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WATER RESOURCE MANAGEMENT AND CONSERVATION FOR THE FUTURE

by

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ABSTRACT

Water conservation is the focal point for a set of integrated studies that attempt to lay the groundwork for appropriate water resource management for the future. The research includes state-wide surveys of water use in homes and industries, organizational analyses of management perceptions and information needs, evaluation of a community incentives program for conservation, and systems analysis of conservation behavior. Data for all studies were developed on the basis of a common sample frame consisting of 54 communities, large, medium, and small across North Carolina. In sum 544 scientific interviews were completed which yielded new information on approximately 726 different variables relating to water resources management and conservation.

Theoretical foundations in environmental perception, cognition, responsibility attribution, knowledge acquisition, organizational development and general systems theory are used to clarify the management problems associated with water conservation. Numerous references are made to the scientific literature in the process of developing the theoretical underpinnings of water conservation programs.

The report includes a complete technical presentation of all research including copies of survey instruments. For the convenience of the reader the major conclusions and recommendations are summarized. The surveys uncover a large reservoir of citizen and industry support for water conservation. At the same time they suggest that trial-and-error approaches to water conservation will be inadequate, given the social complexity of the problem. Currently conservation activities are viewed as a peripheral part of management responsibility and reform of management training, institutional priorities, and informational support will be required to make conservation an integral part of water resource management. Follow-up evaluations of the State's conservation incentives program reveal good progress is being made. In sum, water conservation is an excellent

option for communities faced with water supply shortages and high operating costs. The benefits of water conservation are many but they are contingent on the skill and sensitivity of program leaders.

Recommendations pertain to development of public education programs, management training programs, management information system technology, and State water policy formulation for effective water conservation in North Carolina.

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PREFACE

This report summarizes the work of a research team investigating the psychological bases of water management and conservation. The psychological concerns include the environmental perceptions, information processing, decision-making, attribution of responsibility, knowledge and behavior of persons in relation to their natural and institutional surrounds. The research was proposed in a context of national unpreparedness to deal effectively with the consequences of competing demands for water use and severe droughts. Dwindling water supplies, compounded by inefficient water management practices, were threatening agricultural yields, industrial production and health and sanitation conditions (UPI, 1977). In North Carolina commercial enterprises were forced to shut down and industrial development plans were curtailed (N. C. Department of Commerce, 1977). Citizens were prohibited from certain uses of water and emergency services were required. The economic and social costs attributable directly or indirectly to the water shortage were obviously large but never really documented. With these reminders of the fragile balance between water supply and use, public attention turned to water conservation as a solution.

Fused by a mixture of hope and good intentions, water policy makers and system managers struggled with water shortages and their social and political implications. In this confusion, conservation became the banner for a wide variety of activities which aimed to lessen the demands for water. Lacking clear conceptualization of the problems and supporting research, particularly in regard to the fundamental social and institutional dynamics that underlie the use and management of water, conservation programs necessarily resorted to trial and error methods of community involvement. The situation remains much the same even now. In fact, the most recent review of federal water resources research (NCR, 1981) cites

some of the most pressing needs as follows: 1) the paucity of information about the factors that affect consumer adoption of water conservation devices and practices; 2) the poorly understood effects of public information programs concerning water conservation; 3) the uncertain capacities of institutions for effecting water conservation; 4) the unknown costs and benefits of public participation in relation to water conservation. Until these and other behavioral and institutional dynamics of water conservation are understood the state-of-the-art in water conservation will remain one of trial and error.

Numerous factors alone and in combination propel the new management regard for water conservation. Some are new but most are a continuation of long-standing trends with unfavorable implications on water supply and demand relationships. They include: 1) demographic shifts into areas of fragile water systems; 2) high costs of new plants and equipment; 3) high costs of financing; 4) high costs of water operations; 5) social/political climate of fiscal conservatism; 6) public concern for environmental protection. These and other factors necessitate a new orientation to water. It is in this perspective that AWWA values conservation not as a goal of intrinsic value but rather as a management alternative (AWWA, 1977). The new management orientation is really only part of a rediscovery of the folk wisdom "waste not want not."

This report builds on the conclusions of previous research and field experience which show that conservation has potential benefits in most circumstances. The problem now is one of development and dissemination of effective programs of water conservation and it is these purposes that guide the present research.

Several general hypotheses are tested:

1) Conservation suffers from insufficient awareness of the need among water managers and users.
2) Conservation is burdened by misunderstandings.
3) Conservation is frustrated by persons who disassociate themselves from the problem and possible solutions.
4) Conservation is limited by the knowledge and ability of persons to respond appropriately.
5) Conservation lags because of institutional disincentives.
6) Conservation is resisted out of a generalized reactance to change.
7) Conservation is handicapped by the absence of informational support.

The research approach consisted of a series of studies which were carefully integrated with respect to sampling frame and study objectives. In the course of the project we have completed state-wide surveys of water use in homes and industries; organizational analyses of management perceptions and information needs; evaluation of a community incentives program for conservation; and systems analysis of conservation behavior.

Data for all studies were developed on the basis of a common sample of 54 communities, large, medium, and small across North Carolina. In sum 544 scientific interviews were completed which yielded new information on approximately 726 different variables relating to water resources management and conservation. Contained in the data therefore are 394,944 separate observations on water resources and water resource management. As a set these studies reveal important principles for effective operation of water systems. Our analyses and interpretations, however, are focused on water conservation and only begin to mine the rich contents of these data. We invite other researchers to use these data

alone or in conjunction with other datasets.[1] The results we trust will be a more informed basis for state policy and local management affecting water resources in North Carolina.

This report is organized by chapters that correspond to component studies each complete with problem statement, literature review, description of research method, results, conclusions, and recommendations. One exception to this general rule is Chapter 1 which sets the social/political background within which all studies were completed.

Chapter 2 reports on surveys of water use in home and industry settings. These data are used in systems analysis to build and evaluate a conceptual framework for water conservation behavior where conservation is linked to principles of environmental perception, cognition, responsibility, knowledge, and action. It marks a beginning in the building of a behavioral framework which can guide community programs in efficient approaches to management and conservation.

Chapter 3 presents an organizational analysis of 54 local water agencies focusing on the informational needs for modern management practices. Information needs were developed from analysis of managers' ratings of importance, frequency of use, kind of use, updating requirements, and availability for a sample set of 92 information elements.

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[1]All datasets are available for research purposes through WRRI, North Carolina State University, Raleigh, North Carolina 27650.

Evaluations of the effects of the incentives provided under the N.C. Clean Water Bond Act were made and summarized in Chapter 4. Interviews with recipients of facilities' construction awards were conducted to assess contractor accountability in a system where rewards are contingent on a pledge. Recipients will undertake specific kinds of management improvements such as: water loss prevention, information and education, implementation of N.C. plumbing codes, and infiltration/inflow.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

Our statewide surveys of heads-of households, industrial representatives and local water managers confirm that shortages of water supply represent a serious threat to the well being of many North Carolina communities. In the past five years 28 percent of households and 20 percent of industries sampled have suffered the effects of water supply shortages. The difficulties inherent in management of community water supplies will be even greater in the future because of changing demographic characteristics, rapid industrial growth, declining federal support for water supply projects, and high costs of water development. To successfully meet these challenges of water supply and at the same time honor the broad citizen consensus for fiscal conservatism, environmental protection, and economic opportunity; water management must become: 1) more sensitive to community needs and desires; 2) more technically proficient in management science and planning; 3) more willing to involve citizens in voluntary programs of public works and conservation; 4) more integrated with State and national centers of research and development; 5) more prepared to evaluate system efficiencies and take corrective actions as are appropriate. Each of these changes implies additional training for managers of community water systems which emphasize management and social science content.

In this report we focus on the potential of water conservation as an integral part of a modern water resource management system. We define water conservation broadly to include any action taken by water management or water users to achieve efficient allocation and use of water supplies. From this perspective it is clear that there are many points of possible intervention within the total system which can produce greater efficiencies. For example Government can contribute to conservation through central planning, policy-

making, information dissemination and technical consultation. Utilities management can foster local participation in local planning and programs, implement leak detection programs, supplement educational programs with locally sponsored events and announcements, reform water pricing, and respond to local requests for help in conservation. Industrial management can engage employees in training programs and modify plant and equipment for the purpose of water conservation. Finally residents can install showerheads, aerators, toilet dams and they can adopt more efficient water use practices in the home and in yard and garden irrigation. The effectiveness of any water conservation activity, however, will depend on the knowledge and commitment of those who plan it and participate in it. It is in this vein that the current review of literature and original research attempts to advance the state-of-the-art in water conservation by developing a clearer understanding of its underlying social and organizational dynamics. In particular, levels of public participation in planning and education, utilization of flow restrictors, and sensitivities to prices and policies are fundamentally based on community perspectives which are shaped through psychological processes. Therefore we need to know about environmental perception, cognition, responsibility attribution, knowledge aquisition, and behavioral reinforcements as they pertain to water conservation behavior. Also relevant is our organizational research which identifies the management information prerequisites for monitoring system leaks, pricing decisions, public relations, and planning. Finally, it is important to have evaluation research which systemmatically documents acutal program experiences and results. Such research provides the basic feedback and validation necessary to improve system concepts and programs for the future. Findings, conclusions and recommendations are summarized in each of these research areas in the sections that follow.

Community Perspectives

Our research has uncovered a tremendous reservoir of citizen and industry support for water conservation. The cynical views of many water professionals that citizens are disinterested, inactive and uninformed with respect to general water resource issues are not supported by our data. These managers are out-of-touch with the citizens and industries they attempt to serve. In particular, managers seriously overestimate the extent to which heads-of-households and industry executives prefer to build and pay for more water supply capacity. In fact, a plurality of both groups would rather conserve so existing capacity could be freed in support of additional growth and development. Managers also are unaware of independent actions by approximately two thirds of all water users to conserve water. They do not appreciate the extent to which heads-of-households and industry assume responsibility for their own wasteful practices and are willing to take corrective action as part of a total community effort including local planning and management reform. Also management is unaware and unresponsive to the strong desire among both residential and industrial groups to know and do more about water conservation. Perhaps the greatest benefit of this research is its scientific contradiction of the widespread misperception that water conservation is unpopular, unreliable and unprofessional.

Other major findings suggest the underlying social and organizational complexity of water conservation programming. They warn us that trial-and-error approaches to water conservation will likely suffer from an overly simplified conception of the problem. For example, we find that residents and industry executives rely on 224 different perceptual cues to the conditions of water resources. Some cues have general value within the population and others are highly meaningful only to a small subset of the total population. Public

information campaigns and environmental education programs will have to design and target information in a way that is compatible with the cues people are using to understand their water resource environment. It is also revealing that despite attempts at saturated information programming in recent years, only 57 percent of residents and 55 percent of industry executives report having seen or heard any helpful information on water conservation. Obviously more utilization of the dominant medium, TV, and more diversity of information media including community meetings, water bill enclosures, and industrial trade association channels will be required to reach the total population. Finally, conservation actions tend to be crisis oriented. The most powerful motivator of water conservation is the fear associated with threatened water unavailability. Conservation attributable to good citizenship, mandatory controls, and price account for only 25 percent of all conservation. However, overuse of fear appeals can backfire in the form of incredulity and render a community less prepared to respond to a genuine crisis of water supply or sustain conservation activities in less than crisis conditions.

The following recommendations are based on our review of the technical literature and original research on community perspectives relating to water resource management. Recommendations:

1) Development of new or expanded water supply capacity should be supported only when all reasonable efficiencies of pricing, leak detection, public education, etc. are insufficient to meet projected water demands. In such cases development should be scaled to the size of the supply deficit.
2) Consonant with the desires of citizen and industry representative the State should upgrade its system capacities for informational assistance. Support for individual consultation by field staff

should be reallocated to the development of information systems with greater outreach potential. Beyond that the State should serve as an informational clearing house and refer requests for technical assistance to private providers of consultation services.

3) The State through appropriate agencies should plan and coordinate environmental education programs generally and water conservation programs in particular. Central development and dissemination of educational materials is an appropriate State activity. Content should feature practical information on plumbing repair, reuse, irrigation, installation of flow restrictors and toilet dams. Supplemented by locally sponsored events, announcements, teach-ins the educational process would be welcome and beneficial and have the side advantages of bringing managers and water users closer together.

4) The primary locus of responsibility for water resource management should remain with local government. Technical advantages of regionally integrated water systems can and should preserve local control through a cooperative or federated system.

5) Communities should be encouraged to prepare contingency plans for possible implementation because of water shortage. Plans should rely upon voluntary actions as a first line of defense. Mandatory controls should be held in reserve for reinforcement of voluntary measures under extreme conditions.

6) Greater visibility should be given to opportunities for citizen participation in water supply planning, allocation, and conservation programs.

7) Training programs for local water managers should be revised to include more emphasis on community relations skills, water conservation techniques, leak detection, and management science.

Management Information System

In an era of severe limitation on staff resources, more efficient means must be developed to assist water managers especially in their expanding responsibilities of planning, public education, and conservation. Fortunately there is a viable alternative made possible by the modern technology of management information systems (MIS). A properly designed and implemented MIS is characterized by the fair exchange of basic systems data collected by local agencies for centrally processed information developed by a central State agency. The exchange can have far reaching benefits on local water system operations and at the same time strengthen State based planning. By the preliminary analyses made in this report it is clear that MIS informational exchange would be locally valued, and would help make water conservation activity an integral part of water resource management for the future.

The research strategy involved local management in the process of judging the value of informational content for MIS. The results probably reflect the status quo biaes inherent in the sample. Nevertheless, we found that 43 percent of the information elements which water managers judged important were either unavailable completely or available only in poor quality. The missing information was evenly divided among important and very important categories which suggests the lack of any systematic effort to acquire information in accord with priorities of importance. This finding confirms our earlier claim that managers are without supporting information in even some of their most important areas of responsibility. On the positive side, we found 37 percent of the information elements which water managers judged important were available in good quality. Finally, less than two percent of all information elements studied fell into

a category of waste -- not important but available.

Information needs are felt most keenly within the medium size water utility. They share with large systems a similar view of information importance but they are less likely to have the staff size to maintain an adequate information system. Overall data and software to support comprehensive planning is most needed. Other high-ranking information needs relate to technical assistance, regulation and enforcement, and water conservation. Consulting specialists in planning, management, water law and social sciences are required to develop needed information. These professionals working with consulting engineers constitute a multidisciplinary approach, which best serves the goal of effective water management.

Of the following recommendations the first is the most important. The others are important in a technical sense but basically they qualify and facilitate recommendation number one. Recommendations:

1) Build and implement a State-wide MIS for water resources.
2) MIS content should be guided by the comprehensive needs of local water systems and expressed in terms which are suitable.
3) Refine cost estimates of information.
4) Develop in consultation with agency decision-makers appropriate system cost constraints.
5) Quantify the costs of system inefficiencies which result from the unavailability of timely information.
6) Provide for permanent, central-agency responsibility for MIS. Perhaps the University would be well-suited for this role through the Water Resources Research Institute. Fiscal support would probably be necessary in the form of special legislation.
7) Once information contents are defined, multidisciplinary teams

including specialists in planning, management, law, social sciences, engineering, and finance, should be directed to develop a system for routine collection of data in appropriate form for MIS.

8) Provide for continuing education for local managers in use of the MIS. Again the University has the ideal facilities and personnel to implement this training.

9) Encourage MIS use through demonstration programs, site visits, and other means.

10) Encourage standard record-keeping at the local level which is compatible in form and definition to information retrievable through MIS.

11) Maintain quality control over MIS contents and periodically evaluate MIS assisted management with the aim of better serving local system needs.

Construction Grants Program

The Departments of Human Resources and Natural Resources and Community Development in their first attempt have produced program incentives for water conservation that are both administrable and effective. A variety of conservation approaches have been tried with good results. They include public education, leak detection, N.C. Plumbing Code enforcement, infiltration/inflow detection, rate reform, allocation, and planning. The benefits of these programs include water savings, improved community relations, reductions in operating costs, waste load reductions, extended service opportunities, quality improvements and improved fire protection. Given the early successes of this program State leaders should be encouraged to keep it strong and where possible extend and broaden it so the positive effects can be enjoyed by a larger number of citizens and industries.

A variety of recommendations are posed here for consideration by appropriate State personnel. In making these recommendations we appreciate the wisdom of not tampering with success. Also we are aware that the successes of the water conservation programs notwithstanding, there remain strong adversaries of water conservation who could attempt to kill the program under the guise of reform. Recommendations:

1) Encourage adoption of a standard record-keeping system as part of the State Grants program.
2) Study further the impacts of conservation actions including voluntary rate reforms to assess their merits for inclusion in the State's incentive program.
3) Implement a State-run technical and informational service for local governments. The core of such a system might be a computer-based management information system focused on the high volume information and processing requirements of water management. Other special situations could be targeted for action by a manned-system of assistance. These systems would mitigate the problems of regulation, communications, and technical support which frustrate water managers and lead to less effective programs of conservation.
4) Provide that funds received under the Bond may be applied to non-structural (conservation) programs as well as structural ones, and thereby ease the monetary problems of conservation.
5) Support strategies to involve volunteer workers in conservation programs at the local level.
6) Support local public education and information functions with a variety of conservation materials and publicity. Many conservation materials are already developed and available through State and

Federal agencies. The primary role of the North Carolina program in this regard would be to coordinate actions through appropriate State agencies and arrange for utilization of public information outlets of State-based media, television, radio, and newspaper.

