the projects are to develop methods and patterns to achieve effective use of water and land; the reclamation of saline and agricultural development to determine effect of groundwater management, water quality changes and tubewell performance, their operation, maintenance, rehabilitation and replacement, to determine optimum cropping input-output relationships and to transfer knowledge to farmers.

The C.M.O. and M.R.E.P. have a number of publications to their credit.

7. Pakistan Meteorological Department

The Pakistan Meteorological Department is mainly concerned with the collection, measurement, processing, analysis and publication of meteorological data. It conducts research on a very limited scale in the field of operational hydrology.

8. Pakistan Atomic Energy Commission

The PINSTECH of the Pakistan Atomic Energy Commission at Islamabad has conducted some research on the use of radiation and isotopes in hydrology. This organization has plans to expand their activity in the field of hydrology for which they are getting assistance from the International Atomic Energy Agency (IAEA).

9. Pakistan Agricultural Research Council (PARC)

This Council which is mainly concerned with the Agricultural aspects has a direct interest in the use of water. It has sponsored some research studies in the Irrigation Research Institute on Water Management. An institute to conduct research into the problems of the arid zone, has also been created in the Council. Development of water resources in the arid zone areas is a vital problem which needs urgent attention by this organization.

10. Punjab University of Engineering & Technology, Lahore and other Engineering Colleges

These are all primarily teaching organizations. Post-graduate studies have been started in the University in Hydraulics, Irrigation Engineering and Hydrology. The research is sponsored by the IDFCR Council by awarding research fellowships to post-graduate students for working on thesis. A research Chair in irrigation engineering has also been created by the IDFCR Council.

11. University of Agriculture, Faisalabad

The Irrigation and Drainage Department of the University of Agriculture has carried out some research on watercourse losses, irrigation practices for traditional and precision levelled fields in Pakistan, irrigation application efficiency, surface irrigation systems by using brackish water, economic analysis for selecting the most efficient method of irrigation, determination of consumptive use of wheat crop, relationship of farm water management practices to waterlogging and salinity etc.

12. Agricultural Research Institutes

These institutes established at Lyallpur (now called Faisalabad), Tando Jam, Tarnab & Quetta respectively by the Government of the Punjab, Sind, N.W.F.P. and Baluchistan, undertake research on purely agricultural subjects. Some work on water requirements of

crops and farm water management has been undertaken by these institutes.

13. Directorate of Land Reclamation - Sind

This Directorate was established recently but so far no research work has been undertaken, because of non-availability of funds. The I.D.F.C.R. Council has sponsored a research scheme 'Gaja Pilot Tile Drainage Project' to study the effectiveness of tile drainage system as a means of controlling the water table. Research studies in this scheme have been initiated by the Drainage and Reclamation Institute of Pakistan (DRIP).

14. Pakistan Forest Institute

This Institute established at Peshawar is primarily interested in the development of the forest resource of the country. It has undertaken some studies on the watershed management.

15. Alluvial Channel Observation Project (ACOP)

This Project, initiated in WAPDA, aims to undertake study of the mechanics of alluvial channels using the newly constructed Link Canals of Pakistan. The outcome of these studies is likely to be available after a few years time.

16. Rice Research Station - Punjab

This station established by the Government of the Punjab mostly undertakes research on the agricultural side. However, some work has been done on the effect of irrigation interval and drainage on paddy yield etc.

17. On-Farm Water Management Training and Research Institute, Punjab, Lahore

This is a training-cum-applied Research Institute set-up

at Lahore. A farm comprising 74 acres has been taken which is used for training the personnel and also for carrying out research in various disciplines of On-Farm Water Management Technology.

18. Drainage and Reclamation Institute of Pakistan (DRIP) Hyderabad

Lysimeter studies in Sind are being carried out by DRIP.

SECTION III - TRAINING PARAMETERS

AN INTEGRATED APPROACH

In the context of Pakistan's reliance on managed water as a major critical factor influencing agricultural production and social and economic stability, the entire water/agro system must be considered as a whole rather than as a separate disciplines. TRAINING is seen as a critical input necessary to bring about this technical and attitudinal change necessary for present and future requirements.

It is recommended that the training, both incountry and external provided through the resources available under the Irrigation Systems Management Project and other resources be oriented to the greatest extent possible toward this end. All training should meet the critical objective needs for:

1. Increasing Pakistan's incountry training capabilities and capacity;

2. Changing the basic premise of water disbursement/ disposal to water delivery and utilization with the aim of increasing agricultural productivity and economic status of the rural sector.

3. Increasing the productivity capabilities of the public sector institutions in the planning, development and management of the water-agro system;

4. Strengthening the technical support role capacity of public sector institutions; and,

5. Increasing the level of technical competency and productivity of personnel operating within the broad context of the water-agro system.

Strengthening the public and private institutional water-agro system to the point wherein the system can effectively deliver water to an efficient user and at a just cost will or

may require modifications relative to water resource policy, planning, management, research/design, delivery, water-use optimization, and on-farm management and application. To accomplish this end, a critical trained manpower mass must be available to -

1. Modify and/or develop a national policy of water resource use complementary to the nation's agricultural production and rural sector development policy and goals;

2. Develop and plan projects within the water-agro system with due consideration for technical, social and economic factors;

3. Administer and manage multipurpose watered agricultural projects: water allocation-delivery-utilization-social-economic development;

4. Strengthen the planning, administration, management and operation capacity of the Provincial Irrigation Departments;

5. Strengthen institutional competency in the technical aspects of canal re-design and rehabilitation;

6. Increase research capacity directed toward sedimentation control and structures;

7. Increase institutional capacity for designing and implementing hydrologic and hydraulics research;

8. Investigate and expand research, demonstration and application of irrigation systems for areas outside of the Indus System i.e. sailaba (water spreading), drip, sprinkler, etc.;

9. Expand research on water-soil-plant relationships, optimum water use, water economics, and water requirements data;

10. Expand institutional capacity in hydrology, ground water exploration, utilization and well operations and management;

11. Develop competency in the use of computers for modeling and simulation and management/budget control;

12. Develop machinery specification and procurement incountry capability;

13. Expand university training capacity in the areas of hydraulics engineering and irrigation systems design and management;

14. Develop training capabilities within the Provincial Irrigation Departments for staff development in the areas of operations, management and technical proficiency; and,

15. Develop programs and train extension personnel in on-farm water application and management.

While all of this training can not be undertaken within the scope of resources available to the Irrigation Systems Management Project alone, caution should be exercised to maintain a balance within the program. Training should be looked upon as the institutional mortar, personnel the bricks and the effective delivery and efficient use of water as the structure. The lack of mortar in the right place at the appropriate time may even lead to partial structure failure. Today's needs were yesterday's future needs. The only method for keeping ahead of future needs is to address them today. Within the total training resources now available under the ISM Project and the training opportunities available from other resources, it appears that the opportunity exists for implementing a coordinated training effort that can impact on Pakistan's needs long past the time when these initial financial resources are no longer available. The understanding of a long term staff and institutional development program appears entirely feasible within the existing social, political and administrative structure in Pakistan with only minor adjustments in the institutional relationships and policy. A number of the adjustments are solely mechanical in nature while a number are related to the development of a closer coordination and association between the myriad of organizations already addressing issues of common concern relative to the efficient utilization of Pakistan's natural resource - WATER.

A. COMMON DENOMINATORS

A series of common denominators evolved from the numerous discussions and contacts made while studying the requirements for training. The consensus of opinions expressed orally by those contacted are reflected in the recommendations presented in the training plan. These are summarized as follows:

1. There is a nearly complete absence of staff development training opportunities (career training) for field/operational personnel once they enter the service;

2. There is a need for strengthening the academic preparation of personnel entering service. Particular reference was made to the inadequacy or unavailability of water/irrigation systems technical course work at the undergraduate level in the educational institutions in Pakistan.

3. Trainees experience financial hardships i.e. per diem within Pakistan and there is no incentives and recognition for participants who do participate in non-degree and short term internal and external training opportunities which do not lead to a degree;

4. The reassignment of personnel upon completion of degree training to positions other than those appropriate to the training effectively negates the original purpose and intent of the training;

5. There is a need to broadening the horizons of operational service personnel so as to increase their capacity in program/project planning, management, human relations, analysis and evaluation vis-a-vis solely the technical engineering aspects of their position;

6. The need exists for expanding university staff awareness and capabilities in the operational aspects of their teaching disciplines vis-a-vis instructional presentation largely oriented to theory;

7. There is a need (expressed by nearly all persons interviewed) for correcting the cumbersome procedure for participant selection and clearance now in force. Many instances were cited wherein training opportunities were lost because of the system.

8. There are problems associated with the release of personnel for both incountry and external training. The major factor being a shortage of staff for release, duration of training, and the consequences of the release

of personnel as related to the continued implementation of on-going programs.

B. OBSERVATIONS

In addition to the "Common Denominators" presented above which reflect a consensus of opinion of those interviewed, the consultant wishes to note specific inferences drawn from observations made during this and previous association with Pakistan's development efforts over a period of the last twenty-five years.

Pakistan can be justifiably proud of the development progress it has made over the past quarter of a century, however, the earlier gains often times are the easiest attained. The "Green Revolution" is a case in point. Attention to water-soil (water-agro systems) manifested itself through a series of programs of salinity control and reclamation activities (SCARP) which have ranged from very successful to moderately successful. Private sector tubewell development has been an adjunct of these programs. More water resources have been developed through the construction of Tarbela and Mangala dams. The prospects for the construction of the Kalabagh Dam is coming closer to being a reality. Discussions relative to a "Command Water Management" approach are ongoing. All of these activities leads one to surmise that Pakistan has entered a specific era of the "WATER REVOLUTION".

This era will be more complex because to meet the challenge the effective delivery of water must be closely tied to the efficient utilization of water. All of this carried out in close accord with the crop production disciplines. Thus through a series of natural and planned sequences of events, "WATER" has taken on a value dearer than previously might have been assumed.

It is within this framework that the following observations are offered, some of which may not conform to the scope of training planned for the ISM Project. If not other resoruces should be

utilized to support the training if a productive balance is to be maintained. Addition emphasis appears to be required in -

1. Strengthening the staff and the development of curricula in the agricultural universities with special emphasis placed on on-farm water application and utilization;

2. Expanding curricula offerings and strengthening the teaching staff in selected engineering universities in the disciplines of irrigation systems O&M; groundwater hydrology; project planning, design, and evaluation; engineering management; drainage; etc;

3. The overall subject of water - a national resource with particular attention given to the relationship of surface and groundwater as it relates to watered agriculture;

4. The area of groundwater development. The rapid development of the private tubewell sector appears to be happening in the absence of adequate hydrological data and/or a plan for equitable use;

5. The area of water economics both in terms of delivery costs (now subsidized) and real value (as a production input) in relation to farm gate prices;

6. The area of optimum water use and cropping options. This would appear to be key factor necessary before undertaking a command water systems approach on a national scale. Within the framework of a command system an understanding of the sociological impact would be equally critical;

7. Increasing the level of awareness of agronomic/production researchers that water management is a variable in production research. There appears to be only a minimal level of coordination between crop and agronomic research and water research;

8. The area of water shed management and run-off intrusion with special reference to basin and canal siltation and sediment management.

C. SPECIAL PROGRAMMING/PROJECT IMPLEMENTATION CONSIDERATIONS

A number of considerations seem appropriate aside from the identification of training disciplines and the determination of numbers to be trained if the training plan is to fully meet

both the immediate and longer term objectives. Some of these factors are of a purely mechanical nature, others will require a level of interagency coordination not now apparent, some relate to the need for increased budget or budgetary support, some relate to personnel placement and assignment, while others relate to the utilization of the skills developed as a result of the current training opportunities. Certain courses of action, if adopted, fall within the administrative and management jurisdiction of the Government of Pakistan and USAID project personnel. However, in a number of instances the decision or action authority lies outside of the parameters of responsibility of the ISM project personnel. The factors falling into the latter category are deemed sufficiently important that one would recommend that project personnel assume the catalytic role as a logical step toward assuring that project training resources and other resources fully enhance the immediate and longer training goals. The assumption of this role will increase the demands on time and personnel above the projected levels planned for normal project implementation. Without this addition effort the overall training may only meet Pakistan's requirements of the present. Pakistan's future needs will still remain to be met in another tomorrow at an additional expense much more costly than if addressed now.

The following topics are presented for consideration and action. Specific courses of action or implementation are not defined but left to the discretion of the project or other implementing personnel.

1. Coordination and Utilization of Training Resources -

Pakistan is the recipient of training fellowships from a number of governments and organizations. Some of the fellowships are specific in nature while others are offered without identifying the specific area of training. Many are offered on short notice and failure to respond in time negates the offer. A projected plan

and better coordination between donors accompanied in turn by strong leadership on the GOP side would benefit all concerned. The area of water development, delivery and utilization would appear to be an area in which this framework could be developed.

2. Counterpart Relationships and Informal Training -

Under the auspices of the ISM Project both external and in-country training will be available. The incountry segement will be largely provided through and supported by the contract teams proposed under the technical assistance component of the project. Much of this may take the form of informal on-the-job-training (OJT) conducted on a day to day basis during the implementation of various project activities. This transfer of technology can take place effectively only if a close (physical and personal) and open relationship exists between the Pakistani (ies) and their expatriate counterparts. The physical separation of offices, a lack of understanding of the respective roles, and a lack of easy access to one another would effectively negate this aspect of training.

3. Degree Training Utilization -

Opportunities exist within the training resources for degree training at the Master and Doctorate levels. Extreme care should be exerted in the utilization of degree training. It should be used only in those specific instances where there is a need to fill voids in which a high level of technical skill is a job requirement or one in which the level of training will lead to an acceleration of Pakistan's efforts to develop or strengthen its incountry training capabilites. Prior experience with degree training at an inappropriate level has often resulted in the placement of the graduate upon his/her return into a position unrelated to the problem for which the training was proposed. This type of action negates the intent of training and the void still exists.

4. Medium Term (Non-Degree) Training

Medium term or non-degree training is best defined as that category of training where by the participant is exposed to selected technical courses to increase his/her technical knowledge within a specific scope as required for his present duties to which he/she will return. This may often be done in conjunction with OJT and observation tours. It is very appropriate for operational personnel in speciality fields who already possess the basic skills and experience. It is a training approach that is applicable where in-country technical updating training is not available. This type of training can cover a time span of anywhere from three to twelve months. It also has the advantage of not removing an essential employee from a critical job for an excessive period of time. There is the disadvantage to the employee that often times he/she does not receive proper recognition for this training in his/her progress up the career ladder.

5. Observation Training Utilization -

Observation training is an effective management training tool provided the program is designed toward specific goals and if the participants themselves approach it with specific objectives in mind. This type of training can range in length from two to eight weeks depending upon the scope of problems to be addressed. It is an effective tool wherein mid-level and senior government personnel can become conversant with the activities and relationships associated with complex projects, policy clarification and approaches, and develop an understanding of the technical/technician role in addressing the problems. Instances can be cited throughout the world wherein returning technicians have been unable to apply their new knowledge because the administrative and management personnel responsible for overseeing the work did not themselves understand the job to be done and how the technician should or could function in his respective technical specialty. Should this be allowed to happen, one can only surmise that the technical training was for nought.

6. Formal Short Course Training Utilization -

Formalized short courses organized for specific subject concentration are on effective method for rapidly instilling the basics of the subject and providing a general overview to a large number of individuals at a time. It is also an excellent vehicle by which personnel of diverse experience, level of technical apptitude, or social background can be introduced to a specific subject or approach. The formalized short courses approach could be effectively utilized in Pakistan as the basic training approach to establish a career (inservice) training program if presented as a series of courses. It would also be an efficient and effective manner to develop and strengthen university participation and inter-action with the PIDs. It would enable Pakistan's technical and administrative and management specialists to expand their sphere of influence through imparting knowledge to less experienced personnel.

Special skills are required of those who organize and present courses and such persons should themselves be given training in course development and presentation.
The established professional employee is a more complex individual to instruct than the classroom student.

7. Short Course Utilization Outside of Pakistan -

A number of short courses in the United States and elsewhere are presented yearly (see Section VII for details). While they meet specific needs and take employees away from their jobs for only short periods of time they are an expensive means of training unless used in association with other training programs (long-term, medium term or in conjunction with observation/survey training). Their use does provide a means for broadening the context of training and should be considered as a resource when developing the various specific training program plans.

Because of the expense and limitation in number able to attend in one time, consideration should be given to having at least a number of the more pertinent courses put on in Pakistan. This can be accomplished by bringing the expatriate faculty to Pakistan. It is suggested that key Pakistani personnel first attend the courses at the external institution and that upon their return they join with the expatriate faculty to develop a course specific to Pakistan's needs. It is contemplated that after the second cycle (cycle 1 - Pakistani personnel externally trained; cycle 2 - expatriate and Pakistani faculty course presentation) the course would be established in Pakistan.

8. Command Water Management: Coordinated Delivery and Use -

For many years water resource development; irrigation water transport and delivery through the mogha; and on-farm application and use from the mogha discharge have resided within the juridicial responsibility and control of several public sector institutions. This modus operandi has contributed to the polarization of policy, program development, planning, skill development, education, and personnel interaction in varying degrees. At the present time, however, there is developing an interested and growing awareness toward the possibilities for approaching water distribution and utilization in a more direct and interrelated manner through what is commonly referred to as "Command Water Management". An intergration of new and old skills and functions within and between number of public and private sector institutions will be required if each institution is to meet its own internal and external obligations under such a system. The adoption of such a system would increase the level of responsibility and raise the level of sophisication of performance of all institutions now contributing to the functioning of the present system. The development of personnel and improving and broadening skill performance within the existing institutions to this end NOW will not only strengthen the various institutions ability to perform their present role but will enahance the interaction and intergration process should "Command Water Management" become a reality.

It is within this context that the recommendation is made that training parameters be expanded within the overall structure of water planning and delivery institutions to include where needed -

(a) Water resource planning;

(1) Resource planning and allocation.
(2) Water economics.
(3) Groundwater development and allocation.
(4) Hydrology.
(5) Project design and appraisal.
(6) Analysis and evaluation.
(7) Water shed and surface run-off planning, management and control.
(8) Water scheduling.
(9) Drainage

(b) Systems research;

(1) Hydraulic and design research.
(2) Drainage.
(3) Sedimentation analysis and evaluation.
(4) Alternative systems development.
(5) Modeling and instrumentation.

(c) Irrigation water utilization research;

(1) Optimum water use-crops.
(2) Cropping options.
(3) Economics water use.
(4) Alternative systems.
(5) Application scheduling.
(6) Social impacts.
(7) On-farm water management.
(8) Control structures and water spreading in non-watered arid areas.

(d) Systems O&M;

(1) Tubewell installation and maintenance.

(2) Conveyance and control structures.

(3) Operational planning, management, administration and financial management, and human/public relations.

Within the same general context, training opportunities need to be developed for the institutions having primary responsibility for developing, promoting and extending improved on-farm water application and management techniques. Additional resources will be needed for this component about and beyond those available under the ISM Project.

9. In-Country Training Institution Development -

The presence of the established Tarbela Academy (WAPDA) whose purpose is to train mid and upper level staff in project administration and management and the newly established Engineering Academy (PID/Punjab, Lahore) whose intent is to impart short course training in technical and management disciplines to professional engineers at the lower to mid level provides an existing base from which a incountry pre-service and in-service career training effort can be developed and expanded. Support to these institutions should receive priority consideration. Each institution utilizes or plans to utilize the technical expertise existing within Pakistan to fulfill the teaching staff requirements on a course by course basis. This approach will meet the requirements without leading to institutional structures with large permanent staffs and heavy infrastructures costs.

Primarily the academies need support in three areas. These are -

(a) Permanent staff trained in course design, content, presentation, testing and evaluation with emphasis directed toward adult education and training;

(b) Modest support in training materials, reference materials, texts, and a reproduction capability; and,

(c) Access to qualified instructors who are both technically qualified and are able to present material to an adult audience in a appropriate and productive manner. The latter should receive due consideration when selecting candidates from within the various PID, WAPDA, or other organizations for advanced degree technical training. A system for accessing trainers from the universities and such organizations as the Pakistan Public Administration Institute, etc. must be developed. Long term budgetary support from participating organizations must be considered. Presently both the Tarbela Academy and the Engineering Academy are financially dependent upon their respective parent organizations.

