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CENTRAL TRAINING UNIT

CENTRAL WATER COMMISSION

U.S. AGENCY FOR INTERNATIONAL DEVELOPMENT

WATER RESOURCES MANAGEMENT
AND TRAINING PROJECT
(WRM&TP)

FINAL REPORT

Creation of a Central Training Unit

for

Integrated River Basin Planning

and Management

HARZA ENGINEERING COMPANY
with
UTAH STATE UNIVERSITY
and
CONSULTING ENGINEERING
SERVICES (INDIA) PVT. LTD.

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FOREWORD

Water is a primary natural resource, and India's future requires its effective management. The efficient utilization and management of India's water resources, to ensure national development, depends upon sound assessment and integrated planning of its river basins. These needs are widely acknowledged in the National Water Policy[1], and their fulfillment is one of the challenges now facing the Government of India.

The goal of the Water Resources Management and Training Project is to enhance the nation's capability to undertake integrated planning and management of water resources at the river basin scale. The establishment of a Central Training Unit within the Central Water Commission will help achieve this goal, as it will produce water resources planners with a thorough grounding in the practical and modern techniques of comprehensive river basin planning.

This report describes and presents information about the design and establishment of the Central Training Unit, its training curriculum and materials, the major achievements of the project, problem areas which remain and will require solution, and recommendations for future activity.

[1]National Water Policy, Government of India, Ministry of Water Resources, New Delhi, September 1987.

EXECUTIVE SUMMARY

This report is the final document prepared for the Water Resources Systems Planning and Management Program, a component of the Water Resources Management and Training Project, which was sponsored by the U.S. Agency for International Development (USAID). It provides a summary of the major activities conducted over the life of the Program, the principal achievements of the Program and difficulties faced, and recommendations for further action on the part of the Government of India (GOI) and/or USAID.

The Program was developed, organized, and conducted by Harza Engineering Company of Chicago, Illinois, assisted by Utah State University of Logan, Utah, and Consulting Engineering Services (India) Private Limited of New Delhi. The Program had a five-year life, from January, 1987, to December, 1991. Total USAID funding for the Program was $7,091,815.45.

Background

India is investing heavily in the development of the water resources of its major river basins. These investments are being made to support the economic development of the country, advance the social well-being of its citizens, and preserve precious environmental resources. Traditional methods of water resources planning and management in India, which emphasize local, or project-level planning and management without sufficient regard for regional or basin scale considerations, are inappropriate for addressing the country's present and future water needs. They result in inefficient use of water resources and, occasionally, investment of scarce financial resources in water development projects that are not optimally sized and/or sited.

To improve the efficiency of water allocation in India, its water planners and managers require training in new methods, tools, and concepts. USAID took the lead role in providing outside technical support for the creation of an institution which can provide this training.

Objective

The objective of this project was to develop the institutional capability within the Government of India for imparting training in water resources systems planning and management to practicing water resources scientists and engineers from State and Central Government organizations. The training is based on systems engineering approaches, it is practical and application-oriented, and focuses on planning and management of water, land, and related resources at the river basin scale to provide a framework for policies and implementation of projects at local levels.

Outputs

The contract between USAID and Harza called for the creation of a water resources planning and management training center which, by the end of the contract period, would have:

1. trained approximately 200 professionals;
2. a capability to train 30 to 50 professionals per year;
3. an established training curriculum and training materials;
4. a trained staff;
5. linkages with an Indian and an American educational institution;
6. established procedures for selecting trainees, evolving the program, and maintaining the center's capabilities;
7. a computer facility and software library for training participants in the application of computer technology to river basin development; and
8. a mechanism for continuing the existence of the center, including funding and institutional structure considerations.

Activities and Accomplishments

Early stages of the project focused on designing the training institute--called the Central Training Unit (CTU)--its staffing and management requirements, its facilities and equipment needs, the curriculum and training materials, and so on.

Also early in the project, temporary facilities were acquired at the campus of the Central Water and Power Research Station (CWPRS), at Khadakwasla, near Pune, to provide space for classrooms, hostel accommodations, offices, library, etc. The CTU has plans to relocate to Nagpur at some future date. Over the course of the project, necessary non-expendable equipment was purchased to support the training activities and office administrative work. Computers were obtained and installed for use at the CTU, and software was purchased or developed for direct support of the training. Pertinent technical literature was collected for the CTU library and video tapes and various other materials relevant to river basin planning were procured.

An important project activity dealt with the design of the CTU curriculum. Two different courses were conceived and implemented. One, called the "Introductory Course," has a duration of about three months and is intended to increase the awareness level of mid-level water resources managers . the concepts and methods of river basin planning. The other, called the "Advanced Course," lasts for about nine months and provides the participants with detailed, technical exposure to the tools and procedures of river basin planning. Both courses emphasize a "hands-on" curriculum of lectures on practical subjects, practicums wherein trainee-officers apply the lessons learned in lectures, and a case study involving the application of planning concepts, systems engineering approaches, and multiobjective analyses to the water development problems of a real Indian river basin. Lecture notes, handouts, sophisticated computer models, river basin data bases, and various other materials were developed to support this curriculum.

Institutional linkages between the CTU and Utah State University in Logan and the University of Poona in India were founded. These linkages are strong and can be used to provide the CTU with an important source of new ideas and vitality. Academic recognition has been awarded by the University of Poona to the CTU and its graduates.

Over the five-year life of the project, three Introductory Courses and two Advanced Courses were offered, providing training to a total of approximately 135 professionals. Feedback from grad-

uates of the CTU courses and from their superiors has been very positive. The CTU has the facilities, equipment, and materials to meet its training target of 50 professionals per year. The curriculum, detailed case study and teaching materials, computer facilities and software library are fully in place. Procedures for selecting trainees appear to be effective.

The project has generated a large body of materials that represents an enormous contribution to the field of water resources. Nowhere else has this diverse, interdisciplinary array of basin planning tools, concepts, approaches, methods, and philosophy been assembled. The critical elements of the training program are portable: the curriculum, most of the training materials, and the training approach devised and successfully tested at the CTU could be followed, with appropriate modification, in other countries.

Project Difficulties

Despite the successes of the project, several problems remain and cannot be resolved by anyone outside the Government of India. The most difficult such problem pertains to developing a qualified staff of trainers for the CTU. Staffing and staff development at the CTU have been hampered by several limitations that are characteristic of the overall staffing situation within the Central Water Commission (CWC). The major difficulty is the inability of the CTU to attract qualified and interested full-time faculty from the ranks of CWC who are willing to relocate to Pune. This problem is further compounded by the frequent rotation of personnel within Central Government agencies. In addition, the personnel who are stationed at the CTU are not as effective as they should be in their duties as trainers because of the governmental requirement for the generation of paperwork.

Recommendations

Given the present level of GOI commitment to the training program, the limited amount of training received by the CTU trainers, and the lack of a long-term mechanism for training new CTU

personnel, it is unlikely that the quality of the training program will remain high without further supporting actions. To address this problem, it is critical that the CTU/CWC be encouraged to:

1. Institute and enforce personnel policies which require CTU trainers to accept assignments of at least three years duration (a five-year posting would be far better), and which advance career opportunities;

2. Recruit staff who are well suited for a training position, not just assign people who have no background in planning and who are simply presently available or unwanted elsewhere;

3. Accept any future support from USAID only as a part of a vigorous training-of-trainers package; this should include training in technical specialties, teaching methods, case studies and supporting data base, and use and development of analytic methodologies and models;

4. Create and institute a plan for staffing the CTU and training that staff;

5. Create and institute a plan to strengthen the CTU training staff through preparation of new data sets, methodologies, and models, for instructional and case study use, and research and development activities addressed to the needs of the CTU, the basin planning units, and the Indian water sector;

6. Create and institute a management plan for reducing the administrative work that CTU trainers must face;

7. Create and institute a CTU development plan which addresses long-term needs for financing, permanent facilities, equipment, and operation and maintenance;

8. Pursue and foster linkages with academic and other appropriate institutions, perhaps through the USAID Institutional Linkages Program; and

9. Re-think the decision to locate the CTU outside of the New Delhi area; re-locating the CTU in or near New Delhi would immediately remove most of the staffing difficulties presently encountered by the CTU; it would also reduce the many logistical difficulties and costs associated with running the CTU, and it would enable the CTU management to have better access to Central Water Commission, Ministry of Water Resources, and other Government of India decision makers.

Final Report
Water Resources Management and Training Project
Contract No. 386-0484-C-00-7001-00

Creation of a Central Training Unit
for Integrated River Basin Planning and Management

1 INTRODUCTION AND PURPOSE

Harza Engineering Company began work in January, 1987, under contract for the U.S. Agency for International Development, to assist the Government of India (GOI)--as represented by the Central Water Commission (CWC) within the Ministry of Water Resources (MOWR)--in establishing the Central Training Unit (CTU). In this work, Harza has received the cooperation of its subcontractors, Utah State University (USU), Logan, Utah, and Consulting Engineering Services (India) Pvt., Ltd. (CES), New Delhi.

The mission of the CTU is to provide in-service training to water resources scientists and engineers from State and Central organizations in the concepts and tools appropriate for use in the planning and management of water resources developments at the river basin scale. The purpose of this document is to provide an overview of the project and its history, to discuss both the important project accomplishments and the major difficulties encountered in developing the CTU, and to offer recommendations for further activities in support of the CTU and river basin development in India.