CHAPTER 1: PROSPECTIVE ANALYSIS OF WATER USE

In recent years the mundane matter of water supply has become an issue of general concern. Headlines (e.g. News and Observer, 1981) and cover stories (e.g. Newsweek, 1981) herald the looming crisis of water supply. At the same time a broad consensus is building in support of conservation as a necessary part of water management. Especially now in a time of fiscal conservatism, water conservation may become the primary line of defense against increasing water demands and supply costs.

The combination of rapid regional growth and increasing costs of water projects are straining the capacities of local water systems. The problems felt most keenly at the local level are symptomatic of disequilibrium in supply-demand relationships that transcend local and State jurisdiction. In the future, water management will be pressed even harder to supply water to homes and industries at prices, volumes, and qualities desired and with due regard for environmental protection. In preparation for these difficult times, a new generation of management practices must be developed based on comprehensive utilization of information technology and emphasis on conservation. If we are wise enough to move rapidly in management reform and we are spared any droughts during this transition period, then we may actually succeed in closing this "window of vulnerability" with respect to water resources.

The implications of water shortage become especially vivid when one considers the rather incredible extent to which water resources are managed in support of our current standard of living. Consider the following (from National Geographic, 1980, p. 144-148).

> On an average day you and I each draw about 87 gallons: 24 for flushing, 32 for bathing, laundry, and dish-washing, and 25 for swimming pools and watering the lawn. We use a mere two gallons for drinking and cooking--the only water we actually require to survive. ... the eggs you ate for breakfast required 120 gallons of water each; the steak you'd like for dinner, 3,500 gallons; the ton of steel in your car, about 60,000 gallons. With these indirect uses our daily need soars to some 2,000 gallons each. ... to manage water, we have rearranged our landscape on a colossal scale: built two million dams, irrigated sixty million acres, carved barge canals that carry a fifth of intercity freight, created 50,000 public and private water utilities, drained a hundred million acres of wetlands, and drilled millions upon millions of wells. Billions of dollars have been spent.

Much of the current health and vitality of the U.S. population can be credited to the success of the water industry to supply high quality water and sanitary services. Since 1900 when an estimated 27,000 Americans died of waterborne diseases, the toll has been reduced by a factor of eight within a population that has grown fifty percent. In most cities you can get a ton of water delivered through the tap in your kitchen for 15 cents. In recognition of this expertise and its fundamental contribution to human health and economic development the United Nations has dedicated the decade of the 1980's to the sharing of this water technology for the benefit of peoples around the globe.

In North Carolina, careful water management is particularly important. The State has relatively high rainfall, good river systems and productive ground water aquifers, but complacency now on the part of government, industry, and citizens could cause some severe economic and environmental damage in the future (Grimsley, 1981). The best available research suggests that potable water, like many other so-called "plentiful" resources including fertile lands, and clean air, will require careful planning and management if the State is to achieve its high aspirations set forth in the Balanced Growth Plan.

In 1970, we used about 1.1 billion gallons of water a day in North Carolina for municipal, industrial, and domestic needs. This rate of water use is expected to double by the year 2000. To meet water supply needs for the future, local governments will need to make timely investments to develop additional supplies and conserve their existing supplies. Some of the areas that will need to develop additional supplies are the rapidly-growing Research Triangle area in the Upper Neuse Basin and the Piedmont Triad region in the Upper Cape Fear Basin. Already the North Carolina Department of Natural Resources and Community Development has identified 13 communities with existing source problems in water (NRCD, 1980) and as many as 25 percent of all communities could be in a critical water supply situation by the year 2000 (Harrington, 1975).

Ground water is a major asset in meeting North Carolina's water needs but a decline in water levels in some areas due to heavy withdrawals are creating serious problems. Ground water is the direct source of domestic supply for about 60 percent of the population. Many municipalities and industries also use ground water. There are about 1.2 million wells in operation in North Carolina now with about 10,000 new wells drilled each year. In northeastern North Carolina, water levels in the cretaceous aquifer system are declining several feet per year due to heavy withdrawals in Virginia. Phosphate mining has reduced ground water levels over a wide area in the central coastal region. To assure good management for ground water as well as surface water a comprehensive management program which emphasizes conservation is necessary. Such a plan will require a good information support system.

It is paradoxically the relative abundance of North Carolina water resources that has contributed to the precipitous increase in probability of future water shortages. North Carolina has become an attractive site for expansion of

industries including power generation, brewing, and mining among others. These developments have provided important stimulus to regional development and job opportunities for North Carolina citizens. At the same time they represent a high consumptive use of a water resource and therefore diminish the future development potential of these areas. Decision-making in this context requires a strategic plan where the best interests of North Carolina citizens now and in the future are represented.

The 1980 Annual Report of Economic Development Activities (North Carolina Department of Commerce, 1981) pointed with pride to the fact that nearly 60 percent of the $2.2 billion in new and expanding industrial investments made or announced are sited in communities of under 15,000 population. These communities have very limited capacities for serving or even planning for the changes that will accompany this industrial development. State authorization of revenue bonds for water and sanitary services can offset some of the costs of the necessary infrastructural development but this alone will not address the on-going planning and managerial requirements. The system is going to require support by a comprehensive management policy and information service. The centerpiece of both must be conservation.

The historic roles of the State in water supply have been principally ones of regulation and information support. As the State necessarily becomes more involved in these areas it may be necessary to reorganize these roles in order to separate them (Hufschmidt, 1979). The problem is one of building a solid partnership between State level planners, researchers, extension service and other information providers and local level system managers and operators. This is difficult when the State level service providers are too closely associated with regulatory functions in ways that compromise the trust of local populations.

National Policy Review

On November 12, 1968, President Lyndon B. Johnson transmitted to Congress the first National Assessment of the Nation's water resources under the Water Resource Planning Act of 1965. In that report he characterized the findings as a "sobering report, challenging our technology and spurring our conscience" and admonished that "a nation that fails to plan intelligently for the development and protection of its precious waters will be condemned to wither because of its shortsightedness." More than a decade later, the problem of excessive consumption remains unabated. In 1965, the national per capita per day usage of water was 122.18 gallons.[1] By 1975 (the most recent date for which national data are available) the rate had increased to 123.41 gallons.[2]

President Carter updated and sharpened the focus on the problem with White House policy on water resources that recognized the social and institutional roots of excessive water use:

> ... across the entire Nation, we must begin to recognize that water is not free--it is a precious resource. As with our energy problem, the cornerstones of future water policy should be wise management and conservation. Irrigation efficiency, water pricing, ground water management, and thoughtful land-use decisions will help institute lasting protection from drought and lessen the need for expensive new water projects (Federal Register, Vol. 42, No. 136, p. 36794, 1977)

This White House policy, consistent with the accumulated research evidence, (see U.S. Army Corp of Engineers, An Annotated Bibliography on Water Conservation, April, 1979, Contract Report 79-3) suggested that an increased federal role in water resource management through the State, should 1) foster general awareness

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[1] National Assessment of the Water Resources Council, 1968, U.S. Government Printing Office, Washington, D.C.

[2] Water Resources Council, Second National Assessment, January, 1978 (Draft).

of the problems associated with increasing demands on the national water resource and 2) promote programs for water conservation such as through technical assistance. As a result, conservation began to receive more federal consideration in comprehensive water planning and management.

Under Carter, the Water Resources Council played a leading role in forging an interagency task force of Federal and non-Federal agencies involved in water supply activities. Its purpose, within the constraints of Federal authority, was to develop Federal objectives, policies and plans for water conservation involving municipal, commercial, industrial, and agricultural water applications. Endorsed by General Accounting Office (CED-78-66, April 3, 1978) the task force activities affected:

--River basin plans, principles and standards for planning water and related land resources.

--The Bureau of Reclamation, Soil Conservation Service, and Corps of Engineers, requiring water use plans from purchasers of water supply or storage space in their reservoirs.

--Requiring that water conservation devices be installed in new housing where the Federal Government participates.

--Requiring water-saving devices in designing, constructing, leasing, operating, and maintaining Federal office buildings by the General Services Administration.

--Implementing the use of water-saving devices in the construction and operation of military facilities by the Department of Defense and hospitals by the Veterans Administration.

These were the most specific set of policies yet promulgated by Federal agencies for the achievement of water resource conservation goals. To facilitate policy implementation the 95th Congress authorized a 10 million dollar program in FY80 for technical assistance for conservation (September 20, 1979, amendments to the Water Resources Planning Act of 1965). This was in addition to the Title III programs which had enabled significant involvement in field-oriented technical assistance programs. Still the commitment was small as it related

to a national water industry accounting for annual expenditures in excess of $50 billion.

Under President Reagan, the federal role is changing again with emphasis on a centralized policy making function within the Department of Interior and deregulation. Major responsibilities for programs including planning, research and technical assistance will be returned to states under a block grant concept. At this date, the new mechanics of federal policy are being formulated. It is impossible to anticipate their eventual form or predict their full effects. It is relatively sure, however, that the conditions of water supplies, construction costs, and financial markets will necessitate an incentives policy for water conservation. States and local agencies will have to improve their management efficiency to meet future needs for water in this period of New Federalism.

State and Local Responsibility

The Renaissance in water conservation and water management activities was not only the result of enlightened federal policy, but to a considerable extent was built on the seminal works of State and local water agencies. Leading western states, California, Texas, Utah, and others, were joined by North Carolina in demonstrating exemplary approaches to comprehensive water policy. Among the notable achievements in North Carolina are the North Carolina Water Resources Framework Study, the codification of related goals and policies in the 1978 Balanced Growth Act, adoption by the Environmental Management Commission on conservation criteria in judging grant applications and amendments to the State plumbing code (GS 143-138, Sections 401, 907, 911, 604.3, and 704.2).

Some of the best efforts of State and local governments were presented at the OWRT sponsored Southeastern Conference on Water Use Problems and

Conservation (November 1978) and the EPA sponsored Conference on Water Conservation and Municipal Waste Water Flow Reduction (April 1981). A common theme in the presentations at these conferences was the inadequacy of information on the social, institutional, economic, legal, and other obstacles to water conservation in local settings and how they might be overcome by technical assistance programs (Smith, 1981).

To meet these challenges in North Carolina, efforts are underway to renew the Clean Water Bond Act, which will help communities make timely improvements in their water supply systems. State planning assistance programs will be targeted on the parts of the State that have the most serious problems and the water quality program will emphasize the protection of drinking water sources. A State Conference was held to bring together the best ideas on what we need to do now to assure sound water management for the 1990's and beyond. The conference results helped establish the legislative program for future General Assemblies and will foster a more informed public awareness of the water management issues facing North Carolina. Finally increased support for public information, technical assistance, and water conservation is promised (Grimsley, 1981). As a package these activities bode well for the future.

Summary of Literature

A comprehensive bibliography on residential water conservation was produced recently for EPA (EPA, March 1980). Subject areas included water conservation tips, water conservation devices, water conservation projects, economics, regional variables, costs/savings, energy/water relationships, and water use. Sources for the information included the National Bureau of Standards, personal contacts with trade associations, agency officials, utility management, university experts and leadership of environmental organizations. Also literature in libraries of Washington, D.C. and information from manufacturers and distributors on produces and prices were included.

Our secondary analyses of that literature has revealed a growing attention to residential water conservation. Table 1 gives the frequency of relevant publications by year of publication. Without making adjustments for region, quality, or other differences represented in the collected literature only very general conclusions are permissable. However, there can be little doubt that since 1975 water conservation has surfaced as a subject for research and management attention.

Not coincidentally 1977 was the most active year of published reports on water conservation and was the year of the implementation of Federal water conservation policy and prevalence of severe drought conditions across the U.S. The lessening of published reports since 1977 and the general deemphasis of water conservation in Federal R&D support do not detract from the continuing benefits that flow from the earlier work. Significant momentum and knowledge about water conservation will have positive and enduring effects.

Much of the new discussion at the 1981 National Water Conservation Conference, concerned systems approaches to public education and dissemination

Table 1. Number of Publications Per Year on Water Conservation

Year	Number of Publications	Number of Publications
1959	*	1
1968		
1969	*	1
1970	*	1
1971	*	1
1972	*	1
1973		
1974	***	3
1975	**********	21
1976	**********	12
1977	**********	35
1978	**********	32
1979	**********	13

programs of proven exemplary practices. Trends evident in the literature are the increasing attention to total systems involvement in conservation including planning, pricing, institutional and legal reform, public education, public participation, energy/water relationships and wastewater reuse in residential, industrial and agricultural sectors (Water Resources Council, 1981).

Perhaps case studies give the clearest picture of what one can expect from water conservation in actual practice. Our review of the case study literature in 1980 identified 45 separate programs. They were designed for the needs of particular locations and circumstances and they demonstrate different conservation methods. Their results, as one would expect, vary as a function of community commitment, management skill, and perceived need to save water. But overall it is pretty clear that communities can realistically hope to save as much as 25 percent by modest and unobtrusive conservation methods and with more stringent measures that entail small sacrifices in conveniences and habits communities can achieve more than 50 percent savings (see Table 2).

All these case study programs suffered from the absence of any theoretical framework and consequently even the best programs were guided only by trial-and-error. As early as 1963, Hoover and Schutz (1963, p. 54) had reported that the range of attitudes, values, knowledge and behaviors that are associated with conservation were not understood and that the "... conceptual domain of conservation is still rather loosely defined and organized. In reviewing the water conservation information dissemination efforts of the 1977 drought in the western United States, James and Andrews (1978, p. 27) reported the same observation:

> ... communities need to develop an effective operational program for getting water users to modify their water use practices in accordance with a selected water conservation program. This is a problem in the undeveloped art of non-structural design, an art still in the most rudimentary stages of development.

The authors suggest the development of a "... framework that can be used for

Table 2

CASE STUDIES OF WATER CONSERVATION: METHODS AND RESULTS

#	Location	Savings	Methods	Reference
1	17 Eastern U.S. cities	18%-50%	Voluntary/compulsory restrictions	Abbott, H.E., K.G. Cook, and R.B. Sleight. Prepared for the Office of Water Resources Research. August 1972.
2	Unnamed	20%	Correcting meters measuring input	The American City. November 1974, p. 98.
3	Kingston, NY	27%-average 46%-peak	Changing from flat rates to metered charges	The American City. April 1972, pp. 72-73.
4	Pawtucket, RI	16%-18% (3.3 mgd)	Voluntary; ordinances restricting water use	Anderson, Raymond W. Journal of New England Water Works Association 81 (1967), pp. 301-303.
5	United Kingdom	20% 10%	Voluntary restrictions "Pressure" reductions	Blackburn, Anne M. Journal of the American Water Works Association 70 (February 1978), pp. 51-59.
6	Marin	25% 63%	Ban on outside use Rationing and monetary fine	Bollman, Frank H., & Melinda A. Merritt. Paper presented at fall conference of the AWWA, San Jose, CA, Oct. 10, 1977.
7	Washington, DC	6%-17%	Education, changes in plumbing	Brigham, Arthur P. Proceedings, Conference of the American Water Works Association, June 8-13, 1975, Minneapolis, MN. #8-3a.
8	Washington, DC	6.1%-17.2%	Education, water saving campaigns, shower flow controls, pressure-reducing valves, toilet inserts	Brigham, Arthur P. Paper presented Oct. 1976 at Conference on "Planning Alternatives for Municipal Water Systems".
9	Washington, DC	4.42%	Education, water saving campaign	Brigham, A.P. Journal of the American Water Works Association 68(#12, 1976) pp. 665-668.
10	Orange Co., CA	30,000 acre ft./yr.	Wastewater reclamation, reuse systems, conservation	Cline, Neil M. Planning for Water Reuse, pp. 127-138. Chicago: Maaroufa Press, 1978.

Table 2 (continued)

#	Location	Savings	Methods	Reference
11	Unnamed	Not given	Shallow tray toilets, toilet inserts, flow-reducing valves, reuse of wastewater	Cohen, Sheldon, & Harold Wallman. Groton, CT: General Dynamics, 9/74. EPA-670/2-74-071.
12	Montgomery Co. Prince George's Co, MD	16% 13.5%-26% 30%-37% 1.2%-2% 5.4 mgd	Water-reducing devices Water-reducing devices Pressure-reducing valves Shower flow controls Toilet inserts, shower flow controls, dye for toilet leaks, booklets	Ecological Analysis Incorporated. Washington Suburban Sanitary Commission's Water-Saving and Waste-Reduction Program, October, 1977.
13	Unnamed	From 66%-70% unaccounted for water to 6%-20%	Universal metering to detect leaks	Granger, G.A. Journal of the American Water Works Association 17 (February 1955), pp. 122-123.
14	Southern CA LA	10% 20%	Industry conservation Mandatory conservation	Griffith, Evan L. Journal of the American Water Works Association 70 (February 1978), pp. 74-78.
15	New York	10%-22%	Voluntary conservation, restrictions, education	Groopman, Abraham. Journal of the American Water Works Association 60 (January 1968), pp. 37-47.
16	Boulder, CO	36%	Metered charges	Hanke, S. H. Water Resources Research 6 (October 1970), pp. 1253-1261.
17	Detroit, MI	200 mgd	Voluntary, imposed restrictions	Heggie, G.D. Journal of the American Water Works Association 49 (March 1957), pp. 267-276.
18	Sao Paulo, Brazil	26%	Public appeals, mandatory restrictions, 3 day cut-off in some cases	Jezler, Harold. Journal of the American Water Works Association 67 (June 1975), pp. 331-335.