D. PARTICIPANT SELECTION, QUALIFICATION, SUPPORT AND DOCUMENTATION

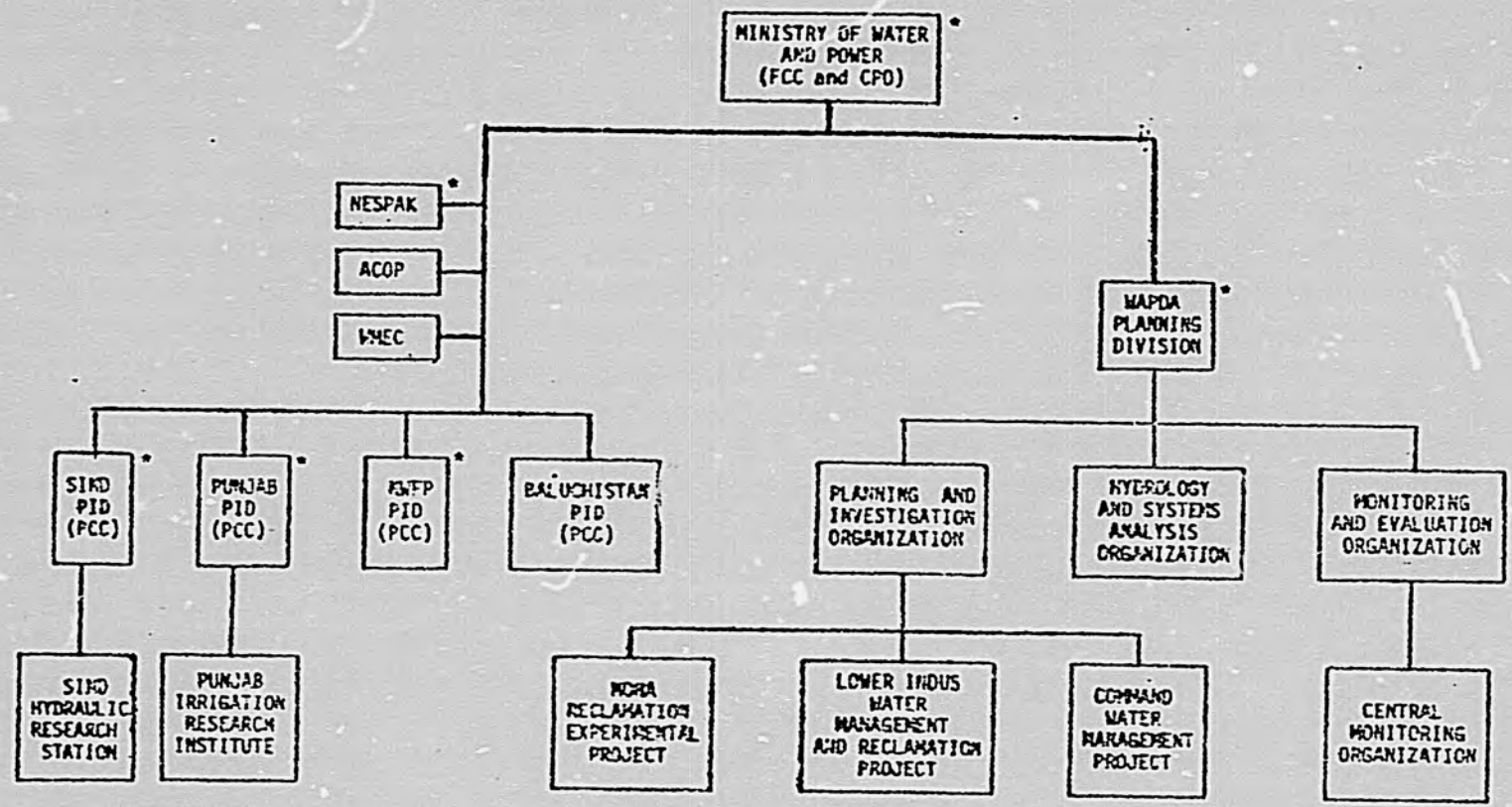
1. Participant Availability and Selection -

The selection of participants should be based on an established set of criteria (refer to page 29 of this report) as well as fully meeting the language and academic requirements established by the training facility. During the consultant's tour throughout Pakistan a number of issues were raised (refer to Section III - Common Denominators). These must be considered in the selection process.

The one main issue with which the consultant would take issue with is that of "staff shortage and non-availability." A shortage of personnel is true in a number of instances but in view of the total manpower available (see Figure 1 and Tables 1 and 2) it appears valid to assume that all organizations could and must make the sacrifice now for the gains to be had in the future. It should be remembered that this training program will be carried out over a period of several years. The constraints became more serious if each year's quota is not met and it is necessary to

FIGURE 1

INSTITUTIONAL RELATIONSHIPS AMONG IMPLEMENTING ORGANIZATIONS



DEFINITIONS:

FCC = Federal Coordinating Cell

CPO = Central Procurement Office

PID = Provincial Irrigation Department

PCC = Provincial Coordinating Cell

NESPAK = National Engineering Services (Pakistan) Ltd. (Supervisory Consultant under IBRD-funded contract with FCC)

ACOP = Alluvial Channel Observation Project (Organizationally, this unit falls under WAPDA's Water Resources Management Organization within the Planning Division; under the ISR/ISM projects, however, ACOP will serve as a "consultant" to the PIDs and FCC in data collection and evaluation.)

WMEC = Watercourse Monitoring & Evaluation Cell (Organizationally, this cell falls under WAPDA's Monitoring and Evaluation Organization within the Planning Division; under the ISR/ISM Projects, however, WMEC will serve as a "consultant" to the PIDs and FCC in data collection and evaluation.)

* A Federal Project Review Board, consisting of the Chief Engineering Advisor, Ministry of Water and Power as Chairman, the four PID Secretaries, and WAPDA's General Manager for Planning will meet regularly to ensure the efficient and timely implementation of this project. Representatives of A.I.D., the IBRD, and NESPAK will serve as ex-officio members of the Board, and the Federal Project Coordinator and Provincial Project Coordinators will attend meetings from time to time as resource personnel.

TABLE 1

SUMMARY OF THE PROFESSIONAL STAFF OF THE PROVINCIAL IRRIGATION DEPARTMENTS, 1981

Title of Post	Punjab	Sind	NWFP	Baluchistan	Total
1. Secretary	1	1	1	1	4
2. Additional Secretary (Irrigation)	0	1	0	0	1
3. Additional Secretary (Power)	0	1	0	0	1
4. Deputy Secretary (Power)	1	0	0	0	1
5. Deputy Secretary (Administration)	1	1	0	0	2
6. Deputy Secretary (Operation)	1	1	1	1	4
7. Deputy Secretary (Development)	1	1	0	0	2
8. Chief Engineer	8	4	1	1	14
9. Superintending Engineer	35	20	5	5	65
10. Executive Engineer	99	57	17	14	187
11. Under-Secretary	13	0	0	0	13
12. Section Officer	6	16	4	4	30
13. Executive Engineer (Operation)	8	0	0	0	8
14. Executive Engineer (SCARPs)	7	0	0	0	7
15. Sub-Divisional Officer	282	172	41	37	532
TOTAL	463	275	70	63	871

TABLE 2

SUMMARY OF THE PROFESSIONAL STAFF OF THE WATER WING OF THE WATER AND POWER DEVELOPMENT AUTHORITY, 1981

Title of Post	Division (Office)								
	Planning	Dams	Kalabagh Dam	North	Central	South	Hydro-geology	Central Design Office	Total
1. General Manager	1	1	0	1	1	1	1	0	6
2. Deputy General Manager	1	0	0	0	0	0	0	0	1
3. Chief Engineer	5	2	1	2	2	3	0	2	17
4. Director/Superintending Engineer	10	2	1	0	0	0	1	6	20
5. Director/Project Director	25	4	1	7	14	8	3	1	63
6. Superintending Officer a/	2	4	0	2	0	5	5	0	18
7. Deputy Director	52	7	2	7	9	7	0	19	103
8. Senior Officer a/	71	30	3	36	42	31	23	0	236
9. Junior Officer a/	255	72	11	82	93	108	69	0	690
10. Assistant Officer a/	21	2	0	10	3	0	0	27	63
TOTAL	443	124	19	147	164	163	102	55	1,217

a/ Officers include the following disciplines: engineering, agricultural engineering, geology, hydrogeology, soil scientist, agronomy, economics, research, and statistics.

move it forward. If this is allowed to occur then five years become four, four become three, three become two, etc. This means more people will need to be released in any given year. It would appear essential to make the sacrifices earlier than later if the available resources are to be utilized.

2. Documentation -

The standard U.S. Government document required for the development of a training program outside of Pakistan is the PIO/P (Project Implementation Order/Participant). It is through this document that U.S. or third country institutions are instructed as to what training is required and the name of the trainee. (see Annex II - PIO/P). This document along with the personal resume and academic credentials of the participant(s) form the basis for acceptance and entrance into a specific course of academic study or OJT training.

The quality and completeness of this document is important since it provides the only means by which the training institution can make judgements and take decisions relative to course content and training methods. The document must be explicit as to -

(i) What is expected of the trainee upon completion of the training. In other words what job will he/she be assigned to upon completion of training, what are the specific duties, what technical knowledge must he/she possess to do the job and how will he/she perform these duties. This is basically a job description.

(ii) What type of training i.e. academic, OJT, or combination is recommended; degree or non-degree schedule; identification of curriculm; concentration of emphasis; and identification of special courses or exposure.

The responsibility for developing this detail will rest with the GOP and USAID project personnel . In essence it is a case by case analysis of the specific need for training and a plan for utilizing that training - placement of the employee upon return to Pakistan.

Sections IV, V, VI, and VII of this report are presented for the purpose of assisting project personnel develop the required documentation in a more succinct manner that can be readily utilized by the organization providing the training opportunities.

3. TOEFL (Test of English as a Foreign Language) -

Most training institutions have a minimum required TOFEL score for entrance into that institution. The TOFEL exam is given at regular intervals in most major cities of Pakistan. The American Consulates can be contacted for information as to time and place of the exam.

Project personnel should immediately have all employees who are potential candidates take this exam in order to ascertain their eligibility (assuming their academic and/or professional experience qualification meet the standards of the training institution).

4. English Language Training -

Although English is officially regarded in Pakistan as a language of knowledge, technology and international communications and is taught in grades six to ten, English language speakers and high proficiency are diminishing. Under this project, where most in-country courses and all overseas training will be conducted in English, it is critically important that participants be adequately versed in the English language before undertaking training. In particular, candidates for overseas training will be required to pass the the standard langauage tests, TOEFL or ALIGU, and otherwise qualified candidates should not be rejected on the basis of inadequate English proficiency.

Accordingly, Project 391-0474, Development Support Training will build on and strengthen already existing language instruction centers. Currently, there are three major English language programs: (i) the British Council teaches English in selected cities as part of the U.K. cultural exchange program; (ii) there are approximately 20,000 students in Pakistan-American Cultural Centers (PACCs); and (iii) the National Institute of Modern Languages (NIML) has a limited English program in Islamabad. Project funds will be used to provide technical assistance in curriculum design and English instruction and limited commodity support for ESL for academic purposes programs.

An intensive English program will be developed at three locations for Pakistanis who plan to pursue training and advanced academic courses in the U.S. and other English speaking countries: (i) a pilot program at a central location, such as the NIML in Islamabad; and, (ii) at two regional centers, such as the PACCs in Quetta and Peshawar, the capital of Baluchistan and NWFP, respectively.

ISM Project personnel should establish and maintain a close association with the Development Support Training Project to assure that ISM participants are accomodated in the ESL program.

5. Financial Support Requirements; Doctoral Thesis -

It is generally agreed to that candidates for Doctoral Degrees select for their thesis topics problems relative to Pakistan and that the field investigation/data base be carried out in Pakistan providing that appropriate facilities, research funds and supervision is assured. The decision to follow this approach must be made prior to completion and submission of the PIO/T so that the training institution is fully conversant of the plan and can develop the training program accordingly. Agreement

and reservation of funds for assuming the additional expense must be an accomplished fact at the time of document submission.

The additional costs will arise largely for the necessity of an additional two round trip airtickets for the participant. It would be highly likely that the student and his/her major advisor would need to return to Pakistan at the end of the first academic year to select the research topic. At the end of academic course work the student would need to return to Pakistan for field work and at the close of this period return to the training institution to prepare the disseration and undertake the defense of the thesis. During the topic selection process and at least once during the field work the major advisor would probably need to make a field visit. This travel for the advisor would probably be funded under existing "Institutional strengthening Grants" under the Title XII grant program.

Firm funding for the field work is essential. A determination as to its funding must be made. Within the context of this training approach foreign exchange costs would be reduced because of less time spent out of Pakistan. Local currency costs would be increased because of additional travel and local support for the research program.

E. THE PROJECTED PLAN; A BEGINNING -

The following plan is projected on the basis of only a sampling of actual requests and projected needs. There appeared to be a high degree of reluctance in a number of cases to project training needs or identify candidates at this time. Training needs were more often translated into financial terms - "we cannot identify training requirements until we know how much money will be available" - than felt needs. The lack of such an assessment makes it impossible to project accurately the total needs, identify priorities and allocate resources to needs.

It is recommended that a general training meeting be convened, after the pertinent personnel have had the opportunity to review and comment on the report, so as to more fully develop the plan projections.

1984 TRAINING PROJECTION

Description	Type of Training	Punjab	Sind	Baluchistan	NWFP	WAPDA	Federal
Water Resource Planning and Development	Ph. D.	-	-	-	-	1	1
Water Resource Planning and Development	M.S.	2	1	1	1	-	-
Resource Economics - Water	Ph. D.	-	-	-	-	1	-
Resource Economics - Water	M.S.	1	1	1	1	1	-
Hydrology - Ground Water Development	Ph. D.	-	-	-	-	1	-
Hydraulics Research - Systems Design and Engineering (Punjab - Irrigation Res. Institute)	M.S.	1	1	-	-	2	-
Hydraulics Research - Sedimentation Control Design (Punjab - Irrigation Res. Institute) (Sind Hydraulic Research Station)	M.S.	1	1	-	-	2	-
Irrigation Systems O&M	M.S.	4	2	1	1	-	-

1984 TRAINING PROJECTION

Description	Type of Training	Punjab	Sind	Baluchistan	NWFP	WAPDA	Federal
Crop - Water Optimization Research (Punjab - Land Reclamation) (WAPDA - Mona Project)	M.S.	2	-	-	-	1	-
Alternate Irrigation - Small Dams, Catchment, Systems Design	M.S.	-	-	1	1	-	-
Sub-surface Drainage Systems Design & O & M	M.S.	1	1	-	1	1	-
Research Instrumentation (Sind - Irrigation Res.) (Punjab - Irrigation Res. Institute)	4 Mos. Obser-vation/ OJT	1	1	-	-	-	-
Sedimentation Data Analysis WAPDA (ACOP)	6 Mos. Obser-vation/ OJT	1	1	-	-	1	-
Irrigation Systems - O&M	2 Mos. Obser-vation	8	4	2	2	-	1
Design and Presentation of Short Course (In-service Career Development) (Tarbela Academy) (Engineering Academy)	10 Mos. Academic/ OJT	1	-	-	-	1	-

ANNEX 1 - CONTACTS

During the period prior to and through the preparation of this report, numerous individuals were contacted. The courtesy extended, the contribution of time, and the personal expression of views by each and all was very much appreciated. Apologies are extended to those persons whose names might have been inadvertantly left off of the list because of an error or oversight on the part of the consultant.

The listing is presented in approximate sequence of contacts.

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Dr. John R. Shields, Support Staff

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Private Sector - Training

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Mr. Jon A. Gant
Chief, Training

ANNEX 2

KEYPUNCH COPY FOR AID/W USE ONLY	AGENCY FOR INTERNATIONAL DEVELOPMENT **PARTICIPANT'S BIOGRAPHICAL DATA**	PAGE 3 OF

BATCH NUMBER ____ (CC1-2)

PARTICIPANT NUMBER ____ (CC3-8)

REGIONAL NUMBER ____ (CC9-11)

1. COOPERATING COUNTRY

2. PIO/P NUMBER

3. NAME (MR., MRS., OR MISS) CAPITALIZE OR UNDERLINE LEGAL SURNAME (B12-46)

4. HOME/MAILING ADDRESS STREET (T12-38)

CITY OR TOWN (T43-68)

5. ATTACHMENTS
- [ ] TRANSCRIPTS
- [ ] PHOTOS
- [ ] DEPENDENT CERTIFICATION
- [ ] OTHER (Specify)

6. BIRTHDATE (MO/DAY/YR) (B56-57)

7. PLACE OF BIRTH

8. EMERGENCY CONTACT (COUNTRY OF TRAINING)

9. SEX/MARITAL STATUS

	MALE	FEMALE
	[ ] SINGLE	[ ] SINGLE
	[ ] MARRIED	[ ] MARRIED

10. LANGUAGE PROFICIENCY

A. ENGLISH LANGUAGE PROFICIENCY STATUS *(Check appropriate box)*

[ ] TEST GIVEN [ ] TEST WAIVED [ ] FURTHER TRAINING NECESSARY [ ] RETEST NECESSARY

B. APPROXIMATE DATE SCORES OR RATING TO BE REPORTED ▶

C. TEST SCORES/RATINGS *(Check and complete appropriate boxes)*

[ ] TOEFL TOTAL SCORE ____

[ ] ALIGU DATE GIVEN ____

	USAGE	ORAL	VOCAB/READ	LISTENING
SCORE				
FORM				

D. PROFICIENCY IN OTHER LANGUAGES

LANGUAGES	SPEAKING			READING			WRITING		
	Excellent	GOOD	FAIR	Excellent	GOOD	FAIR	Excellent	GOOD	FAIR

E. FURTHER TRAINING NECESSARY [ ] HOME COUNTRY [ ] RECEIVING COUNTRY

11. IF YOU HAVE LIVED, STUDIED, OR TRAVELLED ABROAD, COMPLETE THE FOLLOWING

COUNTRY	DATES (MO. & YR.) FROM	TO	PURPOSE *(e.g., Travel, Training, Conference. If Training, indicate type of program & sponsor)*

12. EDUCATION

A. TOTAL YEARS COMPLETED (12-13)

B. HIGHEST DEGREE OBTAINED *(Check one)* (M14)
- [ ] BACHELOR OF ARTS
- [ ] BACHELOR OF SCIENCE
- [ ] MASTER OF ARTS
- [ ] MASTER OF SCIENCE
- [ ] MD
- [ ] DVM
- [ ] PHD
- [ ] OTHER
- [ ] NONE

C. COUNTRY WHERE DEGREE OBTAINED

D. COUNTRY CODE (M15-17)

E. LIST BELOW IN CHRONOLOGICAL ORDER, ALL SCHOOLS ATTENDED. INCLUDE PRIMARY, MIDDLE OR SECONDARY SCHOOLS, UNIVERSITIES, VOCATIONAL OR TRADE SCHOOLS. *(Use continuation sheet if necessary)*

NAME OF INSTITUTION	MAJOR FIELD OF STUDY	LANGUAGE OF INSTRUCTION	DATES ATTENDED FROM	TO	TITLE OF DEGREE, DIPLOMA, OR CERTIFICATE	RECEIVED

13. EMPLOYMENT

A. BRIEF TITLE OF PRESENT POSITION/OCCUPATION (M16-43)

B. DATES OF EMPLOYMENT FROM ____ TO PRESENT

C. TOTAL YEARS (M44-45)

D. PRESENT EMPLOYER *(Name & Address)* (Q38-63)

E. NUMBER OF EMPLOYEES SUPERVISED

F. SIZE *(Approx. No. of Employees)*

G. BRIEF DESCRIPTION OF WORK [ ] GOVERNMENT [ ] PRIVATE [ ] JOINT [ ] STUDENT

12

AGENCY FOR INTERNATIONAL DEVELOPMENT **PROJECT IMPLEMENTATION ORDER/ PARTICIPANTS TRAINING REQUEST FORM** PAGE 2 OF	1. COOPERATING COUNTRY	2. PIO/P NUMBER
	3. ☐ ORIGINAL ☐ AMENDMENT NO.	4. DATE

5. TRAINING REQUEST

A. DESCRIPTION OF TRAINING REQUESTED. *(Describe clearly the training desired, summarize the project input, output, and purpose to which the training will be applied)*

B. ACADEMIC TRAINING ONLY: DEGREE OBJECTIVE

MAJOR FIELD OF STUDY

C. RELATED INFORMATION

D. PARTICULAR EMPHASIS DESIRED

E. SUGGESTED TRAINING FACILITIES *(If known)*

6. PARTICIPANT'S FUTURE EMPLOYMENT

A. CHECK APPROPRIATE BOX (B47)			B. OCCUPATIONAL CATEGORY CODE (B48-49)
☐ GOVERNMENT	☐ PRIVATE	☐ JOINT	

AID 1380-1 (12-79)

AGENCY FOR INTERNATIONAL DEVELOPMENT

PROJECT IMPLEMENTATION ORDER/ PARTICIPANTS (PIO/P)

PAGE 1 OF ____

1. COOPERATING COUNTRY	2. PIO/P NUMBER
3. PROJECT ACTIVITY NUMBER & TITLE	
4. APPROPRIATION	5. ALLOTMENT
6. DATE ORIGINAL ISSUE	7. DATE THIS ISSUANCE

8. PROJECT COMPLETION DATE	9. DESIRED START DATE	10. TERMINAL START DATE	11. NUMBER OF PARTICIPANTS

12. ☐ ORIGINAL
☐ AMENDMENT NUMBER ____

13. LOCATION/DURATION OF TRAINING
☐ U.S. ____ P/M ☐ Third Country ____ P/M ☐ In Country ____ P/M

14. FINANCING

AGENT	TYPE OF EXPENSE	A. PREVIOUS TOTAL	B. INCREASE	C. DECREASE	D. NEW TOTAL
AID	(a)				
MISSION	(b) Int. Travel				
	(c) Maint. Advance				
AID/W	(d)				
	(e)				
THIRD COUNTRY	(f)				
	(g)				
	(h)				
	(i)				
15. COOPERATING COUNTRY FINANCING					

16. U.S. TRUST ACCOUNT	A. TRUST ACCOUNT NUMBER	C. AUTHORIZED	D. CURRENCY UNIT	E. AMOUNT
	B. ALLOTMENT SYMBOL			

17. SPECIAL PROVISIONS

18. MISSION CLEARANCES

SIGNATURE	DATE	SIGNATURE	DATE

19. HOST COUNTRY/BORROWER/GRANTEE		20. AGENCY FOR INTERNATIONAL DEVELOPMENT
SIGNATURE		
TITLE	DATE	

AID 1360-1 (12-79)

14

UNCLASSIFIED

PARTICIPANT TRAINING PLAN

IRRIGATION SYSTEMS MANAGEMENT PROJECT 391-0467

PART - II OF II

DEGREE, NON-DEGREE, ON-THE-JOB, SHORT COURSE
TRAINING REFERENCES

DECEMBER, 1983
ISLAMABAD, PAKISTAN

UNCLASSIFIED

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SECTION IV - PROFILE OF SELECTED UNIVERSITIES IN THE UNITED STATES

A number of universities in the Western Region of the United States offer strong programs in either/or irrigated agriculture and irrigation/water resource engineering and development. These institutions include:

- Arizona State University, Tempe, Arizona

  Agricultural Engineering - M.S.
  Irrigated Engineering - M.S., Ph.D.
  Natural Resource Management - M.S.