1.1 BACKGROUND

India is developing the water resources of a number of its important river basins. Various major water resources projects include components for irrigation, flood control, hydroelectric power generation, municipal and industrial water supply, fisheries, navigation, recreation, etc. This represents a national commitment to water resources development on a grand scale. Many of the individual water projects will have long construction times[1] and very substantial capital costs. If the citizens

[1] Construction times appear longer than necessary in many cases, with adverse impacts on capital costs and realization of benefits. The IRBPM courses discuss--in a general way--the overall development process, and the importance of detailed planning, design, program management and construction management at the project level in achieving planned

of the country are to derive maximum benefit from these large public-sector investments, it is imperative that the investments be concentrated on the best water development projects, and that--relative to one another--these projects be selected, planned, designed, constructed, operated, maintained, and managed in an optimal fashion. Moreover, it is important that flexibility to permit possible future changes in operations or installations be maintained in the implementation of these projects because as India's economy changes and diversifies through time, the country's water needs will also change. IRBPM focuses on the selection of projects, groups of projects, and policies through analyses, at the river basin scale, of interactions between natural events and human actions to best achieve defined objectives over short and long-term planning horizons. Any given iteration of the IRBPM process results in a "plan," which--if accepted and implemented--identifies only the "next" projects and policies to be implemented and also provides a framework for evaluation of future possibilities. The IRBPM process also can provide a common and accepted data base and methodology which can be used to evaluate proposals from any source affecting development and use of the resources of the basin.

Traditionally, development of India's water resources has proceeded on a project-by-project basis. That is, as a local need for water development is perceived, and a specific project is designed, constructed, and operated to address that need. This approach creates projects that are often single-purpose in nature (e.g., only dealing with a single use, such as irrigation) and lacking in physical or institutional flexibility to deal with other water problems and demands as they might arise. Moreover, and perhaps more importantly, this project-by-project approach in the design and management of water resources developments virtually precludes the most efficient allocations of the water resource. This is because a project-by-project approach in design and/or management fails to consider the downstream effects the project will have on other projects, it rarely incorporates full information about the operation of upstream projects, and--in general--it ignores opportunities available to the region as a whole for enhancing the value of water through a coordinated, regional development and management approach. From a river basin or regional perspective, maximum

benefits within estimated costs. More detailed treatment of these subjects, particularly construction management, would be appropriate as part of training and institutional development at the project and program levels.

efficiency can be derived from the development and use of water resources only when water supply projects, demand management measures, and other non-structural measures or policies used in the basin are designed and operated in a coordinated--or "integrated"--manner.

To move from a project-by-project approach to an integrated, basin-wide approach, many existing public-sector institutions will have to change and other, new institutions will have to be created. For example, the agencies at the State and Central Government levels that are charged with planning and development of water resources will have to widen their perspectives. Agencies that are single-mission oriented (say, irrigation only) will have to develop effective linkages with other such agencies (e.g., agencies which deal only with hydroelectric power or water quality). Agencies that deal with only a portion of the resources management question (e.g., agencies that deal only with groundwater, for example) will have to implement means of effectively working with other agencies (e.g., those that deal only with surface water) in order to identify and successfully implement methods to achieve more effective use of the resource. In India, which has a governmental bureaucracy often structured along disciplinary lines, new institutions must be created which foster a truly interdisciplinary apparatus for water resources planning and management. Legal mechanisms must be created to support and give political legitimacy to this new mode of water planning and management. Acceptable approaches for funding these new institutions must be put in place. Finally, skilled personnel must be trained in the concepts, ideas, philosophy, and implementation of this integrated approach to water sector development, and they must be supplied to all these institutions. Establishment of the capability to train these personnel also requires the creation of a new institution, the Central Training Unit, at the national level. USAID recognized the existence of a more advanced body of knowledge and practice in water resources development in the U.S. and elsewhere, and called for it to be adapted and taught in India under Indian conditions in a framework that emphasized getting results from a coherent and integrated process.

Participation by USAID in establishing this training capability was necessary because, for a variety of reasons, the impetus for the development of this training program could not be indigenous:

it could not be expected to come from government, academia, nor the private sector. There are a number of governmental agencies within India that are involved in water planning and management, and within those organizations there are far-sighted individuals who recognize the need for and support the development of this new training program. However, institutional change and development is sometimes difficult to accomplish from within. Government institutions are generally created to deal with particular problems in specific ways, yet when the nature of the problem changes or when new problems arise, existing government institutions often lack the appropriate focus, approach, mandate, and flexibility to deal with the situation. Typically, in government new ideas are only slowly assimilated, and allocation of scarce resources to new and untried approaches is not easily accomplished. So, in the case of the water sector in India, the impetus for this training program could not come solely from government.

It could also not come from academia. Academics are academic: they see subjects as discipline-specific topics rather than as concepts and methods to be employed in a systematic process of water resources planning, development, and management. In addition, change could not be expected as a product of advanced training for individuals. Such training is isolated and narrowly defined along disciplinary lines. Available educational programs emphasize techniques, not processes, and do not provide institutional models to deal with the interdisciplinary nature of river basin planning and management. There would also be little support for individuals trained in these programs upon their return to their home agencies. Individuals returning to these agencies after advanced study often must find their own ways to apply their training. They tend to be isolated, getting little support in the application of new methods and still less in the integration of their training into a broad process of water resources planning and management.

Finally, India's historic approach to economic development has not fostered the growth of a private sector consultant industry. As a result, consultants in India have had a very limited role in water resources planning and development, although substantial capabilities exist and were utilized to good effect in the accomplishment of this program.

To improve the efficiency of water allocation and water development decision-making in India, USAID took the lead role in providing outside technical support for the development of the training program.

1.2 OBJECTIVE

The objective of this project has been to develop the institutional capability within GOI for imparting training in water resources systems planning and management. This training is to be given to practicing water resources scientists and engineers from State and Central Government organizations. The recipients of this training are to apply the concepts they have learned to determine optimal methods of developing river basins in order to obtain the maximum benefit from the available land and water resources. The training should be:

1. based on systems engineering approaches;
2. practical, application-oriented, hands-on, with case studies based on actual Indian conditions;
3. specifically addressed at improving efficiency of water allocation through use of concepts and methods appropriate for integrated river basin planning and management (IRBPM); and
4. presented in India under Indian conditions.

1.3 SCOPE OF WORK

In the contract, Harza was specifically charged with the following major activities:

1. *Establishment of a central training center linked to leading Indian and U.S. universities.* The training center is to provide a continuing source of personnel trained in water resources planning and management. The training center should introduce a computer based systems engineering approach to river basin management, and it should be equipped with computers and software for use in training purposes. The training center should be capable of training approximately 30 to 50 professionals per year.
2. *Development of a suitable course to provide training in river basin planning and management.* The curriculum for the course should focus particular attention on hands-on training and case studies based on actual Indian conditions and data.
3. *Design, in collaboration with appropriate GOI officials, an administrative framework under which the training center is to operate.*
4. *Identify instructors for the training center and determine what training they should receive prior to assuming teaching responsibilities.*

5. *Develop training materials, including manuals, planning guides, and visual training aids.*

6. *Arrange for short-term and long-term overseas study programs.*

7. *Assist with the organization of seminars and workshops on subjects relevant to river basin development.*

8. *Create a computer-based data management capacity for water resources systems planning and management for use at the training center.*

9. *Provide short- and long-term technical assistance, both expatriate and Indian, to accomplish the above tasks.*

10. *Provide regular home office support to the overseas staff.*

The original contract also required support for the establishment of a model operational river basin planning unit within a selected state. The contract was subsequently amended to delete work on this model unit due to the inability of GOI to move ahead with the development of the necessary Central and State organizations that such a unit would require.

1.4 PROJECT OUTPUTS

According to the USAID/Harza contract, by the end of the contract period, a water resources planning and management training center was to be established which would have:

1. *Trained approximately 200 professionals over the five year life of the contract to systematically plan out projects within individual river basins.*

2. *A capability to train 30 to 50 professionals per year.*

3. *An established training curriculum including detailed case study materials and teaching materials.*

4. *A trained staff capable not only of teaching existing methods, but of providing the research and development needed for new methods.*

5. *An established institutional link with Indian and American educational institutions and consulting organizations.*

6. *Established procedures for selecting trainees, evolving its program, and maintaining the center's capabilities.*

7. *A computer facility and software library, and the capability to teach participants to apply computer technology to river basin development.*

8. *A mechanism for continuing the existence of the center including funding and institutional structure considerations.*

1.5 OVERVIEW

The remaining sections of this report provide a brief history of the project and its major activities, a discussion of the significant project accomplishments, a description of those task areas where project outputs are less than anticipated, and recommendations for future institutional development activities for the CTU.

2 PROJECT HISTORY AND MAJOR ACTIVITIES

2.1 CTU DESIGN

In the early stages of the project, activities focused on drafting a design of the CTU and a program for its development. This major task culminated in the production of the "Inception Report" by a team of Harza, USU, CES, and CWC personnel. The Inception Report provides a detailed--though preliminary--design for the CTU. It describes and presents information about the CTU and its training programs, its staffing and management requirements, its facilities and equipment needs (insofar as they could be anticipated at that time), criteria for trainee selection, and preliminary designs of the its training curriculum. The report, published in November 1988, is seen as the initiation of the CTU.

2.2 CTU PHYSICAL FACILITIES

Originally, the CTU was to have been located in New Delhi. However, approximately a year after the beginning of the contract, a decision was made within GOI to place the CTU temporarily at the campus of the Central Water and Power Research Station (CWPRS), which is in Khadakwasla, near the city of Pune in Maharashtra. Accordingly, project resources were utilized to renovate and furnish existing buildings at CWPRS to provide space for classrooms, hostel accommodations, offices, library, etc. By the final quarter of 1988, this work was sufficiently completed to allow the first CTU training course to begin.

Through time, necessary non-expendable equipment was purchased to support the training activity and office and administrative work. In addition to the standard complement of office and classroom furniture, project funds were utilized to purchase a speaker system for classroom use, equipment for projection of videos and computer-generated images, overhead projectors, etc. The most important equipment provided by the project is computer hardware, which is heavily used by the trainees in the classroom, by Consultant personnel for production of training materials, and by

administrative staff for standard office work. Approximately 25 computers have been obtained for use in support of the CTU. This collection is composed of various PC-XT, AT, and portable machines, all of the MS-DOS or "IBM-compatible" type. All except the portable units are of Indian origin. Altogether, project expenditures on nonexpendable equipment totaled about $233,000.

Collection of pertinent technical literature has continued throughout the life of the project. At present, the CTU library houses approximately 1,500 volumes on various subjects related to river basin planning and management. Approximately 45 video tapes on topics relevant to river basin planning have also been obtained for use at the CTU and are in use in the training curriculum.