Table 2 (continued)

#	Location	Savings	Methods	Reference
19	Israel	40%	Recycling water, drip irrigations	Lahav, R. Water and Sewage Works 124 (June 1977), pp. 64-65.
20	California	38%	Water saving devices, conservation	Larkin, Donald G. Journal of the American Water Works Association 70 (No. 9, 1978), pp. 470-474.
21	Oakland, CA	50%	Sealing leaks	Laverty, Gordon L. Willing Water. AWWA (December 1977), pp. 12-13.
22	Denver, CO	21%	Limiting outside watering, restricting new taps, monetary fines	Miller, W.H. Journal of the American Water Works Association 70 (February 1978), pp. 60-63.
23	St. John's Newfoundland	17%	Fixture and leak detection survey	Mitchell, Robert D. Journal of the New England Water Works Association 71 (1957), pp. 173-187.
24	Great Britain	20%-25% 10% 5%	Public appeals, hosepipe bans Pressure reductions Leak reductions	The National Water Council. The 1975-1976 Drought. London: National Water Council, 1977.
25	Dallas, TX	8%-12%	Surcharge during peak demand periods	Rice, I.M., & L.G. Shaw. Journal of the American Water Works Association 1970 (1978), pp. 480-482.
26	Washington, DC	6-13 mgd (est.)	Education, water saving devices	Sharpe, W.E., & P.W. Fletcher, Eds. Proceedings--Conference on Water Conservation and Sewage Flow Reduction with Water-Saving Devices. Penn. State University, July 1975. Report #74.
27	Unnamed	6.5% (est.)	Low water using appliances	Baker, L.K., H.E. Bailey, & R.A. Sierka. "Household Water Conservation Effects on Water Energy and Wastewater Management."

Table 2 (continued)

#	Location	Savings	Methods	Reference
28	Gettysburg, PA	10% water	Water conservation and inflow correction program	Sharpe, W.E. Journal of the American Water Works Association, 9/78, p. 476.
29	Springettsburg, PA	33% reduced waste in steel firm	Flat rate charge for waste treatment	Sharpe, W.E. Journal of the American Water Works Association, 9/78, p. 476.
30	Springettsburg, PA	$15,000 in energy; $3,000 in chlorine	Flat rate for waste treatment; flow restrictors given to customers	Sharpe, W.E. Journal of the American Water Works Association, 9/78, p. 476.
31	Unnamed	32% of residential use	Utilizing water efficient toilets, washing machines, shower heads	Stone, B.G. Journal of the American Water Works Association, 9/78, p. 483.
32	California	10%-18% 9%-12% 0%-5%	Toilet dams Shower heads Clothes washers	California Department of Water Resources.
33	Los Angeles, CA	9% (water)	Restrictive shower heads, toilet dams, flow restrictors, on voluntary basis	Stone, B.G. Journal of the American Water Works Association, 9/78, p. 484.
34	EPA report based upon 39 states	12%-27% 0%-1% 0%-1% 0%-12% 0%-20% 0%-5% 0%-4% 1%-4%	Toilet dams Faucet aerators Flow restrictors on valves Show flow restrictors Pressure-reducing valves Improved clothes washers Improved dishwashers Hot water pipe insulation	Stone, B.G. Journal of the American Water Works Association, 9/78, p. 484.
35	Unnamed	5%-40% in future utility investments	Conservation in general	Stone, B.G. Journal of the American Water Works Association, 9/78, p. 484.

Table 2 (continued)

#	Location	Savings	Methods	Reference
36	Washington Sanitary District	16%-24%	Reducing pressure	Stone, B.G. Journal of the American Water Works Association, 9/78, p. 485.
37	Unnamed	10% in sprinkling in recreational areas	Moisture sensors	Stone, B.G. Journal of the American Water Works Association, 9/78, p. 486.
38	Thames River Basin, United Kingdom	20% (water) 10% (water)	Publicity campaign 25% reduction of pressure in water mains	Blackburn, A.M. Journal of the American Water Works Association, 2/78, p. 55.
39	Southern Wales, United Kingdom	50% (water)	Combined conservation measures 17 hr./day cutoffs	Blackburn. A.M. Journal of the American Water Works Association, 2/78, p. 55.
40	Denver, CO	21% (water)	Guidelines on lawn watering	Miller, W.H. Journal of the American Water Works Association, 2/78, p. 63.
41	Calif. Dept. of Water Resources	50% (water)	Public campaign; voluntary requests	Robie, B.R. Journal of the American Water Works Association, 2/78, p. 66.
42	Monterey Peninsula, CA Eastbury Municipal Utility District, CA	49% (water) 39% (water)	Public campaign; voluntary requests Public campaign; voluntary requests	Robie, B.R. Journal of the American Water Works Association, 2/78, pp. 66-67.
43	Marin	53% (water)	Public campaign; voluntary requests	Robie, B.R. Journal of the American Water Works Association, 2/78, pp. 66-67.
44	Penn. State Univ. Dormitories	37.5%-62%	Flow restrictors in showers (5.5 gpm to 2.5 gpm)	Sharpe, W.E. Journal of the American Water Works Association, 2/78, p. 93.
45	Oakland, CA	2.5% (water)	Leak detection	Laverty, Gordon L. Journal of the American Water Works Association, 2/79, pp. 62-63.

effective water conservation program design." The lack of a systematic and tested method for achieving conservation has probably dissuaded many community leaders who have considered such programs. This would seem to be particularly true for communities with limited resources and expertise since they are least able to design, implement, and evaluate conservation programs of their own (Flack & Hill, 1977). Now there is sufficient data and experience to attempt a theoretical construction of conservation behavior which can guide future programs.

In theory, a conservation program can be built around any factor which is subject to programmatic control and has a causal effect on water use. It is common, as was the case in comments introducing the National Conference on Water Needs and Implementing Strategies (Herr, Sonner, & Thompson, 1979) to identify legal, technical, and economic factors as the "three main facets of water conservation." Without justification, the technocratic view predominates to the detriment of proven psychological and educational approaches. The potential factors that influence water consumption are more appropriately classified as follows:

1. Institutional Factors

    a. Federal, State policies and statutes
    b. Local water use ordinances, building codes, standards

2. Technical Factors

    a. Efficiency of water-using devices
    b. Leaks in home, industry and water system

3. Economic Factors

    a. Price of water
    b. Price of water system expansion/development
    c. Government subsidies, grants

4. Psychological and Educational Factors

   a. Perceptions of the need to conserve
   b. Attitudes and values toward water as a valuable resource
   c. Responsibility for water use
   d. Knowledge of how to conserve
   e. Water use habits

In practice, it is usually best to incorporate some or all of these in a multi-factored strategy for conservation.

An important consideration with respect to the above factors is that they are all in some manner dependent upon human factors of perception, cognition, responsibility, education, and behavior. For instance, the political factors are implemented by State and local decision-makers in a manner consistent with the preferences and interests of the majority of the population (Abbott, Cook, & Sleight, 1972). Through water bonds and referendums citizens can directly express their opinion and determine policies. Likewise technical approaches to water conservation depend upon residential and industrial acceptance. Sharpe and Fletcher (1975, p. 85) state that "greater demand for these (conservation) products created by increased public awareness is necessary before their availability improves."

Empirical support for the potential role of human factors in reducing water consumption is suggested by Harris (1977). In his study 388 descriptors of successful water resource planning were evaluated by 300 raters. A multi-dimensional sealing technique was employed to discover in these data the underlying dimensions of successful planning. Two of the five dimensions were inherently psychological--one, conservation with fair allocation and conservation of water and the other, public involvement in water resource management. From these findings it follows that efforts to develop favorable human factors will have a beneficial impact on the management of water resources. Citizens who are 1) aware of the benefits of needs for conservation and 2) knowledgable about the means for

practicing conservation directly and indirectly contribute to the wise management of water resources. Direct benefits occur when individuals conserve through performing water-saving behaviors and purchasing water-saving devices. Indirect benefits occur as a result of a well-informed and participatory citizenry. For example, at the local level an informed citizenry can influence local prices, policy and regulations, and building codes by attending and participating in public water resource planning meetings (Wagner and Ortolono, 1975; Wright, 1978). Citizen interests would seemingly be reflected by State-level decision-makers in the development and consideration of State plans and policies.

Ibsen and Ballweg (1969) support the position that an informed and participatory citizenry is beneficial to effective water resource policy. From his survey research he concluded that public support for water resource policy is more likely when the public participates in planning. Howells (1976) also indicates that human resource development activities can improve water resource policies and facilitate their administration. Howells (p. 6) states that public education "free from agency bias" leads to more effective public participation and water resource planning and policy development.

Toward a Conserving Society

The new attention on water conservation in scientific policies and literature is important but by themselves they do not achieve the desired goals of balanced growth and water use efficiency. Policies must be accompanied by effective programs. In many respects, the program implementation is more difficult than policy development, as generally there is more consensus on goals than the kinds of system changes that will best achieve them. This is particularly true for water conservation given the highly diversified uses of water across public, domestic, industrial, and agricultural sectors and the regional

differences in hydrologic conditions. The institutional problems associated with more than 100,000 agencies participating in the national complex of water service further complicate the problems (Grigg, 1979). Recognition of these facts has given rise to a realism in Federal policies that provide that future programs in water conservation will rely more heavily on local management initiatives. In the evolving decentralized system, the primary Federal and State functions will be enabling and supporting of local programs and management.

As States and local agencies assume increased responsibility for water management, they can benefit from the collective experiences of others in the form of several planning guides and systems handbooks. These have been produced to facilitate conservation plans and programs (Water Resource Council, 1980; EPA, 1980, 1981; New England River Basins Commission, 1981; U.S. Army Corps of Engineers, 1979; U.S. Geological Survey, 1981). They collate materials in a very useful way and provide a solid foundation for dissemination of conservation programs. Our own contributions in this volume are intended to fortify these works with theoretical merit and to emphasize the neglected but critical psychological and educational preconditions to conservation.

The anticipated benefits of this work are the realization of balanced growth goals. In particular communities will be better prepared to cope with increasing populations. The attractive features of fragile environments including coastal zones, mountains, and arid plains can be preserved in spite of pressures of development. Industrial development and job opportunities can be expanded in proportion to the extended carrying capacities of natural systems through conservation. Municipalities and residents can realize significant energy savings through reduced water volumes processed, pumped and heated (Lattie, 1977; Roberts & Hagen, 1975). Finally municipalities can delay or

avoid financing and construction costs associated with cleanwater and wastewater treatment facilities by adopting conservation practices.

In summary the rationale underlying our studies rests on the following general assumptions:

1. Many of the most serious obstacles to efficient management of water resources are rooted in unrepresentative and inaccurate perceptions of the water resource system as a whole.

2. Unrepresentative perceptions are manifested in conflict and unyielding institutional procedures.

3. Social science research can help develop information and reveal the nature of user perceptions and thus facilitate an open environment in which reforms are possible.

4. The form and content of available information shapes the decisions about water resource management.

5. Rational judgment will prevail and management improvements will follow a careful explication of the social issues.

6. Informational support will enable management to follow through with effective conservation programs.

CHAPTER 2: COMMUNITY PERSPECTIVES ON WATER USE

Needs for water are subjectively defined in relation to the prevailing standards of community living. In North Carolina most citizens are accustomed to washing machines, flush toilets, daily bathing and irrigated lawns. The psychological consequence is a perceived dependency or need for approximately 87 gallons per capita per day (gcd) which compares with as little as 2 gcd in some less developed countries of the world (National Geographic, 1980, p. 144). Part of this difference is necessary to support the superior standard of living enjoyed by North Carolinians but another part reflects a wasteful style of management of water resources. Review of case studies in Chapter 1 suggests savings of between 25 and 50 percent are practical now with minimum impact on subjective quality of life. Before these savings can be realized, however, people must be prepared to participate effectively in community-based conservation programs. We will show in this chapter that preparation depends on perceptual, cognitive, social, educational, and behavioral principles of psychology.

Views of local water problems are similarly affected by our social and professional roles in the community. In our research we have conducted over five hundred interviews with water management and their residential and industrial users in 54 communities across North Carolina. Communities were stratified by size and region so we could look at any possible differences as a function of hydrological conditions and population demographics. We found that water management, residential and industrial users have broad areas of agreement but also some striking differences in concerns and priorities for their local water systems. The pattern of these differences is informative and lays the groundwork for more responsive and sensitive management of local water resources.

In this chapter we evaluate water systems from the various perspectives of system managers and their industrial and residential customers. The content and method is designed to fit the new era of water management characterized by uneconomic demand for water, growing social and political concerns for infrastructural development of communities, and environmental protectionism. The research is addressed to the present lack of either a conceptual framework or the broad-based systems data available on which to construct management models suitable for these complex problems. Through this research we hope to stimulate processes of systems development for water consistent with State and local policies of balanced growth. Our emphasis is on five areas which are theoretically promising but where systems data are now most lacking. Specifically they are:

Environmental Perception. Environmental perception pertains to processes of reception and attention to specific environmental cues such as temperature, moisture of soil, color of vegetation, levels of reservoirs and stream flows, and media coverage (Gibson, 1966; Craik and Zube, 1976; Bell, Fisher, and Loomis, 1978; Ittleson, Proshansk, Rivlin, and Winkel, 1974). Environmental perception processes because they govern our consciousness to information from the environment are basic to virtually all aspects of behavior, management, and social policy.

Environmental Cognition. Cognition refers to the human processing of information perceived. This includes memory for environmental cues, associations of cause and effect, abstract reasoning, evaluation, attitude formation, and the effects of past experience and social roles on understanding environmental systems. Again these processes of cognition are fundamental to describing and shaping individual response to environmental contingencies. The relevant literature includes social learning theory (Bandura, 1974),

classical conditioning (Byrne and Clore, 1970), and operant conditioning (Insko, 1965; Hildum and Brown, 1956).

Environmental Responsibility. Responsibility derives from considerations of personal involvement, fairness, cooperation, and systems accountability for environment and behavior (Renshaw, 1957; Ibsen, 1969; Harris, 1977; Howells, 1976; Maass and Anderson, 1978). How responsibility is psychologically partitioned among water professionals, community representatives, and industrial and residential users has far-reaching implications on the effectiveness of community programs and policy.

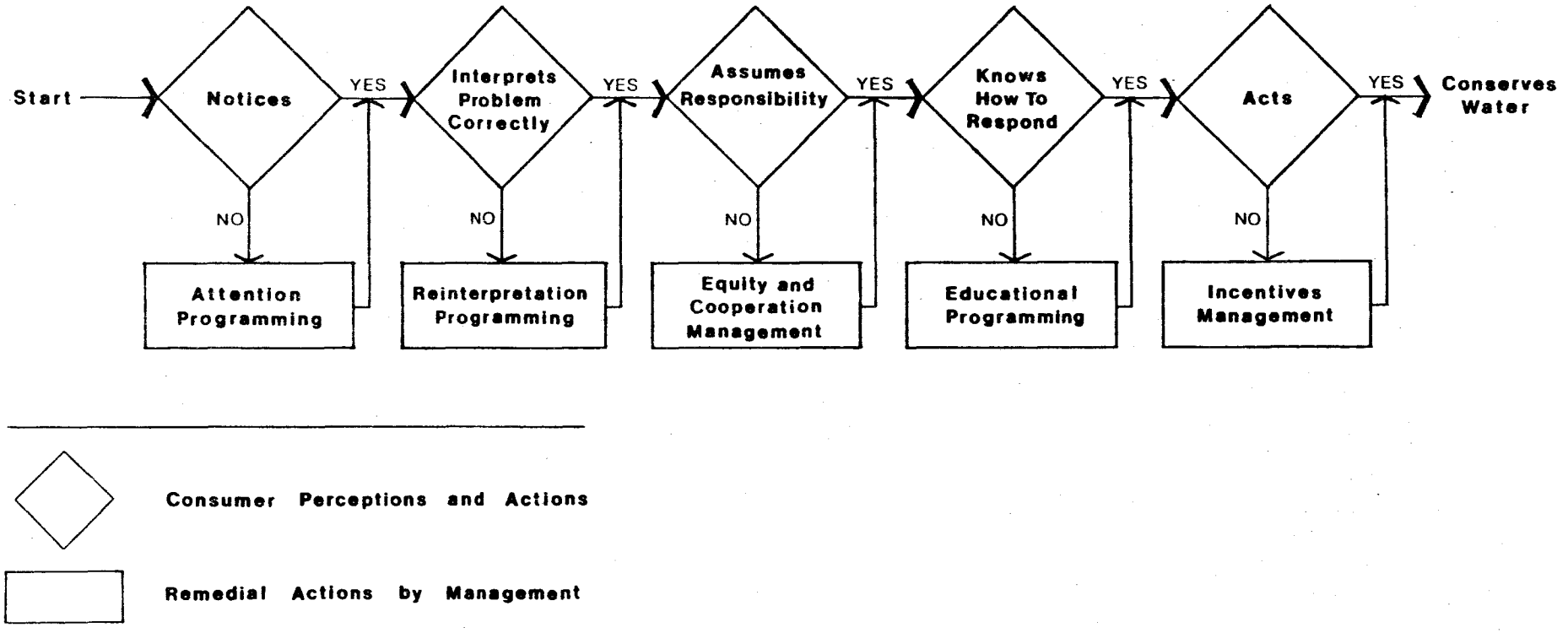
Environmental Education. Considerations of content, methods of presentation, and target populations for environmental education must be carefully considered (Roth and Helgeson, 1972; Schafer, 1976; Dunlap and Van Liere, 1978; Roth, 1979). With effective environmental education populations are better prepared to respond.

Environmental Action. Effective environmental action depends on such factors as economic incentives, social and institutional support (Ingram, 1972), commitment by individuals and collectives to environmental goals (Smith and Hester, 1982) and performance feedback (Becker, Seligman, and Darley, 1980). Clearly effective conservation programs must culminate in many individuals taking the initiative for environmental actions in their professional roles, in industries and in their homes. The facilitation of these environmental actions depends on basic principles of human behavior.