- University of Arizona, Tucson, Arizona

  Irrigation Engineering - M.S.
  Water Management - M.S.
  Natural Resource Management - M.S., Ph.D.

- University of California, Davis, California
  See detailed description.

- Colorado State University, Fort Collins, Colorado
  See detailed description.

- University of Hawaii, Manoa Campus
  Irrigation Engineering - M.S.

- University of Idaho, Moscow, Idaho
  See detailed description.

- Utah State University, Logan, Utah
  See detailed description.

- Washington State University, Pullman, Washington

See detailed description

The major university outside of the geographical Western Region that places heavy emphasis on water is:

Cornell University, Ithaca, New York

Irrigation Engineering - M.S., Ph.D.
Water Management - M.S., Ph.D.

The Contractor wishes to point out explicitly that the institutions identified above represent only a small portion of the educational institutions - capable of contributing to the development of training opportunities for Pakistan personnel in the areas of administration and management, social sciences, computer science, agronomy, soil science, mechanical engineering, economics, planning and evaluation, career development training, etc.

The material in this section of the "Training Plan' is presented for the purpose of having a ready reference in the development of training programs and documents. It represents information the Contractor gleaned from a review of each institution's catalogs available at the time of the review and on-site visitations to the respective campuses. For greater detail as to total courses offered within many disciplines, the reader is referred to the specific catalogs themselves. The Contractor also wishes to emphasize that many other institutions offer similar training opportunities of quality equal to the five institutions visited. The material is presented in order of visitation and does not in any form represent a specific preference for one institution over another.

The common thread woven throughout the visits and many discussions was the fact that all universities were interested in and prepared to provide the training requested with the

understanding that they were a teaching institution and that the quality of proposed candidates meet existing institutional standards and expected levels of performance. Each institution was very explicit that the type of training requested be well documented. Specific mention was made of the need to have, besides the prerequisite academic credentials, a definitive statement as to the duties the student was expected to undertake upon completion of the course of study and his/her return to Pakistan. All institutions contacted responded favorably to the suggestion that OJT (on-the-job training) be incorporated as part of the program. The institutions indicated that this might be the most difficult portion of the program to arrange but saw a role for the Bureau of Reclamation, Soil Conservation Service or irrigation districts in this aspect of training during the summer break or at the end of the academic training period. Special short courses were mentioned as one means of attaining the OJT emphasis.

All institutions responded favorably to the idea that Ph.D. candidates return to Pakistan after completion of course work to carry out their field work for the dissertation. A number of issues were raised relative to this approach. They were:

1. Possible need for faculty advisor and student to visit Pakistan at end of first academic year to pick out thesis topic;

2. Availability of rupee funds to support students research in Pakistan;

3. Supervision of student while in Pakistan - possible need for faculty advisor or an associate to travel to Pakistan a couple of times during field work;

4. Possible use of surrogate faculty advisor i.e. a qualified U.S. graduate advisor from a U.S. institution stationed in Pakistan;

5. Need for students to return to campus to write and defend dissertation.

A. COLORADO STATE UNIVERSITY

COLLEGES

CSU offers undergraduate and graduate instruction in a variety of academic disciplines. These are available through the:

- College of Agricultural Sciences
- College of Arts, Humanities, and Social Sciences
- College of Business
- College of Engineering
- College of Forestry and Natural Resources
- College of Human Resource Sciences
- College of Natural Sciences
- College of Professional Studies
- College of Veterinary Medicine and Biomedical Sciences
- The Graduate School

ADMISSION

Admission at the undergraduate level is limited to students on specific educational training programs, private sponsorship, or the sponsorship of the U.S. or a foreign government. Copies of current academic credentials should accompany all requests for International Undergraduate Applications.

TOEFL (Test of English as a Foreign Language)

All international applicants whose native language is not English are required to submit TOEFL scores. The minimum acceptable TOEFL score is 550. An intensive course in English is available at CSU and is given by the Department of English. Conditional admission is possible for students with TOEFL scores of between 450 - 549 but must achieve 550 before registering for courses.

All applications for international students must be submitted at least six months prior to the beginning of the term

for which admission is requested. The application should indicate the applicants academic background, experience background and proposed program of study. Those seeking an advanced degree must have a minimum grade point average of 3.00 out of a possible 4.00.

CSU is on a semester system and offers a summer session. The 1984-85 schedule is as follows:

- Fall Semester - August 22 - December 15, 1984
- Spring Semester - December 27, 1984 - May 11, 1985
- Summer Session - May 13 - August 2, 1985

Admission formalities must be completed at least six months prior to the opening of the semester under which they plan to enter.

INTERNATIONAL TRAINING PROGRAMS

The Office of International Training Programs exists to strengthen, enhance and promote the institutional and individual capabilities at CSU related to international non-degree training activities. It is a source of information regarding CSU's international training capabilities. The Office is responsible for coordination of the International School of Economic Development Studies and the International Water Resources School. It is through these two schools that short and medium (non-degree) training programs can be developed within a number of disciplines.

THE GRADUATE SCHOOL

The Graduate School has general charge of all graduate work offered by CSU. It consists of the Dean of the Graduate School, the Associate Dean, and those academic faculty members designated by the various departments from within the nine Colleges. Most departments offer graduate programs in their specialities, and many offer interdepartmental and interdisciplinary programs.

GRADUATE PROGRAMS OFFERED

A sampling of programs (those considered likely to be relevant to the ISM scope) offered by the departments and units of administration include in part:

- Agricultural Economics - M.S., Ph.D.
- Agricultural Engineering - M.S., Ph.D.
- Agricultural Sciences (College-wide) - M. Agr.
- Agronomy - M.S., Ph.D.
- Business - M.B.A., M.S.
- Civil Engineering - M.S., Ph.D.
- Computer Science - M.S., Ph.D.
- Earth Resources - M.S., Ph.D.
- Geology - M.S.
- Horticulture - M.S., Ph.D.
- Mechanical Engineering - M.S., Ph.D.
- Physiology and Biophysics - M.S., Ph.D.
- Sociology - M.A., Ph.D.
- Vocational Education - M. Ed., Ph.D.

Hydrology and Water Resources

The M.S. and Ph.D. programs prepare specialist to solve problems in hydrology and conservation, control, development and management of water resources. The program trains the student to understand and predict various environmental behaviors and responses. Training in applied mathematics and statistics, applied earth sciences, scientific and applied engineering, optimization techniques, systems analysis, and other aspects of water resource activities is available.

Water Resources Planning and Management

The M.S. and Ph.D. programs are developed to equip those interested in any of the various aspects and levels of planning, design, and management of water resources with a fundamental understanding of these problems and modern tools for attacking them effectively. The program stresses the interdisciplinary aspects of water resources by including studies in physical, social and life sciences.

Groundwater

The M.S. and Ph.D. programs educate engineers in groundwater, hydrology, and fluid flow through porous media. It covers both applied and theoretical aspects. This includes the major areas of theoretical fluid mechanics, multiphase flow, analytic solution, groundwater modeling, reservoir analysis, drainage, artificial recharge, well drilling, pumping plants, salinity control, conjunctive use, and optimal management of groundwater reservoirs.

Hydraulics

The M.S. and Ph.D. programs aim at giving the candidate a comprehensive understanding of hydraulics, water resources, and the environment. A selection of emphasis options are available. These include hydraulic engineering, fluid mechanics, applied mathematics, structural engineering, hydromachinery, systems analysis, environmental hydrolics, remote sensing, and water resources.

Research support is provided through the Engineering Research Center with laboratory facilities for hydraulics, hydromechanics, fluid dynomics and diffusion; and a 100 acre outdoor hydraulics and hydrology laboratory.

A student enrolled in graduate work must maintain at least a 3.00 cumulative grade point average. Required courses in a program of study must be graded 3.00 or higher.

CSU requires a thesis of all Ph.D. candidates. Candidates for the M.S. degree in most cases are given the option of either carrying out special topic study (B) or writing a thesis (A) based on a research topic. The general consensus is that foreign students returning to an operational or functionary position follow option B.

COURSE SUMMARY/OPTIONS

The following course descriptions represent only a portion of the study disciplines and course work offered by CSU. Its presentation in this report is made solely for the purpose of providing a ready reference point for use in the preparation of training documents (PIO/P - Project Implementation Order - Participants) or the identification of training formats that might be developed for medium (up to two semesters - non-degree) and degree programs. The CSU General Catalog should be referred to for greater detail.

Course numbering is based on the content level of material presented in a course:

300-499	Courses primarily for junior and senior students. Acceptable for graduate credit when approved by the students' graduate committee.
500-699	Courses primarily for students enrolled in master's degree programs or equivalents.
700-799	Courses primarily for students enrolled in Ph.D. level programs or equivalents.

GENERAL AGRICULTURE (A)

A 300. Agriculture, Pollution and Resources. Environmental and resource issues including policies and conflicts concerning pollution, agricultural chemicals, and use of land, water, and energy.

A 320. Survey of Computer Applications in Agriculture. Use of computer for data acquisition and manipulation, optimization, and simulation procedures for a wide range of agricultural applications.

A 420. Development of Computer Applications in Agriculture Advanced programming techniques applied to independent development of a computer program in agriculture.

ADULT EDUCATION (AD)

AD 525. Designing Programs for Undereducated Adults.
Comparison of major cultural groups with implementation for design, conduct and evaluation of adult education programs.

AD 586 A-B. Practicum.
Participation in field experiences relevant to study program and objectives. A) Adult education. B) Community education.

AD 590 A-B. Workshop.
Specifically designed learning situations to provide opportunities for concentrated problem - solving experiences. A) Adult education. B) Community education.

AD 620. Processes and Methods.
Methodological theory and research emphasizing application to formal and inform adult learning experiences.

AD 624. Adult Teaching and Learning.
Theory, research and practice of adult teaching and learning concepts of behavior related to adults as learners in contrast to the young.

AD 629. Program Development.
Theory, research and practice in planning, implementing, and evaluating adult education programs.

AD 630. Supervision and Administration.
Applied administrative and organizational theory, research, and practice in adult education emphasizing middle management roles; case study approach.

AD 687 A-B. Internship.
Career or job fieldwork experience with an adult education institution, agency, or program. A) Adult education. B) Community education.

AGRICULTURAL ENGINEERING (AE)

AE 330. Soil - Water Engineering.
Control of the plant - soil - water environment, irrigation and drainage.

AE 370. Operations Research in Agriculture.
Mathematical programming, simulation, and modeling applied to analysis of agricultural systems.

AE 505. Irrigation Scheduling.
Engineering principles related to crop evaporation, irrigation requirements, water transport and budget, and climate monitoring.

AE 531. Irrigation and Drainage Pumping.
Types, characteristics, and economics of pumps; selection of pump components.

AE 532. Drainage Engineering.
Drainage design for agricultural applications. Subsurface and surface drainage for water table and salinity control.

AE 535. Surface Irrigation Systems.
Design and evaluation of surface irrigation systems. Water measurement, conveyance and control structures, land forming.

AE 536. Sprinkler and Trickle Irrigation Systems.
Basic principles, design, and evaluation of pressurized irrigation systems.

AE 537. Surface Irrigation Laboratory.
Outdoor laboratory experiments in surface irrigation.

AE 538. Groundwater Hydrology.
Groundwater occurrence, distribution, movement, exploration and recharge, well hydraulics and design, interaction of ground and surface water.

AE 733. Flow in Porous Media.
Mechanics of single and two-phase fluids in soils and porous rocks with application to infiltration, drainage, and petroleum production.

AE 767. Advanced Irrigation Topics.
Advanced topics selected from soil-water-plant relationships, irrigation hydraulics, irrigation management, developments in equipment.

AE 795. Independent Study.
A) Irrigation and drainage.
B) Environmental engineering.
C) Land use, environmental and water law.

AGRONOMY (AG)

AG 340. Soil Conservation.
Land capability classification and factors affecting erosion; emphasis on soil and water conservation and land use management systems.

AG 350. Soil Fertility Management.
Principles of soil fertility and procedures in fertilizer use. Management of soils to achieve optimum production.

AG 353. Dryland Soil Management.
Soils, crops, cultural practices best suited for production under conditions of limited rainfall emphasizing soil-water management, erosion control.

AG 370. Irrigation.
Administration and measurement of irrigation water, soil moisture measurement, irrigation methods emphasizing soil-water-plant relationships.

AG 406. Crop Production.
Adaptation, production, and utilization of cereals and special crops.

AG 414 Plot Techniques.
Methods of field experimentation and statistical analysis of agronomics data.

AG 415. Crop Response to Environment.
Effects of environmental factors on physiology, development and yield of important food crops.

AG 470. Soil Physics.
Physical properties of soils emphasizing mechanical composition, moisture, aeration, temperature, and structure related to management, plant growth.

AG 475 A-C. Topics in International Agriculture.
A) World soils.
B) Crop production systems.
C) Food crops.

AG 666 Salinity and Soil-Water Management.
Origin, analysis, reclamation of salt-affected soils; effects of salt, sodium on plant growth; management in relation to water quality, soil properties.

AG 770 Advanced Soil Physics.
Description and analysis of principles of storage and movement of water, solutes, heat, and gases in soils.

ANTHROPOLOGY (AP)

AP 320 Nature of Culture.
Introductory anthropology emphasizing role of culture in human affairs.

AP 329. Cultural Dynamics.
Processes of cultural development and theories of change.

AP 435. Economic Anthropology.
Tribal and peasant economic systems; impact of Western and industrial world on economies of developing nations.

AP 438. Applied Anthropology.
Anthropological theory, methods, and findings in programs of community and national development, public health and international aid.

CIVIL ENGINEERING (CE)

CE 300. Fluid Mechanics.
Fluid properties; statistics, kinematics, and dynamics of fluid motion including viscous and gravitational effects.

CE 301. Hydraulics Engineering.
Basic principles of fluid mechanics applied to practical problems in hydraulics engineering.

CE 350. Soil Engineering for Non-engineers.
Concepts of soil mechanics and soil behavior, elementary application to compaction, seepage, earth pressure, foundations and slopes.

CE 413 Environmental River Mechanics.
Fluvial geomorphology, sediment transport, river response with special emphasis on environmental aspects.

CE 422. Basic Hydrology.
Study of hydrologic cycle, precipitation processes, soil moisture, infiltration, groundwater, rainfall-runoff processes, utilization of water resources.

CE 423. Ground Water Engineering.
Development of ground water resources; origin, movement, distribution of water below ground surface.

CE 450. Soil Mechanics and Engineering.
Soil behavior, stress-strain and strength properties, application to earth pressure, slope and foundation problems.

CE 513. Computer Applications in Hydraulic Engineering.
Solutions to hydraulic engineering problems; unsteady free-surface flow; erosion and sedimentation analysis.

CE 514. Hydraulic Structures and Systems.
Analysis and design of hydraulic structures which make up components of water resource systems.

CE 520. Physical Hydrology.
Properties of water; hydrologic relevance; thermo-dynamic, mass and heat transport; dissolution and chemical characteristics; momentum and energy.

CE 521. Hydrometry.
Principles, methods, instruments, and equipment for measuring water quantity and water quality variables in nature.

CE 522. Engineering Hydrology.
Flood frequency analysis, regionalization; rainfall and snow melt runoff, routing; analysis, use, and design of watershed models.

CE 544. Water Resources Planning.
Planning concepts; economic and financial analysis; multiobjective planning; multisector planning; related topics.

CE 546. Water Resource Systems Analysis.
Application of systems analysis and optimization techniques in water resources planning and management.

CE 605. Experimental Fluid Mechanics and Hydraulics.
Design of experiments; instrumentation and experimental techniques for flow situations; data acquisition and processing.

CE 613. Hydraulics.
Fundamental equations of fluid mechanics, application to hydraulic problems, modern concepts of control volume, and laminar and turbulent flows.

CE 615. Open Channel Flow.
Steady, uniform, and non-uniform flow; backwater curves; flow through bridge piers, transitions, and culverts; spatially varied and unsteady flow.

CE 620. Optimization in Hydrology and Water Resources.
Survey of relevant optimization techniques; application in hydrology and water resources.

CE 622. Statistics in Water Resources.
Probability theory, mathematical statistics applied to hydrology, hydraulics, and other water resources disciplines.

CE 624. Control of Floods and Droughts.
Flood and drought characteristics, reservoir and channel routing, methods of flood mitigation, drought prediction, drought control, drought response.

CE 631. Solutions to Ground Water Problems.
Steady and transient saturated flow; well hydraulics, drains, recharge, bank storage, dispersion; ground water models.

CE 632. Optimal Ground Water Management.
Ground water systems; conjunctive use; deterministic and stochastic input; optimal management and sensitivity analysis.

CE 712. Hydraulic Structures Design.
Design of water-conveyance systems and related hydraulic structures including sediment exclusion and ejection methods; and sediment-water routing.

CE 716. Erosion and Sedimentation.
Transport mechanisms and transport of sediment in relation to hydraulics, water resources and environment.

CE 717. River Mechanics.
Characteristics of rivers, mechanics of sediment and water discharge emphasizing alluvial systems, channel stabilization, control response.

CE 746. Advanced Water Planning and Management.
Water resources planning and management; current innovative systems analysis tools; recent research results.

ECONOMICS (EC)

EC 342. Economics Analysis - Water Resources Development.
Water resource evaluation; concepts, issues, and problems; techniques employed in analyzing and evaluating water use in alternative situations.

EC 542. Economics of Water Resources Planning.
Benefit - cost analysis of public water development programs; economic analysis of selected water allocation issues; groundwater, pollution, pricing.

B. WASHINGTON STATE UNIVERSITY

COLLEGES

WSU offers undergraduate and graduate instruction in a variety of academic disciplines. These are available through the:

- College of Education.
- College of Veterinary Medicine.
- College of Engineering.
- College of Science and Arts.
- College of Economics and Business.
- College of Agriculture and Home Economics.
- College of Pharmacy.
- The Graduate School.

WSU and the University of Idaho (eight miles distant) have developed a program of cooperative courses in which one institution exclusively offers a particular course for use by graduate students of both. The program provides a wider variety of graduate courses than otherwise would be possible at either university.

ADMISSION

WSU encourages the application of qualified students from other nations to complement its cosmopolitan student community. However, because of limited supporting services, the university may from time to time find it necessary to limit the total number of foreign students, students from any single country, or students desiring any specific academic program. Applicants must submit official copies of all academic records, and evidence of the TOEFL score (550 minimum for graduate school).

General admission to the Graduate School on a regular student status requires at least a 3.00 average out of 4.00 for the last half of undergraduate work. Admission of a student from a foreign university may be approved by the Dean of the Graduate

School if the student presents a superior academic record and meets minimum TOEFL requirement (550 score). All applications for international students must be submitted at least six months prior to the beginning of the term for which admission is requested.

WSU is on a semester system and offers a summer session. The 1984-85 schedule is as follows:

- First Semester - August 23 - December 26, 1984
- Second Semester - January 10 - May 13, 1985
- Summer Session - June 10 - August 5, 1985

THE GRADUATE SCHOOL

The Graduate Faculty of over 700 members is primarily responsible for conducting graduate education. The Graduate Faculty emphasizes both independent research and classroom learning. The individualized nature of graduate work at WSU provides students with a great deal of flexibility in designing programs of study.

In the general disciplines of agriculture and water resources there are three centers of research. These include the College of Agriculture Research Center, the College of Engineering Research Division, and the State of Washington Water Research Center.

The College of Agriculture Research Center

The College of Agriculture Research Center is composed of the research personnel and facilities of the thirteen departments within the College of Agriculture. These departments include Agronomy and Soils, Agricultural Economics, Agricultural Engineering, Agricultural Chemistry, Animal Science, Entomology, Food Science and Technology, Forestry and Range Management, Home Economics, Horticulture, Plant Pathology, Rural Sociology, and Veterinary Science.

In addition to the departmental research facilities on campus there are six outlying research centers and six other research units located throughout the state. One of the larger centers is the Irrigated Agriculture Research and Extension Center at Prosser, Washington.

College of Engineering Research Division

The Engineering Research Division is an organized research force which places major research emphasis in the engineering aspects of environmental quality; energy generation, utilization and consumption; and resource development. The scope of research effort varies from fundamental to applied research; from development, to proto-type, to pilot plant, and to practical application.

State of Washington Water Research Center

The State of Washington Water Research Center was established in 1964 as a joint organization of WSU and the University of Washington (UW). The research program of the Center is very broad, including single-discipline, multi-discipline, and interdisciplinary studies. The Center's first major research project was an evaluation of the water resources of the state. The Center also completed a report on the concept of a state water plan and prepared a statement of water policy. Present plans call for development of a committee to examine state water research priorities. Under the auspices of the Center, a broad range of course offerings in many disciplines concerned with water is available. The Center's major emphasis is placed on research, education and information dissemination.

GRADUATE PROGRAMS OFFERED

A sampling of programs (those considered likely to be relevant to the ISM scope) offered by the departments and units

of administration include in part:

- Agricultural Economics - M.A., Ph.D.
- Agricultural Engineering - M.S., Ph.D.
- Agronomy - M.S., Ph.D.
- Civil Engineering - M.S., Ph.D.
- Computer Science - M.S., Ph.D.
- Engineering Science - Ph.D.
- Engineering Management - M.S.
- Soils - M.S., Ph.D.
- Vocational Technical Education - M.S.

WSU requires a thesis of all Ph.D. candidates. Candidates for M.S. have a thesis or non-thesis option.

COURSE SUMMARY/OPTIONS

The following course descriptions represent only a portion of the study disciplines and course work offered by WSU. Its presentation in this report is made solely for the purpose of providing a quick point of reference for use in the preparation of participant training documents (PIO/P). The WSU General and Graduate Catalogs should be referred to for greater detail.