At the time of writing, plans are under way to establish permanent facilities for the CTU in the Nagpur area as a part of the GOI-proposed Central Water Engineering Academy. Acquisition of land is proceeding, and options are being explored for design and construction of buildings, provision of transportation, etc.

2.3 CTU CURRICULUM AND TRAINING MATERIALS

2.3.1 Curriculum

During the preparation of the Inception Report an initial design was developed for the training curriculum. This design called for a single course--subsequently named the "Advanced Course"--of nine months duration to train junior water resources scientists and engineers. Subsequent to the Inception Report, GOI requested that the curriculum be expanded and a second course be added to the training program. This course was to be of a shorter duration and to address the training needs of middle-level officers. This course--which has a duration of about three months and is known as the "Introductory Course"--was also designed.

Both courses follow a format of classroom instruction, daily hands-on practicums, and a case study which lasts several weeks and involves data from an actual Indian river basin. The case study component is the most important part of the curriculum. It provides a focal point for the lessons learned in the lectures and practicums and gives the trainees an opportunity to apply the concepts they have studied and to experience a planning process that is different from procedures now followed in India. For both the Introductory and Advanced Courses, it represents the capstone of the training.

2.3.1.1 Introductory Course Curriculum

The purpose of the Introductory Course is to provide training to mid-level water resources scientists and engineers who have 10 to 15 years of in-service experience and typically are at the grade of executive engineer. The objective of the training is to create an awareness on the part of these mid-level managers and an appreciation for the techniques, concepts, and benefits of integrated river basin planning and management. The course has three major components. The first is class-room lectures and "practicums" in a variety of discipline areas. The lectures introduce the trainees to selected theory and important concepts which these disciplines offer to the practice of river basin planning and management. An essential step of selection of concepts and material takes place at this point. Neither the scale of the course nor the resources available for the river basin planning process permit topics to be addressed at the level appropriate for detailed project planning. In some respects, however, the basin planning process is more demanding than project planning. Accordingly, each presentation must be honed to deal specifically with the relevance of the topic to planning at the river basin scale and methods of application that are practical within typical constraints of time and resources. Though the lectures present the pertinent academic background ideas, they are intended to be practical and to offer insight into the utility that various disciplines bring to the water resources planning process. Emphasis is placed on real-world examples and data from Indian river basins. Each lecture is followed by a practicum which provides hands-on experience for the trainees in applying the concepts and methods that are discussed in the lecture. The major subject areas for which lectures and practicums are given are:

1. Introduction to IRBPM
2. Computer orientation
3. The hydrologic system
4. Water supply planning
5. Environmental and social analysis
6. Economics of river basin development
7. Plan benefits
8. Water resources systems engineering

The second major component is the case study. During the case study, the trainee-officers are given the assignment of assembling a river basin plan for the development of the water and related land resources of a real Indian river basin. They are provided with maps, a data bank, and investigation memoranda which describe the resources of the basin and the water development and management problems and potentials. The whole group of trainees then work as an inter-disciplinary planning team to identify planning objectives, understand the resource base (hydrologic, economic, social, environmental, etc.) and the existing water resources supply and management system, propose and evaluate alternative development plans, select a "preferred" plan, and document and defend this process and its findings. Ideas, methods, and approaches from the lectures and practicums are integrated into the case study activity. Though it is only a training exercise, its application to a real river basin in India, its use of real data from that basin (as well as real "data gaps" that will always occur in basin planning), the use of sophisticated simulation and optimization models, the emphasis on teamwork and communication among different disciplines to solve planning problems, and the requirement for documentation of the entire process make the case study as practical an experience as is possible given the limited time and resources of the training program.

The third component of the Introductory Course is the study tour. After the lectures, practicums, and case study have been completed, the trainees are taken for a two- to three-week tour of several river basins in the U.S. There, they see put into practice the concepts and methods which they have studied in the classroom. Emphasis is placed on understanding the diverse array of institutions used

in the U.S. to increase water use efficiency and to integrate water management at the river basin scale. Typical stops on the tour include the Tennessee Valley Authority, the U.S. Bureau of Reclamation in Denver, the Northern Colorado Water Conservancy District, the Salt River Project, the Central Arizona Project, and the Central Valley Project in California. Briefings before, during, and after the tour emphasize that each location visited involved several, perhaps many, alternatives which were weighed before selecting the plan and projects which are seen in the visits. At all these locations, trainees are given the opportunity to talk to water resources officials, water users, planners, etc., to see modern technology, and to understand how water resources institutions (agencies, water rights mechanisms, water pricing policies, water and environmental laws, etc.) in the U.S. contribute toward efficient allocation and management of the resource.

2.3.1.2 Advanced Course Curriculum

The purpose of the Advanced Course is to train practicing water resources scientists and engineers who will be responsible for actually doing the work of integrated river basin planning and management. The trainee-officers for the Advanced Course are in the 30- to 35-year age bracket, have about five to ten years in-service experience, and are approximately at the grade of assistant engineer.

The training in the Advanced Course is seen as more than just "awareness" training. The participating officers will eventually be responsible for detailed, technical work in water resources planning and management, and they must therefore have a solid background in the more technical aspects of integrated river basin planning and management than is provided to the officers who attend the Introductory Course.

Five major components comprise the curriculum of the Advanced Course. First, trainees are given a series of lectures and practicums in a variety of prerequisite subjects in order to bring their

level of understanding of some disciplines to a necessary and common threshold. These prerequisite courses last for a total of about eight weeks and cover the following subjects:

1. Computer fundamentals
2. Probability and statistics
3. Agricultural science
4. Hydrology
5. Environmental science
6. Applied sociology
7. Engineering microeconomics
8. Introduction to modeling

Second, lectures and practicums are given to the trainees on more advanced topics that have been synthesized from various disciplines into approaches and concepts focused in support of river basin planning and management. These are called the synthesis courses because they draw upon many disciplines to understand river basin planning and management. The synthesis courses in the curriculum are:

1. Introduction to IRBPM
2. Information and display systems
3. River basin irrigation
4. River basin hydrology
5. Environmental analysis
6. Social analysis
7. River basin systems analysis
8. Economic analysis
9. River basin engineering
10. Integrated systems operation
11. Synthesis and application of concepts

Third, the trainee-officers in the Advanced Course are required to complete a self-directed project. These projects are proposed by the trainees themselves, and the trainees are responsible for data collection, model formulation, analysis, and documentation and presentation of results. A self-directed project problem need not be of the scale of a river basin, but it must have interdisciplinary trade-offs, it must have something to do with water resources planning or management, and the trainees must use methods they learn in the training program to solve the problem. The trainees work in small groups of three or four individuals. This builds team-work skills that are important not only for the case study portion of the course, but also for water resources planning in general. Most self-directed projects are developed from problems that the trainees bring from their home agencies. Thus, the trainees--as well as the departments they work in--have interest in the outcome of the project. The self-directed projects serve to generate a high level of interest among the trainees early in the Advanced Course training program and to demonstrate to them that the tools and concepts taught at the CTU have immediate application to real problems.

The fourth component of the Advanced Course is the case study. The case study for the Advanced Course is similar to that of the Introductory Course, and it has the same broad objectives of familiarizing the trainees with the interdisciplinary and systematic process of river basin planning. However, more time is devoted in the Advanced Course to case study activities and, in general, the trainees are given greater latitude to steer the process themselves. In the Advanced Course the case study is not a cook-book activity. The trainees make more of the analyses and decisions about what to analyze. Less is given to them than in the Introductory Course. This provides a more intense learning experience where the trainees are free to make their own mistakes, to propose ways of overcoming them, and in general learn from their failures as well as their successes.

The final component of the Advanced Course is a U.S. study tour. This is in all aspects similar to the study tour included in the Introductory Course.

2.3.2 Training Materials

Both the Introductory Course and the Advanced Course follow a schedule involving lectures, hands-on practicums, a case study wherein trainee officers simulate the planning of a real Indian river basin, and a study tour to see for themselves the concepts and ideas of IRBPM begin put into practice. The curriculum of the Advanced Course also includes the self-directed project which the trainees themselves propose and for which they use methods and ideas learned in the lectures and practicums to obtain solutions. A wide range of materials have been collected to support these training activities.

2.3.2.1 Course Materials

A large number of expatriate and national trainers have participated in the courses taught to date at the CTU (see Appendix 1 for a list of expatriate trainers involved). These trainers have produced a wealth of lecture notes, handouts, transparencies, practicum assignments, etc. Altogether, in excess of 11,000 pages of handouts and notes have been prepared for support of the two major courses conducted by the CTU. This does not include the case study materials.

In the beginning, the courses were conducted primarily by expatriate trainers. These trainers produced the first set of notes and practicum materials, which were liberally augmented with contributions by participating national trainers. However, given the initial heavy participation of expatriates and the general lack of data available to them about water resources conditions for Indian river basins, most of the examples and assignments in lectures and practicums utilized hypothetical data or data from U.S. river basins.

As the case study preparations took shape, however, data describing the hydrologic, social, environmental, and economic conditions in the case study river basins became available. Gradually, these data were utilized more and more in the lectures and practicums, which are by design more academic than the case study. This increased use of indigenous data where ever possible strength-

ened the lectures and practicums and established stronger linkages among lectures, practicums, and case study activities.

2.3.2.2 Case Study Materials

As discussed above, the case study is the most important part of the curriculum for several reasons. The case study brings together the bases and objectives of river basin planning and management into an integrated and systematic process, the understanding of which is a principal learning objective of the program. The process requires each topic to be addressed in its turn, with its own questions of detailed objectives, criteria, data, and procedures, rather than set aside for consideration at another time. It is student-centered, giving the trainee-officers not only hands-on practice with new approaches, methods, and equipment but considerable latitude within which to plan and direct their own activities. As such, it engages the interest of the trainees and greatly increases their sense of ownership and retained learning of the process. Finally, and not least, the case study comes to a conclusion, in the form of a draft report, which provides the opportunity for critical review and reflection on what has been accomplished. During the preparation of the Inception Report in the first year of the project, five river basins were identified as "case study" basins. These were the Pennar, the Subarnarekha, the Upper Narmada (above Barghi Dam), the Mahi, and the Indravati Basins. During the initial stages of the project, preliminary data were collected for the first three of these basins in preparation for more intensive study and analysis in formulating the materials which comprise the case studies.