We will investigate these concepts independently and also with reference to a proposed model of conservation behavior (see Figure 1). The model systematically relates these concepts and at the same time indicates possible program or policy interventions in support of conservation objectives. The model conforms to a generalized framework or theory of decision-making where conservation behavior derives from a series of processes. The model (adapted from Latane and Darley, 1970) holds that people will exhibit either of two classes of behavior, conserving or nonconserving, depending on their (1) noticing of environmental cues, (2) interpreting of relevant information, (3) assessing of personal responsibility, (4) ability to act, and (5) contingencies associated with conservation behaviors.

Persons who fail to conserve because they failed to notice appropriate environmental information might be reoriented by high visibility mass media, notes accompanying water bills, activation of social communication networks, educational programs, conferences, etc. Likewise, persons who draw inappropriate interpretations about the water resources issue might be led to reconsideration of their interpretations. Past review of research (Miller, Brickman and Bolen, 1975) has shown that optimal efforts to steer interpretations should involve (1) a high-credibility source, (2) a repeated message, (3) an explicitly stated conclusion, (4) arguments which point out the benefits of change, (5) overlearning by the audience, (6) face-to-face communications by the source, (7) reinstatement of the source at the time of attitude assessment, and (8) active role playing or participation by the audience in the message.

Figure 1. Psychological Model of Conservation Behavior



Persons may draw the erroneous conclusion that their consumptive behavior does not significantly affect the total system. Interventions to re-involve them in conservation might include appropriately worded messages for mass media distribution, ordinances or standards for uniform compliance within a population or subpopulation. For those who are aware and favorably pre-disposed toward conservation but do not know how, educational strategies are useful. Functional education might include the various forms (e.g., public/personal, formal/informal, classroom/field-based). Conservation behaviors should be observed if the above conditions are met. It may be, however, that action is discouraged by some disincentive, tradition, social norm or resource problem. Such obstacles to conservation, require still other intervention strategies. In summary, the model gives a descriptive explanation of why there continues to be public and individual inactivity and neglect of the water conservation problem. Perhaps more importantly, the model suggests means to the achievement of conservation objectives.

In order to tap into these five domains which are primarily psychological, we have designed special survey instruments. Our choice of methodology is based on a long tradition of scientific survey research. Being one of the most flexible and popular of all social science methods, surveys are most often conducted for

the purposes of description. For example, in market research surveys describe consumer preferences, brand loyalties, price elasticities and psychographic characteristics of a demand function. Socio-political surveys of candidates and policy positions can be gauged with respect to public opinion. That surveys permit inquiry on concepts that are intangible and subjective is both a strength and weakness of the method. The strength is in the ability to address cognitive factors directly and the weakness is that the measurements are more susceptible to problems of reliability and validity. It is for the latter reason that professional polling organizations monitor volatile social subject matter repeatedly and with various phrasings of key items. Properly used, surveys represent a powerful tool for systems development.

Use of surveys for purposes of theoretical analysis of social systems is a less common but productive application of this methodology. In this role, the survey has more lasting value because the underlying theoretical principles are relatively durable. The focus of analysis is not on the absolute value of a response but rather the relative pattern of relationships among responses. In the dynamic environment of water resource management specific response values will change but presumably the changes are orderly in relation to other systems variables. If surveys are well constructed they have the potential of drawing attention to meaningful relationships that have been overlooked or neglected in social policy and management practices. Particularly important are survey results which reveal system misconceptions by public, industry, or management. Survey results which confirm common opinion also have a salutory effect when they clarify and verify system relations. In general then survey research can give rise to new knowledge about systems which can lead to creative solutions to local management problems.

Our survey data are designed to satisfy both descriptive and theoretical analyses of water management systems. Discussion of results will emphasize the theoretical analysis and draw implications for practices of water management and policy. The next section provides detailed description of the research method for the benefit of researchers and others interested in research procedure. Others may want to skip directly to the Results section.

Research Method

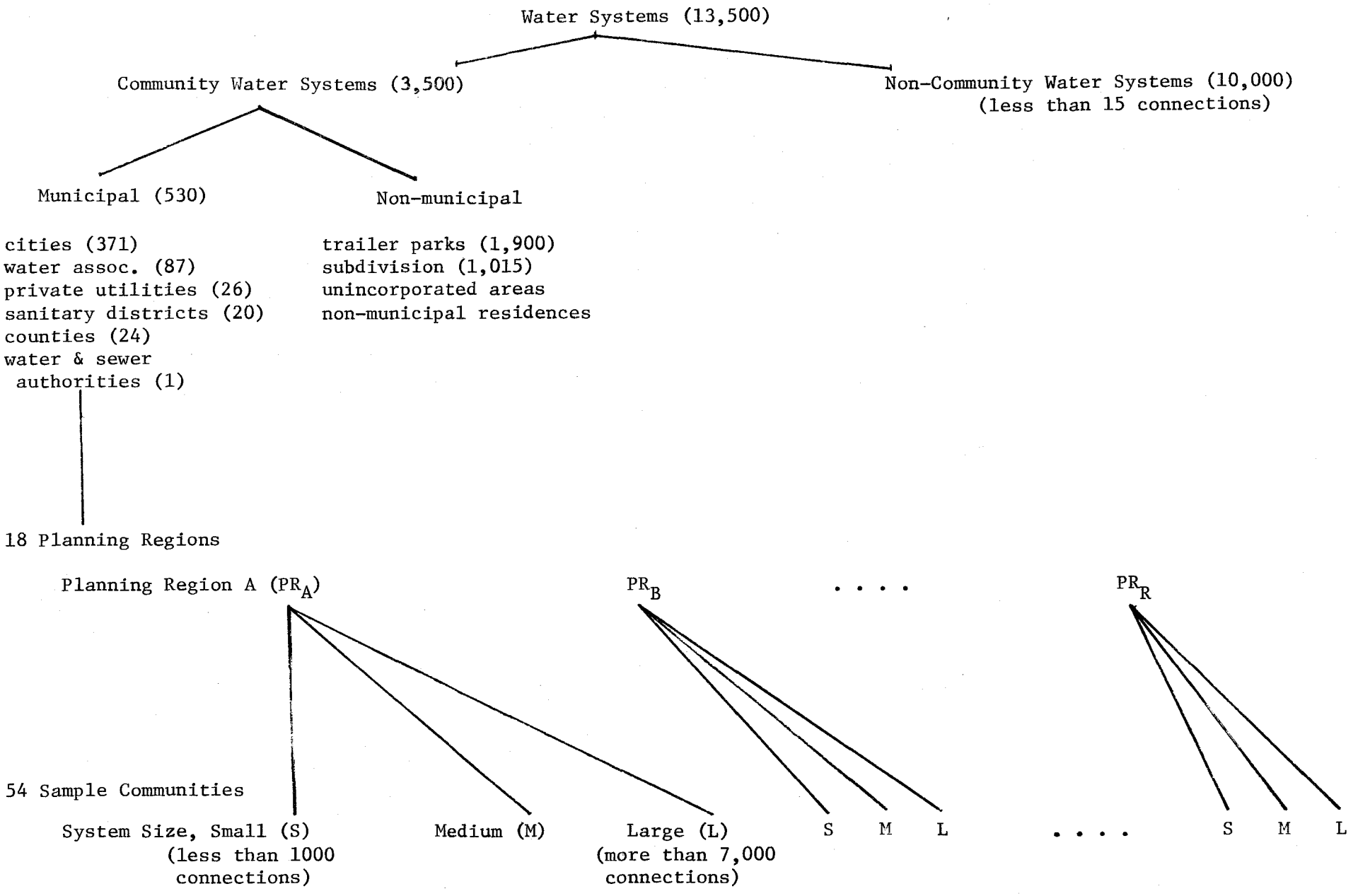
Research Sample

The research focus on community perspectives of water management and conservation was achieved with a two-level sampling procedure. The first level was the selection of communities from a list of municipal water systems using a random procedure stratified by region and size (see Figure 2). The second level of sampling was within communities where water accounts were randomly drawn to fit a stratified design for households and industries (see Figure 3).

Comprehensive lists of all the community and non-community water systems as of October, 1977, were obtained through the Water Supply Branch, Environmental Health Section, Division of Health Services, Department of Human Resources with the cooperation of staff from that office. This agency routinely collects and updates the names, addresses and demographic information of every community and non-community water system in the State. The State defines community water systems as those having at least 15 connections and a minimum of 25 year-round users. As of 1977, there were approximately 3,500 community and 10,000 non-community water systems in the State.

In this study only municipal water systems were surveyed. The rationale for studying municipal systems results from the fact that they serve larger

Figure 2. SAMPLING DESIGN: Level ONE[1]



[1] appropriate numbers are given in parentheses

Figure 3. Sampling Design: Level Two

Communities

Water System CEO	Household	Industry
1 interview and 1 follow-up mailed questionnaire/community	5 interviews/community	5 interviews/community or all industries/ community, which ever is less

populations and have an established organizational structure with at least part-time personnel employed to manage and maintain the system. There, the benefits of system improvements benefit the largest number. Also these larger systems are more likely to have the resources and communication network to effectively implement conservation strategies.

For each Planning Region municipal water systems were rank-ordered in terms of the number of people they served. Inspection of rankings revealed three natural divisions -- small (serving less than 1,000 people), medium (serving between 1,000 and 7,000 people), and large (serving more than 7,000 people). One water system of each size was then randomly selected from each of the State's 18 planning regions. One deviation from an otherwise random sampling design was that the largest water system in each of the seven SMSA planning regions was included in the survey. These systems serve large numbers of people and thus have a potentially large impact in promoting water conservation. This procedure assured representation of the largest state systems and was assumed to have minimum effect on sampling error.

Next, the executive directors of each planning region (see Appendix A) were contacted by telephone. Conversations with the executive directors served four purposes: 1) to establish rapport between staffs and familiarity with study objectives; 2) to identify any special situation in the sample communities which might produce sampling error; 3) to garner support for the study; 4) to provide an opportunity for recommendations and suggestions. Table 3 lists the water systems that were selected for the sample along with some descriptive information on each. Figure 4 shows their geographical distribution.

Figure 4. **MUNICIPAL WATER SYSTEMS IN THE RESEARCH SAMPLE**

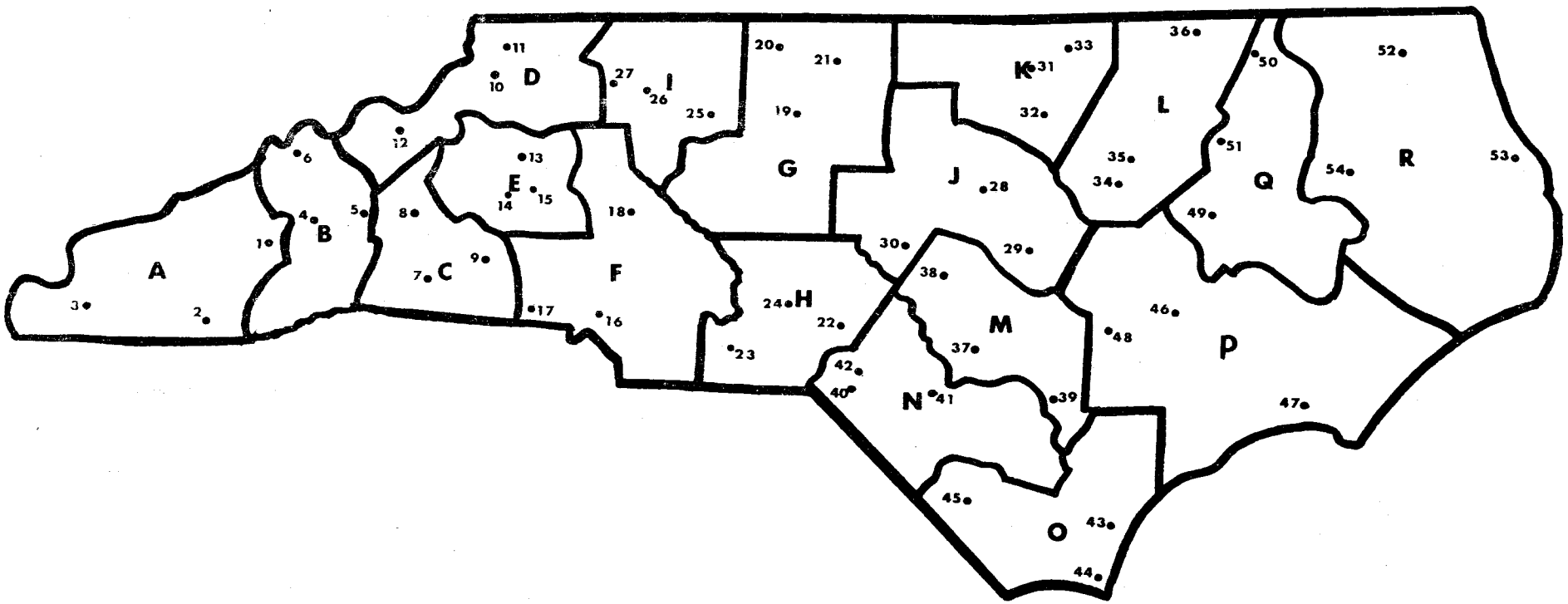


Table 3

MUNICIPAL WATER SYSTEMS IN THE RESEARCH SAMPLE

Number	Water System Name	County	Approx. # of People Served	Large = L Med. = M Small = S	Largest System in SMSA = L	Responded to Survey Yes = Y No = N
1	Canton-Penland	Haywood	8,000	L		Y
2	Franklin	Macon	4,000	M		Y
3	Marble	Cherokee	575	S		Y
4	Asheville	Buncombe	114,000	L	L	Y
5	Black Mtn.	Buncombe	6,600	M		Y
6	Hot Springs	Madison	650	S		N
7	Forest City	Rutherford	9,500	L		Y
8	Marion	McDowell	4,000	M		Y
9	Lawn Dale	Cleveland	600	S		Y
10	Boone-Winkler	Watauga	8,000	L		Y
11	West Jefferson	Ashe	1,592	M		Y
12	Bakersville	Mitchell	450	S		Y
13	Lenior Rhodhiss	Caldwell	20,000	L		Y
14	Triple Community	Burke	3,500	M		Y
15	Rhodhiss	Caldwell	800	S		Y
16	Charlotte Hoskins	Mecklenburg	330,000	L	L	Y
17	Bessemer City	Gaston	5,100	M		Y
18	Cleveland	Rowan	800	S		Y
19	Greensboro Townsend	Guilford	160,000	L	L	N
20	Town of Stoneville	Rockingham	2,400	M		Y
21	W. Yanceyville	Caswell	220	S		Y
22	Southern Pines	Moore	8,000	L		Y
23	Wadesboro	Anson	5,000	M		Y
24	Candor	Montgomery	600	S		Y
25	Winston Salem	Forsyth	183,500	L	L	Y

Table 3 (continued)

Number	Water System Name	County	Approx. # of People Served	Large = L Med. = M Small = S	Largest System in SMSA = L	Responded to Survey Yes = Y No = N
26	Town of Eastbend	Yadkin	1,200	M		Y
27	Arlington	Yadkin	200	S		Y
28	Raleigh	Wake	160,000	L	L	Y
29	Four Oaks	Johnston	1,100	M		Y
30	Broadway	Lee	900	S		Y
31	Henderson	Vance	18,000	L		Y
32	Louisburg	Franklin	3,100	M		Y
33	Norlina	Warren	969	S		Y
34	Wilson	Wilson	32,500	L		Y
35	Sharpsburg	Nash	2,000	M		Y
36	Seaboard	Northampton	800	S		Y
37	Fayetteville	Cumberland	75,000	L	L	Y
38	Lillington	Harnett	3,500	M		Y
39	Garland	Sampson	700	S		Y
40	Laurinburg	Scotland	10,000	L		Y
41	St. Pauls	Robeson	2,900	M		Y
42	Wagram	Scotland	400	S		Y
43	Wilmington	New Hanover	50,000	L	L	Y
44	Southport	Brunswick	3,500	M		Y
45	Chadbourn	Columbus	300	S		Y
46	Kinston	Lenoir	30,000	L		Y
47	Newport	Carteret	1,500	M		N
48	Faison	Duplin	900	S		Y
49	Greenville	Pitt	35,000	L		Y
50	Murfreesboro	Hertford	4,000	M		N
51	Oak City	Martin	600	S		N
52	Elizabeth City	Pasquotank	17,000	L		Y
53	Manteo	Dare	5,000	M		Y
54	Roper	Washington	700	S		Y

When the above preliminary work was completed, the research staff initiated telephone contacts with municipal officials in each of the 54 sample communities. The target person in each case was the "key decision-maker" who was identified as the person responsible for water allocation, facilities construction, and programs. Names and numbers were drawn from The North Carolina League of Municipalities' Directory and referrals were made where necessary. In small and medium sized water systems the key decision-maker was frequently the town manager/mayor. In the larger systems the key decision-maker was usually a full-time employee whose professional responsibilities related entirely to water system operations. Table 4 gives the job titles of the key decision-makers who participated in the survey. These people were informed about the purposes and sponsors of the study and were invited to participate in the study sample. It was explained that as a participating community they would be responsible for completing two questionnaires and supplying the research staff with lists of their current industrial and residential customers from which the staff would sample and conduct interviews. Confidential treatment of customer information was assured. In only one case did a community official decline to participate and in that case another community of the same size and planning region was recruited as a sample replacement. Confirmatory letters, instructions, and survey questionnaires were mailed immediately thereafter. Three weeks after the initial contact, approximately 75% of the mailing lists and questionnaires were received. Follow-up telephone calls were then made to those who had not yet responded. This request generated another 20%. Three weeks later another phone call was made. This generated the remaining 5% for a total of 100%.