Course numbering is based on the content level of material presented in a course:

200-399	Undergraduate courses.
400-499	Courses primarily for juniors and seniors but may be included in graduate programs if they are published in the Graduate Study Bulletin and provided they are not specific requirements in preparation for graduate study.
500-599	Courses primarily for graduate students.

ADULT AND CONTINUING EDUCATION (ACE)

ACE 510 Development and Evaluation of Adult Education Programs.
Development, implementation, and evaluation of adult education programs.

ACE 511 Seminar.

ACE 514 Adult Learning.
Theories, principles, concepts, and practices that apply to adult learning.

ACE 515 Teaching Methods.
Methods and procedures of informal adult and continuing education.

ACE 516 Methods of Research in Adult Education.
Methods of research and design of studies in adult and continuing education.

AGRICULTURAL ECONOMICS (Ag Ec)

Ag Ec 380 Introduction to Resource Economics.
Introduction to resource scarcity, use, and control; resource problems as they relate to rural areas.

Ag Ec 425 Economic Analysis of Projects and Programs.
Principles and procedures for valuing project effects, estimating distributional and environmental consequences, and making social choices; case studies.

Ag Ec 480 Advanced Resource Economics.
Economic principles applied to problems of natural resource utilization, development, and conservation.

Ag Ec 540 Agricultural Production Economics.
Theoretical economic concepts applied to analysis of agricultural problems, production intensity, factor and product combination, uncertainity and technological change.

Ag Ec 541 Advanced Agricultural Production Economics.
Current multiple product production theories and functions applied to agricultural policy issues.

Ag Ec 580. Resource Economics.
Problems and issues in natural resource use, development, and conservation.

Ag Ec 581. Seminar in Resource Economics.
Current policy issues, methods of evaluation and resource agency procedures and practices.

AGRICULTURAL ENGINEERING (Ag E)

Ag E 390. Introduction to Soil and Water Engineering.
Fundamentals of soil and water engineering including agricultural hydrology and hydraulics, erosion control, and water quality.

Ag E 491 Irrigation Engineering.
Theory and design of gravity, sprinkler, and trickle irrigation systems; water requirements and sources; efficient use of water and energy.

Ag E 555.1/ Natural Channel Flow.
Hydraulics of non-uniform flow in irregular channels; unsteady flow, flow routing, sediment transport and density currents.

Ag E 558.1/ Fluid Mechanics of Porous Materials.
Statics and dynamics of multi-flow systems in porous materials, properties of porous materials; steady and unsteady flow.

Ag E 590. Advanced Theory of Irrigation Water Requirements.
Energy balance and consumptive use of water; influence of farm and project irrigation system design criteria, management and efficiencies.

Ag E 591. Irrigation Engineering.
Theory and design of gravity, sprinkler, and trickle irrigation systems; water requirements and sources; efficient use of water and energy.

Ag E 592. Advanced Theory and Design of Irrigation Systems.
Design and development of irrigation water application systems.

1/ Course of instruction at the University of Idaho.

Ag E 593. Drainage Engineering.
Engineering principles applied to surface and sub-surface drainage problems; investigation, design, materials, construction, and inspection applied to agriculture.

Ag E 594. Drainage Investigation and Design.
Continuation of Ag E 593.

Ag E 595. Water Resources Seminar.
Oral presentation and discussions of leading research on water resources and water policies.

Ag E 600. Special Projects or Independent Study.

AGRICULTURAL MECHANIZATION (Ag M)

Ag M 344. Irrigation and Drainage.
Principles of irrigation and drainage, water measurement, irrigation methods and practices, selection of irrigation system components.

Ag M 345. Irrigation Laboratory.
Principles of soil moisture measurement techniques, water measurement, pumps and pump efficiencies, conveyance and distribution.

AGRONOMY (Agron)

Agron 411. Environmental Crop Physiology.
Effects of environment and management on crop growth and development.

Agron 501. Agronomic Research Techniques.
Biological and physical principles used in environmental crop research.

ANTHROPOLOGY (Anth)

Anth 403. Economic Anthropology.
Introduction to economic organization and processes in comparative perspective; tribal and peasant economies.

Anth 462. Human Issues in International Development.
Interdisciplinary analysis of complex interaction between tradition and modernity in Third World society.

Anth 503. Economic Anthropology.
Graduate level of Anth 403.

Anth 504. Cultural Change and Modernization.
Culture changes through the processes of innovation, diffusion, and acculturation.

BOTANY (Bot)

Bot 501. Plant Physiology - Water Relations.
Physical biochemical and environmental processes in plant-water relations.

CIVIL AND ENVIRONMENTAL ENGINEERING (CE)

CE 315. Mechanics of Fluids.
Principles of fluid statics and kineties.

CE 351. Hydraulic Engineering.
Principles; hydrology, fluid mechanics, structures, and economic analysis applied to problems of hydraulic engineering.

CE 416. Hydraulic Engineering Laboratory.
Experiments related to fluid flow principles and their application to hydraulic engineering.

CE 450.[1/] Hydraulic Design.
Hydraulic problems in planning and design of gravity and pressure systems; introduction to unsteady flow.

CE 451. Open Channel Flow.
Steady, non-uniform flow; controls and transitions in fixed-bed channels.

CE 464. Construction Management.
Job scheduling, job planning, project control, records and policies, and construction equipment.

CE 475. Ground Water Hydrology.
Fundamentals of ground water accumulation, storage, and flow; exploration and development.

CE 550. Intermediate Fluid Mechanics.
Basic flow equations; Navier-Stokes equations; similitude; potential flow, boundary layers, turbulence, and diffusion; uniform and non-uniform conduit flow; drag and lift.

CE 551. Turbulent Flow and Diffusion.

Theories of turbulent motion; statistical description and numerical models.

CE 552. Advanced Topics in Hydraulic Engineering.
Individual topic selection.

CE 553. River Engineering.
Fluid mechanics, morphology, hydrology, and hydraulic engineering as they affect natural and man-made influences on rivers.

CE 554.[1/] Hydraulic Design.
Dams, spillways, and outlet works; design of a major sturcture.

CE 556. Numerical Modeling in Fluid Mechanics.
Fundamentals underlying fluid mechanical modeling; physical basis of the techniques being used.

CE 559. Stochastic Hydrology.
Applications of probability in hydrology; analyses and evaluation of hydrologic data; regression analyses and simulation techniques.

CE 560. Advanced Hydrology.
Principles of hydrometeorology and severe storm analysis; flood and runoff analysis, project design and operation.

CE 561.[1/] Water Resources Systems.
Concepts in water development; coordination of development of other natural resources; systems approach and optimization techniques.

CE 562.[1/] Water Resources Planning.
Design and feasibility studies in water supply, power, flood problems, navigation, irrigation, recreation.

CE 577. Advanced Ground - Water Hydrology.
Ground water flow systems; modeling and resource management.

CE 600. Special Projects or Independent Study.

COMPUTER SCIENCE (Cpt S)

Cpt S 203. Computer Programming for Engineers.
Use of FORTRAN in solving problems related to engineering applications.

Cpt S See Catalog for wide range of applicable Courses.
Systems programming, data management, simulation, modeling, etc.

C. UNIVERSITY OF IDAHO

COLLEGES

The University of Idaho (UI) offers undergraduate and graduate instruction in a wide variety of academic disciplines. These are available through the:

- College of Agriculture.
- College of Art and Architecture.
- College of Business and Economics.
- College of Education.
- College of Engineering.
- College of Forestry, Wildlife and Range Science.
- College of Law.
- College of Mines and Earth Resources.
- Veterinary Medical Education (Utah - Oregon).
- College of Letters and Science.
- The Graduate School.

One of the several associated institutions within the UI systems is the Idaho Water and Energy Resources Research Institute. The institute serves the state by developing and coordinating water and energy research programs. The area of water resources planning, development, and management is a composite of many disciplines and draws upon the faculty of many departments to carry out its objectives. The institute has coordinated master's and doctoral programs in several disciplines and specializations.

ADMISSION

The University of Idaho accepts qualified students from other countries to the extent that space is available. Applicants for admission as graduate students whose previous degree was earned outside of the U.S. must present the equivalent of a "C" (2.00) average (by international standards). Those whose previous degree was earned at an institution in the U.S. must present at least 2.70 grade point average.

Applicants must present the minimum score (550) on the Test of English as a Foreign Language or that proscribed by the academic unit in which they plan to study.

The Graduate School serves three groups: students working for advanced degrees, those wishing certain courses but not toward a degree objective, and those working for certification as teachers.

The University of Idaho is on a semester system and offers a summer session. The approximate 1984-85 schedule will be:

- Fall Semester - August 22 - December 16, 1984.
- Spring Semester - January 9 - May 12, 1985.
- Summer Session - June 11 - August 3, 1985.

For applicants who are currently residing outside the U.S. final application and approval must be completed by:

- Fall Semester - April 15.
- Spring Semester - September 15.
- Summer Session - March 15.

GRADUATE PROGRAMS OFFERED

Degree programs are offered in 108 areas for master's degrees, 6 for professional degrees, and 21 for doctoral degrees. A sampling of those offered relevant to the scope of training under the ISM Project include in part:

- Agricultural Economics - M.S.
- Agricultural Engineering - M.S., M. Eng., Ph.D.
- Applied Statistics - M.S.
- Civil Engineering - M.S., M. Eng., Ph.D.
- Computer Science - M.S.
- Hydrology - M.S.
- Plant Science - M.S., Ph.D.
- Public Administration - M.P.A.
- Soil Science - M.S., Ph.D.

A student enrolled in graduate work must maintain at least a 3.00 average for all courses taken during the period a student is registered in a particular degree program.

UI requires a thesis of all Ph.D. candidates. Candidates for the M.S. degree are in most cases given the option for thesis or special problem study.

UI and WSU (eight miles distant) have developed a program of cooperative courses in which one institution exclusively offers a particular course for use by graduate students of either university.

COURSE SUMMARY/OPTIONS

The following course descriptions represent only a portion of the study disciplines and course work offered. The UI General and Graduate Catalogs should be referred to for greater detail.

Course numbering is based on the content level of material presented in a course:

300-499	Upper division courses for advanced undergraduates, fifth year students and graduates.
500-600	Restricted to students enrolled in Graduate School.
J -	Courses conducted jointly between departments. Students assignments reflect the level for which they are enrolled.
ID -	Courses offered at UI but available to WSU students.
WS -	Courses offered at WSU.

AGRICULTURAL ECONOMICS (Ag Ec)

Ag Ec 332. Economics of Agricultural Development. Problems associated with the economic development of the major agricultural areas of the world.

Ag Ec 358. Agricultural Programs and Policies. Goals, methods, results of economic programs and policies in agriculture, including role of government and farm organizations.

Ag Ec 467. Economics of Rural Community Development. Economic theory, analytical methods, and literature relevant to study the development of rural areas.

Ag Ec 493. Agricultural Production Economics. Economic theory related to agricultural production at the enterprise, firm, and industry levels.

Ag Ec 508 Problems in Production Economic Research. Objectives and techniques; application of probability models and their evaluation employing a number of econometric techniques.

Ag Ec 551. Economics of Natural Resource Development. Allocation of natural resources over time and among uses; welfare economics: project evaluation and benefit cost analysis; valuation of extramarket goods; problems for public policy.

AGRICULTURAL ENGINEERING (Ag E)

Ag E 351. (CE 321.) Hydrology. Analysis of precipitation and runoff events, principles of evaporation, infiltration, and snow-melt.

Ag E 352. Soil and Water Engineering. Plant-soil-water relationships, applied hydraulics, soil erosion principles and control, drainage, and legal aspects of water resources.

Ag E 451. (CE 421) Engineering Hydrology.
Hydrologic cycle as applied to engineering projects; hydrograph routing; design hydrographics; introduction to hydrologic simulation.

J 454/J 554. Drainage System Design.
Theory and design of subsurface drainage systems in agriculture, waste management, and construction; introduction to unsaturated flow.

Ag E 456. Irrigation Systems Design.
Crop water requirements, irrigation scheduling and water management, design of irrigation systems, pump selection.

Ag E 458. (CE 428) Open Channel Hydraulics.
Hydraulics of uniform and varied flow in open channels with fixed and movable beds.

Ag E 551. Advanced Hydrology.
Principles of the hydrologic cycle in mountainous areas, including precipitation, snow melt, and systems simulation.

WS 552. Advanced Theory of Irrigation Water Requirements.
Energy balance and consumptive use of water; influence of farm and project irrigation system design criteria, management, and efficiencies.

WS 553. Advanced Theory and Design of Irrigation Systems.
Design and development of irrigation systems.

ID 555. Natural Channel Flow.
Hydraulics of non-uniform flow in irregular channels, unsteady flow and flow routing.

Ag E 589. (CE 589) Water Resources Seminar.

AGRICULTURAL MECHANIZATION (Ag Mech)

Ag Mech	315	Irrigation and Drainage. Irrigation methods, water resources, water rights, conveyance and measurement, pumps, soil-water-plant relationships and drainage.

CIVIL ENGINEERING (CE)

CE (Ag E 351)	321	Hydrology. See Ag E 351
CE	322	Hydraulics. Applied principles of fluid mechanics; open channel flow, pressure conduit flow, introduction to pumps.
CE	420	Fluid Mechanics. Fluids in motion; basic laws for systems and control volumes; Navier-Stokes
CE (Ag E 451)	421.	Engineering Hydrology. See Ag E 451.
ID	422.	Hydraulic Design. Hydraulic problems in design of gravity and pressure systems.
CE (Ag E 458)	428.	Open Channel Hydraulics. See Ag E 458.
CE	460.	Soil Mechanics. Physical and mechanical properties of soils; behavior of soil structures under load.
CE	482.	Project Management Techniques. Four accelerated (4 week per course) minicourses offered in one semester. Modern engineering management techniques for design, construction, and operation of typical engineering projects: (1) linear programming applied to project design and operation; (2) project economics and cost estimation; (3) reliability, risk, and decision analysis; (4) scheduling and bidding of projects.

ID 522. Advanced Hydraulic Design.
Application of principles of fluid mechanics and hydraulics in design of hydraulic works, structures, and systems; design problems - wells, pumps, pipelines and control valves; spillways, outlet works, and open channel control structures.

ID 523. Water Resources Systems.
Concepts in water development; coordination of development of other natural resources; systems approach and optimization techniques.

CE 524. Water Resources Planning.
Use of water resources; provision for domestic water supply, power, flood control, navigation, irrigation, and recreation; design and feasibility problems.

WS 525. Intermediate Fluid Mechanics.
See WSU 525.

WS 527. Advanced Hydraulic Engineering.
See WSU 527.

WS 528. Stochastic Hydrology.
See WSU 528.

CE (ID 555) 529. Natural Channel Flow.
See Ag E - ID 555.

WS 539. Water Quality Management.
Systems Analysis applied to management of water quality problems, including economics, political and social aspects.

COMMUNICATIONS (Comm)

Comm 332. Communications and the Small Group.
Problem - solving methods; small group behavior.

Comm 347. Communications and Attitude Change.
Approaches to attitude change, with consideration of application in the mass media.

COMPUTER SCIENCE (CS)

See Catalog - 36 courses offered.

GEOLOGY - HYDROLOGY (Geol Hydro)

Hydro 569. Application of Hydrological Concepts.
Application of hydraulic and chemical characteristic of well and aquifer systems to practical field problems.

Hydro 572. Ground Water Management.
Hydrologic, economic, and legal factors controlling development and management of ground water resources.

Hydro 575. Design and Construction of Water Wells.
Analysis of geologic and energy factors important to design, construction, operation, and maintenance of water wells.

SOCIOLOGY (Soc)

Soc 235. Sociology of Natural Resources.
Sociological perspective applied to natural resources management; relationship between natural resources and human social systems; analysis of resource issues.

Soc 312. Sociology of Organizations.
Analysis of positions, roles, norms, and authority structures in organizations.

Soc 410. Introduction to Social Research.
Principle methods of data collection, analysis, and interpretation.

Soc 574. Psychology of Adult Learners.
Psychological, social, and physiological characteristics of adult learners.

D. UNIVERSITY OF CALIFORNIA, DAVIS

COLLEGES

The University of California, Davis (UC/DAVIS) offers undergraduate and graduate instruction in a wide variety of academic disciplines. These are available through the:

- College of Agricultural and Environmental Sciences.
- College of Engineering.
- College of Letters and Science.
- The Graduate Division.

The Graduate Division is the academic home of several thousand post-baccalaureate students who are seeking advanced degrees in more than 70 graduate programs on the Davis campus. In developing its graduate programs, Davis campus takes advantage of a special pattern of organization allowing greater flexibility: the creation of graduate "groups" which cut across the usual lines of faculty divison. Groups may be organized to offer an inter-disciplinary program.

One of the many facilities associated with UC/Davis is the Water Resources Center. The Center is a system-wide organized research unit charged with coordinating water resources research on the UC campuses. Research interests include water resource systems engineering, economic evaluation of water development and conservation, political strategy in water resource development, environmental and energy relationships in water resource management, watershed hydrology, ground water use, soil and land use management in relation to water resource use, and maintenance and improvement of water quality.

ADMISSION

Applicants from other countries are admitted in accordance with the same general procedures governing non-resident admission.

Students admitted to graduate status must hold a bachelor's degree or the equivalent from an institution of acceptable standing. Generally, a minimum grade-point average of B in undergraduate work is required.

Applicants for admission to the Graduate Division with credentials from universities or colleges in foreign countries should make their initial inquiry for enrollment at least one year before the date of intended enrollment.

Applicants must present a minimum TOEFL score of 550 for admission to the Graduate Division. On arrival, international students take the special University examination in English. Those who do not pass are assigned to remedial courses. Registration may be deferred until an adequate command of English is acquired.

The University is on a quarter system. The approximate 1984-85 schedule will be:

- Fall Quarter - September 26 - December 17, 1984.
- Winter Quarter - January 3 - March 22, 1985.
- Spring Quarter - March 29 - June 15, 1985.

Applications from Foreign Nationals must be filled by:

- 1984 - Fall Quarter - May 1, 1984.
- 1985 - Winter - September 1, 1984.
- 1985 - Spring - December 1, 1984.

Two short term summer sessions are also available between the ending of the Spring Quarter and the beginning of the Fall Quarter Course selection is not as extensive as that available during normal quarter sessions.

GRADUATE PROGRAMS OFFERED

Degree programs are offered in some 70 areas. In addition to these, professional degrees are offered in the schools of Law,

Medicine and Veterinary Medicine. A sampling of those areas offered which may be relevant to the scope of training under the ISM Project include in part:

- Administration - M. Admin.
- Agricultural and Environmental Chemistry - M.S., Ph.D.
- Agricultural Economics - M.S., Ph.D.
- Agronomy - M.S.
- Computing Science - M.S., Ph.D.
- Earth Sciences & Resources - M.S., Ph.D.
- Engineering - M. Engr., M.S., D. Engr., Ph.D.
- Water Science - M.S.

A masters degree may be awarded upon completion of one of two basic plans in which either a thesis or a comprehensive examination is required. Ph. D. candidates are required to write a dissertation.

GRADUATE STUDY WITHOUT AN ADVANCED DEGREE OBJECTIVE

Students may be admitted to a specified field of study for course work only. Such a program, which must be approved by the Dean of the Graduate Division, must have a definite scholarly or professional purpose. Candidates for this type of program must meet the same scholastic requirements as required for admission to degree programs.

COURSE SUMMARY/OPTIONS

The following course descriptions represent only a portion of the study disciplines and graduate work offered. The US/DAVIS General Catalog should be referred to for greater detail.

ADMINISTRATION

201 A - 201 B. Accounting, Budgeting and Control. Introduction to basic principles of accounting, budgeting and control. Basic accounting, financial reporting, cost accounting, planning and budget formulation, management control techniques, operational control and auditing, financial reporting and management information.

204 A - 204 B. Economic Analysis for Management.
Economic reasoning applied to resource allocation in public and private sectors

RICULTURAL EDUCATION

301. Planning for Instructional Programs.
Major paradigims in program planning anc development. Emphasis on key steps in curriculum development, including selection and organization of educationa objectives, learning experience, materia and methods.

HAVIORAL SCIENCES

201. Planning Processes in Applied Behavioral Sciences.
Systematic approach to planning, includi new concepts, theories, and methods of planning with application to educatic institutions, agencies and the community at large.

202. Systems Approach to Organizational Chanc
Study of institutional processes, resour allocations, communication networks, program priorities and destruct mechanic needed for change.

203. Evaluation and Decision Making.
The study of decision - making behavior, theoretical formulations of evaluation a decision making, value conflicts, multip information requirements at different organizational levels, and the role of evaluation in programs.

RICULTURAL ENGINEERING

242. Hydraulics of Surface Irrigation.
Mathematical models of surface - irrigat systems for prediction of the ultimate disposition of water flowing onto a fiel Quantity of runoff and distribution of infiltrated water over field length as a function of slope, roughness, infiltrati and inflow rates.

265. Design and Analysis of Engineering Experiments.
Design, management, and analysis of engineering experiments with emphasis on criteria for the selection and utilization of statistical methods.

CIVIL ENGINEERING

260. Noncohesive Sediment Transportation.
Sediment materials. Particle suspension by currents, waves, and winds. Modes of transport. Bed load relations and suspended load relations. Calculation of total load in streams. Similarity criteria for moveable bed models. Stable channel design.

261. Cohesive Particle Transportation.
Cohesion; cohesive particulate materials; processes of aggregation and dispersion; aggregate properties; deposition and scour, channel and harbor design and maintenance.

268. Economics of Water Resources Planning.
The value of water and evaluation of project alternatives. The uniqueness of water in micro-economic theory. The relation of traditional methods such as benefit cost analysis to multi-objective optimization and utility theory in evaluating non-commensurable objectives.

270. Advanced Water Resources Planning.
Philosophy and history of planning. Descriptive structure of plans and procedures to formulate plans. Advanced topics in institutional analysis, decision theory, data management, value theory and mathematical modeling.