Ultimately, complete case study materials were prepared for three of these river basins: the Pennar, the Subarnarekha, and the Upper Narmada. Figure 1 illustrates the location of these three river basins and provides some information about their major water resources problems and potentials. For each basin, the training materials that have been prepared consist of a river basin case report, a data bank, a map portfolio, a case study report, and several working computer simulation and optimization models as may be appropriate for the basin in question.

The river basin case report is a detailed description of the basin and its water resources development problems and potentials. It provides both a quantitative and qualitative overview of the basin's water resources picture, but it makes no recommendations regarding development objectives, water resources projects, etc. It serves both the trainers and the trainees as a bench mark document which begins their education about the basin.

It would not be possible for the trainee-officers to participate in the full detail of all aspects of river basin planning during the training program. This would simply be too time consuming. In particular, data collection is an activity that requires very large amounts of time. This task has been done by the Consultant project staff, and the results of the data collection effort have been recorded in a data bank for each case study basin[1]. The data bank, some of which is computerized, is used by the trainers and the trainees as the primary source of basic information about the basin. The contents of the data bank are augmented by the additional data and visual impressions which the trainees collect on a field trip to the basin. The data bank provides the raw material for many of the exercises and analyses which are conducted by the trainees as a part of the case study. It contains data about all major water-related aspects of the basin, including surface and groundwater hydrology, meteorology, land use, agriculture, demographics, economics, social and cultural aspects of the people, environmental quality, etc.

The map portfolio contains maps which provide information about the location of meteorological and stream gaging sites, land use, groundwater availability, soil types, topography, etc. The maps are used by both the trainers and the trainees, especially for obtaining ideas about possible structural water management projects and opportunities for modifications in land management patterns.

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[1] In most basin planning situations, but perhaps especially in India, large amounts of potentially useful data and information exist but it takes time and perseverance to find and gain access to them. In the present context, therefore, the collection and preparation of data and design of the basin planning study to take advantage of available information are important learning activities. Certainly the consultant team learned a great deal in preparation of the case study materials for the courses at the CTU! These aspects were discussed at length with the trainee-officers, to prepare them for a real planning assignment, and should receive major emphasis in establishing a model river basin planning unit.

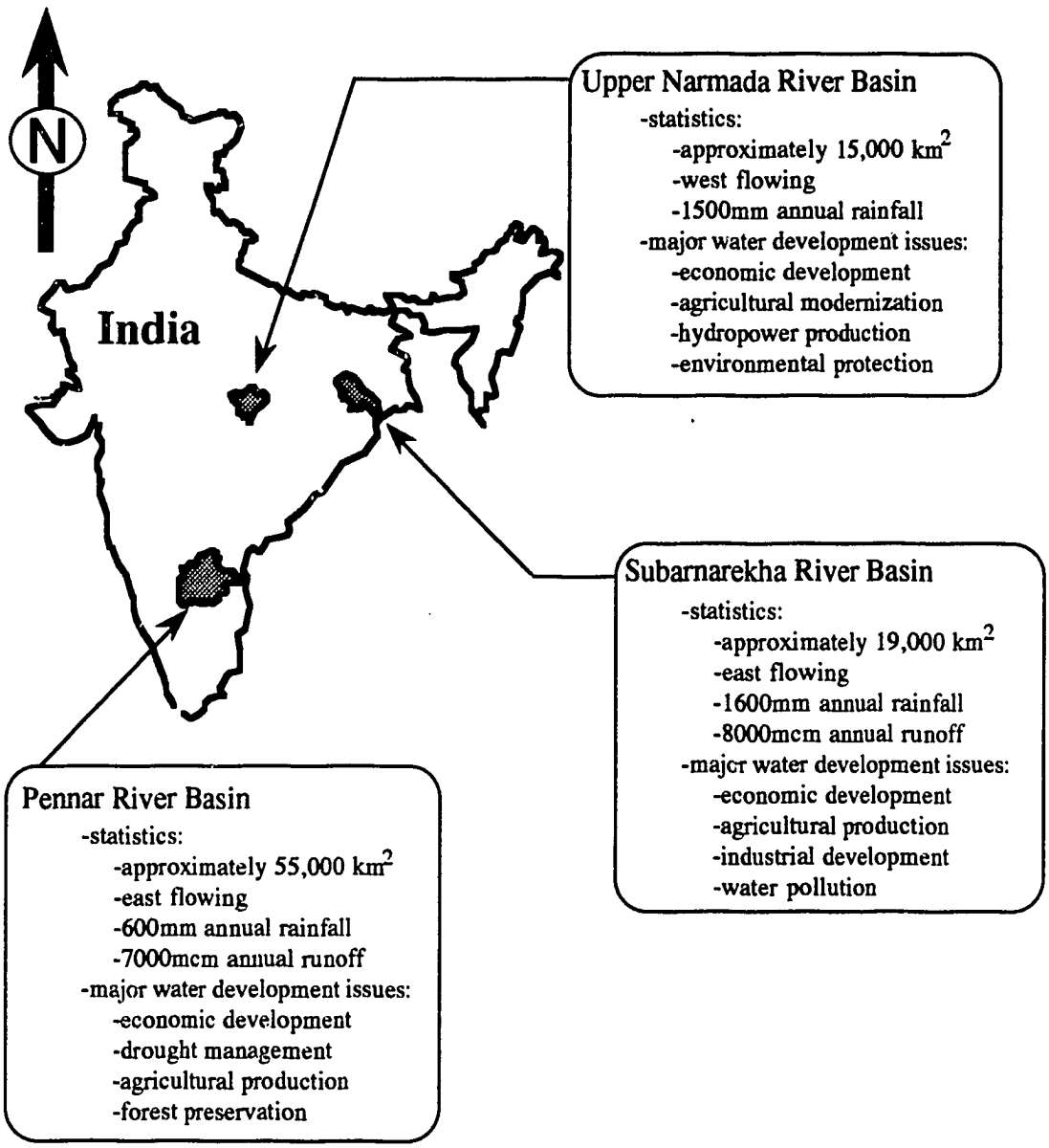

Figure 1: Location of Case Study River Basins

The case study report is written for the use of the trainers only. It provides complete documentation of the case study materials, the data base and data analyses, available simulation and optimization models, suggested exercises--with solutions--for the trainees to carry out as a part of their case study work, and the comprehensive results of extensive computer modeling efforts to simulate and evaluate alternative river basin development plans. This information is used by the trainers to help them guide the case study activities of the trainees.

Simulation and optimization models are used extensively for the case studies that have been compiled. The hydrologic, social, environmental, and economic systems that will be affected by basin-scale water developments are complicated. Understanding and forecasting the impacts of water resources development on these systems requires the careful use of computer models. The trainees are taught about the appropriate use of models in basin-scale planning, the importance of assumptions in modeling and the limitations implied by gaps in the data base, the need for careful calibration and sensitivity analysis, and the requirement for continually conducting "reality checks" to be satisfied that the modeling results are consistent with the real systems.

The models used in the case study underwent an evolution as case study teaching experience was gained during the first two Introductory Courses. From the beginning, it was recognized that the case study models used by the trainees in the classroom had to be sophisticated enough to demonstrate that useful information can be generated from river basin scale models. At the same time, however, the models had to be simple enough for trainees with very limited computer skills to use. Initially, the case study models were based on an extensive set of spreadsheet programs. Since the trainees acquire rudimentary spreadsheet skills quickly, it was thought that spreadsheets could provide a convenient means of compiling, editing, and manipulating a large amount of data, which could then be put directly into a river basin system operation model. This model would provide the sophisticated simulation capability. (The model that was used for this, called "MODSIM," was authored principally by Dr. John Labadie at Colorado State University and is an outgrowth of the river basin system simulation programs developed for the Texas Water Board. MODSIM is a very

sophisticated river basin simulation program intended for actual basin planning studies. It provides a mechanism whereby the operation of the water storage and conveyance facilities of the river basin can be simulated dynamically through time.) Its output could be directly examined by the trainees, who could then use this information to carry out side calculations to estimate agricultural production, income generation, employment impacts, etc. In practice, however, this combination of user-friendly spreadsheets and advanced river basin simulation model proved to be too cumbersome. The trainees simply did not have enough time to generate several simulation iterations. After the second Introductory Course, a new series of programs was created which speed up the data handling work, provide rapid calculations of water demands for various sectors at different locations in the basin, and assemble the results in a format which is immediately acceptable as input to the MODSIM system simulation model. Other programs receive the output of MODSIM and provide graphical and tabular summaries of reservoir operations, water allocations to the various users, and the implications of all of this for agricultural production, income, and employment. After becoming familiar with the use of this integrated set of models, the trainees can now make several simulation runs per day instead of one in several days. With this capability, the trainees can see complete, if simplified, results of "what if" cases, beginning with data and assumptions on land use, cropping pattern, precipitation, reservoirs and other facilities, and ending with patterns of reservoir operation, water shortages and surpluses, and resulting crop production, value, and employment. The models also provide for consideration of municipal and industrial water supply, water for livestock, and interbasin imports and exports and could be used to examine questions of instream flow and flood control. These results are directly useful in the case study, and the ability of the trainees to obtain them makes the process believable.

The trainees are cautioned that models are developed and applied to meet the defined needs, and that no one set of models or approaches will serve for all situations. The availability of at least one set of models, however, which the trainees can learn to use to obtain results in a short time, makes it worthwhile to establish objectives, ask questions, and formulate alternative plans of action for

analysis. The case study thus gives credibility to the entire concept of planning and management at the river basin scale.