It was the intention of the staff to interview five residential and five industrial accounts drawn randomly from each of the 54 selected water systems.

Table 4

TITLE OF RESPONDENT'S POSITION BY WATER SYSTEM SIZE* AND PLANNING REGION

Planning Region	Size of Water System: Large	Medium	Small
A	Town Clerk	Mayor	Treasurer
B	Planning R&D Director	Town Manager	
C	Town Manager	City Mgr/City Clerk	Maintenance
D	Town Manager	Town Manager	Mayor
E	Supt.-Water/Sewer Div.	Manager	Town Commissioner-Water/Sewer
F	Dir.-Charl.-Mecklen. Utility Dept.	Supervisor-Water Plant	Treasurer
G	Water Treatment Plant Supv.	Water Superintendent	President
H		Chief Plant Operator	Town Clerk/Manager
I	Utility Plants Eng.	Mayor	Mayor
J	Public Utilities Dir.	Town Clerk	Maintenance Supervisor
K	Dir. and Superintendent	City Manager	Town Clerk
L	Director-Public Works	Water Commissioner	Mayor
M	Mgr. Water System	Water Commissioner	Mayor
N	Supt.-Water Plant	Town Administrator	Water Commissioner
O	Supt. of Utilities	"C" Well Water Operator Acting City Manager	Town Manager
P	Dir.-Water/Sewer Util.		Supt.-Public Works
Q	Supt.-Water/Sewer Dept.		
R	City Manager	Mayor	Town Clerk

*a water system's size was determined by the number of people it served. Small system served up to 999 people, medium system served from 1000 to 6,999 people and large system served 7,000 or more people.

Thus, ten names (five primary and five alternates) were randomly selected from each residential and industrial mailing list. The telephone number for each name was obtained by using telephone directories and information operators. In cases where neither the primary nor alternate number resulted in a completed survey, a new name and telephone number was randomly selected from the list and called. When alternate numbers were used it was usually because: 1) the telephone was not answered, 2) the telephone number was changed, disconnected or out of order, 3) the respondent refused to answer, and 4) the respondent only partially completed the survey. In this way, the project staff were able to obtain five completed residential surveys from each of the 54 selected water systems. Roughly half of all names selected resulted in on-line connection with heads-of-households and of these virtually all respondents were cooperative and joined in a productive interview.

The procedure for selecting industrial users from each water system was identical to the procedure for selecting residential users. However, since some water systems serviced less than five industrial users, it was not possible in every community to complete five surveys. Quite naturally, the small systems are least represented by industrial surveys in the sample. As with the residential survey, industrial representatives recognized the importance of the survey and cooperated fully in the interviews.

Training the Staff

All interviewers were given training procedures before they were permitted to administer the surveys. A total of 12 different interviewers were involved in administering the telephone surveys to residential, industrial, and water system managers. The interviewers were undergraduate students at North Carolina State University recruited through campus advertising. The final 12 interviewers were selected from the large number of candidates who applied for the available

positions on the basis of criteria including: previous interviewing experience, the ability to communicate effectively over the telephone, and a professional disposition for telephone interviewing. All interviewers completed a training course which was designed to familiarize them with the survey instruments and their administration and increase inter-interviewer reliability for recording open-ended responses and interpreting closed-ended responses. The actual training combined tape presentation, discussion, simulation, and supervisor and peer review.

During the pretesting of the survey instrument, two interviews were tape recorded to be used as interviewer training materials. The interviewers listened to each taped survey question and response. After each response the tape recorder was stopped and the question and answer discussed. The various issues which were discussed and clarified during this meeting were:

a) How should the interviewer introduce him/herself and explain the nature and intention of the survey to the respondent?

b) How should open-ended responses be coded?

c) How should nonconforming responses to closed-ended responses be recorded?

d) In what manner should the interviewer politely curtail lengthy and irrelevant conversation?

e) What methods should the interviewer use to obtain sensitive demographic information (e.g., income)?

After the interviewers listened to and discussed the prerecorded tapes in a group with each other and the project staff, they each administered three trial surveys in the local area. The problems and uncertainties encountered during the trial interviews were discussed in a group setting. After these rough spots were resolved to the group's and project staff's satisfaction, the interviewers commenced with the formal data collection procedure.

Table 5

Completed Industrial Surveys by Planning Region and Size of Water System

Planning Region	Water System Size			
	Large	Medium	Small	Total
A		3		3
B	5		1	6
C	3	5		8
D	3	3		6
E	2	4	1	7
F	5	3		8
G	5			5
H	2	5	4	11
I	4			4
J	5			5
K	4	4	1	9
L	5	1	2	8
M	4	2		6
N	2	3		5
O	4		3	7
P	2	1	1	4
Q	5	2	2	9
R	4	2		6
Total	64	38	15	117

Survey Content

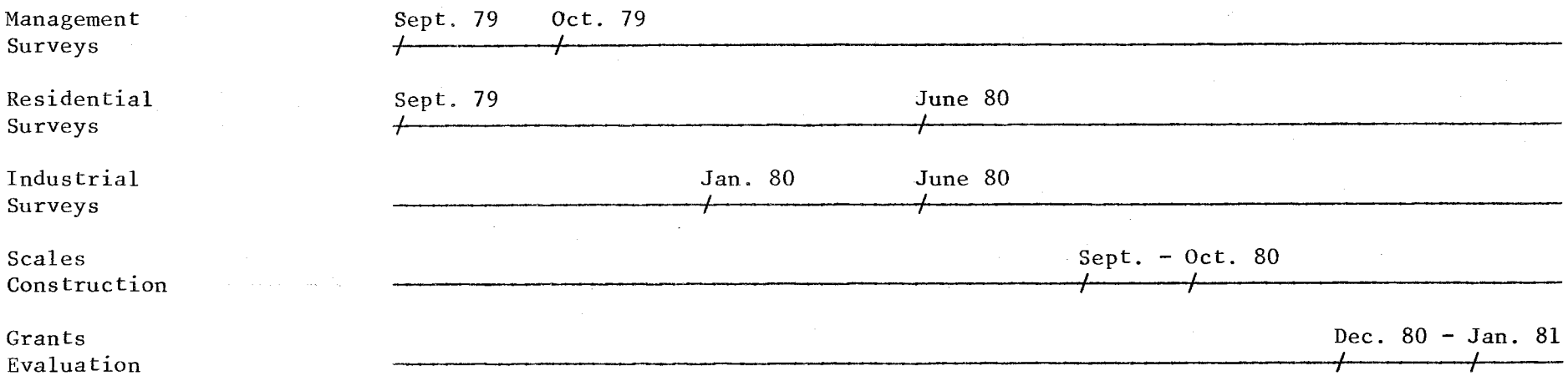
Survey items were written to relate to each of five concepts posed in our model of water conservation behavior. From the item pool generated by staff, the best and most clearly phrased items were retained for inclusion in a test instrument. From the start, we recognized the respondents, particularly for the household survey, would include some who are functionally illiterate. It was felt, however, that all respondents should be capable with the help of a trained telephone interviewer of recalling specific environmental cues, judging environmental events, and reporting opinions and behaviors. These specific items are indicative of perceptual, cognitive, social, educational, and behavioral processes. Relevant demographic information was collected to complete the survey. Trial administration of the survey led to structural improvements and streamlining. The final instrument which was produced in equivalent forms for residential, industrial, and management populations is reproduced in Appendix B along with a key that relates survey items and theoretical concepts from our model.

Survey Administration

All surveys and questionnaires were completed between September 1979 and January 1981. The time devoted to separate surveys was concentrated in blocks as indicated by Table 6 . During the course of the surveys there were no great deviances from standard weather patterns which might distort the results. The span of data collection through summer, fall, winter, and spring for the residential surveys and winter, spring, and summer for the industrial surveys enabled control of results for seasonal effects. All surveys of households were conducted between the hours of 6:00 and 9:30 p.m. in order to reach a qualified head-of-household at home. On the request of the respondent call-backs were scheduled at other times. Telephone interviews with water managers and industrial executives

Table 6

Time Frame for Administration of Surveys



were conducted during standard business hours. The typical survey lasted 15-20 minutes but some lasted as long as 30 minutes when respondents were particularly enthused and forthcoming with information. The time spent in dialing telephone numbers, arranging call-back appointments and record-keeping roughly equaled the time spent in interviews.

Once contacted most persons were happy to participate. The procedures produced 270 completed residential surveys, 54 management surveys and 117 industrial surveys. In the industrial and management surveys, interviewers found it easier to locate and complete an interview with an eligible respondent. These respondents were also quite articulate as a group so there was not so much difficulty in communicating the questions and classifying the responses. The household surveys were more difficult in these respects but there was no alternative than to persevere.

Coding and Scaling

For the most part, response formats were prearranged based on staff familiarity with the probable kinds of responses to each question. For these questions the interviewer entered appropriate scale values as responses were given. If the interviewer was in doubt about the appropriate scale value or if quite sure the response did not fit any of the anticipated categories of responding then the nature of the response was described in a space provided for "other." Many of the questions were common across surveys and served as a standard for comparisons of responses made by water professionals, industry executives, and heads-of-households.

In addition eight general questions were asked and responses taken in free, narrative form. Despite the difficulties of content analysis posed by these data it was felt that they were valuable to allow personal expressions

on the subject and build rapport with the interviewer. Interviewers were instructed to record key phrases and words used by the respondent without attempting instantaneous evaluation.

The same general approach to coding and scaling was used for all eight free-format questions. The first step was to generate a comprehensive list of all the unique responses given to the question. This comprehensive list was then reduced to categories by grouping similar responses together under a category name. Interrater reliabilities were computed for classification of responses and used to refine categories to increase reliability. After this revision process the formal coding of items commenced. In this procedure each open-ended question was independently coded by two members of the project staff who were involved in the revision process. The responses of independent coders were compared and disagreements noted. Agreements ranged from a low of 75% to a high of greater than 95% for the items. The coders working in conjunction with the program director met to achieve consensus on "best" scaling of responses for which there was initial disagreement. Each disagreement in coding was then resolved.

Results

We have found that water management, residential, and industrial users have somewhat different concerns about their local water systems (see Table 7). The highest ranking problem for both residential and industrial water users was quality. Management, however, was more concerned with water supply expansion and difficulties in relating with State and Federal water authorities. For management, quality concerns were considered along with costs of water, office

Table 7 Biggest Problems Facing Water Systems

	Residential N=269		Industrial N=122		Management N=47	
Problems	Percent	Rank	Percent	Rank	Percent	Rank
Cost of water	7.06	5	2.46	8	4.65	7
Demand for treatment	----	16.5	.82	13	----	14.5
Demand for supply	1.49	11.5	----	16	----	14.5
Land use	1.49	11.5	.82	13	----	14.5
Management (local)	.74	14	1.64	10	4.65	7
Management (State, Federal)	.37	15	4.10	6	20.93	2
Planning	2.23	10	1.64	10	4.65	7
Quality	22.68	2	12.30	2	4.65	7
Waste treatment expansion	3.35	7.5	.82	13	4.65	7
Water supply expansion	7.44	4	10.66	3	30.23	1
Waste system maintenance	----	16.5	----	16	----	14.5
Supply system maintenance	3.35	7.5	1.64	10	4.65	7
General supply problems	4.46	6	5.74	5	4.65	7
General treatment problems	2.60	9	3.28	7	----	14.5
None	26.77	1	46.72	1	13.95	3
Don't know	14.87	3	7.38	4	----	14.5
Other (not applicable)	1.12	13	----	16	2.33	11

management, planning, waste treatment expansion, supply system maintenance, and general supply problems but without special priority consideration. While it is not entirely surprising that water professionals have a different view of water problems than water users, it is important that water management understand those differences. Our evidence suggests that such understanding is lacking and that management would benefit from community relations training with particular focus on appraisal of community goals, needs, and problems (see Table 8).

The following examples illustrate the need for this kind of training:

(1) We asked management what percent of their residential and industrial customers have taken actions in their home and firm to conserve water. Management predicted only 31 percent of residents and 56 percent of industries had taken actions to conserve water. In fact, 66 percent of residences and 68 percent of industries report having so conserved. This represents a significant underestimate of the willingness of water users to adopt conservation practices.

(2) We also asked management to rate the effectiveness of various incentives to control water use for both residential and industrial groups. Price was consistently over-valued as an incentive and community involvement consistently under-valued. Beneficial forms of citizen involvement include having customers read their own meters as was done in Orange County, California, and serving on community boards as is the practice in the Washington Suburban Sanitary District. We also have found these and other community spirited activities to have a positive effect on water usage beyond the expectation of most water managers and consequently we recommend their use.

(3) Another unexpected result was the extent to which residential and industrial consumers accepted responsibility for contributing to problems of water shortage. Managers predicted both groups would attribute water shortages to the vagaries of the weather, when in fact responsibility was assigned rather

Table 8

Expected and Observed Responses of Citizens and Industries to Water Resource Survey

Question*	Residential		Industrial	
	Expected	Observed	Expected	Observed
1. What percent of citizens (industries) have taken actions in their home (firm) to conserve water?	31.02	66.10	55.53	68.20
2. How important do citizens (industry) regard the following in causing water conservation? (High Importance = 3; Moderate Importance = 2; Low Importance = 1)				
a. Higher prices	2.63	2.29	2.55	2.22
b. Threatened unavailability	2.06	2.69	2.13	2.51
c. Mandatory use regulation	1.98	2.29	2.17	2.18
d. Community spirit	2.20	2.44	2.17	
e. Other		3.00		3.00
3. What percent of citizens (industries) report a water shortage during the past 5 years?	27.67	28.20	32.53	20.40
4. What percent of citizens (industries) report taking conservation actions to deal with a shortage?	63.05	70.43	73.50	69.67
5. What percent of citizens (industries) continue these conservation actions?	30.58	56.70	56.00	53.30
6. What percent of citizens (industries) have received helpful information on water conservation?	28.56	56.80	58.87	54.50

*Questions are abbreviated here

Table 8 (continued)

7. What percent have benefitted from the following?				
a. Newspaper	59	68.60	53	67.90
b. TV	48	76.80	38	38.50
c. Radio	39	40.10	36	28.00
d. Printed material	26	50.70		
e. Enclosures with water bill	28	27.80	26	18.00
f. Friend	19	35.90		
g. Government agency			30	38.90
h. Trade association			49	39.20
i. Other				
8. How helpful do citizens (industries) believe the following kinds of information would be in increasing their conservation of water? (Rate Very Helpful = 3; Moderately Helpful = 2; Not Helpful = 1.)				
a. Information on conservation equipment.	2.48	2.40	2.09	1.93
b. Information on efficient ways to use water in daily activities in the home (firm).	2.56	2.45	2.28	2.20
c. Information on repairing leaky plumbing.	2.70	2.59	2.28	
d. Information on efficient ways to irrigate lawn and garden space.	2.06	2.17	1.39	
e. Other				
9. How much do citizens (industries) believe each of the following contribute to the problems of water shortages? (Rate Very Much = 3; Moderately = 2; Not Much = 1).				
a. Weather	2.22	2.73	2.11	2.38
b. Industrial wastefulness (excesses)	1.53	2.34	1.40	2.04
c. Public wastefulness (excesses)	1.57	2.47	1.72	2.20
d. Poor planning	1.67	2.51	1.72	2.25
e. Poor management of water resources	1.55	2.47	1.53	2.18

Table 8 (continued)

10. Rate the degree that citizens (industries) hold each group responsible for proper management of water resources.				
a. Federal government	1.65	2.09	1.47	1.78
b. State government	1.98	2.41	1.87	2.31
c. Local government	2.78	2.78	2.94	2.77
d. Water utility	2.74	2.70	2.83	2.69
e. Business and industry	1.85	2.59	1.85	2.58
f. Citizens	1.77	2.70	1.83	2.44
11. How do citizens (industries) rate their knowledge about how to conserve? (Know Very Little = 1; Know Some = 2; Know A Lot = 3).	1.91	1.87	2.55	2.26
12. What percent of citizens (industries) want to learn more about conservation?	47.46	84.90	73.70	91.70
13. Of the following, which do citizens (industries) most prefer for dealing with continued increases for water and water treatment?				
a. Build and pay for more capacity.	42.59	32.96	42.59	25.45
b. Conserve so the same capacity can accommodate more development.	51.85	47.57	40.74	47.27
c. Limit development.	3.70	7.49	1.85	2.73
d. Other		7.87		21.82
14. Of the following, which do citizens (industries) most prefer for drought management?				
a. Voluntary measures only	16.67	6.74	16.67	2.73
b. Mandatory measures after voluntary measures.	46.30	49.06	40.74	50.00
c. Mandatory measures only.	22.22	28.09	18.52	22.73
d. Surcharges	3.70	8.24	3.70	16.36

evenly to industrial excesses, public excesses, poor planning, and poor management of local resources and weather. It is encouraging to find citizens and industries accepting their appropriate responsibility for excesses in water use.

(4) Finally management overestimated residential and industrial desire to build and pay for more water and waste treatment capacity. When given a choice among several development options, a plurality of both user groups preferred a strategy of conservation so that present facility capacities could accommodate new growth and development.

In sum, these misperceptions of community interests on some fundamental issues of water management are the basis on which local problems often emerge. With training, managers can identify the priorities and preferences of citizens and industries and, therefore, be better prepared to deal with problems when they arise.

Our evaluation of conservation practices in the field also has revealed a creative set of on-going activities (see Table 9). As expected, the specific conservation practices vary with the particular home or industrial situation. A lot of publicity has been given to structural approaches to conservation including capital investment in more efficient equipment, redesign of production systems, reductions in operating temperatures and pressures and so forth. An example of this sort is the move by textile mills to new foam technologies for applying dye to fabrics. The new process requires little water and eliminates much of the expense of drying the treated fabrics.