270 L. Water Resources Planning Laboratory.
Application of hydrology, hydraulics, economics, systems analysis and planning in conducting a water resources planning study. Computer modeling and advanced planning techniques.

272 A. Advanced Groundwater Hydrology.
Fundamental equations of groundwater flow. Flow is confined, unconfined, and leaky aquifers. Hydrolic maps and flow nets. Hydraulics of pumping and recharging wells. Identification of aquifer parameters.

272 B. Advanced Groundwater Hydrology.
Numerical methods of fluid flow systems. Flow in the unsaturated zone. Hydrodynamic dispersion. Identification of regional aquifer parameters. Fresh and salt water interface. Modeling of aquifer systems.

275. Stochastic Hydrology.
Application of modern statistical analysis in hydrology: time series analysis, stochastic models, simulation by Monte Carlo methods, statistical assessment of predictive capacity of models.

276. Hydrologic Systems Analysis.
Theory and application of the methods of modern systems analysis and mathematical statistics to problems of hydrological prediction. Emphasis on current development in parameteric and stochastic hydrologics.

277. Unsteady Flow in Open Channels.
Long waves in open-channel systems; Saint-Venant equations; method of characteristics; explicit and implicit finite - difference solutions, stability of numerical schemes, double-sweep method; influence of hydraulic structures; flood routing; bores; dam break; long waves in two-space dimensions.

287. Dynamic Response of Soils.
Seismic survey, dynamic soil properties, analysis of the behavior of soils under earthquake conditions applications to liquefaction; earth dams and other structures.

ELECTRICAL ENGINEERING

Refer to catalog for wide range of computer and computer application and modeling.

WATER SCIENCE

200. Water-Soil-Plant Relationships in Irrigation Programming.
Selected topics including prediction of crop responses to irrigation, evapo-transpiration and water requirements, production functions, strategy for using limited water supplies, and irrigation planning and operations for optimizing water use and crop production under conditions of developed and developing nations.

201. Advanced Plant - Water Relations.
Chemical and component potentials of water quantitative aspects of water transport to, within, and from plants; dynamics, regulation, and environmental factors affecting plant water status; metabolic and other characteristics associated with efficient water use, responses to water deficiency and salinity.

202. Evapotranspiration.
Radiation and energy balances of water, soil and vegetative surfaces and the effect of wind; temperature, humidity thereon. Lysimeter and other measurement techniques. Prediction of evapotranspiration from aerodynamic, energy balance, and empirical approaches.

205. Water-Resource Systems Analysis: Deterministic Models.
Applications of deterministic linear and dynamic programming techniques to water-resource system designs. Allocation of aqueduct and reservoir capacities, conjunctive surface and groundwater systems. Sequencing of water supply projects.

207. Water-Resource Systems Analysis: Stochastic Models.
Application of stochastic linear and dynamic programming. Markov chains, and inventory theory to water-resource systems design. Design and operating policy models of reservoirs. Water quality management models.

291. Seminar in Water-Soil-Plant Relations and Irrigation.
Informal presentations on current developments in water-soil-plant relations, plant water use, and irrigation management.

E. UTAH STATE UNIVERSITY

COLLEGES

Utah State University (USU) offers undergraduate and graduate instruction in a wide variety and range of academic discipline. These are offered through the:

- College of Agriculture.
- College of Business.
- College of Education.
- College of Engineering.
- College of Family Life.
- College of Humanities, Arts and Social Sciences.
- College of Natural Resources.
- College of Science.
- School of Graduate Students.

In addition to the colleges listed above a number of cooperative research units, extension and training centers are closely associated with teaching and student activities. Specific note is made of three:

1. Utah Center for Water Research.

The UCWRR among other things serves to promote University - wide coordination of research in all aspects of water and faster interdepartmental interdepartmental research and educational programs in the water resources field. All faculty engaged in water resources education or research are associates of the Center. The Center encourages development of instructional programs that will further the training of water resource scientists and engineers.

2. Utah Water Research Laboratory.

The UWRL houses facilities for research in hydraulics, water quality, atmospheric water resources, and hydrologic and economic modeling. Most of the professional staff hold joint teaching appointments with USU in various departments.

3. The International Irrigation Center

The Agricultural and Irrigation Department, College of Engineering is engaged in an extensive program of international irrigation technology transfer. The International Irrigation Center was organized to provide an appropriate entity within which to sponsor these ongoing training activities. The Center offers non-degree programs leading to a Certificate of Specialization (9-12 month training cycle, Certificate of Completion (1-5 month training cycle), and can organize and present specific training or research programs applicable to specific needs. Emphasis is placed on irrigation water management and utilization.

ADMISSION

Completed application form and supporting documentation must be submitted to the School of Graduate Studies on or before the following dates:

- April 15 for summer quarter.
- July 15 for fall quarter.
- October 15 for winter quarter.
- January 15 for spring quarter.

The 1984-85 schedule is as follows:

- 1984 Spring Quarter - March 21 - June 2.
- 1984 Summer Quarter - June 4 - August 17.
- 1984 Fall Quarter - September 21 - December 12.
- 1985 Winter Quarter - January 2 - March 15.
- 1985 Spring Quarter - March 20 - June 1.
- 1985 Summer Quarter - June 3 - August 16.

A bachelor's degree from an accredited college or university and a minimum 3.0 (B) grade point average is required if the candidate is to be considered for admission. In addition international students are required to submit scores from the Test of English as a Foreign Language. A minimum TOEFL score of 500 is required for admission.

GRADUATE PROGRAMS OFFERED

Graduate programs are available in 42 of the University's 45 departments and through several interdepartmental curriculums. A sampling of the programs offered includes:

- Agricultural Economics - M.S.
- Plant Science - M.S., Ph.D.
- Soil Science - M.S., Ph.D.
- Business Administration - MBA.
- Agricultural and Irrigation Engineering - M.S., M.E., M.E.S., Ph.D.
- Civil & Environmental Engineering - M.S., M.E., M.E.S., Ph.D.
- Irrigation Science - M.S.
- Applied Statistics - M.S.
- Computer Science - M.S.

The Master of Engineering (M.E.) degree is a terminal professional degree which provides a year of training beyond the bachelors degree. The ME degree program emphasizes the professional aspects of engineering instead of theory and research.

The Master of Engineering Science (M.E.S.) degree is offered in conjunction with a cooperative program between USU, University of Utah and Brigham Young University.

The Department of Agricultural and Irrigation offers an M.S. in Irrigation Science (water management and utilization emphasis). The Department of Civil and Environmental Engineering offers M.E., M.S., C.E. (Civil Engineer), and Ph.D. Areas of specialization include Structural Engineering, Geotechnical Engineering, Engineering Materials, Water Engineering, Water Resources Engineering and Hydrology, Fluid Mechanics and Hydraulic Engineering and Environmental Engineering.

COURSE SUMMARY/OPTIONS

The following course descriptions represent only a portion of the study disciplines and course work offered by USU. The USU

General Catalog and Graduate Catalog should be referred to for greater detail.

Course numbering is based on the content level of material presented in a course:

Below 300	Not acceptable for graduate work.
300-399	May be recommended by the supervisory committee subject to the approval of the graduate dean.
400-499	May be approved by the supervisory committee but subject to final approval of the graduate dean.
500-599	May be part of students program if approved by the supervisory committee.
600-699	Master level courses.
700-799	Doctoral level - Research & Thesis.

AGRICULTURAL AND IRRIGATION ENGINEERING

543. Irrigation Engineering.
Soil-water-plant relationships; water requirements; efficiency of water use; flow of water in soils; effects of irrigation on water quality.

544. Trickle (Drip) Irrigation.
Development and design of trickle (drip) and subsurface irrigation systems. Emitter characteristics, filtration, system planning and layout. Design economics, applications, system operation, and management.

545. Drainage Engineering.
Introduction to principles and practices of drainage. Engineering investigation and design of agricultural drains and wells.

546. Water Supply Development and Conveyance Systems.
Development of surface and ground water supplies. Capacity requirements and outlet conduits for storage reservoirs. Design of wells and pump selection. Design of canals, pipelines, flumes, and inverted siphons. Water Measurement.

547. Sprinkler Irrigation Design.
Irrigation demand, systems selection and uniformity, selecting system types and layouts, lateral and main-line design economics, pumping plant selection, and system operation and maintenance.

548. Surface Irrigation Design.
Design, evaluation, and management of basin, border and furrow irrigation systems. Field measurements in evaluating system performance and design. Land leveling computation and equipment. Headland and tailwater facilities. Automation.

549. Water Law and Institutions.
Acquisition, adjudication, and administration of water rights, state, interstate, and international water laws; irrigation, water pollution control districts, state and local organizations.

550. Irrigation System Analysis.
Field lab with formal reports covering water measurement; soil water management, land leveling, and evaluation of border, furrow, sprinkle, and trickle systems.

556. Design of Water Control Structures.
Design of transitions, drops, chutes, spillways, checks, headgates, and other control structures for water conveyance systems.

560. Water Management.
Organization and administration of water distribution institutions. Financing for construction and operation, maintenance of canals, flumes, pipelines, dams, regulating reservoirs, and other water facilities.

585. Agricultural Resources Engineering for Development.
Review and analysis of underdevelopment. Role of irrigated agriculture as an agent for development via a value system of a particular culture. Case studies.

590. Cooperative Practice.
A planned work experience in Industry. Detailed program must have prior approval. Written report is required.

645. Drainage Principles.
Advanced treatment of drainage theory, soil water potentials. Darcy's law, Dupuit-Forcheimer, anisotropy, homogeniety, design equations and their assumptions. Relief drains, interceptors, and wells.

660. Irrigation Project Planning and Evaluation.
Integrated analysis and techniques for irrigated agriculture development and project evaluation including technological water management and socio-economic considerations.

693. Special Problems in Agricultural Engineering.
Independent study of problems in agricultural engineering.

695. Design Project.
Individual projects involving the design, development, and/or testing of components, devices, or systems. A formal report is required.

731. Irrigation Science.
Interrelationships of irrigation system design with crop production economics. Advanced topics in water-soil-plant relations, crop growth stage, and irrigation scheduling. Systems analysis of agricultural production.

732. Sprinkle Irrigation Engineering.
Advanced topics including system selection, pipe network analysis, economic optimization, project layout, pump selection, energy conservation, water hammer, salinity, microclimatic control, and soil factors.

733. Surface Irrigation Engineering.
Advanced study of surface irrigation:flow hydraulics of furrows and borders; application of efficiency and uniformity; computers in land leveling calculations; land reclamation; water disposal.

735. Irrigation Return Flow.
Water pollution problems. Role of irrigation in producing water quality changes, nature of changes, and use of irrigation as method of water quality renovation.

745. Drainage Investigation and Design.
Comprehensive engineering of drainage systems. Investigation, design, specifications, contracts, cost estimation, outlets, main drains, on-farm systems. Relation of drainage to total water and land use.

AGRICULTURAL EDUCATION

512. Vocational Technical Education Program Planning and Evaluation.
Program planning and evaluation strategies are studied. Local manpower surveys and evaluation questionaries are designed. Job analysis as a basis for curriculum planning.

530. Foundations of Adult Education Programs.
Historical and philosophical foundations of adult and continuing education programs. Emphasizes measurable factors as administration, curriculum and program development, conducting and evaluating adult programs.

APPLIED STATISTICS

501. Engineering Statistics.
This course is designed to provide a probability background. Probability, discrete and continuous distributions, and mathematical expectation are considered. Applications to operations research.

502. Engineering Statistics.
Topics include sampling distributions, statistical inference, regression, and correlation. Applications in industrial quality control and reliability.

503. Engineering Statistics.
Design and analysis of industrial experiments. Analysis of variance, factorial design, split plot design etc.

510. Sampling.
Random sampling, sampling for proportions, stratified sampling, cluster sampling. Emphasis will be placed on applications.

515. Categorical Data Analysis.
Analysis of categorical data. Contingency tables; goodness of fit; work of Goodman, Kullback; Markov chains; use of computer programs.

520. Design of Experiments.
The design, analysis, and interpretation of experiments especially factorials, split plots, incomplete blocks, confounding, factional factorials, and nested design.

525. Least Squares Analysis of Unbalanced Data.
The analysis of messy data. Two-and Three-factor analysis, different dummy variables, codings, unbalanced split plots, multiple comparisons, expected mean squares, and general analysis of covariance.

530. Statistical Methods in Logistics.
Application of statistics and probability to the management and assessment of support systems; reliability; formulating maintenance policies; inventory control; mathematics as a management tool.

BOTANY

641. Plant-water Relationships.
Factors affecting the availability of water, its absorption and use in plants, and the effects of water deficits on plant processes.

647. Plant-Water Relationships Laboratory.
Methodology and instrumentation in plant-water relationships.

CIVIL ENGINEERING

500. Construction Cost Estimating.
Introduction to construction contracting, methods of preparing cost estimates, including an introduction to the critical path method of planning and scheduling construction projects.

541. Small Watershed Hydrology.
The role of land conditions in dealing with problems of applied hydrology with emphasis on the small watershed, limited data, and land management situations.

552. Hydraulic Design.
Design of pipelines including pumping stations and control structures outlet works from dams including intakes, gates, tunnels, hydropower equipment, spillways, and stilling basins.

553. Engineering Hydraulics.
For graduate students needing an engineering hydraulics course. Hydrostatics, continuity, work-energy, impulse-momentum, pipe and open channel flow. Not accepted for graduate credit in engineering.

566. Management of Water Resources Projects.
Management concepts and techniques for a practical water resources project, including a consideration of stream water quality.

570. Watershed Hydrologic Modeling.
Digital modeling of the hydrologic system in small water-sheds. Model definition, formulation, calibration, interpretation, and application.

590. Cooperative Practice.
A planned work experience in industry. Detailed program must have prior approval. Written report is required.

591. Teaching Engineering.
Upper division engineering students learn to prepare and present course work and advise students in lower division engineering courses.

639. Hydrologic Instrumentation.
The installation, use, and maintenance of various instruments used in the collection of hydrologic data.

640. Engineering Hydrology.
Qualitative concepts in the hydrologic cycle, hydrograph analysis, surface runoff, groundwater, basic statistical concepts, sources of hydrologic data, hydrologic instrumentation laboratory.

641. Hydrologic Processes.
Analysis of the physical laws governing such hydrologic processes as infiltration, overland flow, snow hydrology, and storage and channel routing.

642. Statistical Hydrology.
Techniques for analyzing hydrologic data for flood frequency, stochastic modeling, estimating runoff from precipitation and studying hydrologic change including regression, principal component analysis, and curve fitting.

643. Groundwater Hydrology.
Aquifer properties, storage, movement, recharge, and withdrawal; safe yield; planning, development, and management of groundwater; economic and legal considerations; maintenance of groundwater quality; conjunctive use.

644. Advanced Groundwater Hydrology.
Stochastic streamflow generation with applications to reservoir yield, terminal lake fluctuations, operation of water storage facilities, and stochastic simulation models for water resources planning.

645. Parametric Hydrology.
Synthesis of the material taught in CEE 640 and CEE 641 into the development of hydrology computer models with applications to water resource management problems.

653. Hydraulic Modeling and Experimental Methods.
Hydraulic modeling; design and development of laboratory equipment and instrumentation; experimental design and investigation of fluid flow; data acquisition and analysis.

655. Open Channel Flow.
Theory and application of steady uniform and varied flow under both sub-critical and supercritical flow conditions. Unsteady flows which result in both positive and dispersive waves.

656. Sediment Transport.
Channel roughness and design of stable channels.

742. Water Resources Engineering Systems Analysis.
Technique of operation research, and systems analysis - linear, integer, mixed integer, and dynamic programming - applied to water resources and water quality problems.

743. Water Resources Engineering Systems Analysis.
Technique of operation research, system and stochastic analysis-nonlinear programming, stochastic and multi-objective methods - applied to water resources and water quality problems.

744. Water Resources Planning and Institution.
An examination of the theory and practice of planning as applied to water resources and the institution involved in the planning process.

COMMUNICATIONS

523. Technical Training for Innovative Programs.
Preparing prospective and incumbent teachers to implement and conduct contemporary programs. Skill development and the philosophy needed to innovate are included.

540. Training Program Management.
Development and management of corporate and government training programs and conferences. Provides training experience.

COMPUTER SCIENCE

515. Information Systems II: Management Information Systems.
Data organization, storage,hardware, management in the MIS, problem solving, examining the MIS, case studies.

516. Information Systems III: Analysis and Design of Information Systems.
Development cycle, preliminary survey, analysis of present system, design, implementation, installation, other influences.

520. Data Base Management.
A study of data base concepts and management of large data base systems.

521. Data Base Management Systems - Lab.
Laboratory for CS 520, taken concurrently.

525. Computer Modeling and Simulation.
Introduction to simulation and comparison with other techniques. Discrete simulation models and discrete change simulation. Analysis of data generated by simulation experiments and validation of simulation models and results. Prerequisite: statistical methods and computer programming.

AGRICULTURAL ECONOMICS

555. Resource Economics.
Allocative and distributive implications of using and managing natural resources: environmental quality, valuation of nonmarket goods, resource scarcity, evaluation of public and private actions.

585. Regional Economics and Area Development.
Location theory, regional development theories, methods, and model of regional analysis, and public policy for regional development.

655. Economics of Exhaustible Resources.
Economic theory of the use of exhaustible resources, (renewable and nonrenewable) under conditions of perfect and imperfect property rights including externalities and common property problems.

SOCIOLOGY.

560. Sociology of Natural Resources.
For students interested in the social organization and social systems associated with natural resources. Includes principles and a field of study of resource problems.

563. Social Impact Assessment.
Theoretical and methodological problems of social impact assessment. Government policy processes are increasingly mandating social impact assessments to evaluate policy.

SOILS.

614. Soil Physics.
The flow of water and heat, and air in soils as influenced by evapotranspiration; plant uptake and drainage as related to irrigation and dryland management.

619. Salt-affected Soils.
The chemistry of salt-affected soils and its relation to soil management of irrigated systems.

SECTION V. ASIAN INSTITUTE OF TECHNOLOGY

The Asian Institute of Technology (AIT) is an autonomous, international post-graduate technological institute in Bangkok, Thailand providing advanced education in engineering, science and allied fields through:

> Academic Programs leading to the degrees of Master of Engineering Science, Doctor of Engineering, Doctor of Technical Science, and Diplomas;
>
> Research Activities by faculty and students directed towards the solution of technological problems to improve the quality of life in Asia;
>
> Continuing Education Programs comprising conferences, seminars and short in-service training courses.

Originally established in 1959, the Institute was chartered in 1967 as an independent, international and non-profit making educational institution. The Institute's 400-acre campus is located 42 kms north of Bangkok.

At the Institute, students from many Asian countries pursue practical academic studies: seeking, defining and testing alternative solutions to urgent problems found in the region.

From its inception, the Institute has stressed the problem-oriented nature of its academic programs to the end that appropriate solutions may be found for Asian Problems.

The Institute offers degree and diploma programs in nine Academic Divisions, viz: Agricultural & Food Engineering, Computer Applications, Energy Technology, Environmental Engineering, Geo-technical & Transportation Engineering, Human Settlements Development, Industrial Engineering & Construction and Water Resources Engineering.

Providing academic support and complementary programs are the Academic Centers: Continuing Education Center, English Language Center,

Library & Regional Documentation Center, Asian Regional Remote Sensing Training Center, Regional Computer Center and Regional Research and Development Center.

CONTINUING EDUCATION CENTER

Cognizant of the needs of the region in continuing education and following the successful experience of AIT in organizing conferences, workshops and short courses, the AIT Board of Trustees established the Continuing Education Center in March 1979. The Center is charged with the responsibilities of:

> assisting in the professional development of engineers, planners and managers in the region by providing suitable learning opportunities both on and off campus.
>
> assisting in the training of those involved in the process of appropriate technology innovation and dissemination.

The continuing education programs of AIT include such form as seminars and workshops, short courses, and conferences.

Seminars are generally run for a few days. They usually cover state-of-the art topics and current developments. Experts and authorities from industry, research, private practice and education serve as lecturers and resource speakers.

Workshops are similar to seminars in terms of duration and subject matter. However, they differ in that workshops usually involve participants in special projects or case studies. Enrollments are often limited so that lecturers can work more closely with the participants.

Short courses normally run for a few weeks. Participants are involved in more detail and depth of instruction and study. The Faculty of the Institute as well as experts from industry and private practice serve as lecturers to these courses.

Conferences of three to five day duration are periodically organized to provide engineers, planners, scientists and educators the venue to present the results of their studies and to exchange views and experiences on special topics of regional or international relevance.

Various programs are structured and offered in consultation with those in private practice, industry, government, educational institutions and the alumni of AIT in the region.

Certain programs can be adapted to a single organization's needs. Indeed, AIT accepts requests from organizations to structure and offer programs geared to their specifications.

ADMISSION

To be eligible for admission to the master's degree program or the Diploma program, a candidate must:

(i) hold a degree at the bachelor level, or its equivalent, in an appropriate field of study from an institution of recognized standing;

(ii) have undergraduate grades well above average;

(iii) be fluent in the English language;

(iv) be physically and mentally fit; and

(v) have a record of good conduct.

To be eligible for admission to the doctoral program, a student must:

(i) hold a master's degree, or its equivalent;

(ii) have both undergraduate and graduate grades well above average; and (iii), (iv), and (v) as above.

Applications for admission must be received by the normal closing date related to the proposed date of entry. If places are available, late applications may be considered but scholarships will not normally be available for such applicants.

Depending on the Division for which a candidate has applied, students are admitted to the Institute in January, May, and September. The following information shows the term in which students may enter each Division for the master's degree.

Fore entry in...	Normal closing date
January 1984	15 May 1983
May 1984	15 September 1983
September 1984	15 January 1984

January Term Intake: Candidates may apply for admission to the Divisions of Agricultural & Food Engineering, Computer Applications, or Energy Technology.