2.3.2.3 Supporting Software and Other Materials

In addition to the library volumes, video tapes, case study data and analyses, river basin planning models, etc., a host of supporting materials have been assembled that are critical for the training program. The most important of these is the array of software that has been purchased or developed for the CTU and which is regularly used in the program. All software has been selected to run on standard IBM-type PC-XT and PC-AT computers operating under MS-DOS. Many of the application packages used at the CTU are readily available in India (e.g., WordStar, Lotus-123, d-Base, etc.) and are likely to be available to trainee officers when they return to their home agencies. Appendix 2 contains a partial listing of the computer software supplied by the project.

2.3.3 Trainee Selection

In addition to the service grade, number of years of experience, and age requirements for the trainee officers of the Introductory and Advanced Courses, other criteria were specified for trainee selection. The trainee officers are drawn from State and Central Units engaged in water resources planning and management. (The multiple objective and interdisciplinary aspects of river basin planning could be enhanced in the course setting by inclusion of professionals from other agencies whose work affects or is affected by the subject matter of the course.) The trainee officers should have good academic and professional records in civil and/or water resources engineering or related water planning fields. They should also have a sincere interest in learning and applying methodologies to be taught at the CTU. They should be mature enough to comprehend the complex issues of planning for development at the basin scale. They must be interested in planning work, and willing to continue their work in a planning unit for a State or Central agency, following their training at the CTU, although it is understood that such assignments are frequently beyond the individual's control.

The trainees should also be given adequate allowances by the parent organization to compensate for the extra expenditure involved in maintaining double residences while posted at the CTU for training. It is hoped that after successful completion of the training, trainees will receive appropriate merit allowance from their parent departments in acknowledgment of their completion of an academically recognized program.

2.3.4 Courses Taught To Date

Instruction for the first Introductory Course at the CTU began in November of 1988. This was followed by the second Introductory Course in June of 1989, the first Advanced Course in January of 1990, the third Introductory Course in January of 1991, and the second Advanced Course in June of 1991.

With each subsequent course, much was learned about the curriculum and its management. As a result, the design of the curriculum was continually refined and new training materials created. In particular, a substantial amount of lecture and practicum material was assembled with each new course, and training materials used to support the instruction of the case study underwent a significant evolution.

2.4 CTU INSTITUTIONAL CAPABILITIES AND LINKAGES

Both the contract and the Inception Report call for the staff of the CTU to receive training so they will be "capable not only of teaching existing methods, but of providing the research and development needed for new methods." In the Inception Report, categories and numbers of teaching and support staff are identified, mechanisms for staff training are given, and the CTU administrative and institutional setting is described. Moreover, the broad framework which was designed in the Inception Report for the staffing, management, and operation of the CTU was agreed to by the Central Water Commission. The following sections summarize these topics.

2.4.1 CTU Organizational Structure

The design of the CTU called for it to have a Project Director of the rank of Chief Engineer. The Chief Engineer was to be assisted by five Directors who were to be responsible for the management of the courses and instruction. The Chief Engineer was also to be assisted by one Deputy Director for administration and coordination. There were to be a number of Deputy Directors to assist the Directors in handling the course program and case studies. (The CWC sanction for staff allocation calls for a total of five Deputy Directors to be assigned to the CTU.) In addition, the organizational design called for supervisors, draftsmen, librarians, computer operators, programming assistants, and other staff to support the needs of the CTU.

In the three years since the publication of the Inception Report, the CTU has had three Chief Engineers. At present, its senior staff is composed of a Chief Engineer, three Directors, and three Deputy Directors. The CTU has also been assigned a few assistant engineers, a draftsman, clerical workers, related office personnel, and drivers. No librarians, computer operators, or programming assistants are on the CTU staff. In terms of numbers and approximate distribution of personnel, the staffing pattern at the CTU seems to have reached a rough equilibrium.

The Inception Report called for creation of an Advisory Board, to be chaired by the Chairman of CWC and with membership from CWC, MOWR, and the CTU. The Advisory Board was to have an administrative role to review the progress and evaluate the program of the CTU from the perspective of the interests of GOI. It was to provide policy guidance and address situations that arise during the course of the program and offer recommendations for coordinating the work of the CTU within the framework of other water resources activities in India.

The Inception Report also identified another advisory body for the CTU, called the Course Management Committee, which was to provide needed technical guidance to the CTU and introduce

into the program the technical aspects of water resources planning and development from the perspective of GOI. It was to be chaired by the CWC Member for Water Planning, and senior Indian officials familiar with water resources planning and management in the country were to be represented on the committee.

The Advisory Board and the Course Management Committee were constituted and met for the first time approximately three-and-one-half years after the project began. Figure 2 provides an organizational chart of the CTU.

Prior to the formulation of these advisory bodies, the CTU required an organizational and coordinating board which could provide needed guidance and take timely decisions as the CTU was being formulated, its curriculum designed, and its facilities prepared. In 1988, such a body, called the Joint Project Management Committee (JPMC) was created. The JPMC is chaired by the Chief Engineer, CTU, and has membership composed of the USAID project Officer and the Consultant Resident Manager.

2.4.2 CTU Staffing and Staff Development

Initially, the teaching faculty at the CTU were to be drawn from expatriates and national trainers supplied by the Consultant and from selected experts within CWC. Available CTU staff were to participate with the national and expatriate trainers and, in so doing, become familiar with the subject matter and how to present it. This early use of experts would serve to formulate and establish the CTU curriculum, teaching methods, and course materials while a cadre of CWC personnel could be given specific training in river basin planning and management. Gradually, the Consultant and non-CWC trainers would be phased out until, by the final year of the contract, the CTU trainers would take over the conduct of the courses with only nominal assistance from outside. Ultimately, a fully trained staff would be achieved through national and external training programs in which selected CWC trainers would go to the U.S. for advanced training in specialized fields. This would include

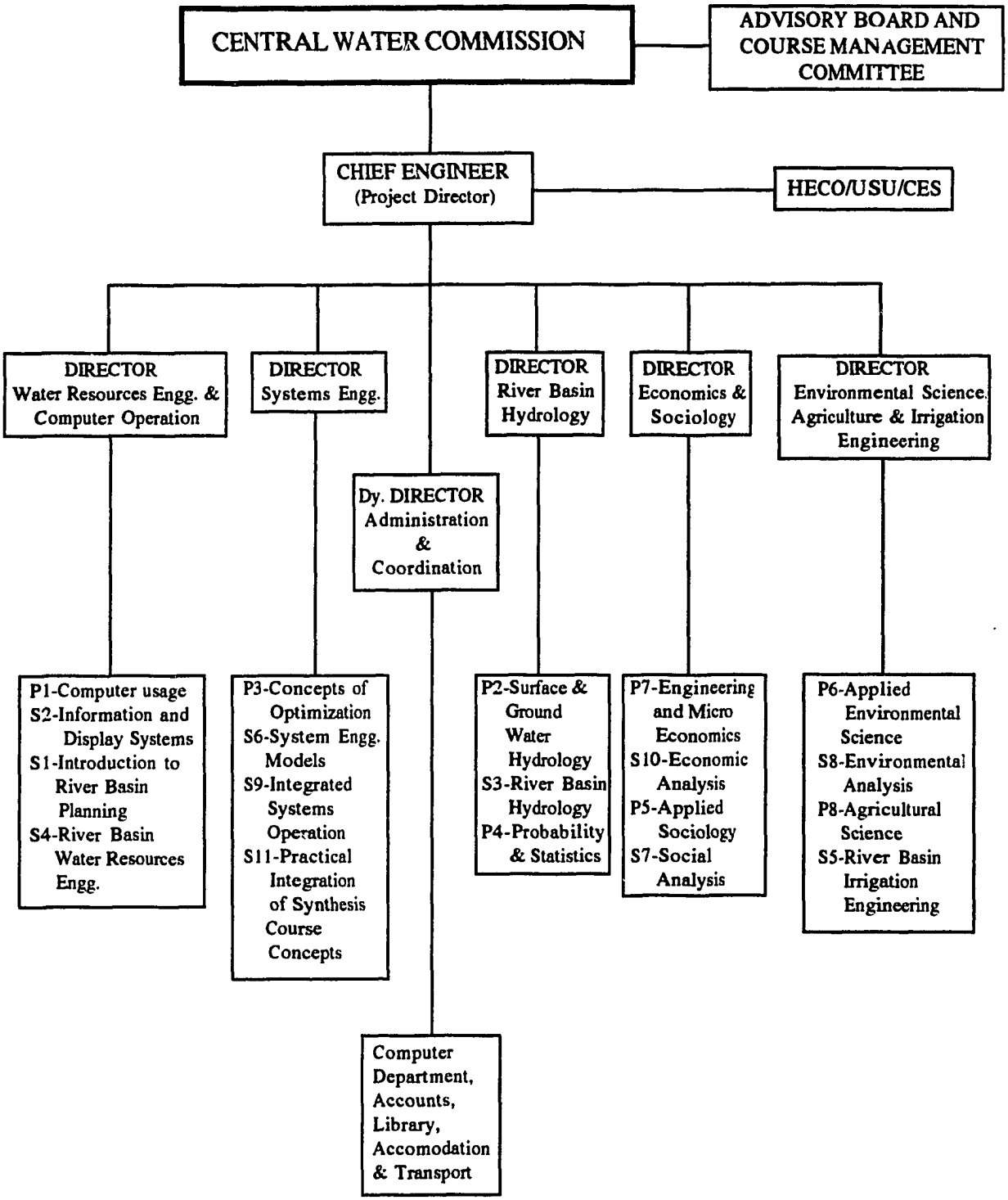

Figure 2: CTU Organizational Chart

non-degree and advanced university degree training as deemed necessary. Young staff would also be drawn at the Deputy Director grade from among the graduates of the training program.

Staffing difficulties within CWC have had a detrimental effect on development of a qualified CTU staff. Though the CTU staff allocation calls for five Directors and five Deputy Directors, only three Directors and three Deputy Directors have been assigned to the CTU. To date, minimal training has been imparted to the CTU staff, and none in the U.S. Two of the three present Deputy Directors are graduates of earlier CTU courses.