Technical assistance in this context must have a complementary effect, not replace local initiative. Our research and experience show that particularly welcome and useful forms of assistance are nonstructural in nature including

Table 9

Listing of Water Conservation Methods Being Used by Citizens & Industries

Method	Citizen		Industry	
	During Shortage	After Shortage	During Shortage	After Shortage
1. Shower not bath	15	2	-	-
2. Consolidate wash	39	5	-	-
3. Stop irrigating	31	30	-	-
4. Equipment or dev.	9	0	11	1
5. Repair leaks	30	1	15	0
6. Toilet modifications	8	0	2	0
7. General cutback	60	8	2	0
8. Stop carwash	23	31	0	3
9. Stop dishwasher	10	2	-	-
10. Schedule washing	8	1	1	0
11. Flush less	4	1	0	1
12. Cut water main	1	1	1	0
13. Recycle water	2	1	32	1
14. Efficient wash	36	7	1	2
15. Water play reduction	1	0	-	-
16. Use well	2	2	1	2
17. Haul water	0	3	-	-
18. Collect water	0	1	2	0
19. Extract water	-	-	1	0
20. Automatic shutoff on air compressors	-	-	1	0
21. Inspections	-	-	6	1
22. Flow meters	-	-	3	1
23. Operations modifications	-	-	8	2
24. Employee conservation	-	-	2	1

Table 9 (continued)

Listing of Water Conservation Methods Being Used by Citizens & Industries

Method	Citizen		Industry	
	During Shortage	After Shortage	During Shortage	After Shortage
25. Reduce temperatures & pressures	12	0	6	0
26. Cutback production	0	1	0	3
27. Nonpeak production	-	-	0	1
28. Delay expansions	0	1	0	1

grantsmanship, regulatory compliance, permit applications, personnel training, and general system improvements such as leak detection and quality control (see Table 10).

The above technical assistance needs notwithstanding, there is a persistent and overriding wariness among water users to inviting technical assistance, particularly from public agencies, that also have regulatory functions. Forty-three percent of all industrial respondents and 21 percent of residential respondents preferred no technical assistance from State agencies. Technical assistance consultation by private parties is seen as a preferable alternative.

Table 10

Preferred Kinds of Government Assistance

	Residential		Industrial		Management	
	Freq.	Rank	Freq.	Rank	Freq.	Rank
Regulation, policies, permit	2.23	8	3.31	5.5	9.30	4
Consolidation of systems	----	18.5	----	14.5	2.33	8.5
General monetary	11.52	3	14.88	3	37.21	1
Personnel (technical)	1.12	10	2.48	7	4.65	6
Personnel (fiscal)	.37	14.5	----	----	----	14.5
Research & development	1.12	10	----	14.5	----	14.5
Equipment	.37	14.5	.83	8.5	4.65	6
Water system improvement	5.95	5	6.61	4	23.26	2
Treatment system improvement	2.60	7	3.31	5.5	4.65	6
Quality control	6.32	4	.83	8.5	----	14.5
Enforcement	----	18.5	----	14.5	----	14.5
Public education	.74	12.5	.83	8.5	2.33	8.5
Subsidy, water purchases	.37	14.5	----	14.5	----	14.5
Emergency systems	.37	14.5	----	14.5	----	14.5
Price reform	.74	12.5	----	14.5	----	14.5
Management	1.12	10	.83	8.5	----	14.5
Watershed protection	----	18.5	----	14.5	----	14.5
Planning	----	18.5	----	14.5	----	14.5
None	21.19	2	43.80	1	11.63	3
Don't know	40.52	1	22.31	2		
Other (not applicable)	3.35	6				

Conclusions and Recommendations

Our research has uncovered a tremendous reservoir of citizen and industry support for water conservation. The cynical views of many water professionals that citizens are disinterested, inactive and uninformed with respect to general water resource issues are not supported by our data. These managers are out-of-touch with the citizens and industries they attempt to serve. In particular, managers seriously overestimate the extent to which heads-of-households and industry executives prefer to build and pay for more water supply capacity. In fact, a plurality of both groups would rather conserve so existing capacity could be freed in support of additional growth and development. Managers also are unaware of independent actions by approximately two thirds of all water users to conserve water. They do not appreciate the extent to which heads-of-households and industry assume responsibility for their own wasteful practices and are willing to take corrective action as part of a total community effort including local planning and management reform. Also management is unaware and unresponsive to the strong desire among both residential and industrial groups to know and do more about water conservation. Perhaps the greatest benefit of this research is its scientific contradiction of the widespread misperception that water conservation is unpopular, unreliable and unprofessional.

Other major findings suggest the underlying social and organizational complexity of water conservation programming. They warn us that trial-and-error approaches to water conservation will likely suffer from an overly simplified conception of the problem. For example, we find that residents and industry executives rely on 224 different perceptual cues to the conditions of water resources. Some cues have general value within the population and others are highly meaningful only to a small subset of the total population. Public

information campaigns and environmental education programs will have to design and target information in a way that is compatible with the cues people are using to understand their water resource environment. It is also revealing that despite attempts at saturated information programming in recent years, only 57 percent of residents and 55 percent of industry executives report having seen or heard any helpful information on water conservation. Obviously more utilization of the dominant medium, TV, and more diversity of information media including community meetings, water bill enclosures, and industrial trade association channels will be required to reach the total population. Finally, conservation actions tend to be crisis oriented. The most powerful motivator of water conservation is the fear associated with threatened water unavailability. Conservation attributable to good citizenship, mandatory controls, and price account for only 25 percent of all conservation. However, overuse of fear appeals can backfire in the form of incredulity and render a community less prepared to respond to a genuine crisis of water supply or sustain conservation activities in less than crisis conditions.

The following recommendations are based on our review of the technical literature and original research on community perspectives relating to water resource management. Recommendations:

1) Development of new or expanded water supply capacity should be supported only when all reasonable efficiencies of pricing, leak detection, public education, etc. are insufficient to meet projected water demands. In such cases development should be scaled to the size of the supply deficit.

2) Consonant with the desires of citizen and industry representative the State should upgrade its system capacities for informational assistance. Support for individual consultation by field staff

should be reallocated to the development of information systems with greater outreach potential. Beyond that the State should serve as an informational clearing house and refer requests for technical assistance to private providers of consultation services.

3) The State through appropriate agencies should plan and coordinate environmental education programs generally and water conservation programs in particular. Central development and dissemination of educational materials is an appropriate State activity. Content should feature practical information on plumbing repair, reuse, irrigation, installation of flow restrictors and toilet dams. Supplemented by locally sponsored events, announcements, teach-ins the educational process would be welcome and beneficial and have the side advantages of bringing managers and water users closer together.

4) The primary locus of responsibility for water resource management should remain with local government. Technical advantages of regionally integrated water systems can and should preserve local control through a cooperative or federated system.

5) Communities should be encouraged to prepare contingency plans for possible implementation because of water shortage. Plans should rely upon voluntary actions as a first line of defense. Mandatory controls should be held in reserve for reinforcement of voluntary measures under extreme conditions.

6) Greater visibility should be given to opportunities for citizen participation in water supply planning, allocation, and conservation programs. Training programs for local water managers should be revised to include more emphasis on community relations skills, water conservation techniques, leak detection, and management science.

CHAPTER 3: MANAGEMENT INFORMATION SYSTEMS FOR STATE AND LOCAL WATER AGENCIES

The evolving role of water system managers now requires mastery not only of the technical matters of water supply and treatment but also basic social and political issues of the community and State. The change has profound implications on the water industry and particularly for local systems managers. An indication of the new demands on water managers was evident at the 1981 EPA National Conference on Water Supply. There the dominating themes were social and political, and speakers made frequent reference to the concepts of equity, cooperation, attitude change, needs evaluation, public education and conservation. The new attention to these social concepts is welcome but there is still much confusion and amateurism in the application of these concepts for the benefit of water systems. Water utility managers who are usually trained in technical fields of science and engineering are unable to effectively cope with these difficult social problems which go beyond traditional areas of training or the reach of present informational support systems. Improved use of information systems technology is one means to service the expanding role of the water manager.

Computer technology offers the potential of backstopping management in their difficult decision-making roles, but before this promise can be realized, data bases must be designed and built which will meet the diverse needs of management for information. Ideally data bases would be an archive of information which would grow to keep pace with changing system needs and always emphasize content which is relevant, high quality, and low in cost. A major objective of the present research was to complete an organizational analysis of local water agencies focusing on informational needs. It is intended that the results of the study will help to fill a major void in the knowledge of management information needs in water agencies and guide the development of future information support systems.

Several states and large metropolitan water systems have led the way in development of sophisticated information systems, computer models and staff information specialists.[1] Reports of their experiences suggest that the payback to systems in reduced cost of development and operations is attractive. Yet most large systems have not followed this lead and conservation remains the stepchild of water management activities. Furthermore, for smaller water systems these models are simply not applicable given their special information needs and their severe constraints of system resources. With this in mind, we have surveyed water agency personnel to identify efficient sets of information for water systems large, medium, and small on which water management can confidently rely to support system operations, rate setting, public relations, planning, and conservation programs to name only a few. Unless we are prepared to back managers with these informational prerequisites, they understandably are going to be reluctant to assume the risks of new programs such as water conservation. Among other things, they will want to be able to track program performance on revenue, consumer demand, leak detection, regulation and enforcement, pricing, emergency allocation, and call on support information for the various activities.

Theoretical Background

Contemporary theories of organization reflect growing attention to the use and flow of information within and across system boundaries. Replacing the earlier

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[1]Based on numerous conversations with water agency representatives, the leaders in information system development include the California Department of Water Resources, Washington Suburban Sanitary Commission, Dallas Water Authority, Denver, and the Atlanta Regional Commission. These systems are well known for their excellent programs of conservation but the informational support systems which underlie these successes have not been the focus of attention or dissemination.

theories of bureaucracy and scientific management are the more flexible, open systems views of organization. Where the former tended toward conceptual closure of the organization by assuming known tasks or goals, conveniently disappearing outputs, and available resources, the latter are less dependent on fixed or known quantities and determinate states (Katz and Kahn, 1966; Buckley, 1967; Thompson, 1967; Berrien, 1968; Bobbitt et al., 1974).

In a cogent theoretical analysis, Thompson (1967, p. 10) states the central problem facing organizations is coping with what he has called the "cutting edge of uncertainty in the environment." The same principle concern governs biological systems in which "to survive is to anticipate correctly environmental events" (Von Foerster, 1968, p. 178) and "to live effectively is to live with adequate information" (Wiener, 1956, p. 18). The key then to operating efficiently in an uncertain environment is "to increase the amount of information in the system" (Bobbitt et al., 1974, p. 321). The management of the organizational environment is essentially the management of information (Kelly, 1974, p. 426).

Given the critical needs for information one would expect that organizations would have long ago developed rational systems for information acquisition, storage, processing, and retrieval. Yet when we look at the literature we find little systematic developments of this kind. Apparently the situation has not changed since McWhinney (1968, p. 272) observed that studies of organizational attention mechanisms for sensing of discrete segments of the environment are virtually absent and since Porter and Roberts (1976, p. 1562) lamented that how information comes into organizations is seldom researched. Previous research is especially lacking in its ability to provide effective coping strategies for management. It is in this context of inadequate informational support that one can best appreciate the frustration and anxiety of water managers as they attempt to cope with the

uncertainty of their environment. The clear challenge for the researcher is to identify and classify the relevant information elements of a water agency in such a way as to facilitate acquisition and use of organizational and environmental information to reduce uncertainty and guide programmatic activities. It is that objective that we pursue here.

Three organizational strategies for coping with environmental uncertainty are recognized. The first is the buffering of technological process cores (Simon, 1957; Thompson, 1967; McWhinney, 1968) from unnecessary contact with informational uncertainty, with the result that incoming information is routed to specific locations within the organization. Typically, information inputs have been the province of middle- and upper-level management (Coffey et al., 1975) and related to the organizational processes of regulation and control (Haberstroh, 1965).

A second strategy that organizations may employ to moderate the potentially dysfunctional effects of uncertainty is that of selective attention to certain portions of their environment. "In practice, life for a manager is a flood of messages varying in scope and significance" (McDonough, 1963, p. 131). The organization has a limited capacity to collect and process information and, thus, develops strategies for searching the environment (Thompson, 1967, p. 9). Selective filtering of information inputs can reduce the costs to the system, both psychological and economic, of attention, interpretation and storage. Research on material resource inputs into organizations has established that organizations attend to only the "relevant" or "task" environment (Dill, 1958, 1962) defined as those subsets of the environment which are "significantly related" to the organization (Bobbitt et al., 1974, p. 213).

A third way in which organizations can cope more effectively with uncertainty is to streamline the information-processing function. There is evidence to

suggest that conditions of uncertainty tend to accelerate both acquisition and processing of information among individuals (Maccrimmon and Taylor, 1976, p. 1408). The recent proliferation of management information systems (MIS) in both private and public agencies is attributed to this increased organizational uncertainty (Anthony, 1965; Simon, 1965; Lucas, 1973; Murdick and Ross, 1975; Prince, 1975). Unaccountably, the rules by which organizations as units sense, attend to, interpret, store and retrieve information for decision-making through the MIS are virtually unaddressed by current theories of organizational and industrial psychology. This neglect is particularly surprising in view of both the acknowledged salience of information-processing for an understanding of organizational behavior (Bobbitt et al., 1974) and the pervasive problems associated with the effects of MIS on managerial behavior (Thayer, 1968, p. 114). It is important that MIS design and development follow orderly, lawful and objective lines of progression, yet little empirical research exists in this area, especially in water resources (Smith, 1981).

The problems of information management become increasingly complex as one considers the frequent and important information traffic within organizational networks including local, state and federal water agencies, consulting firms, universities, construction companies, suppliers and others. The boundary between the organization and its environment is particularly resistant to definition in view of the fact that organizations can and do modify their own structure (Lawrence and Lorsch, 1967, p. 16). Thus, the relatively clean division between a local water agency and the State becomes obscure, for example, when the state water agency delegates organizational functioning to a local office. To handle these problems recent literature on inter-organizational relations (Evans, 1966; Miller, 1973; Baker and O'Brien, 1973) advocates use of

intersystem models for the study of complex organizations. In the case of water resource management the necessarily complex set of relations between numerous State and local agencies would require that a MIS intended for support of local system managers have a scope that is Statewide. Also because of costs, the only feasible approach is a centralized MIS which is dedicated principally to the support of local systems in the context of their larger environments. Whether the decision-making strategies delineated in organization psychology (e.g., Maccrimmon and Taylor, 1976) hold under this new set of conditions where the local decision-maker is supported by a MIS is still unclear, but the overall effectiveness of the system should be enhanced.

Finally management information systems vary in capability and require levels of complexity and structure appropriate for the intended purposes. For example, a MIS intended to facilitate water resource planning is more demanding of information and processing capability than a MIS intended primarily for systems operations. MIS in State agencies have been predominately designed for operational and management applications (Evans, 1970) with over 40 percent of data processing budgets supporting "housekeeping" functions (Hayman et al., 1973). Now the need for MIS is to provide more for management than merely high-speed clerical services (Churchman, 1968). The evolution of MIS capabilities from the operational to planning is a desirable goal but one that is constrained by an array of organizational, administrative, economic, environmental and technological factors which may limit further development (Prince, 1975, p. 55). Also some negative managerial reaction to MIS suggests that there is considerable psychological reactance aroused by the perceived threat to decision-makers of having to ground decisions in data. The development process will need to take account of all these factors.

In summary, the use of MIS as a problem-solving resource within local water systems, to be accessed as necessary by decision-makers, is consistent with the

view of organizations as problem sensing systems (Weick, 1969; Thayer, 1968; Ference, 1970). The maintenance of stable organizational components for information collection and interpretation in the public planning process was proposed by Friedmann (1973). "Technical secretariats" provide relatively permanent centers generating information for policy guidance from measurement and evaluation of system states (analogous to operational decision contexts) to experimental system design and testing (p. 211). Formal models of the organizational decision-making process are provided by Thayer (1968) and Friend and Jessop (1969). Although these treatments construe organizational information-processing as seeking to reduce uncertainty through an iterative process in interaction with the environment, neither incorporates the MIS directly into the model. None of them addresses the identification of specific units of information an organization should regularly input into its MIS prior to, and in anticipation of, access by decision-makers.

Goals and Objectives

While the fundamental dependency of management on information is generally accepted, presently there exists no systematic approach in North Carolina or elsewhere, except as represented in this research, to develop information systems appropriate to the new and emerging water management problems of the 1980's and beyond. What information technology is available now reflects the past concerns and priorities of the local water utility. These traditional systems vary tremendously from community to community. They are systems that are familiar but unsuited to the demands of a modern management approach including conservation. Managers of community systems are not going to pursue water conservation if they perceive implicit risks to revenue or severe informational requirements. With this in mind, we have sought to identify an efficient set of information on which water management can confidently develop and operate a modern water management system including a water conservation component--at minimum cost.