May Term Intake: Candidates may apply for admission to the Divisions of Human Settlements Development, Industrial Engineering & management, or Water Resources Engineering.

September Term Intake: Candidates may apply for admission to the Divisions of Geotechnical and Transportation Engineering, Environmental Engineering, or Structural Engineering & Construction.

Students reach the Institute with a wide variety of linguistic backgrounds and a considerable range of abilities in English. Since English is the medium of instruction and communication at AIT, all entrants are required to understand English as spoken by a variety of different speakers, to take notes in lectures, to read extensively in their field of study, to write reports, and eventually to complete a thesis.

All students must sit the language entry test administered at the commencement of term. Exemption from language classes is made only on the basis of a candidate's results in this test.

DEGREE PROGRAM OFFERINGS

Agricultural and Food Engineering.

Current areas of emphasis in the Division are: soil and water, power and machinery, food processing, and aquaculture.

Soil and Water.

This program involves fundamental soil soil properties and processes, choice of crops in relation to climate and soil, soil erosion and control measures, soil improvement and reclamation, effective use of fertilizers, soil-plant-water relationships, water management, field irrigation, agricultural drainage, quantitative and qualitative improvement of crop production, and integrated farming.

A typical course work schedule for the Master's degree in this area of specialization could include the following courses:

Introduction to Tropical Agriculture
Soil Physics
Soil Conservation
Field Evaluation of Irrigation Techniques
Crop Water Management in the Tropics
Statistical Methods and Experimental Design
Mathematical Techniques for Engineering
Computer Technology

Water and Management

This program provides a broad knowledge of the functional requirements and principles of operation of field machines, machinery selection and management, design of appropriate machines, and application of systems techniques to the bio-economic and technological problems involved in managing agricultural production.

A typical coursework schedule for the Master's degree in this area of specialization could include the following courses:

Theory of Field Machinery
Agricultural Mechanization and Management

Agricultural Machinery Laboratory
Ground Drive Systems
Agricultural Systems Analysis
Instrumentation and Measurement Techniques
Mathematical Techniques for Engineering
Computer Technology
Statistical Methods and Experimental Design

Computer Applications.

The Division of Computer Applications seeks to promote faculty and student ingenuity to exploit the considerable computing facilities available for solving Asian problems, and to enhance computing capabilities for that purpose.

The Institute has a flexible approach to its study programs and will wherever possible, subject to resources and candidate qualifications, attempt to accommodate individual programs to fit candidate needs. All students admitted to the Division of Computer Applications will normally take the following core courses:

Software Concepts
Information Systems Analysis and Design
Software Engineering
Data Base and Data Management
Applied Statistics
Computer Architecture
Microprocessor Applications

In addition, a wide range of electives, within and outside the Division, can be taken to complete the coursework requirements.

Water Resources Engineering.

Academic Programs.

The tremendous potential for the development of Asia's water resources requires the services of engineers trained to plan, design, and construct engineering works for the Water Resources Engineering Division's academic programs place emphasis on

hydraulic and coastal engineering, irrigation engineering, and water resources development in order to train engineers to achieve these objectives.

The Institute has a flexible approach to its study programs and will, wherever possible, subject to resources and candidate qualifications, attempt to accommodate individual programs to fit candidate needs. All students in the Division will normally take the following core courses:

Engineering Fluid Mechanics
Flow in Open Channels
Applied Tropical Hydrology
Mathematical Techniques for Engineering

In addition, a wide range of elective courses, within and outside the Division, can be taken to complete the course-work requirements. Current areas of emphasis in the Division are:

Hydraulic and Coastal Engineering:

This program examines the hydraulic and morphological conditions peculiar to the riverine and coastal environment. Pre-requisites are, therefore, knowledge of the mechanics of fluid flow and of recent developments and established techniques in civil engineering practice.

Irrigation Engineering:

Methods of engineering, irrigation policy, land development, drainage, and salinity control are among the topics on which research and instruction in this program are focused.

Water Resources Development:

In this program of study the focus is on the hydrology of both surface and ground water, as well as on modern methods of system analysis used in the planning, design, and operation of water

resources projects.

Laboratory Facilities:

The hydraulics laboratory is in several sections; the largest of these is employed for experimental work on open channel flow, sediment transport, wave motion, river and estuary models, and hydraulic structures. A towing basin is available for current-meter calibration and similar work. Other sections have been equipped with apparatus for the study of turbo-machinery, fluid metering, pipe flow, and ground water. Subsonic wind tunnels are available for studies involving air flow. Two temperature controlled laboratories are available for specialized studies in porous media flow and other problems of fluid flow. The total covered area of the laboratory is approximatory 1350 square meters. A fully instrumented climatological station is operated as part of the national meteroro-logical network.

Admissions:

The preferred fields of undergraduate study for candidates seeking admission to the mater's program are in civil and agricultural engineering. For the doctoral degree, a higher degree in water resources engineering is required.

SECTION VI - BUREAU OF RECLAMATION (BUREC)

ON THE JOB TRAINING OPPORTUNITIES

The BUREC is a water and land resources development organization within the U.S. Department of Interior that plans, designs, constructs, operates and maintains multipurpose water projects in the western United States. As a part of its effort to further the international sharing of technology developed and used in the development of its projects the BUREC provides training and study opportunities for foreign personnel at its facilities in the United States.

The scope of the overall Reclamation activities involve many disciplines which serve as the basis for a wide range of training opportunities. The training programs may be highly specialized and of short duration, or may last as long as one year and involve academic study besides the on-the-job application and work experience associated with the specific training goal(s). Each program is designed for the specific needs and capabilities of the participating individual or group.

Foreign nationals visiting the Reclamation offices are designated as in-service trainees, official observers or accredited visitors. Specific programs are prepared for each category.

- In-service trainees spend from 4 months to 1 year working with experienced engineers, technicians and scientists in an informal, on-the-job training program. In addition, in-service trainees may receive formal academic training at a college or university, and undertake practical training with the Bureau during vacation periods.

- Offical observers are expected to be experienced engineers, administrators or other officials whose objective can best be met by a program ranging in length from a few days to 4 months. These programs combine office studies and

consultations with visits to field sites to observe project planning, construction or operation activities. Programs for official observers permit study and discussions of broad aspects of Reclamation's work at high professional levels.

Accredited visitors are limited to a maximum of 3 days.

Most of the training programs combine field and office assignments. The training is carried out by regular professional employees in the course of their normal duties rather than in a classroom situation. The exception to this would be where trainees may participate in formal short courses designed primarily for BUREC employees.

Trainees are guided and instructed in the performance of their tasks commensurate with their background, skill and experience. The instruction is based on American management practices which may or may not conform to the conditions in the trainee's home country. Trainees are expected to adopt these practices to their own country conditions after they return to their country.

While training is available in numerous aspects of the Bureau's work, the number of subjects studied in any one program is restricted to allow in-depth training rather than a cursory examination of a large number of areas. The subjects selected for study should relate to the trainees work duties at home.

The scope of activities from which training programs may be developed is extensive. The major subject areas include - Planning - Design - Dams - Electrical - Mechanical - Applied Sciences - Geotechnical - Electric Power - Instrumentation - Hydraulics - Operation and Maintenance - Land Resources Management - Water Operation and Maintenance - Drainage and Groundwater - Water Conveyance - Construction - Geology - Laboratory Research and Testing - Concrete and Structural - Economics and Statistics - Power Operation and Maintenance - Dams and Structural Safety - Management Support.

Specific activities under selected headings directly related to the scope of training under the ISM Project includes:

Planning - Technical aspects of conducting planning studies and preparing and reviewing planning reports - developing standards, procedures and evaluation systems governing economic, environmental, social, public involvement, etc. - technical aspects of flood, sedimentation, and river channel hydraulic studies.

Design - Separate disciplines in which design methods may be studied include:

1. Dams - Concrete and earthfill dams - spillways - outlet works - river diversions and controls - desilting works.

2. Mechanical - Hydraulic machinery and mechanical equipment such as pumps, pump-turbines, gates, valves, etc.

3. Instrumentation - Investigation, developing and designing testing and research instrumentation.

4. Hydraulic - Analytical, laboratory and field investigations of hydraulic structures - sedimentation, flow measurement, drainage - special purpose, hydraulic related equipment and apparatus for field and laboratory application.

Operation and Maintenance - Training activities available to meet specific requirements including:

1. Water Operation and Maintenance - Operation, maintenance and water management on Bureau constructed and related facilities - examination of completed systems - efficient water use on farms and throughout distribution and storage system - control of weeds and other pests - evaluating facilities for rehabilitation and betterment.

2. Drainage and Groundwater - Investigating, designing, construction, operating and maintaining drainage and groundwater systems.

3. Water Conveyance - Canals - irrigation conveyance systems - lateral and drainage systems - irrigation pipe distribution systems - headworks - diversion dams - diversion control facilities - pumping plants - intake structures - irrigation structures.

4. Construction - Technical aspects of supply and contract administration - preparing specifications - cost estimating - scheduling - inspection procedures.

Laboratory Research and Testing - Research and testing activities in which participants may be trained include:

1. Concrete and Structural - evaluating new materials, equipment, design and methods.

2. Economics and Statistics - collection and utilization social and statistical data for water and land resource development and repayment.

3. Dams and Structural safety - preparation of engineering analysis policy, inspections and performance evaluations.

4. Management Support - budget process - fund control and administration - personnel functions and development - management analysis - technical report and publication writing.

Trainee Requirements

1. Language - BUREC training is non-academic and is conducted in the English language. A minimum TOEFL score of 450 is required.

2. General - Trainees must be fully professional in disciplines applicable to water resource development and have graduated from a recognized university. Trainees should have had at least 2 years of experience in the professional field the participant proposes to study with the BUREC.

3. Special Requirements

   a. Trainee will work under a supervisor and is expected to do work as assigned.

   b. Trainee must be willing to live in a small town.

   c. Trainee must be willing to work in field (requires work clothing). The normal work week will be 40 hours (8-5 Monday through Friday).

   d. The technical requirements of the training program may necessitate some evening and weekend reading or research.

SECTION VII - SHORT AND MEDIUM TERM COURSE OPPORTUNITIES

A. EUROPE

1. IRRIGATION COURSE (Bari) 1/

The International Centre for Advanced Mediterranean Agronomic Studies, Bari Institute (ICAMAS) in Italy organizes an International Irrigation Course. Lecturers come from various countries and institutions, including several from the Agricultural Faculty and Engineering Faculty of Bari University and several research institutes and experimental stations.

Course content:

The irrigation course is divided into three sections with various subunits:

1. Planning: orientation to Mediterranean area and developing countries; integrated planning of projects; water institutions and law; economics of irrigation development; hydrology and hydrogeology; soils.

2. Development: source of water; water structures and hydraulic systems design; other water sources; maintenance.

3. Use: general; irrigation preparation; irrigation systems and methods; water removal.

Language:

English, French and Italian.

Admission:

Agricultural or civil engineering degree or BSc degree or equivalent with at least one year of practical experience.

1/ Material/information from Food and Agricultural Organization of the United Nations (FAO).

Duration:

One academic year (starting approx. October).

For further information contact: The Director, International Centre for Advanced Mediterranean Studies, Institute de Bari, Str. Prov. Ceglie, Valenzano, Italy. Tel: (080) 652401/652157/652160.

2. IRRIGATION ENGINEERING POST-GRADUATE COURSE (Leuven) 1/

The (Dutch speaking) Catholic University of Leuven, Faculty of Agricultural Sciences, organizes yearly a post-graduate course in irrigation engineering starting in the academic year 1981-82. The aim of this course is to train agricultural and civil engineers, particularly from developing countries, in advanced irrigation and management of irrigated lands. Special attention is devoted to promoting a quantitative mathematical approach.

Course content:

- Agricultural use of land
- Soil conditions
- Numerical techniques
- Field irrigation systems and management
- Irrigation conveyance systems
- Water resource planning.

Language:

English.

Admission:

Applicants must be holders of an academic degree (MSc) in agriculture or in civil engineering from a recognized university or institute.

Duration:

One academic year (October to beginning of July).

For further information contact: K.U. Leuven, Faculty of Agricultural Sciences (p.a. Irrigation Engineering), Kardinaal Mercierlaan 92, B-3030 Leuven (Heverlee), Belgium.

3. IRRIGATION ENGINEERING COURSE (Southampton) 1/

The Institute of Irrigation Studies at the University of Southampton, UK, offers a MSc course in Irrigation Engineering, to train engineers from all parts of the world in both technical and non-technical aspects of irrigation planning and design, with special emphasis on conditions in less developed countries.

Course content:

The course will highlight the following subjects: surface water hydrology, groundwater hydrology, soil physics, geotechnical engineering, open-channel flow, hydraulics of control structures, hydraulic models, dams, fundamentals of irrigated agriculture, design of irrigation systems, drainage of irrigated lands; Project planning, appraisal and monitoring; Management economics, statistics, computation, language and communication; Visiting lecturers, seminars and site visits.

Language:

English.

Admission:

Degree in civil engineering or equivalent.

Duration:

12 months, beginning in October.

For further information contact: The Academic Registrar, University of Southampton, Southampton SO9 5NH, UK. Tel: (0703) 559122 Ext. 2837.

4. IRRIGATION ENGINEERING COURSE (Silsoe) 1/

The National College of Agricultural Engineering, Silsoe, Bedford, UK, conducts a three-year course leading to a BSc in Agricultural Engineering with specialization in the final year. The Field Engineering major includes the study of: soil-plant-water relationships, water supplies and storage, soil and water conservation, irrigation and drainage.

The advance courses are a nine-month Post-graduate Diploma in Agricultural Engineering, and the MSc in Agricultural Engineering which may be taken as a twelve-month or twentyfour-month programme. All the advanced courses have options in Soil and Water Engineering. Courses include: Soil Mechanics; Soil-Plant-Water Relationships; Hydrology; Resource Survey Methods; Statistics; Water Supplies; Water Resources Development; Theory and Practice of Cultivation; Irrigation; Drainage; Soil Conservation.

The short course programme includes courses on Irrigation and Drainage, Air Photo Interpretation, and Practical Land Surveying. Short courses can be arranged for in-country, in-service advanced training in developing countries.

For further information contact: Careers and Recruitment Officer, The National College of Agricultural Engineering, Silsoe, Bedford MK45 4DT, UK. Tel: (0525) 60428.

5. SOIL SCIENCE AND WATER MANAGEMENT POST-GRADUATE COURSE (Wageningen) 1/

The Agricultural University, Wageningen, offers a MSc course in Soil Science and Water Management.

Course content:

Participants may specialize in one of the following subjects: (1) Land evaluation and agropedology; (2) Soil fertility, soil and plant analysis; (3) Water management: irrigation, drainage and agrohydrology.

Language:

English.

Admission:

The course is open to those with a BSc or MSc degree in agriculture or in a science closely related to soil science or water management. The course is designed for foreign students particularly from developing countries. An entrance examination in the fundamental sciences (mathematics, physics and chemistry) as well as a test in English are required for admission.

Duration:

2 years.

For further information contact: MSc Course in Soil Science and Water Management, P.O. Box 37, Wageningen, The Netherlands.

6. INTERNATIONAL COURSE ON RURAL EXTENSION 1/

The aim of the course, organized by the International Agricultural Centre, Wageningen, is to give an in-service training of the refresher type and therefore participants are invited who have some experience but wish to hear about recent developments in their profession.

Course content:

The themes will be dealt with as aspects of management of extension:

- management and organization
- communication
- planning and programming (task performance)
- field work management
- media in extension
- extension services and other services in the Netherlands
- various subjects
- excursions

Language:

English, French and German.

Admission:

BSc level and preferably some years of experience in rural extension either in management of a service or in actual advisory work or in teaching.

Duration:

4 weeks (28 June - 25 July 1981).

For further information contact: Director of the International Agricultural Centre, P.O. Box 88, 6700 AB Wageningen, The Netherlands.

7. INTERNATIONAL COURSE ON LAND DRAINAGE 1/

An international course on Land Drainage is held in Wageningen, The Netherlands. The course is intended for people mainly from developing countries who are engaged in land drainage, and its objective is, in a period of three months, to provide participants with a thorough knowledge of the questions related to this subject: the underlying physical and agricultural principles, the surveying methods, and the principles of design and construction in both humid and arid regions. The course, however, does not cover civil engineering works.

Language:

English.

Admission:

BSc degree and experience in land drainage.

Course content:

The programme comprises lectures, practical exercises, demonstrations and field trips to various projects in The Netherlands. The programme of lectures may be summarized as follows:

- Introductory subjects
- Principles of land drainage
- Surveys and investigations for drainage problems
- Engineering aspects
- Case studies.

During the second part of the course specialization groups will be formed in:

- main drainage systems
- soil moisture measurements
- salinity control.

Duration:

14 weeks.

For further information contact: The International Agricultural Centre, P.O. Box 88, 6700 AB Wagenin, The Netherlands. Tel: (08370) 19040. Cables: INTAS. Telex: 45888 INTAS NL.

B. MIDDLE EAST / AFRICA

1. LAND AND WATER DEVELOPMENT TRAINING COURSES 1/

The Egyptian International Centre for Agriculture, Cairo, was established in 1965 and is supervised by the Foreign Agricultural Relations Department of the Ministry of Agriculture.

The international courses which are conducted at the Centre are designed to cover both the theoretical and practical aspects relating to subject matter under study, with special reference to the Egyptian experience in this field. There are four courses conducted at the Centre each year for five months which are as follows:

- Agricultural extension, cooperatives and credits (February - June)
- Plant production and protection (February-June)
- Land and water development (July-November)
- Animal production and health (July-November)

The course on land and water development covers a wide range of subjects grouped under the following main headings:

- Fundamentals of soil science
- Land reclamation, planning and execution
- Development, exploitation, management and settlement schemes
- Irrigation principles and development
- Drainage network, function and design.

For further information contact: The Director, The Foreign Agricultural Relations Department, Ministry of Agriculture, Dokki, Cairo, Egypt.

2. POST GRADUATE COURSE ON IRRIGATION/SOIL CONSERVATION 1/

A post-graduate course on Irrigation and Soil Conservation is given at the University of Nairobi, Kabete Campus.

Course content:

a. Applied mathematics and fluid mechanics (60 hours)
b. Hydrology and agrometeorology (40 hours)
c. Soil and plant water relations (40 hours)
d. Irrigation technology (80 hours)
e. Land evaluation (20 hours)
f. Drainage (60 hours)
g. Soil erosion (40 hours)
h. Water resources, survey and land forming (60 hours)
i. Economics of irrigated agriculture and feasibility studies (40 hours)
j. Soil conservation methods (20 hours)
k. Land reclamation of eroded land (20 hours)
l. Land use planning (40 hours)

Language:

English.

Admission:

A BSc degree in agriculture, agricultural engineering or equivalent qualifications in the field of agriculture or engineering.

Duration:

One year.

For further information contact: The Chairman, Department of Agricultural Engineering, University of Nairobi, Kabete Campus, P.O. Box 30197, Nairobi, Kenya. Tel: Fortsmith 2175.

C. ASIA & THE PACIFIC

1. COURSE ON WATER MANAGEMENT FOR RICE CULTIVATION 1/

The Japan International Cooperation Agency (JICA) organizes a special irrigation training course every year with emphasis on water management for rice cultivation.

Language:

English.

Admission:

The course is given to irrigation engineers from developing countries with about ten years of practical experience. Number of trainees varies from twenty to forty per year.

Duration:

6 months.

For further information contact: JICA, P. O. Box 216, Mitsui Building, 2-1 Shinjuku, Shinjuku-ku, Tokyo 160, Japan.

2. IRRIGATION COURSE 1/

Yanco Agricultural College, New South Wales, was set up to provide vocational training for future farmers. The 10-month Irrigation Certificate Course is designed to provide a fundamental understanding of the relationship between irrigation and the environment and a working knowledge of certain principles selected from various disciplines as they apply to irrigation.

Course content:

The disciplines of irrigation science dealt with are: irrigation agronomy, irrigation engineering, irrigation planning and operation and irrigation economics.

Integration of subjects is achieved with the aid of practical work and assignments, which usually involve various aspects of all five disciplines. In addition, integration is achieved by two or more lecturers combining to present lectures and demonstrations, and take part in discussions.

The emphasis in all topics is on the practical application of the subject matter. The field activities will vary from year to year depending on seasonal conditions and the particular requirements of each group of students. These involve complete management and operation of discrete irrigation units of the college farm.

Language:

English.

Admission:

The course is intended to provide vocational education and training at the farmer/manager level; specialist education and training for persons who will be involved in general agricultural extension work, and education and training in irrigation for professional irrigation technologists.

Duration:

10 months (usually commencing mid-February/March).

For further information contact: The Principal, Yanco Agricultural College, Yanco, New South Wales, Australia 2703. Tel: (069) 530211. Telex: Yanco AA 69060.

3. POST GRADUATE COURSE ON AGRICULTURAL SOIL AND WATER ENGINEERING 2/

The Division of Agricultural and Food Engineering, Asian Institute of Technology, offers a post-graduate programme in Agricultural Soil and Water Engineering.

Course content:

Emphasis is placed on means of obtaining increased crop production, including studies on on-farm irrigation techniques and management, salinity and drainage, soil physics and chemistry, soil-water-plant relationship, soil erosion and control measures, and soil fertility and crop production. Research is mainly concentrated in the areas of irrigation and drainage, fertilization and amelioration of soil for increased crop production.

Language:

English.

Admission:

Post-graduate course.

For further information contact: The Registrar, Asian Institute of Technology, P. O. Box 2754, Bangkok, Thailand. Telephone 5168311-5. Cables: AIT Bangkok.

4. SYSTEM DESIGN IN WATER RESOURCES DEVELOPMENT 2/
4-week course

This course is designed for the engineers and planners involved in the development and planning of water resources projects.