2.4.3 Academic Recognition and Linkages to Universities

Formation of linkages between the CTU and universities in the U.S. and India was thought necessary to give the CTU a continuing infusion of new ideas, to establish long-term opportunities for training CTU trainers, to supply national trainers outside CWC that might be occasionally needed, to foster continued improvement of case studies, etc.

The association between the CTU and Utah State University could prove to be a valuable long-term benefit to the CTU if the CTU and CWC choose to take advantage of it. Several graduates of the CTU training program have applied for admission in the water resources program at USU, and some have been accepted and have begun their graduate studies in Logan. Placement of good people in graduate water resources programs at USU would go a long way in upgrading case studies, staff development, infusion of new ideas, etc., if these people could be made available to, and would be used by the CTU. The possibility of bolstering the relationship between the CTU and USU--as well as the relationship between the CTU and other institutions--through the USAID Institutional Linkages program could be a possibility in the future.

In early 1991, the University of Poona recognized the CTU as a specialized, adjunct research institute. It also recognized the courses offered by the CTU. Graduates of the Introductory Course

are awarded a certificate by the University, and graduates of the Advanced Course are awarded a post graduate diploma. With additional study, Advanced Course graduates might convert the diploma into a post graduate degree. Faculty of the University are frequent trainers in the CTU courses, and with financial support provided by the project, the University produced a video for and about the CTU. The linkage between the CTU and the University of Poona is a valuable one, but it might be threatened by the CTU's proposed move to Nagpur unless adequate steps are initiated to ensure survival and viability.

The CTU has less formal linkages with other universities in the U.S. and India. The project has received contributions from faculty from U.C.L.A., Cornell, the University of Virginia, the University of Colorado, and others in the U.S. Key water resources engineers at these institutions are familiar with the CTU and are in position to provide graduate training for meritorious applicants that might come from the CTU. Similarly, several national trainers who have supported the training efforts at the CTU have been drawn from strong water resources institutions in India (e.g., IIT-Bombay, IIT-Khanpur, Gokhale Institute of Politics and Economics, University of Roorkee, etc.), and will be available to continue support for the CTU. Appendix 3 provides a listing of the institutions with which the CTU has had significant formal and informal linkages over the course of the project.

2.5 PROJECT EXPENDITURES

2.5.1 Project Budget

As finally amended, the project budget was $7,091,815.45. The contract specified four budgetary line items, namely "Technical Assistance," "Equipment," "Training," and "Other Direct Costs." A summary of the allocation of expenditures among these four categories is given in Table 1. Note that these cost data are as of the most recent invoice (December, 1991) and do not contain all project completion and close-down expenses.

Table 1: Summary of project expenditures as of December, 1991 (all amounts in U.S. dollars)

Item	Contract Budgeted Amounts	Amounts Invoiced (through Dec., 1991)	Amounts Remaining	Line Item Percentage Invoiced
1.Technical Assist.				
a.Harza				
i. Home Office	702,777.98	690,556.66	12,221.32	
ii. Long Term	489,793.54	481,568.87	8,224.67	
iii. OH & FB	1,706,187.44	1,686,268.81	19,918.63	
iv. Fixed Fee	100,728.00	100,728.00	0.00	
Harza Subtotal:	2,999,486.96	2,959,122.34	40,364.62	
b.USU	909,600.49	909,600.49	0.00	
c.CCN	680,745.14	638,145.09	42,600.05	
TA Subtotal	4,589,832.59	4,506,867.92	82,964.67	98.1
2.Equipment	233,592.60	233,377.55	215.05	99.9
3.Training	314,239.45	314,244.88	(5.43)	100.0
4.Other Direct	1,954,150.81	1,810,787.28	143,363.53	92.6
Grand Total:	7,091,815.45	6,865,277.63	226,537.82	96.8

2.5.2 Personnel Resources

As amended, the contract called for the use of approximately 1,300 person-months of professional and non-professional effort on the part of the consultant. As of the December, 1991, billing period, approximately 1,260 person-months had been expended. A detailed breakdown of technical effort utilized by the project is given in Table 2.

Table 2: Level-of-effort summary (as of December, 1991)

Item	Budgeted Person-Months	Person-Months Invoiced (through Dec., 1991)	Person-Months Remaining	Percent of Budgeted Person-Months Utilized
1. Harza Professional				
a. Home Office	122.35	121.33	1.02	99.2
b. Short Term	18.93	18.93	0.00	100.0
c. Long Term	77.21	75.50	1.71	97.8
Subtotal:	218.49	215.76	2.73	98.8
2. USU Professional				
a. Home Office	30.67	30.67	0.00	100.0
b. Short Term	27.00	27.00	0.00	100.0
Subtotal:	57.67	57.67	0.00	100.0
3. CCN				
a. Professional	383.45	380.10	3.35	99.1
b. Nonprofessional	643.84	622.32	21.52	96.7
Subtotal:	1,027.29	1002.42	24.87	97.5
GRAND TOTAL	1,303.45	1,275.85	27.60	97.8

3 PROJECT ACCOMPLISHMENTS

3.1 ACHIEVEMENT OF PROJECT TARGETS

Section 1.4 of this report listed the project outputs that are identified in the contract. The degree to which these outputs have been achieved is discussed here.

The contract called for approximately 200 professionals to be trained over the five year life of the project. At the close of the present Advanced Course, a total of approximately 135 trainee officers will have graduated from the five courses held to date. About 40 of these have received training in the Advanced Course.

Also by the close of the contract, the CTU was to have an established capability to train 30 to 50 professionals per year. Under the present temporary situation of CTU utilization of CWPRS facilities, this goal has been fully reached. Subject to decisions by GOI regarding establishment of permanent facilities in Nagpur, and depending on the capacity of those facilities, the target of 30 to 50 trainees per year should remain feasible.

The outputs called for by the contract specifically require an established training curriculum with detailed case study and teaching materials. This target has been fully achieved.

The contract also called for establishment of an institutional link with an Indian and an American educational institution. The CTU ties with the University of Poona and Utah State University are strong, beneficial to all parties, and will continue to improve if the CTU nurtures them. Its formal and informal linkages with other universities in India and the U.S. are very valuable and can continue to supply useful inputs to the training programs.

A computer facility and software library, with the capability to teach students to apply computer technology to river basin development, is an important output identified in the contract. This has been fully achieved.

Another output is the establishment of procedures for selecting trainees. The process and criteria for selection of trainees appears to be working well. From time to time trainee nominations have been received that are probably motivated more from political considerations than on the basis of individual merit or interest, but these seem to be rare. In general, the quality of the trainee officers is high, especially for the Advanced Course.

Procedures were also to be established for evolving the CTU program and maintaining CTU capabilities. In addition, a trained staff was to be created that would be capable not only of teaching existing methods, but of providing the research and development needed for new methods. Actually, achievement of the first of these goals is predicated upon achievement of the second. Generation of these related outputs has not been fully possible. Reasons for this will be discussed in Section 4.

Finally, the contract called for a mechanism to be put in place for continuing the existence of the CTU, including funding and institutional structure considerations. Continued existence of the CTU will require funding, institutional linkages and support, trained and dedicated staff, and aggressive and forward-looking management. Many of these things can be designed, but all must be supplied by GOI. To date, the record on these outputs is mixed. This is discussed in further detail in Section 4.

3.2 CONTRIBUTION TO THE FIELD OF WATER RESOURCES

Greater water use efficiency for all water-using sectors of the economy is a desirable goal for India and for many other developing and developed countries. One way of achieving improvements

in efficiency is through coordinated, systematic, and integrated planning, development, and management of water and related resources at the river basin scale. As a whole, this process of integrated river basin planning and management is not taught in academic institutions. Traditionally, to learn about this process one must participate in its practice. However, the CTU represents a unique training institution in that IRBPM is the only subject that is taught. Traditional disciplines are accorded attention because of what they have to offer in understanding and managing water allocation and use at the river basin scale. The training curriculum, the case study process, and the large quantity of training materials used in lectures and practicums at the CTU represents an enormous contribution to the field of water resources. Nowhere else has this diverse, interdisciplinary array of basin planning materials, concepts, approaches, methods, and philosophy been assembled. Moreover, the critical elements of the program are portable: the curriculum, most of the training materials, and the training approach devised for the CTU could be followed, with appropriate modifications, in other countries.

4 PROJECT DIFFICULTIES

The major difficulties that the project has faced in establishing the CTU are generally related to the institutional structure of the training program. CTU staffing and management have been the most critical concerns, but the ability of the CTU to attract good trainee officers is also a lingering problem. Many of these difficulties still remain and cannot be resolved by anyone outside the GOI/ MOWR/CWC/CTU chain of command. Yet, if the CTU is to become a viable organization without on-going heavy investment from non-GOI donors, these problems must be resolved.

4.1 STAFFING AND STAFF DEVELOPMENT

4.1.1 Staffing Difficulties

The early decisions to staff the CTU with Central Government officers and yet to locate the organization outside the New Delhi area created a serious and long-term (perhaps permanent) staffing problem. From the point of view of career advancement, training programs are not attractive opportunities. In addition, a change in posting often brings with it a loss of income (due to loss of a spouse's second employment), difficulties with children's schooling, language differences to be overcome, hardships with residential accommodations, etc. The net result is that posting to the CTU is often vigorously resisted. In general, even the 30 percent salary bonus received by the training and management staff of the CTU does not make up for the added burdens of CTU employment. At present, the teaching faculty of the CTU is staffed at only 60 percent of its designed strength, and a large fraction of the staff now stationed at the CTU are seeking an opportunity to transfer elsewhere. The proposed move to Nagpur will not markedly improve this situation, and may even have an adverse effect on staffing.

4.1.2 Training-of-Trainers

In general, the past training and experience of government officers in the water sector does not automatically turn them into skilled trainers nor prepare them to be managers of training institutions. To become good trainers (or managers of trainers), they must have a suitable educational and experiential background, aptitude, and interest, and they must themselves receive appropriate training to prepare them for their new duties. Background, aptitude, and interest are issues that can be addressed in job posting. Training, however, is something that can only be supplied once the persons to be trained are identified.