The purpose of this study then was to identify the information needs of water management as a first step toward the development of an automated management information system (MIS) for the State of North Carolina. As previously discussed, water managers are confronted repeatedly with difficult decisions which require a good information support base. Use of a MIS in some cases would serve to confirm subjective conclusions about system solutions to problems and thus ease feelings of uncertainty. Other times when information contradicts subjective conclusions, the decision-maker might be moved to investigate the problem further. Overall a well designed information system would facilitate management in operations control, fiscal affairs, inter-agency interrogatories, public relations, planning and other important areas of responsibility. But the MIS will only be as good as the data it contains and form and extent of its accessibility on a timely basis. Information also can be costly to obtain and maintain so cost considerations must also be factored into any development plans. Clearly then a MIS offers much promise to water management but before any state proceeds with actual development systematic studies are required to establish appropriate specifications of content and form for such a system. It is to that purpose that the present research is dedicated. Specifically the study objectives were as follows:

1) Identify a comprehensive set of information elements important to the effective functioning of a local water system.
2) Document the information holdings of local water agencies in North Carolina.
3) Determine the fit between the importance, use, and availability of management information.

4) Produce a ranking of informational elements according to need.

5) Evaluate the implications of the results for development of a State-wide MIS for water resources.

Research Method

The basic research method consisted of a questionnaire which was mailed to each of the water resource managers in the 54 communities comprising our North Carolina sample. (See Chapter 2, pp. 30 for detailed description of the sample.) The questionnaire which was designed especially for the purposes of this study was completed by 47 of the 54 managers in the sample. These data were analyzed using a variety of statistical models to produce a clear description of the current uses and needs for management information.

Questionnaire Design

The questionnaire was developed by the project staff in consultation with water policy officials and a technical advisory group. Its content and format represents the sum of the inputs from these persons as well as the state-of-the-art in water information systems as represented in the professional literature, on-line technical databases, and private conversations with numerous water officials from around the country. An orderly synthesis of all these inputs was achieved using a general systems theory framework to classify information elements.[1]

The questionnaire began with three general questions that allowed managers

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[1]For the present study the term "information element" will refer to units of raw data and not to the meaning attributed to these data by individual decision-makers. This definition is consistent with quantitative information theory (Rappaport, 1968; Porter and Roberts, 1976) which strictly differentiates between data, signals or messages on the one hand and meaning on the other.

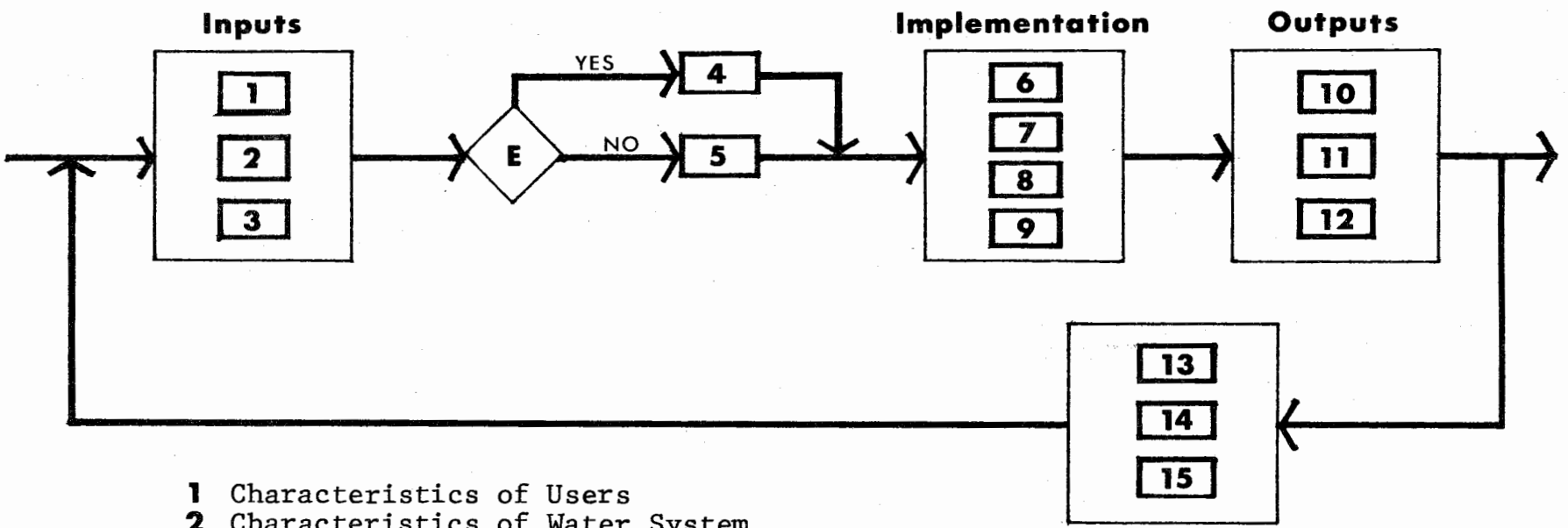
to respond freely about the major problems, and possible solutions to problems they saw affecting water resources. The same questions had been put to a sample of heads-of-households and industrial executives drawn from the same sample communities. The views of management on these questions then were valuable both as an informed basis of opinion and as a standard against which citizen and industrial responses could be compared.

The main part of the questionnaire called for detailed appraisal of information elements for possible inclusion in a MIS. The content was derived from an extensive listing of all information elements potentially relevant to water system operations and planning. Staff were guided in this task by information elements identified by review of community records, information inventories, and models systems, e.g., Washington Suburban Sanitary Commission, East Bay Municipal Utility Districts, Dallas Water Utility, and The Atlanta Regional Commission among others. Subsequently the staff categorized all information elements according to general systems concepts -- inputs, throughputs, outputs, feedback, and environment (see Figure 5). Finally the classified sets of information elements were edited to eliminate duplication and unnecessarily technical language and put in a consistent form for a mailed questionnaire. The result was a set of 92 information elements representing all 15 categories of system activity organized by familiar labels and keyed as follows (see Appendix B, p. 131).

Procedures

Respondents were asked to evaluate each information element on five standard scales. Specifically ratings were made for each information element on importance (I), primary use (P), frequency of use (F), updating requirements (U), and current adequacy (A). All scales possess interval scaling characteristics except P which produces nominal values only. A total of 47 water managers in the respondent panel of 54 completed the questionnaire. All subsequent analyses

Figure 5. **WATER MANAGEMENT INFORMATION SYSTEM**



1 Characteristics of Users
2 Characteristics of Water System
3 Available Information
4 Emergency Preparedness
5 Planning & Balanced Growth
6 Water Pricing
7 Billing
8 Technical Assistance
9 Regulations & Enforcement
10 Water Conservation Behavior
11 Water Use
12 Attitudes Toward Water Resource Management
13 General Fund
14 Population Characteristics
15 Economic Indicators
E Emergency

therefore are based on a data matrix of 47 x 460 where each of 47 water managers made 460 separate evaluations (92 information elements x 5 scales).

$$I = \{i_1, i_2, i_3 \cdots i_{92}\}$$

$$P = \{p_1, p_2, p_3 \cdots p_{92}\}$$

$$F = \{f_1, f_2, f_3 \cdots f_{92}\} \qquad R' = \{r_1, r_2\ r_3 \cdots r_{47}\}$$

$$U = \{u_1, u_2, u_3 \cdots u_{92}\}$$

$$A = \{a_1, a_2, a_3 \cdots a_{92}\}$$

Within this context operational definition of information need (N) is as follows:

$$N = f\ (I \cap \overline{A}) \qquad \text{(See Figure 6)}$$

In effect need is co-determined by the importance attributed to an information element and the rating of its current unavailability. The specific functions used to scale need are given in Table 11.

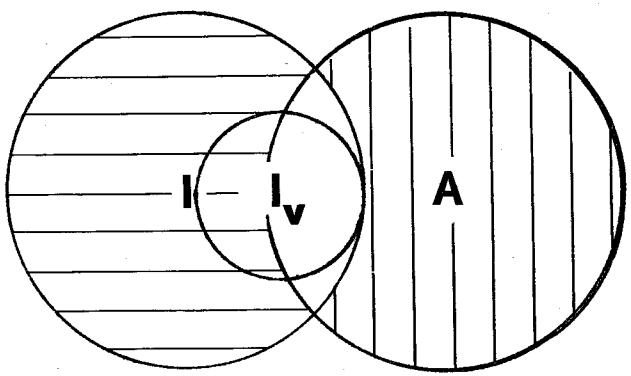
Table 11

Scale Values for Information Needs

Adequacy of Current Information	Importance of Information: Not Important	Important	Very Important
Unavailable	0	1	2
Available but poor quality	0	1	2
Available but good quality	0	0	0

In this construction of a need scale, there is no discrimination between information unavailability and information available in poor quality. This

Figure 6. **Information Management**



I = Important Information

I_v = Very Important Information

A = Available Information

Need = $I \cap \bar{A}$

Waste = $A \cap \bar{I}$

scaling, we argue, is proper and realistic. It gives no weight to poor quality information which in practice would not be used except perhaps to give an appearance of informational back-up for a favored position. In fact, the literature suggests management is historically reluctant to rely on MIS under the best of circumstances.

The need scale, however, does distinguish between information which is important and information which is very important. This distinction can facilitate MIS development with priority attention to items in the very important category.

Similarly information waste (W) is defined as follows:

$$W = f\ (A \cap \overline{I})$$

if I = not important and

A = available in good quality

then $W = 1$

otherwise $W = 0$

Finally information cost (C) is defined as:

$$C = f\ (U)$$

such that $C = U_{adj}$

where $U = \{1, 2, 3, 4, 5\}$

$U_{adj} = \{1, 2, 24, 104, 230\}$

Cost factors are not a prime factor in this research and on that basis we excuse this cursory approach to cost. In this construction of the cost scale we assume that collection of all units of information incur the same costs, so the single determinate of cost becomes the required frequency of updating per biennium.

Results

Looking at the most general and perhaps the most basic results first, we see that 43 percent of the information elements which water managers judged important were either unavailable completely or available only in poor quality (see Table 12 , totals). The missing information was evenly divided among important and very important categories which suggests the lack of any systematic effort to acquire information to the extent that resources allow in accord with priorities of importance. These findings give dramatic confirmation of our earlier claim that managers are without supporting information in even some of their most important areas of responsibility.

On the positive side, we find that 37 percent of the information elements which water managers judged important were available in good quality. Of these, information elements in the very important category predominated by a ratio of more than 2 to 1. Subsequent analyses of the uses of these information will provide a state-of-the-art description of current practices.

Less than two percent of all information elements studied fell into a category of waste -- not important but available. Overall then waste is not a major problem and instead the major problem is meager informational resources. Still analysis of the range of waste in individual systems shows that waste runs as high as 15 percent which represents a significant and nonproductive information burden on a local system which could be saved or reallocated to information elements of established need.

On average a residual 19 percent of information elements were regarded not important and not available. Changing circumstances and exposure to new and improved management procedures might result in greater awareness of the importance of some of these elements. Availability is less a matter of viewpoint than importance.

Table 12

Summary Statistics (in percent) for Information Elements

Across Categories of Information Need and System Size

Information Needs		System Size: Small (N=12)	Medium (N=15)	Large (N=17)	Total (N=44)
Needs Unsatisfied					
	$\bar{X}$	35.87	52.90	39.13	42.93
	SD	19.28	24.41	21.59	22.73
Needs Satisfied					
	$\bar{X}$	37.14	30.00	43.41	37.13
	SD	22.74	25.65	20.86	23.27
Waste					
	$\bar{X}$	2.80	.58	2.04	1.71
	SD	3.16	1.23	3.68	3.00

Analyses of the same sort made on small, medium, and large systems separately have important implications for MIS development. We note for example that medium systems have the greatest needs for information. When we examine the origins of this need we find that medium systems share with large systems a similar view of information importance and they are less likely to have that information available. Apparently the costs of information cannot be born by the medium-sized systems alone. Small systems show fewer information needs in part because these systems are simpler and thus more manageable without formal informational support. Undoubtedly the results for small systems also reflect a relatively unsophisticated view about management generally and the importance of information particularly. The relatively large standard

deviations suggest that within the general pattern, some systems suffer more than others from informational deficits. Those already more advanced in their information management could be designated as test sites for experimental implementation of a State-wide MIS. These systems have management that are already committed to modern management practices. They would be helpful partners in the development, astute in their evaluation of the system and later effective advocates of the system in a State-wide dissemination.

In order to learn more about the consistency of views over the large (L), medium (M), and small (S) systems, Spearman Rho correlations were then computed based on the means of the Need scale for each information element. The resulting correlations were all significant, $p < .001$ ($r_{sm} = .57$, $r_{ml} = .71$, $r_{sl} = .49$). Again these results suggest the relative similarity in judgments of information requirements between large and medium-sized systems. Small systems are less similar and perhaps require a slightly different MIS approach.

Information Needs by System Category

A summary of information needs by general system categories is presented in Table 13. Overall information to support comprehensive planning is most needed. Other high-ranking information needs relate to technical assistance, regulation and enforcement, and water conservation. Small water systems also singled out waste treatment as a most needed information category. Medium-sized systems indicated significantly greater information needs than either small or large systems.

Table 13

Measured Need for Water Management Information by Category

Category Number	Category Name	Overall (Small, Medium, Large) Systems		Small Systems		Medium Systems		Large Systems	
		Mean	Rank	Mean	Rank	Mean	Rank	Mean	Rank
1	Water service population	.407	12	.197	12	.715	11	.289	12
2	Treatment service population	.515	10	.504	9	.770	9	.329	11
3	Water supply system	.439	11	.350	11	.595	12	.420	9
4	Water treatment system	.589	9	.702	1	.708	10	.380	10
5	Supportive information systems	.821	5	.590	7	1.034	5	.780	7
6	Emergency preparedness	.786	7	.418	10	1.016	6	.872	4
7	Comprehensive planning practices	.937	1	.678	2	1.167	1	.927	1
8	Pricing practices	.695	8	.521	8	1.088	4	.486	8
9	Billing practices	.322	13	.184	13	.616	13	.158	13
10	Technical assistance	.898	2	.638	3	1.110	3	.884	3
11	Regulation and enforcement	.873	3	.591	6	1.128	2	.845	5
12	Water use	.806	6	.593	5	.957	8	.833	6
13	Water conservation	.843	4	.630	4	.964	7	.898	2
		$\bar{X}$ .687 SD .208		$\bar{X}$ .507 SD .171		$\bar{X}$ .912 SD .204		$\bar{X}$ .623 SD .281	

To investigate the consistency of information across the 15 categories of system activity, Spearman Rho rank order correlations were computed between 1) small and medium, 2) medium and large, and 3) small and large subsamples. All three comparisons were statistically significant ($rho_{sm} = .607$, $p < .05$; $rho_{ml} = .801$, $p < .01$; $rho_{sl} = .664$, $p < .05$) which indicates general stability in the rank order of the categories across the three differently sized systems. Medium and large systems were most similar of all.

While the general pattern is one of consistency, it is important to note several exceptions. Both medium and large size systems give a low priority to information about the water treatment system (category 4) while small systems give information on water treatment their top ranking. Also information relating to emergency preparedness (category 6) increases monotonically with the size of

the system studied. Finally, information needs relating to conservation are ranked fourth overall and as high as second in large systems and as low as seventh in medium-sized systems. In view of the generally high levels of unsatisfied information needs at the medium-sized systems, conservation concerns tend to be diluted.

An analysis of variance based on the overall category means systematically established the differences in information need by system category. A one-factor model tested the relationships among categories of information (1 through 13) with respect to mean need value. The result of this analysis indicates significant differences between the category means ($F = 9.58$; $df = 12,79$; $p < .0001$). Table 4 below presents a rank ordering of the overall category means, and the means which significantly differ ($p < .05$) from each.

Table 14

Differences in Information Need by System Category

	Category	$\bar{X}$	Differences by Category
7	Comprehensive Planning Practices	.938	1,2,3,4,8,9
10	Technical Assistance	.898	1,2,3,4,8,9
11	Regulation and Enforcement	.873	1,2,3,4,9
13	Water Conservation	.843	1,2,3,4,9
5	Supportive Information Systems	.821	1,2,3,4,9
12	Water Use	.806	1,2,3,4,9
6	Emergency Preparedness	.786	1,2,3,9
8	Pricing Practices	.695	1,3,7,9,10
4	Water Treatment System	.590	1,3,5,7,9,10,11,12,13
2	Treatment Service Population	.515	5,6,7,10,11,12,13
3	Water Supply System	.493	4,5,6,7,8,10,11,12,13
1	Water Service Population	.407	4,5,6,7,8,10,11,12,13
9	Billing Practices	.322	4,5,6,7,8,10,11,12,13

An analysis of uses for information based on management reports, basically confirms results already established with respect to systems categories. Respondents were given a simplified set of categories and asked to indicate their probable use of each information element for purposes of 1) planning, 2) operations, 3) rate-setting, 4) resource allocations, 5) public relations and communications, and 6) other. These data then were converted to 6 binary scales and therefore the sum of scale values for each category gives the proportion of water managers who would use the information if available. Table 15 gives these relationships between major survey categories and use categories with respect to information use. For example, the survey category on comprehensive planning information (category 7) contains elements for which 74.3 percent of managers rate useful for planning purposes. The table also suggests that information on conservation (category 13) is viewed predominantly as a kind of planning information.

Table 15

Purpose for Which Category of Information is Used

Category	Planning	Operations	Rate Setting	Allocating	Requests	Other	Mean
1	.460	.344	.349	.065	.271	.054	.257
2	.539	.256	.266	.101	.216	.072	.241
3	.478	.463	.132	.046	.120	.019	.209
4	.494	.453	.151	.078	.141	.018	.222
5	.551	.437	.121	.080	.141	.024	.225
6	.570	.387	.088	.124	.142	.023	.222
7	.743	.273	.150	.075	.110	.028	.229
8	.463	.369	.407	.058	.083	.024	.234
9	.437	.406	.180	.050	.145	.044	.210
10	.529	.437	.150	.061	.099	.006	.213
11	.328	.646	.110	.096	.121	.024	.220
12	.664	.400	.151	.075	.092	.017	.233
13	.701	.295	.059	.052	.146	.046	.216
Mean	.535	.397	.178	.073	.140	.030	.225

Information Needs by Discipline

The same information on information needs was also categorized by discipline to identify the professional specialties best prepared to assist with regard to the needed information. As seen in Table 16, the greatest needs can be addressed best by consulting specialists in planning, management, water law, and social sciences. Clearly then, if priority information needs are to be met community and regional water systems must not be the exclusive turf of the consulting engineers. A multidisciplinary approach will best serve the goal of effective water resource management.