2/ Material/information from Asian Institute of Technology (AIT), Bangkok, Thailand.

After the course the participants will be able to apply the system design techniques, deterministic and stochastic models in water resources system design; be able to develop efficient reservoir operation policy including short term, long term and online operation; be able to develop, select and appraise the water resources projects for both single and multipurposes.

5. PLANNING AND DESIGN OF SMALL IRRIGATION SYSTEMS 2/
4-week course

The course aims to provide a thorough understanding of the planning and design of small scale irrigation project so that the participants will be qualified as a specialist engineer. In particular, the participants will be able to identify, select and appraise irrigation project; to understand and practice the techniques to analyse small watershed hydrology and the use of insufficient input data; to design small scale irrigation systems based on latest but appropriate design and construction techniques.

The course is intended for engineers with practical experience in the design of irrigation systems.

6. DEVELOPMENT AND MANAGEMENT OF GROUNDWATER 2/
2-week course

The purpose of the course is to provide the up-to-date information on the various aspects of groundwater development and management. After this course- the participants shall be able to assess the quantity and quality of groundwater making the use of recent but appropriate techniques and tools and be able to develop proper management criteria so as to prevent mining of groundwater reserve.

The course is intended for engineers, groundwater hydrologist, and geohydrologist who deal with groundwater development and management problems.

7. ON-FARM WATER MANAGEMENT 2/
4-week course

The short course presents principle and practical application of soil-water-plant relationships that relate to crop water management. Emphasis is placed on land levelling, water quality, salinity and drainage in relation to efficient utilization of water; and on the evaluation, selection and improvement of different irrigation methods. The lectures, workshop and project works are designed in such a manner that the participants will receive adequate preparation to apply the knowledge to evaluate the existing operation and management conditions of the irrigation system and to assess the potentiality for further improvement; to recommend modifications involving simple changes in the management practices of irrigation system; to assist the agricultural and irrigation related technicians and farmers identify local problems of irrigation systems and implement solutions.

The course is particularly designed for those engineers working in irrigation system operation and management who require a better understanding of the new concepts and application of on-farm water management.

8. FLOOD FORECASTING AND STREAM FLOW ROUTING TECHNIQUES 2/
2-week course

This 2-week program is designed for those who are working in the field of flood forecasting operation and flood routing computation and need to improve their familiarity with concepts and techniques of flood forecasting.

The main objectives of this program are that by the end of the course participants should be familiar with flood forecasting methods and flood routing techniques in tidal and non-tidal river reaches and be able to make judgement as to the reliability and accuracy of forecasts; be able to construct flood routing mathematical models selecting appropriate boundary and initial conditions.

9. COMPUTER INFORMATION SYSTEMS DEVELOPMENT 2/
4-month AIT Certificate Program

The objectives of the program is to provide the participants with a knowledge and the techniques in the evaluation, design and implementation of data processing system. The participants in this program will gain greater competence as system analysts as a result of increasing their knowledge in the areas of different programming languages, software engineering, systematic techniques and analysis of procedural data. Emphasis is also being placed on the microcomputer and microprocessor application development.

The training consists of 3 hours of lecture in the morning and 3 hours of computer-lab work in the afternoon. The program has four modules including a special project study and a trainee can register for any one of the three modules except special study. The AIT certification is awarded upon completion of four modules.

This course is designed to meet the needs of individuals who must function with a data processing environment and have some experience in computer programming.

10. APPLICATION OF MICROCOMPUTER TO PRIMARY PROCESSING OF HYDROLOGICAL DATA 2/
4-week course

This course is intended for the engineers and scientists with sufficient background knowledge in hydrology but little or no previous knowledge in microcomputer.

The objectives of the course is to give the participants a practical knowledge of the potential applications of microcomputers in hydrological data analysis. In the introductory classes the participants will be exposed to the fundamentals of microcomputer and FORTRAN programming with practical application and exercises. Finally, the course will teach how to use the microcomputer software package in the analysis of hydrological data.

11. APPLICATION OF SYSTEM ANALYSIS AND COMPUTER TECHNIQUES TO HYDROLOGY 2/

3-month program

This course is designed for the engineers and scientists with some experience in hydrological work but little or no previous exposure to computer techniques.

The objective of this program is to provide the participants with practical and conceptual knowledge of the application of computer for hydrological data analysis. After the course the participants will be able to use the computer in monitoring, control, data acquisition application and analysing data. The first half of the course will be devoted to understand the computer architechture, operating principles, programming concepts, FORTRAN language, advance programming and file design. The later part of the time will be spent in the basic techniques of system analysis which will include the system design principles and techniques, data management and data base, basic statistics in hydrological analysis and simulation techniques in hydrological and flood forecasting.

D. NORTH AMERICA (USA)

U.S. DEPARTMENT OF AGRICULTURE

1. IRRIGATION PROBLEMS AND PRACTICES, TC 120-1

Dates & Duration: 8 weeks - June 18 - August 10, 1984.

Participants should arrive in Washington, D.C., on June 11 for course orientation and administrative procedures.

Target Auidence:

Irrigation practitioners with an educational background at the B.S. or M.S. level in agronomy or agricultural engineering.

Objectives:

Participants will: (1) gain knowledge and practical experience in onfarm water management and crop production; (2) develop skills to plan, design, establish, and maintain new irrigation systems; and (3) develop skills to increase the efficiency of existing irrigation systems in their home countries.

Content:

For the first five weeks, the course is conducted primarily on the Colorado State University campus and includes lectures, field and laboratory practice, field training at the agronomy experiment station farm, and seminars centered on participant presentations of irrigation problems in their home countries. Topics covered include basic soils; soil-water-plant relationships; land leveling; irrigation methods and practices; administration and distribution of water; water law; water quality; salinity; drainage problems and remedies; economics and sociology of irrigation; and extension methods. The last three weeks of the course consist of field visits to irrigation programs and projects

in New Mexico, Arizona, and Southern California, including the rice production area around Sacramento.

Other Information:

Conducted in English by Colorado State University. Simultaneous interpretation is not available. Academic credit is available for qualified participants.

Overseas Availability:

TC 120-14 "Assessment and Improvement of Onfarm Irrigation Systems" is a similar course specifically designed for overseas presentation.

2. RESOURCE DEVELOPMENT OF WATERSHED LANDS, TC 120-8

Dates & Duration: 6 weeks - June 11 - July 20, 1984.

Participants should arrive in Washington, D.C., on June 4 for course orientation and administrative procedures.

Target Audience:

For midlevel technicians and professionals engaged in the management and development of watershed lands in developing nations. Individuals with a B.S. or M.S. in forestry or agriculture, or who work with water resources.

Objectives:

Participants will acquire the knowledge and skills necessary for the effective development, use, and management of water resources to increase food and fiber production.

Content:

Watershed lands are habitable areas which do not include agricultural, urban, or reserve areas. Because production from these lands is linked with water, the course deals with the fundamentals of hydrology, including hydrologic measurement and predictive methods. The course presentation is supplemented with practical problems and demonstrations. Since most of the difficulties in developing the multiple products of watershed lands are social and economic, the course emphasizes those aspects of development. Other major areas include range assessment and management, soil and water conservation techniques, and natural resource economics and management.

Other Information:

Conducted in English by the University of Arizona. Simultaneous interpretation is not available.

Overseas Availability:

Available for overseas presentation upon request by AID, the World Bank, FAO, developing country governments, foundations, and private organizations. Can be conducted in English, Arabic, French, and Spanish.

3. LAND USE PLANNING IN NATURAL RESOURCE MANAGEMENT, TC 120-10

Dates & Duration: 6 weeks - May 21 - June 29, 1984.

Participants should arrive in Washington, D.C. on May 14, for course orientation and administrative procedures.

Target Audience:

Land use and regional planners, officials who establish or administer planning programs at the State or national level, and

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resource specialists whose duties include working on land use planning teams.

Objectives:

Participants will be able to: (1) define, analyze, and evaluate land use planning in the context of natural resource policy and management; (2) explain and give examples of principles, assumptions, and methods useful in developing objectives, gathering and analyzing data, and developing and evaluating land use alternatives; and (3) better understand the techniques used to analyze the social and economic impacts of alternative land uses.

Content:

Participants will study the land use planning process including the challenge of effectively working on an interdisciplinary planning team. The course will emphasize the importance of and techniques used in understanding the social, cultural, physical, and biological environments in the land area for which a plan is developed. Participants should bring a case study from their home country on a potential or existing land use situation which they wish to work on during the course. Field trips will examine local and regional areas facing a variety of land use planning problems.

Other Information:

Conducted in English by the University of Idaho. Simultaneous interpretation is not available.

Overseas Availability:

Available for overseas presentation upon request by AID, the World Bank, FAO, developing country governments, foundations, and private organizations. Can be conducted in English and Spanish.

4. ASSESSMENT AND IMPROVEMENT OF ONFARM IRRIGATION SYSTEMS, TC 120-14

Dates & Duration: 4 weeks

Presented overseas only. Dates arranged with sponsor.

Target Audience:

Agriculturalists such as engineers, agronomists, or extension specialists working directly with onfarm irrigation systems.

Objectives:

Participants will develop knowledge and practical skills to: (1) examine farm irrigation practices and identify physical constraints and socioeconomic problems faced by farmers growing irrigated crops; (2) use field measurement techniques to evaluate the efficiency of water control and water use; (3) plan efficient irrigation practices for specific crops grown on particular soils to maximize yields and quality; and (4) evaluate irrigation methods and develop practical and economical improvements.

Content:

Specific topics covered during the course include: the relationship of efficient water use to farm water management; field surveys; general principles of flow measurement; movement, retention, and use of water; methods to determine soil moisture content; consumptive use of water and peak period use rates; surface irrigation methods, including field evaluation of such methods and factors important to the efficient operation of each method; and technological changes and institutional modifications to improve water quantity and quality as well as water management. Frequent field visits provide practical experience in collecting data, evaluating water management problems on farms, and planning improvements.

Other Information:

Conducted by USDA in collaboration with university personnel and consultants.

5. WATER HARVESTING FOR AGRICULTURAL PRODUCTION, TC 120-25

Dates & Duration: 4 weeks - July 16 - August 10, 1984.

Participants should arrive in Washington, D.C., on July 10 for course orientation and administrative procedures.

Target Audience

Agricultural personnel with a B.S., M.S., or Ph.D. in plant sciences, soils, agricultural engineering, or range management and other personnel interested in water harvesting (runoff farming).

Objectives:

To provide participants with the knowledge and skills necessary for the effective design, development, operation, and maintenance of water harvesting facilities that can increase agricultural production in arid and semiarid areas.

Content:

Major topics to be included are the hydrology of water harvesting (including soil and topographic considerations), water harvesting technology, agronomic and horticultural aspects (crop selection, fruit and tree crops, annual crops, forage crops), design criteria, and the operation and maintenance of water harvesting facilities. Courses will include lectures, laboratory exercises, group discussions, practical experience, problem solving, and field trips.

Other Information:

Conducted in English by the University of Arizona in Tucson and at nearby facilities.

Overseas Availability:

Available for overseas presentation upon request by AID, the World Bank, FAO, developing country governments, foundations, and private organizations. Can be conducted in English and Spanish.

COLORADO STATE UNIVERSITY
(Inernational School for Economic Development Studies)

The International School for Economic Development Studies is part of Colorado State University's "Program for International Education, Research and Technical Assistance." This School engages in educational, research and technical assistance activities in areas relating to economic development in developing nations, with particular reference to agriculture and natural resource management.

The educational programs of this School are basically designed to serve nondegree training needs of a variety of less developed countries' (LDCs) government officials (e.g., agricultural and irrigation engineers, agricultural scientists, economists, administrators, project managers, and other officers) directly responsible for designing, implementing, monitoring and evaluating developmental programs. These needs may consist of specialized training in net techniques and procedures, of bringing otherwise capable personnel up to the normal standard for the position, and/or to update the basic professional knowledge and techniques in the light of recent developments.

The essential requirement in these cases is to provide this supplemental education and training in an educational structure that will allow maximum acquisition of the specific educational training desired and in a time frame compatible with the requirements of the individual and organization concerned.

Subject areas in which students in the International School will be offered non-degree training include:

- Irrigation Water Management
- Evaluation and Improvement of Farming Systems
- International Agricultural Marketing
- Economic Planning and Project Evaluation
- Agricultural Sector Planning
- Rural Development
- Agricultural and Economic Development Policy
- International Aspects of Development
- Planning for Development, Utilization, and Conservation of Natural Resources
- Water Resources Systems Planning
- Agribusiness, Cooperatives and Marketing
- Computer Applications (including Data Management Systems)

The studies in the above areas are interdisciplinary in nature. Courses will be chosen from a wide variety of disciplines and departments.

Diplomas will be awarded by the School to those participants who successfully complete their prescribed program of study, provided it includes at least two full semesters, not necessarily consecutive. A certificate is given to those participants who attend the School for less than that period or who do not satisfy the requirements for the diploma. The diploma and the certificate are evidence only of successful participation the International School and do not constitute evidence of an academic degree.

(International School for Water Resources and Associated Programs)

There are many professional personnel in governmental and private organizations whose working assignments in water resources create a requirement for additional education and training for their effective accomplishment. These requirements may consist of specialized training in new techniques and procedures, of bringing otherwise capable personnel up to the normal standard for the position, or updating basic professional knowledge and techniques in the light of recent developments.

The essential requirement in those cases is to provide this supplemental education and training in an educational structure that will allow maximum acquisition of the specific educational training desired and in a time frame compatible with the requirements of the organization concerned.

The International School for Water Resources and Associated Programs was established by Colorado State University to provide such a structure through which these needs could be met by programs of study, individualized to the professional requirements and time limitations of the individual and his/her sponsoring institutions.

There is no formal curriculum. Rather, individual curricula are developed to meet the specific needs of each participant through mutual agreement. Arrangements normally involve taking maximum advantage of the University's campus resources (faculty experts, formal classes, informal classes, short courses and special institutes, computer teaching and production facilities, laboratories, etc.) However, special purpose short courses and integrated training programs can be developed and presented at CSU or at other locations that would best meet the sponsor's requirement. This flexibility allows for group training of major office units, coordinated with regular

work assignments so as to minimize the temporary impact on scheduled work. Where training of a sequence of groups in the same subject matter is required, special purpose audiovisual television tapes and related training material can be produced.

In some cases, it may be desirable to combine an International School Program with on-the-job training and experience in the United States. This can usually be arranged by direct negotiation with the agency involved.

Illustrative of the academic fields in which students in the International School have focused would include:

- Water Resources and Development
- Hydraulic and Fluid Mechanics
- Hydrologic and Hydraulic Modeling
- Hydrology
- River Mechanics
- Water Resources Systems
- Power Systems
- Groundwater
- Watershed Management
- Water Resources Economics
- Water Law and Related Administrative Aspects
- Sociological Aspects of Water Development
- Environmental Engineering
- Control of Air and Water Pollution
- Agricultural Engineering
- Agricultural Extension
- Agronomy
- Soil Science (Agricultural Soils)
- Urban Water Management
- Computer Applications (including Data Management Systems)

Additional fields of interest are available for participants in the International School. The broad spectrum of water-related programs at Colorado State University permits the development of virtually any field of study related to water resources development, conservation and use.

The International School not only allows flexibility in program content but also in beginning and ending dates of the periods of attendance. This usually permits participants to conform to the stipulations of the fellowships granted by the sponsoring agencies or organizations. If the terms of fellowship include observational or practical training periods, the study program can be adjusted to allow these requirements to be met. Although admission at any time is feasible, it will usually be much more cost effective to made the period of attendance correspond to the regular teaching schedule of the University.

The acceptance scores on TOEFL represent guidelines. TOEFEL scores lower than 450 can be accepted providing the student and the sponsor agree to additional English training upon arrival at the University. An additional fee is charged for this purpose by the Intensive English Program. If language proficiency is below the above indicated margin for acceptance, Intensive English training must be completed before enrollment in professional courses in the International School. If the score is close to the margin, one professional course may be allowed to provide more proficiency in technical English usage as well as for content.

Diplomas are granted by the School to those participants who successfully complete their prescribed program of study, consisiting of at least two full semesters, not necessarily consecutive. A certificate is given to those participants who attend the School for less than that period or who do not satisfy the requirements for the diploma. The diploma and the certificate are evidence only of successful partic-pation in the International

School and do not constitute an academic degree.

Of the short course options available, special note is made of -

Social, Technical, and Economic Aspects of Improved Irrigation Management

A seven-week course for persons with bachelor's level training in a field relevant to irrigated agriculture. Examines irrigation as a social, economic, engineering, and agronomic phenomenon requiring the integration of several disciplines. Course combines developing proficiency in analysis and improvement of irrigation systems with applied field experience. Topics include: 1) nature of irrigation technology and its relationship to social organization; 2) challenge of development, definition of progress, and the meaning of appropriate technology; 3) preliminary interdisciplinary reconnaissance of an irrigation system; 4) identification of strategic problems which constrain production; 5) construction and assessment of potential organizational solutions; and, 6) program implementation and evaluation process.

UTAH STATE UNIVERSITY
International Irrigation Center

1. On-Farm Water Management
(International Course)

Development of the Course

This course is part of the extension program of the International Irrigation Center at Utah State University. Due to the nature of the objectives, the course is highly practical and can be applied immediately. The course aims to respond to a need frequently felt and stated but not adequately met in the

field of irrigation water management: the need to define a strategy for the direct application of technology to the ultimate user of water, the small farmer; to simplify methods and procedures for him; and to motivate him by demonstrating the importance of water in terms of increasing his production.

Course Objectives

This is an intensive course for field engineers and technicians with the following purposes:

- To focus upon the importance of irrigation technology transfer from the professional specialist to the small farmer.
- To develop criteria for selecting methods and systems of irrigation which are most adequate to the farmer's environment.
- To propose methodologies and techniques for conducting experiments in irrigation and to demonstrate these experimental results to the farmer.
- To demonstrate the economic importance of water as an input in agricultural production.
- To demonstrate the importance of training to the farmer in the effective use of devices and methods for water management.

Program

I. Introduction

II. Soil-Plant-Water Relationship

Soil properties, physics, retention curves, and measurement of soil moisture. Water uptake and movement; plant response to water, fertilizer, and salinity.

III. Methods of Determining Soil Moisture

Observations of plant response to water and techniques of sampling soil moisture by feel, appearance, and gravimetric method. Theory, installation, use and care of: tensionmeters, electrical resistance blocks, and the neutron scattering technique.

IV. Water Management

Land leveling. Crop water requirements and scheduling. Drainage, salinity, and fertilization in relation to irrigation.

V. On-Farm Water Measurement

Methods and instruments for measuring water and recording water discharge to and in the field. Techniques for evaluating the efficiency of water farm field channels.

VI. Farmer Inputs and Response

Techniques, procedures and utilization of farmer interviews and inputs. Procedures for extending irrigation management information to farmers.

a. Economic and social aspects.

b. Technical aspects and engineering.

VII. Irrigation Methods and Systems

Sub-surface, surface, and sprinkler methods and systems.

VIII. Irrigation System Evaluation

Efficiency and uniformity, comparative evaluation of farm distribution and application systems.

IX. Experimental Procedures for Crop-Water Responsive Functions

a. Agricultural practices.

b. Methods of analytical evaluation.

X. Experimental Follow-up and Technology Transfer

Presentation of demonstration fields and farmers' workshops.

XI. Economics of Water Production Function

Economic interpretation, water productivity, efficiency, and optimality.

XII. Use of Programmable Pocket Calculators

Use and application for field and water management problems.

Schedule

August 7 - September 10, 1983 3/

The course will be taught in an intensive five week session with classes held five days a week. Classes concerned with

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3/ 1984 dates not yet available.

theoretical considerations will be held in the morning; laboratory and field work will take place in the afternoon. Week-ends will be utilized for scheduled extra-curricular activities to the extent possible.

Participants

The course is designed for Agricultural and Civil Engineers and Agronomists; particularly those involved in experimentation, extension work, and administration of water for irrigation operations in agricultural cooperatives and water-courses, extension engineers, and researchers will find this course useful. The course will also have important implications for technical staff of public and private enterprises. Universities, and research and training centers who are involved in the problems of irrigation in developing countries.

2. Design and Evaluation of On-Farm Irrigation Systems

and

3. Irrigation Scheduling

Course Development

These courses include the necessary theory and academic training during the first portion and field observation and practice during the final weeks. The training is intensive, practical and pragmatic. Methods and procedures are simplified where practical to do so. An attempt is made to relate academic training to the conditions in the various home countries of the participants.

For the Irrigation Scheduling course each participant should, if possible, bring from their country a summary of several years of daily rainfall records, mean monthly temperatures; the mean monthly values of the daily temperature, range, mean

monthly relative humidities, percent of possible sunshine and solar radiation if available. For those taking the design and evaluation course, information relative to streamflow, hydrology, water supply, soils, land classification, project operation, canal losses, irrigation efficiencies, management problems and social and economic conditions will be useful. The course will incorporate as much of their local information as feasible and practical.

Objectives

The two courses, Design and Evaluation of On-Farm Irrigation Systems and Irrigation Scheduling have the following objectives:

- Improved knowledge of on-farm irrigation system investigation, plannining and design.
- Familiarization with the design principles for sprinkle, drip and surface irrigation.
- An understanding of the basic concepts of irrigation systems evaluation.
- A knowledge of soil-plant-water relationships and of crop water requirements.
- Concepts for scheduling the amount, timing and methods of irrigation.
- An understanding of how plant densities, fertilizer application and climatic factors interact to produce a given yield.
- An improved concept of both on-farm and project irrigation management practices.
- A knowledge of costs and benefits and of methods to maximize returns on investment.

Program - Design and Evaluation

I. Introduction

Course objectives and content.

II. Preliminary Investigations

Land classification, water supply, basic hydrology, climate, crop selection.