In the past two-and-a-half years, several versions of a training-of-trainers (TOT) program have been designed and submitted to the CTU and CWC for approval and action. Ultimately, the project mounted no significant TOT program primarily because CWC could not identify the candidates to receive the training. Limited, local efforts were made in Pune to provide training in basic computer fundamentals and teaching skills to the resident CTU faculty. Other, more informal attempts at TOT were also made locally. In particular, since July of 1990, the Consultant repeatedly requested the CTU management to post at least one Deputy Director to work on a part time but regular basis with the Consultant staff in understanding and preparing case study materials. In so doing, at least one Deputy Director would become familiar with the details of data collection, analysis, modeling, etc., that are so critical in conducting the most important part of the training program. However, the offer was never fully acted upon by the CTU. In October of 1991, barely two months before the end of the contract and as the Consultant was beginning close-down procedures, three CTU members (two Deputy Directors and one Junior Engineer) made a few sporadic visits to the Consultant's technical office to ask questions about data, models, etc., which are used in the case studies. This interchange was late and limited and an inadequate response to a serious institutional development need.

4.1.3 Staff Tenure

No good training institution can hope to build a skilled and qualified staff when, first, it takes a great deal of time to train new staff members, and second, new staff members are likely to be posted to another position after a period of time that is relatively short. IRBPM is not a subject that most water resources scientists and engineers are experienced in, trained in, or--at least initially--enamored with, and almost none of them (in the CWC and water sector organizations generally) are prepared to conduct training in the subject. On exposure to the concepts of IRBPM, however, most water resource professionals see its importance and potential as a framework for the decision-making process that culminates in the design, construction, and operation of projects. After sufficient exposure and practice with a provided set of data, approaches, methodologies, computer models, classroom materials, and guidance in teaching methods, most well-selected staff candidates can assimilate and learn to present segments of the IRBPM course.

New staff arrive at the CTU with inadequate training about their job and the concepts of IRBPM. In the absence of an effective TOT program, they require long lead times to become prepared. Staff members also know that assignments at the CTU will be brief, so they look upon themselves as "only" temporary. This is not an atmosphere conducive to staff development. Recently, GOI has promulgated a policy whereby officers engaged in training programs will be required to perform a three-year tour of duty. If the policy is enforced, if those assigned to the CTU are well qualified for their positions, and if they are given sufficient training, this period of service would be minimally acceptable. A five-year period would be much better.

It must be emphasized that getting up in front of a class is not a trivial step for new staff members selected from agency ranks. Few are experienced teachers, and typically their career paths have made them more generalists than specialists in any one of the course topics or groups of topics as shown on Figure 1. This is especially true since IRBPM really is different than traditional project planning approaches. IRBPM makes sophisticated use of broad-brush approaches, and it requires some confidence in one's understanding of each subject area to support the selection of appropriate

levels of aggregation and simplification in each case. Furthermore the trainee-officers, as previously noted, are bright, capable, and experienced professionals who tend--quite properly--to be demanding of their trainers.

On the other hand, the designated CWC trainers bring their own unique experiences, insights, and capabilities. Key elements to help them become effective trainers are well-focused assignments as trainers (as opposed to administrators), personal commitment to the program, a supporting environment for them to learn the program and how to teach it, and time for them to accomplish the preparation and serve as full-fledged trainers.

To close this seeming digression from the topic of "staff tenure," assignments of three years would be the minimum acceptable and five years would be greatly preferable. In either case, except for unusually qualified new staff trainers, the first several months should be devoted primarily or entirely to assimilation and training, perhaps in the role of members of a trainee class.

4.2 CTU MANAGEMENT

A major problem preventing CTU staff who are nominally designated as "trainers" from actively and vigorously participating in the training program is the huge GOI bureaucratic requirement for generation of paperwork. The design of the CTU called for program administration to be done by a Chief Engineer assisted by one Deputy Director. In reality, everyone at the CTU--most especially the Directors and Deputy Directors who are supposed to be trainers--is a manager, and no one spends anything like full time actually engaged in training activities.

An equally difficult problem which must be faced by the management of the CTU is the limited commitment of resources and support from GOI. Presently, the CTU requires GOI input in terms of qualified personnel, transport, permanent facilities, etc. The CTU management must also look ahead to anticipate future directions and requirements. New institutions are fragile and must be nurtured.

Establishment of a new institution requires management who will do this, and who will also be active, vigorous, and willing to fight for needed resources and personnel. The institutional structure within which this could be done is available in the form of the Advisory Board and the Course Management Committee, but it must be used with greater effectiveness.

4.3 CTU FACILITIES

The facilities provided at CWPRS for offices, accommodations, and classrooms have been adequate. However, the fact that the CTU is only temporarily located at CWPRS has placed severe limitations on many activities from the beginning of the training program. For example, computers and copy machines malfunction and sustain damage during the hot season because CWPRS will not install sufficient electrical capacity to run air conditioners. The scheduled training sessions can be evicted from the classroom at a moment's notice because someone in CWPRS has decided to offer a seminar. The trainee officers generally are denied access to use of the CTU computers in the evenings and on weekends because of CWPRS security regulations. Cumulatively, these things are more than simple nuisances. In total, they place severe limitations on the working and teaching effectiveness of the CTU.

Many of these types of facilities problems can be resolved by placing the CTU in its own permanent facility, such as is contemplated in the prospective move to Nagpur. However, others will not. The CTU is in desperate need of a bus for providing local transport for the trainees. Though it was not budgeted, this transportation was provided by the Harza contract for the three Introductory Courses and the first Advanced Course, until the cost exceeded the financial capabilities of the project. There are other examples among the many details involved in running a residential academic institution for in-service training. If GOI is serious about support of the CTU, it must begin to deal with these kinds of facilities needs.

4.4 ATTRACTING TRAINEES AND PLACEMENT OF CTU GRADUATES

One of the incentives for trainees to attend courses at the CTU is the U.S. study tour. This was instituted at the beginning of the training program, and subsequent to the Inception Report, at the recommendation of the USAID project monitor. This was successful in attracting initial applicants, and it serves a very valuable educational function in the curriculum. As a long-term strategy for attracting participants, it is neither desirable nor financially feasible. Before USAID support for this activity terminates, there must be some other incentive in place or the CTU will find it increasingly difficult to draw trainees to the program. Academic recognition for the courses is a good beginning, but it must be matched by financial incentives and recognition to the trainees from their home organizations upon successful completion of their CTU training. It should also be matched by posting of trainees to appropriate water planning positions with high levels of job satisfaction. The most effective recognition of the trainees' efforts will be allowing and facilitating their use of what they have learned.

The full value of the training program will be made available to the people of India only if those who receive training at the CTU are placed in positions of responsibility where they can use the skills and knowledge they have acquired. At present, there are few basin-scale planning organizations in India and essentially none at the State level. These institutions must be created if there is to be appropriate employment for the trainees of the CTU. The Central Government is now seeking ideas and means for the establishment of State river basin planning units, but much remains to be done before these can be created.

The river basin planning organizations, when established, must have sufficient resources and assurance of continuity to get them through the startup process to the point of meaningful contribution to the analysis of existing conditions and future alternatives in their assigned study areas. As that begins to happen, the career opportunities for CTU graduates will become more clear.

In the meantime, a Model River Basin Planning Unit, originally planned in connection with the present program, would be highly beneficial as a prototype for the startup process and application of methodology and also would provide the ideal type of assignment for a selected group of CTU graduates.

Our experience at the CTU is that the trainee-officers quickly become interested in the subject of IRBPM and come to appreciate what its application can do for India. Some of the graduates will choose to pursue IRBPM if encouraged in that choice by recognized career paths within their agencies. The remainder, pursuing other career paths, can provide important support for IRBPM as they achieve positions of greater responsibility. In either case, effective agency recognition of the training in IRBPM is a key incentive to attend.

5 RECOMMENDATIONS

5.1 FURTHER CTU DEVELOPMENT AND SUPPORT

After the close of the contract and termination of Consultant support, the CTU will be operational and it will carry out its primary task of conducting courses in integrated river basin planning and management. However, given the present level of GOI commitment to the program, the limited amount of training received by the CTU trainers, and the lack of a long-term mechanism for training new CTU personnel, it is difficult to imagine that the quality of the training will not seriously deteriorate through time. (With the reduction of Consultant input in the training activities in the past year and the concomitant increase in input on the part of untrained CTU personnel, this deterioration is already visible.) To halt and then reverse this trend, it is critical that the CTU/CWC be encouraged to:

1. Institute and enforce personnel policies which require CTU trainers to accept assignments of at least three years duration (a five-year posting would be far better), and which advance career opportunities;

2. Recruit staff who are well suited for a training position, not just assign people who have no background in planning and who are simply presently available or unwanted elsewhere;

3. Accept any future support from USAID only as a part of a vigorous TOT package; this should include training in technical specialties, teaching methods, case studies and supporting data base, and development of analytic methodologies and models;

4. Create and institute a plan for staffing the CTU and training that staff;

5. Create and institute a plan to strengthen the CTU training staff through preparation of new data sets, methodologies, and models, for instructional and case study use, and research and development activities addressed to the needs of the CTU, the basin planning units, and the Indian water sector;

6. Create and institute a management plan for reducing the administrative overburden that CTU trainers must face;

7. Create and institute a CTU development plan which addresses long-term needs for financing, permanent facilities, equipment, and operation and maintenance;

8. Pursue and foster linkages with academic and other appropriate institutions, perhaps through the USAID Institutional Linkages Program; and

9. Re-think the decision to locate the CTU outside of the New Delhi area; re-locating the CTU in or near New Delhi would immediately remove most of the staffing difficulties presently encountered by the CTU; it would also reduce the many logistical difficulties

and costs associated with running the CTU, and it would enable the CTU management to have better access to GOI, MOWR, and CWC decision makers.

In addition, it is important that GOI continue to build the other water resources institutions that will be necessary to receive full benefit from the new concepts of water resources planning and development being taught at the CTU. The GOI should be encouraged to pursue the definition and development of river basin authorities and basin planning units. Linkages should be forged between these agencies and the CTU, including mutual support in the research and development activities referred to above. Importantly, a framework for formulation and evaluation of plans should be encouraged which stresses effective recognition of multiple objectives and multiple interests, national objectives and criteria for environmental, social, economic, and financial goals, longer planning horizons, coordination and flexibility in the operation of projects, and democratization of the water resources planning and management process (including financing, public involvement, monitoring, and enforcement).

5.2 PUBLICATION OF IRBPM CONCEPTS

This project has been successful in assembling an extensive and unique collection of materials on river basin planning and management. These materials and the training approaches that have been designed for the CTU are transportable and, with appropriate adjustments, could be used in settings other than India. More importantly, they represent a substantial advance in the field of water resources planning. These materials should be compiled and edited into a series of volumes on river basin planning and management. This editing task is not a simple one, but its product would be an invaluable addition to the science and art of water resources development throughout the world.

5.3 USAID/GOI/CONTRACTOR RELATIONSHIPS

A few recommendations can be offered regarding the relationships among and between USAID, GOI, and any Contractor. First, it is critical that the Contractor have access to the appropriate level of GOI decision makers. It is all too easy for local officers to defer decisions to higher-ups in New

Delhi. The Contractor can directly approach the higher-ups within GOI "over the head" of the official contact officer only with the greatest care and with risk of jeopardizing local working relationships. By assuring proper access to the actual GOI decision making authority, this can be avoided.

Next, broader and higher level USAID/GOI contact in support of the project mission and objectives and contractor activities could foster better GOI support for the project. If a highly placed USAID officer occasionally takes an opportunity to mention favorably or even praise a specific program before a highly placed GOI official, this can do wonders for the local officials and the Contractor who are struggling with the day-to-day difficulties.

Finally, there is a need for more frequent USAID/Contractor communications at high levels on technical aspects. There were several contract amendments over the course of this project, and from time to time GOI gave extended consideration to with the idea of asking for a contract extension. Discussions surrounding these and other events would be more productive and would conclude more quickly if those in USAID who must make the decisions are in closer touch with some of the details.

Appendix 1: CTU Expatriate Trainers

Over the course of the project, a large number of expatriates worked on various phases of project activity, both in India and in the U.S. In the U.S., this work focused on development of course curriculum and teaching materials, including computer models to be used in practicums and the case study. In the first two years of the project, many expatriates were involved on short-term assignment to work on the Inception Report and to make preparations for producing the case studies. During the first two Introductory Courses and the first Advanced Course, many expatriates also came to India to act as trainers. The following is a list of the expatriates that came to India on short-term assignment:

Name	Organization	Dates
Bowles, D. S.	USU	87/06/04-87/06/19
Hall, W. A.	CSU Emeritus	87/06/04-87/06/20
Garvey, W. A.	Harza	87/06/03-87/06/24
Garvey, W. A.	Harza	87/07/31-87/08/15
James, L. D.	USU	87/06/03-87/08/22
Riley, J. P.	USU	87/08/10-87/08/31
Israelsen, C. E.	USU	87/08/20-87/08/22
Rudberg, R. C.	Harza	87/10/10-87/10/15
Hughes, T. C.	USU	88/07/09-88/07/28
James, L. D.	USU	88/07/22-88/08/07
Kohl, W. P.	Harza	88/07/20-88/08/22
Kohl, W. P.	Harza	88/09/29-88/11/20
Keller, A.	USU	88/07/30-88/08/11
Nichol, L. D.	Harza	88/10/20-88/11/05
Nichol, L. D.	Harza	88/12/17-89/01/14
Parlin, B. P.	USU	88/10/07-88/10/21
James, L. D.	USU	88/11/14-88/11/28
Keller, A.	USU	88/11/15-88/12/20
Grenney, W.	USU	88/11/26-88/12/10
Lee, B. K.	Harza	88/12/09-88/12/18
Bowles, D. S.	USU	88/12/11-88/12/18
Loucks, D. P.	Cornell	88/12/13-88/12/23
Hughes, T. C.	USU	88/12/28-89/01/14
Hartel, P. G.	Harza	88/12/29-89/01/19
Miller, D.	Harza	88/12/03-88/12/19
Parlin, B. P.	USU	89/01/12-89/01/22
James, L. D.	USU	89/01/26-89/02/16
Ames, P. L.	Harza	89/01/09-89/01/27
James, L. D.	USU	89/06/20-89/07/13
Hartel, P. G.	Harza	89/06/18-89/07/01
Rahmeyer, W.	USU	89/06/18-89/07/09
James, L. D.	USU	89/08/25-89/09/08

Name	Organization	Dates
Hartel, P. G.	Harza	89/08/16-89/09/02
Ames, P. L.	Harza	89/07/09-89/07/27
Bowles, D. S.	USU	89/07/02-89/07/30
Miller, D.	Harza	89/07/30-89/08/11
Nichol, L. D.	Harza	89/08/06-89/08/27
Loucks, D. P.	Cornell	89/08/15-89/08/29
Bishop, A. B.	USU	89/10/01-89/10/06
Parlin, B. P.	USU	89/12/30-90/01/06
McKee, M.	Harza	90/01/02-90/01/27
Rahmeyer, W.	USU	90/01/09-90/01/24
James, L. D.	USU	90/01/15-90/01/25
Dudley, E. F.	Harza	90/02/05-90/02/24
Haimes, Y. Y.	Virginia	90/03/10-90/03/18
Loucks, D. P.	Cornell	90/03/18-90/03/24
Keller, A.	USU	90/03/22-90/04/07
Bowles, D. S.	USU	90/03/22-90/04/07
Parlin, B. P.	USU	90/05/02-90/05/12
James, L. D.	USU	90/06/14-90/07/13
Dudley, E. F.	Harza	90/04/24-90/05/12
Hughes, T. C.	USU	90/06/14-90/07/13
Elmore, R.	Harza	90/04/28-90/05/06
Riley, J. P.	USU	90/04/08-90/05/05
Hartel, P. G.	Harza	90/06/03-90/06/24
Parlin, B. P.	USU	90/07/09-90/07/26
Eastmond, J. N.	USU	90/07/09-90/07/26
Yeh, W.	UCLA	90/07/20-90/08/06
Miller, D.	Harza	90/08/09-90/08/26
Elmore, R.	Harza	90/08/23-90/09/16
Bishop, A. B.	USU	90/09/16-90/09/27
Nichol, L. D.	Harza	90/09/20-90/10/10
Nichol, L. D.	Harza	91/10/07-91/10/15

In addition to these short-term expatriate participants, three individuals were assigned, at various times, by Harza to long-term duty in support of the CTU. These people were:

1. Alan H. Schultz, April 1987-May 1990, Resident Manager
2. G. T. Keith Pitman, August 1987-November 1989, Water Resources Advisor
3. Mac McKee, March 1990-December 1991, Water Resources Advisor and Resident Manager

Appendix 2: CTU Computer Software

A sizable collection computer software has been obtained for use at the CTU and support of the training activities. Much of this has been specially developed for the CTU. A partial listing would include:

Systems software and program development:

1. MS-DOS, versions 3.2, 3.3, 4.1
2. Norton Commander, with the Norton Editor and Norton Utilities
3. PKZIP and PKUNZIP, file compaction software
4. MS FORTRAN-77
5. MS QuickBasic
6. BACKIT, file backup software
7. BROKLYN BRIDGE, file transfer software
8. CROSS TALK, file transfer software
9. CUBIT
10. DESQ VIEW
11. FLICKER FREE, screen saver
12. MS MOUSE DEVICE DRIVER
13. PC UTILITIES
14. PC-VAULT, system security software
15. SCAN, virus protection software
16. SIDEKICK PLUS
17. SPINRITE
18. VSHIELD, virus protection software

Applications packages:

19. dBASE IV, data base management
20. EUREKA THE SOLVER, systems equations solver
21. FILLIN, stream flow statistical analysis
22. FREELANCE PLUS, graphics drawing and drafting
23. LINDO, LINGO, GINO, VINO linear and non-linear optimization packages
24. LOTUS 123, spread sheet applications
25. MS EASY CAD, computer aided drafting
26. QUATTRO PRO, spread sheet software
27. REFLEX, data base management
28. SEMINAR 123 AND MACROS, software support for LOTUS 123
29. WordStar, word processing
30. Word Perfect, word processing

Simulation and optimization models:

31. CANAL, canal operation model (developed by USU)
32. HEC-4, river basin simulation (US Army Corps of Engineers)
33. IRIS, river basin system operation model (developed by D. P. Loucks, Cornell)
34. MODSIM, river basin simulation model (developed by John Labadie, Colorado State University)
35. PENSAMOD, SUBSAMOD, NARMAMOD, programs which provide user-friendly access to MODSIM, specially tailored for the Pennar, Subarnarekha, and Upper Narmada Case Studies, respectively (developed for the CTU by Harza and CES)

36. QUAL2E, water quality simulation program (US EPA)
37. AMJMAC, water quality simulation program (developed for the CTU by Harza)

In addition to this partial list, more than 50 programs have been developed to support various case study analytic tasks.

Appendix 3: Project Technical Reports

Inception Report, November 1988

Inventory of Institutions, Organizations, and Professionals in Water Resources Sector, May 1987

Environmental Effects of Major Water Development Projects, June 1989

Case Report	Pennar River Basin, November 1988 Upper Narmada River Basin, September 1989 Subarnarekha River Basin, November 1989
Case Study	Pennar River Basin Subarnarekha River Basin Upper Narmada River Basin

The Process of IRBP&M, March 1989

Lecture Notes:
- Introductory Courses
- Advanced Course
  - Prerequisite Courses
  - Synthesis Courses
  - Practicums

Working Papers:
- CTU Facilities
- Advisory Board
- Course Management Committee
- Life-of-Project Work Plan
- CTU Staffing
- CTU Trainee Feedback
- CTU Introductory Course(s)
- CTU Advanced Course
- Budgets
- Mobile Workshops
- CTU Resident Course Coordinator
- Model State Planning Unit
- Reconnaissances of the Case Study River Basins
- Accreditation of CTU
- Seminars and Workshops
- CTU Seminar Concept
- Model Planning Unit