III. Economic, Social and Leval Evaluations

Benefit cost analyses, internal rate of return, evaluation of administrative and management potentials, water laws and regulations and identifying strategic problems.

IV. Irrigation System Design

Sprinkle and trickle irrigation design furrow, border and basin irrigation design.

V. Water Supply and Conveyance

Water conveyance systems, seasonal demands, peak demands, storage requirements, design and improvement of canals and water controls structures.

VI. Evaluation of Sprinkle Irrigation Systems

Evaluation of sprinkle lateral irrigation, perforated pipe systems, orchard sprinkle, center pivot, travelling sprinklers and gun and boom sprinkler systems including equipment required, procedures, uniformity, efficiency and full evaluation.

VII. Evaluation of Trickle Irrigation

Field procedures, uniformity, potential efficiency and analysis.

VIII. Evaluation of Surface Irrigation

Evaluation of furrow, border strip and basin irrigation including field equipment, procedures, uniformity, efficiency and full evaluation.

IX. Use of Small Programmable Calculators

The use of standard programs, program development and application to irrigation design and evaluation.

Program - Irrigation Scheduling

I. Introduction

Course objectives and content.

II. Soil-Plant-Water Relationship

Bulk density, field capacity, permanent wilting percentage and readily available soil water.

Soil moisture tension and plant growth, soil moisture extraction, water production functions, water-fertility production functions and the effects of soil salinity.

III. Methods for Determining Soil Moisture

Observation of the plants, gravimetric methods, use and care of tensiometers, electrical resistance blocks, the neutron probe and the use of weather and climatic data.

IV. Plant Water Requirements

Factor that influence plant water requirements, methods for estimating potential and crop evaporation.

V. Irrigation Water Requirements

Irrigation methods, irrigation efficiencies, effective and dependable rainfall, allowable deficits, frequency of irrigation and scheduling of water deliveries.

VI. Water Management

Evaluating irrigation system efficiency and cost effectiveness, optimization of production, use of fertilizer, use of crop production and economic model and the maximization of irrigation benefit-cost ratios.

VII. Use of Small Programmable Calculators

The use of standard programs, program development and applications to irrigation scheduling.

Schedule

May 1 - June 4, 1983 and May 29 - June 25, 1983 3/

The two courses are overlapped one week so that those attending both courses do not repeat the first week of basic elements common to both courses. The courses are taught on an intense schedule of five days per week, with theoretical sessions in the mornings and laboratory practices and office exercise in the afternoons. Occasional use of Saturday morning will be made extra programming of technical activities. Basically, weekends will be utilized for personal and extra curricular activities.

Location

First part of the academic material will be at Logan. The field exercies will be carried out in the San Luis Valley, Colorado. Headquarters for the courses will be at Adams College in Alamosa. Those attending both courses will stay in Alamosa at the termination of the first, and will join the second course without interruption in Alamosa.

Participant

These courses are designed for agricultural engineers, civil engineers and agronomists that will be working in the planning, design, operation and management of on-farm irrigation. The courses are also recommended for those engaged in investigati data collection and research. Principal emphasis is on practical applications to improve knowledge of how to make irrigation activities more efficient, profitable and cost effective. In addition to those engaged in development programs such as planner designers and administrators it is recommended that professors ar consultants will find those courses useful.

4. Soil and Water Conservation and Management

Course Development

The course is a logical result of the basic philosoph of the International Irrigation Center which emphasizes the judicious use and management of the natural resources available t the small farmer in the developing world. As in other courses given by the International Irrigation Center, great emphasis will be placed on practicality, motivation and committing the particip to the interactive teaching/learning process. Fundamentally, he will learn through training and personal action.

This course will provide the opportunity for participants to discuss their individual soil and water related problems and to seek possible solutions. Participants are encouraged to bring field maps and resource data for consultation and design assistar

Course Objectives

This is an intensive course designed for field enginee technicians and those with responsibilities in soil and water management. It has the following primary goals:

- To discuss the various environmental aspects relevant to soil and water management.
- To focus on the theoretical and practical aspects of soil and water conservation and management methods in use.
- To provide field experience in the planning and design of conservation systems.
- To provide an opportunity for site-specific resourc problems to be discussed and solutions sought.
- To demonstrate the role and importance of soil and water resources in the agricultural production syst
- To offer a complete training package which includes classroom and laboratory instruction, use of programmable calculators, field exercises, and visits to soil conservation centers and other areas of technical interest.

Program

I. Introduction

Philosophy, objectives, and outline of the course.

II. Programmable Calculators

The use and application of modern tools to solve resource management problems. A micro computer demonstration would also be included.

III. Principles of Surveying

Topographic surveying and planning.

IV. Precipitation and Its Characteristics

Rainfall intensity, duration, frequency, and variety.

V. Soil-Plant-Water Relationships

Soil properties, physical relationships, and plant response to water.

VI. Small Watershed Hydrology

The watershed as the basic unit for resource development and use.

VII. Soil and Water Conservation and Management

Soil erosion, mechanical and bilogical methods of soil and water conservation, and techniques for round control and management.

VIII. Water Harvesting and Recycling

Rainfall-runoff relationships; runoff collection and its use as supplemental irrigation.

IX. Measurement of Runoff and Soil Loss

Techniques for field measurement and laboratory analyses of runoff and soil loss.

X. Design of Small Structures

Design principles for small drop structures and other field installations.

XI. Economic and Social Aspects of Soil and Water Conservation and Management

The impact of soil and water degradation problems on the farmer and on the country economy. Socio-institutional components of the problem. Conservation and management as an alternative.

Schedule and Location

July 10 - August 20, 1983 3/

The course will be taught in an intensive four week session at the International Irrigation Center, Utah State University. Theory sessions will be held in the morning hours,

laboratory practice and field exercises will be conducted in the afternoons requiring a total of eight hours of effort five days a week. An additional two week period is set apart for field observation and practice involving visits to U.S. Soil Conservation Centers and places of technical interest in Utah and neighbouring states. Week-ends will be utilized to schedule extra-curricular activities to the extent possible.

Participants

The course will be structured in such a way that a broad range of persons can participante. However, it will be aimed more at Agricultural Engineers, Civil Engineers, and Agronomists who are now (or will be) involved with soil and water related work. Sufficient flexibility will be allowed in the level of instruction to benefit all participants attending. Attempts will be made to provide individual attention where ever necessary.

5. Operation and Management of Irrigation Districts - USA - Mexico

Course Development

The course is developed in three parts. In an initial week of sessions on the campus of Utah State University, home of the International Irrigation Center, discussions will focus on the conceptual framework of the course and clear definition of aspects to be dealt with further on in the course. The course will then proceed to Mexico for two weeks under the combined auspices and direction of the International Irrigation Center and the Secretaria de Agricultura y Recursos Hidraulicos de Mexico. After sessions in Mexico City, participants will continue on into northwestern Mexico, visiting the most important irrigation districts of this region in terms of the program framework and objectives for this part of the course. In the third portion of the course, after crossing the Mexico - U.S. border, participants will visit irrigation districts of the southwestern U.S., in California and Arizona.

This last two-week portion in the U.S. will end at the Hoover Dam on the border of the States of Nevada and Arizona. The closing ceremony will take place in nearby Las Vegas, Nevada.

The course will be conducted so as to provide discussion of the concepts and characteristics of managing irrigation systems in Mexico and in the United States. Conferences and discussions are to be led and directed by specialists from the oppropriate institutions and/or irrigation districts involved. Personnel of the International Irrigation Center and the Secretaria de Agricultura y Recursos Hidraulicos will moderate the discussions discussions. Field visits and exposition will complement these discussions in each of the districts programmed.

The selection of irrigation districts and institutions has been structured to include a wide range of conditions and situations present in the operation and management of irrigation systems. The objective of this selection is to demonstrate the many physical, political, social, and economic variables which interact to make unique a system and its response to the management policy implemented.

The variability in conditions from Mexico City to the southwestern United States will demonstrate a wide spectrum of problems and their solutions. Particular emphasis will be given to the discussion of common problems related to irrigation district or project management in various parts of the world. It is obvious that the problems from diverse geographic areas have much in common. However, solutions must be adapted so that the management of systems is designed for each particular set of conditions.

Objectives

- To improve the concept of water resource development as related to the national economy, and to compare the similarities and differences in development between multi-purpose projects and irrigation projects

- To provide a better understanding of the traditional development phases of an irrigation project, the needs for coordination, and the importance of proper operation and maintenance.

- To explain the interactions of the various factors that influence production and the methods for maximizing the overall economic return from the project.

- To compare actual project production with pre-project estimates and to explain the differences as a result of prevailing management practices.

- To describe and analyze irrigation district operation and maintenance under different conditions including procedure, personnel required, and their various duties and responsibilities.

- To present existing management programs and to analyze the degree to which they can be adapted to different local conditions.

- To discuss institutional and legal aspects of water management, and the need for institutional support for research and training to improve water use.

Program

I. Introduction

Presentation of the philosophy and objectives of the course, the course outline, and itinerary.

II. Development of Water Resources and Planning Policies

Goals and objectives of water resource development in a country. Problems of water allocation arising from national development and multisectorial claims on water resource use. Structural and non-structural planning strategies in water use.

III. Phases of Development in Irrigation Project

Expansion of the agricultural frontier. Irrigated agriculture and dry-farming or rain-fed agriculture. Programs with hydro-agricultural infrastructure. Phases of an irrigation project. Operation and maintenance of an irrigation system. Water management at the farm level. Evalaution of systems and efficiency levels.

IV. Organization and Function of Irrigation Districts

Conceptual and contextual framework of the function and organization of irrigation districts.

V. Operation and Maintenance of Irrigation Districts

Operational plans. Supply and demand of water. Optimization schemes. Cropping patterns and irrigation scheduling. Water management in the distribution network. Water management at the farm and field levels. Plans for structural and non-structural improvement in the system. Maintenance programs at different levels.

VI. Management Variables

Physical, institutional, and human resource variables in the operation and management of irrigation districts.

VII. Management Plans and Their Adaptability

Interaction of local conditions with management. Established management systems and their degree of adaptability to local conditions.

VIII. Economic Aspects of Management

Economic parameters in irrigation water management at the system level. Total productivity of water; maximization of global economic returns.

IX. Institutional and Legal Aspects

Institutional and legal framework in irrigation water management. Institutional receptiveness to the development of non-structural means of improving water use efficiency.

<u>Technical Aspects to be Considered in Each Irrigation District Visited</u>

- Physical characterisitics of the area.
- Technical characteristics of the water source.
- Water availability in relation to demand.
- Technical characteristics of the delivery system.
- Irrigation systems and methods at the farm level.
- Crop planning and type of development.
- Degree of management control in relation to the farmer's crop planning.

- Characteristics of the water tariff.
- Local socio-political factors.
- Level of experience and efficiency of the farmer in water management.
- Development and "maturation" period of a project.
- Comparison of structural and non-structural improvements.
- Improvement of operational procedures.

Schedule

October 2 - November 5, 1983 3/

6. Irrigation Water Production Function

Course Development

It has been developed in response to the growing need to define the true economic dimenstion of irrigation water and its role in a countyr's development process. Emphasis will be on practicality and motivation, invoking participant commitment to the interactive teaching/learning process. In essence, the participant will learn by doing. This course is intensive and has a duration of three weeks. It will take place on the campus of Utah State University in Logan, Utah.

Course Objectives

The main topics covered in this short, intensive course are as follows:

- The role of water in the development process; the role of irrigation in food production; population and environmental problems related to the use of water; the finite dimension of water as a resource; multi-sectorial competition for water.
- The economic dimension of water in irrigated agriculture and in rainfed agriculture (with supplementary irrigation) from the farmer's point of view.

- The need for a multidisciplinary and interdisciplinary approach to water use and management.
- Experimental aspects in the generation of the production function and its effect on water management policy in the field.
- The economic impact of improving water management.
- Economic and financial evaluation tools for decision making in the use of water.
- Legal and institutional aspects in the use and cost of water.

Program

I. Introduction

Philosophy, conceptual framework, objectives, and course outline.

II. The Role of Water in Socio-Economic Development

Macroeconomic impact of water resource development in developing countries. Multipurpose use and irrigation use. Institutional and technological changes caused by irrigation. Competition for resources and for funding.

III. The Multidisciplinary and Interdisciplinary Approach to Irrigation Water Development and Management

The need for coordinated team work in approaching irrigation development and management. The correlative roles of the team members in the decision process.

IV. Use of Small Programmable Calculators

Generation and use of short programs for irrigation water use evaluation and for statistical, economic and financial analyses.

V. Production Function Analysis

Production function curve; total, average and marginal concepts; physical and economic optimization Interpretation and application of the production function.

VI. Experimental Generation of Irrigation Water Production Functions

Procedures to generate the production function. Factors of production. Evaluation of the factors which intervene in the use of water. Analytical evaluation methods. Experimental production functions and real world production functions.

VII. Approaches to Water Pricing

Supply, demand, pricing, value, allocation, the scarcity problem. Methods and approaches to water pricing.

VIII. Economic Dimension and Impact of Water Management

The role of management and the output of the project. Management and water distribution. Productivity, efficiency, and optimization. Efficiency in the use of water resource, use of energy, evaluation criteria; selection of irrigation methods and systems.

IX. Elements of Economic and Financial Analysis

Water resource economics concepts. The use of the production function for economic and financial analysis. Tools for optimization and decision making.

X. Institutional and Legal Aspects in the Use of Water Resources

Policy and organization in the use of the water resource, institutional and legal limitations, and economic importance.

Schedule

November 13 - December 3, 1983 3/

The classes during the three weeks of the course will be on an intensive schedule of five days per week, with theoretical sessions in the mornings and practical sessions in the afternoons. Occasional night sessions may be programmed, and Saturdays may be utilized for extra-curricular activities.

Classes will generally take place in the Eccles Conference Center on the Utah State University campus. Detail as to exact location of classes will be given to the participant at the time of registration.

Participants

The design of this course is directed toward agricultural and civil engineers and agronomists, as well as agricultural economists - particularly those professionals in decision-making

positions with respect to planning and management of water resources. Similarly, this course applies to professionals charged with defining policies for water resource use and to those responsible for the legal and institutional aspects. This course is also highly recommended for professionals involved in financial decisions concerning water, such as loans to farmers and projects. Chief engineers of irrigation projects and districts as well as professionals in charge of technical and economic evaluation of irrigation water development will find this course definitely useful.

7. Drainage System Design and Salinity Control

Course Development

The focus and the conception of the course have fundementally the following premises: time, practicality and motivation. The course is INTENSIVE; the conception in the technology transfer process is PRAGAMATIC; simplifying methods and procedures, learning, observing, doing, and analysing in the field; MOTIVATING the professional and teaching him to induce motivation in the user of the resource and of the system as to the importance of a policy of conservation is a major goal.

The course will be conducted in two phases: the first will be basically academic in character and will have duration of three weeks; this phase will take place in the facilities of Utah State University in Logan, Utah. The second phase will be solidi practical in nature and will also last three weeks; this phase will be excuted in the zones of drainage project development in the San Joaquin, Imperial and Coachella valleys of central and southern alifornia. A visit to the U.S. Salinity Laboratory at Riverside. California is also included.

Course Objectives

The course is intensive in theory as well as in practical application, and has the following goals:

- The conception of drainage as an integral part of the total soil-water management system.
- An understanding of the drainage problem and the physical process involved. The consequences of a rupture in the natural hydraulic equilibrium. How drainage problems, soil salinity, and environmental modification are related. The relationship between peak river flows, excess precipitation, and the control of surface flooding with drainage problems in tropical areas.
- To define the conditions required for the maximization of crop production in areas where precipitation is excessive and surface drainage is less than adequate.
- The definition and application of drainage criteria in relation to a need rather than just solution tools (equations to be used). A combination of the intuitive, the empirical, and the analytical in the promotion of an optimal solution process.
- To induce and motivate an imaginative application of the vast repertoire of artifices to the development of design procedures.
- An evaluation and critique of the construction methods, and the importance of an adequate continuity in the operation and maintenance of the system.
- To implant bases for the economic evaluation of a drainage project.

Program

I. Introduction

Philosophy, objectives, and outline of the course.

II. Environmental Impact of Irrigation

The natural system components. Physical impact of irrigation on the initial hydrological equilibrium. Geology, geomorphology and hydrology in relation to the occurance of the drainage problem. Hydrologic equilibrium in

arid and semiarid watershed. Comparative hydrology in arid, semiarid, humid, and humid tropical areas.

III. Applied Soil Science

Soil physics; soil moisture, capillarity, infiltration, agro-hydrologic constraints. Soil chemistry: the genesis and evolution of saline and sodic soils, reclamation procedures, soil-salinity-irrigation interactions.

IV. Plant Development in Relation to Drainage and Salinity

Comparative plant response to different environmental conditions in the root zone: aereation, salinity, fertilization, oxidation-reduction phenomena, micro-biology, etc.

V. Applied Hydrology

Rainfall-runoff relationships; surface runoff; groundwater recharge; statistical analysis. Relationships between peak river flows, their control, and drainage problems in tropical areas.

VI. Flow of Water Through the Soil

Basic laws and principles, saturated flow, unsaturated flow, Darcian and non-Darcian flow, permanent and non permanent flow, groundwater flow in extense aquifers, flow towards drains and wells.

VII. Soil and Water Parameters in Drainage

Hydrogeologic and soil constants, methods for their determination, field procedures.

VIII. Drainage Surveys and Studies

Level of studies and organization. Analysis of the components of the hydrologic balance: precipitation, evaporation; analysis of the natural drainage conditions; adequacy of surface and subsurface drainage. Groundwater conditions and regimes; aquifer behavior; groundwater balance; water quality.

IX. Salt Balance and Drainage Requirements

Water quality, salt balance, irrigation efficiency, leaching theory, leaching efficiency, sodium problems, calculations.

X. Drainage Criteria

Function of the drainage system: criteria for arid, humid, and humid-tropic zones; water table control; salinity control; trafficability; etc. Water table behavior: steady, fluctuating, and cyclic depressions/ Development of design criteria.

XI. Drainage System Design

Alternative solutions to the problem:

A. Surface Drainage

B. Sub-surface Drainage
Drainage formulas: horizontal, vertical, steady state, non-steady state.

C. System Layout
Principal, secondary, and field systems; wells; sumps; and pumping plants.

XII. Irrigation Water Management and the Drainage Problem

Prevention and/or reduction of the drainage problem by improving the irrigation water management. Irrigation efficiencies.

XIII. Construction, Operation, and Maintenance of Drainage System

XIV. Legal and Institutions of Aspects of Drainage

XV. Economic Aspects of Drainage and Soil Reclamation

XVI. Use of Programmable Pocket Calculators.

Schedule

March 6 - April 16, 1983, 3/ Utah - California

During the three weeks in Logan, Utah, the classes will be on an intense schedule of five days per week with theoretical sessions in the mornings and laboratory practices and office exercises in the afternoons. Occasional use of Saturday mornings will be made for extra programming of technical activities. Basically, the week-ends will be utulized for personal and extra-curricular activities.

The second phase will consist principally of field operations having classes, expositions, and practical observations during the work week. The first two hours of each day will be utilized for the theoretical presentation of the field activities that will be conducted during that day.

Participants

This course is structured at the level of Agricultural and Civil Engineers and Agronomists, particularly for those that are (or are going to be) involved in projects for the reclamation of agricultural land; drainage, leaching of saline soils, soil and water conservation, etc. I will be highly beneficial in the formation of responsible personnel in the planning, studies, diagnostic, design, execution, and maintenance phases of agricultural drainage.

Engineers charged with the administration of irrigation and drainage districts, chiefs of the field operations in agricultural communities or complexes, and technical personnel of specialized consulting and engineering offices will find this course very valuable. The course is also recommended for university professors and persons involved in the planning and development projects dealing with the management of soil and water resources.

CALIFORNIA STATE POLYTECHNIC UNIVERSITY

1. Drainage and Soil Conservation

Objectives and Intended Audience

- To learn various types of drainage problems
- To learn soil and water erosion problems
- Proper ways of solving drainage erosion problems.
- Drainage system design
- Soil conservation structure design

High school graduates or college-level participants

Content

- Drainage and erosion problems
- Basic hydrology -- runoff estimates
- Drainage and conservation structures selection and design
- Maintenance and problem solving applied to drainage and erosion problems

Duration

4-6 weeks/short course

2. Surface and Ground Water Hydrology

Objectives and Intended Audience

- To learn how the water circulates on the earth
- To learn storm characteristics
- To learn how to estimate various types of runoff volume
- To learn groundwater flow characteristics and their contribution to the groundwater storage
- To learn groundwater utilization

High school graduates or college-level participants

Content

- The nature of water cycling processes
- Rainfall characteristics
- Runoff estimate
- Storm frequency analysis
- Flood routing
- Estimates of groundwater storage
- Groundwater hydraulics

Duration

4-6 weeks/short course

3. Irrigation System

Objectives and Intended Audience

- To learn how to do simple and accurate irrigation system design.
- To learn how to operate and maintain irrigation systems properly.

High school graduates or college level.

Content

- Soil-water-plant relationship
- Basic hydraulics
- Design
- Maintenance

Duration

4-6 weeks/short course

CALIFORNIA STATE UNIVERSITY, FRESNO

1. Irrigation Technology

Objectives and Intended Audience

- Learn modern aspects of irrigation technology as applied to individual crops
- Gain experience at using various methods of irrigation, e.g., flood, sprinkler, and drip (trickle)
- Learn techniques of evaluating irrigation equipment, e.g., sprinklers and drippers.

Those who will supervise and train others in irrigation techniques.

Content

Participant will:

- perfom each method of irrigation in actual field conditions
- evaluate each method
- study soil/plant/water relations for several crops
- develop a technical handbook for future use
- evaluate various sprinklers and drip emitters
- designand evalaute an irrigation system based on expected needs in their home country.

Duration

Intensive workshop, twice a year for one month in June, July or August.