Table 16

Mean Need Value of Information Elements by Professional Areas

Professional Areas	Need Value
Planning	.968
Management	.919
Legal	.873
Sociology	.835
Engineering	.644
Hydrology	.608
Economics	.603
Accounting	.564

Psychological Bases of Information Needs

Information that is used most often will be viewed most important. This principle is fundamental to the various theories of cognitive psychology (Abelson et al., 1968; Kelley, 1972). The converse tends also to be true (Bem, 1972) and in the present context it has an unfortunate psychological effect. Because operations control and rate setting by their nature require more continuous attention they are viewed as more important. By the same criterion planning and responding to external persons and agencies which are

intermittent by nature, are regarded less central to the water system's responsibility.

The general pattern of these psychological effects is revealed in correlational analyses. Consider the following patterns. Information rated most useful in planning tends to be least available ($r = -.52$), it is infrequently used ($r = -.66$), and it requires infrequent updating ($r = -.74$). In contrast operations data tend to be available ($r = .26$), frequently used ($r = .84$), and require frequent updating ($r = .80$). Operations data are regarded as unimportant ($r = -.27$) while the planning data are judged important ($r = .38$). By these results clearly the MIS system tends to be self-justifying with regard to the content and uses of information. Needs for modernization of MIS are therefore understated in these data based on views of managers. Traditional areas of training that emphasize operations and finance only reinforce the status quo in information.

What is needed is a new perspective that uncouples the psychological relationship between frequency of use and judgments of importance. At minimum water managers must be made sensitive to the fact that while planning is less frequent, it has implications on all facets of systems activity with important implications for everyday activities.

Implications for MIS Development

Any MIS will incur certain information costs and satisfy certain information needs. In the final analysis, what is needed is a procedure through which a decision-maker might identify an optimal subset of information elements to be included in a MIS. Because information varies in its usefulness and cost, the problem is one which requires a multi-objective decision-making strategy. Also information units are regarded as indivisible so the problem is one that requires integer programming.

Depending on the underlying assumptions, the problem will be either complex or not. Here because of the exploratory aims of this research and the data limitations we have chosen a simple but very practical formulation of the problem. We assume that: 1) The principal constraint on information can be expressed as a cost inequality, C, which is less than or equal to some amount, X; and 2) Both need and cost variables are additive. It is then possible to compute the ratio of N/C for each information element and subsequently order the ratios in descending values. Each successive information element contributes less value per unit cost. If a prior cost constraint is fixed, then information elements are added until the cost constraint limits further inclusions of a whole information unit. Some adjustments can be made to use information elements of lesser cost as one approaches the limiting constraint. Without a prior cost constraint, the decision-maker can take account of the function, f(N/C), to assess at what point the change in N becomes unfavorable with respect to C for purposes of the total MIS requirements.

Conclusions and Recommendations

In an era of severe limitation on staff resources, more efficient means must be developed to assist water managers especially in their expanding responsibilities of planning, public education, and conservation. Fortunately there is a viable alternative made possible by the modern technology of management information systems (MIS). A properly designed and implemented MIS is characterized by the fair exchange of basic systems data collected by local agencies for centrally processed information developed by a central State agency. The exchange can have far reaching benefits on local water system operations and at the same time strengthen State based planning. By the preliminary analyses made in this report it is clear that MIS informational exchange would be locally valued, and would help make water conservation activity an integral part of water resource management for the future.

The research strategy involved local management in the process of judging the value of informational content for MIS. The results probably reflect the status quo biaes inherent in the sample. Nevertheless, we found that 43 percent of the information elements which water managers judged important were either unavailable completely or available only in poor quality. The missing information was evenly divided among important and very important categories which suggests the lack of any systematic effort to acquire information in accord with priorities of importance. This finding confirms our earlier claim that managers are without supporting information in even some of their most important areas of responsibility. On the positive side, we found 37 percent of the information elements which water managers judged important were available in good quality. Finally, less than two percent of all information elements studied fell into

a category of waste -- not important but available.

Information needs are felt most keenly within the medium size water utility. They share with large systems a similar view of information importance but they are less likely to have the staff size to maintain an adequate information system. Overall data and software to support comprehensive planning is most needed. Other high-ranking information needs relate to technical assistance, regulation and enforcement, and water conservation. Consulting specialists in planning, management, water law and social sciences are required to develop needed information. These professionals working with consulting engineers constitute a multidisciplinary approach, which best serves the goal of effective water management.

Of the following recommendations the first is the most important. The others are important in a technical sense but basically they qualify and facilitate recommendation number one. Recommendations:

1) Build and implement a State-wide MIS for water resources.
2) MIS content should be guided by the comprehensive needs of local water systems and expressed in terms which are suitable.
3) Refine cost estimates of information.
4) Develop in consultation with agency decision-makers appropriate system cost constraints.
5) Quantify the costs of system inefficiencies which result from the unavailability of timely information.
6) Provide for permanent, central-agency responsibility for MIS. Perhaps the University would be well-suited for this role through the Water Resources Research Institute. Fiscal support would probably be necessary in the form of special legislation.
7) Once information contents are defined, multidisciplinary teams

including specialists in planning, management, law, social sciences, engineering, and finance, should be directed to develop a system for routine collection of data in appropriate form for MIS.

8) Provide for continuing education for local managers in use of the MIS. Again the University has the ideal facilities and personnel to implement this training.

9) Encourage MIS use through demonstration programs, site visits, and other means.

10) Encourage standard record-keeping at the local level which is compatible in form and definition to information retrievable through MIS.

11) Maintain quality control over MIS contents and periodically evaluate MIS assisted management with the aim of better serving local system needs.

CHAPTER 4: FOLLOW-UP EVALUATION OF WATER CONSERVATION PROGRAMS SUPPORTED BY THE NORTH CAROLINA CONSTRUCTION GRANTS PROGRAM

In 1977 under authority given in the North Carolina Clean Water Bond Act of 1977, the North Carolina Departments of Human Resources (HR) and Natural Resources and Community Development (NRCD) implemented revised rules and regulations governing state grants for wastewater treatment works, wastewater collection systems and water supply systems (North Carolina Administrative Code, Title 1, Chapter 22). As part of the evaluation criteria specified for award of grants was an innovative provision to award bonus points for water conservation (Section .0402). Applications were scored on the basis of 100 points possible. In addition applicants could earn 15 bonus points by demonstration of a local commitment to water conservation programs as follows[1]:

1)	Applicant demonstrates it has a continuing Infiltration/Inflow program in its wastewater sewer maintenance program. (Wastewater Projects Only)	5 points
2)	Applicant demonstrates it has a continuing water loss program in its water supply system program. (Water Supply Projects Only)	5 points
3)	Applicant has a continuing program of water conservation education and information	5 points
4)	Applicant has adopted and is effectively enforcing the state plumbing code within the applicant's jurisdiction	5 points

Under the competitive conditions of the program most successful applicants have sought and received the bonus points by signing a resolution of community action to implement some or all of the above water conservation programs.

Until now, no systematic follow-up evaluation of the water conservation program has been made. Therefore it is appropriate and useful that this study seeks to document the processes and effects of this program.

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[1]Statutory Authority S.L. 1977, Ch. 677; Eff. February 1, 1976; Readopted Eff. February 27, 1979.

Historical Context

This evaluation of water conservation programs under the North Carolina Clean Water Bond Act of 1977 is being completed while preparations are being made for a Statewide referendum on the new Clean Water Bond Act of 1981. The new act if ratified will retain the major focus of the current act as follows:

> The primary purpose of the North Carolina Clean Water Bond Act of 1977 is to provide grants to local units of government to stimulate the construction and improvement of needed wastewater treatment plants, wastewater collection systems and water supply systems in order to provide the state's citizens a clean and healthy environment and an adequate supply of pure water for domestic consumption (Section .0101)

Findings of the current study therefore will be relevant even in the context of the new legislation. The most likely consequence of the ratification of the 1981 Act would assure increased flexibility for decision-makers consistent with a new emphasis on industrial development to extend the range within which conservation activities will be encouraged.

Rationale and Objectives

The implementation of rules and regulations by the State presumes an importance of the regulated activity and the need for a systematic form of government intervention. In the case of water conservation there was pervasive apathy, if not active resistance, to conservation as an integral part of modern management practices for water systems. Despite the documented benefits of conservation in California, Pennsylvania, Washington, D.C. and elsewhere, local conservation practices lagged excessively. In this context, the incentives provided in the construction grants program were judged necessary and appropriate. The State sought a program in which the goals of water conservation could be achieved without a burdensome regulatory framework. The result was an administrative procedure based largely on the pledges of good faith by grant applicants to

implement specific conservation programs as part of the total system improvements proposed in the grant application. It is appropriate now to seek an objective evaluation in part to verify the effectiveness and satisfaction with the current procedures. Therefore:

Objective 1: Establish applicant accountability to the rules and regulations adopted pursuant to the North Carolina Clean Water Bond Act of 1977.

Local systems were given maximum flexibility within the various areas of water conservation, to design programs in accordance with local needs. The accumulated experiences of local management working toward common conservation goals but using a variety of approaches in different situations warrants systematic evaluation. Maybe there are some general lessons that can be learned and shared from these experiences. Therefore:

Objective 2: Describe the kinds of water conservation activities underway or planned consistent with the act.

Successful reforms in management practices are often achieved as a result of great perseverence and creative solution of problems which arise in the course of events. In water conservation programs, it was expected that analysis would reveal a variety of problems which were successfully mitigated by special local efforts. Knowledge of the capacities of communities to respond to conservation in a variety of ways and overcome obstacles in pursuit of common goals was a prime consideration in study design. Therefore:

Objective 3: Identify any problems that have arisen in association with water conservation programs, and

Objective 4: Document the success of problem-solving strategies used by communities in various situations.

The extensive literature on the costs and benefits of water conservation notwith-

standing, it is clear that regional demonstrations of successful water conservation programs are most persuasive with local populations. Of particular relevance are the subjective views of local water managers whose acceptance is essential if meaningful programs are to be implemented. It was expected that the special sensitivities of professional water managers would lead to a rather extensive delineation of costs and benefits. Also the relative weighting of costs and benefits by this group should constitute a practical test for the viability of water conservation as a component of management's responsibility.

Therefore:

Objective 5: Identify the associated costs of water conservation programs.

Objective 6: Delineate the benefits resulting from conservation activities.

Objective 7: Assess the overall balance of benefits and costs.

The provision for conservation bonus points constitutes an experimental program for which there is no prior experience. The full implication of these incentives are only now beginning to become apparent. Of particular interest now is the identification of ways in which the State could better facilitate local conservation programs within the applicable constraints of resources. Therefore:

Objective 8: Identify areas in which further State assistance in support of conservation would be desirable.

Objective 9: Suggest possible improvements in the State water conservation program.

Research Method

The research sample consisted of 59 water systems identified by the N. C. Department of Human Resources which had received water supply construction grants in the period 1978-80 under terms including a commitment to water conservation. A list prepared especially for the purpose of this research, identified each system by name and indicated the kinds of water conservation activities that were obligated as part of the grant application. In addition, several systems were coded to indicate special situations that might affect subsequent interpretations of the statistical results. For each system on the list the research team based at NCSU obtained the names and telephone numbers for water managers using the N. C. League of Municipalities Directory, local information services and referrals. Although the sample constituted in this way excludes systems receiving only wastewater collection or treatment grants, it was felt no systematic bias would be introduced by these procedures which would preclude generalizations to the water conservation program as a whole.

The research procedure consisted of structured telephone interviews with each of the 59 water system managers. A telephone protocol was designed with questions targeting each of the study objectives as set forth in the preceding section. The wording and order of questions were intended to surface the relevant information on each objective. Beyond content, the form and style of the interview was a primary consideration. Obviously an interview procedure should avoid any hint of the regulatory considerations which would tend to stifle the free discussion of water conservation practices. Similarly, separate and detailed questioning of conservation actions was ruled out because such a procedure is inevitably formal, tedious and vulnerable to a variety of response biases.

As an alternative, the interview procedure adopted was one characterized by questions designed to open up an area for discussion without suggesting any specific framework for responding. Appendix A contains a copy of the telephone protocol. Note that only the portions preceded by a question mark were put to the sample of water managers. The portions typed in upper case letters were for interviewer guidance and coding purposes only. Interviewers were trained to pick out key words and concepts contained in the stream of unstructured conversation of the water managers. A draft of the telephone protocol was submitted to a technical panel for review and suggestions.[2] The work of the technical panel was particularly helpful in delineating the kinds of response categories that interviewers should be prepared to use in recording responses to the various questions.

Use of the telephone protocol generated good, content-laden conversations ranging in length from 7 to 15 minutes. The longer interviews were invariably the result of water managers eager to share in-depth their views on the subject of water conservation. Generally, the conversational responses could be coded easily in terms of prior established categories. However, interviewers were also prepared to freely note comments in order to capture important content not fitting standard categories. The interviewer was given some discretion to probe in areas mentioned by the respondent but passed over without adequate explanation.

[2]The technical panel are identified in the acknowledgement section of this report.

Results

Evaluation Overview

Of the 59 municipal water systems included in the follow-up study, 55 reported taking actions to foster water conservation in their service areas. Those who hadn't already taken actions were planning to do so with one exception. Looking closer at the kinds of actions taken it is clear that the kinds of activities singled out for conservation bonus points under Section .0402 were having an effect. The greatest activity was in water loss prevention, infiltration/inflow, information and education, and implementation of N.C. plumbing codes (see Table 17). All of these are encouraged by the State and while bonus points for infiltration/inflow are not applicable to water supply grants, the results suggest that many systems in the sample have also received wastewater collection or wastewater treatment grants which have carried an obligation to attend to this important aspect of conservation. In addition some systems have voluntarily implemented rate reforms, conservation planning and allocation systems. These measures go beyond the scope of the present rules and regulations and therefore can only be attributable to their intrinsic benefits to a system. These data suggest that the emphasis on conservation under the construction grants program produced a generalized salutory effect for water conservation including voluntary actions.

Table 17

Actions Taken as a Fraction of Actions Pledged

45/54	Water loss prevention	83%
41/*	Infiltration/inflow	
38/57	Information and education	67%
32/57	N.C. Plumbing Codes	56%
10/0	Rate reform	
4/0	Planning	
3/0	Allocation	

*An undetermined number of the 59 systems received grants for wastewater collection or treatment for which pledges of infiltration/inflow were made.

Overall, these results suggest that the conservation program as presently implemented is having a significant effect toward making practices of water conservation an integral part of overall water system improvements. Despite these gains it is also clear that pledges are not always translated into actions, in fact compliance rates are 83% for water loss prevention, 67% for information and education, and only 56% for implementation of N. C. Plumbing Codes. If it is assumed that pledges by applicants under the water supply grants program were made in good faith, as we do, then it is both necessary and useful to examine the data further to identify the obstacles encountered by systems that prevented their complete follow-through with their conservation plans. The remaining parts of our analyses therefore are intended to reveal the patterns of relative success and failure in water conservation programs carried out across the state. Particular reference will be made to the kinds of problems encountered, the problem-solving strategies tried, and the costs and benefits and the general lessons learned from hands-on experience with community water conservation programs.

Both monetary and non-monetary problems are associated with the conservation actions. They are tabulated below using familiar categories (see Table 18). Expenditures for construction, supplies, and equipment are necessary in connection with the detection, repair, and replacement of water lines but clearly the greatest costs are for personnel and consultants. Conservation is a labor intensive enterprise and in particular, leak detection, community education and N. C. Plumbing Codes enforcement rely on the availability of people to do the job. It is precisely in these areas of high personnel costs that the levels of compliance with terms in the grants applications is low.

Table 18

Problems Associated with Conservation Actions*

	Monetary		Non-Monetary
51	Personnel and Consultants	13	Regulatory Compliance
24	Construction	11	Public Ignorance
20	Supplies	2	Time Constraints
7	Equipment	2	Contractor Delay
		2	Legal

*Based on frequencies of problems identified by managers through the structured interview procedure.

In 64 instances local systems attempted to overcome their problems by independent problem-solving actions of various types (see Table 19). Most often these independent actions were insufficient to resolve the problems and managers expressed frustration. The State should explore ways to assist water systems through the trials and tribulations encountered in emerging water conservation programs. For example, the State could adopt procedures similar to those demonstrated by this report to target systems whose needs can be eased by State action. The pervasive problems of public ignorance and regulatory burdens might be lessened for all systems by centralized information and education programs. This would not lessen the local responsibilities in these areas but they would then proceed with the visible support of the State. In this way the rhetorical State-local partnership would become tangible with respect to conservation goals.

Local systems are not currently bound by any specifications of the construction grants program to maintain a systematic record-keeping system of their water conservation programs. In our investigations we were disappointed but not surprised to find very little documentation of the costs and benefits and certainly there were insufficient monetary data to support any meaningful evaluation study. By necessity,

Table 19

Problem-Solving Strategies by Problem Area

PROBLEMS	PROBLEM-SOLVING STRATEGIES: Education & Public Relations	Political Action	Bond Issue	Organizational Changes	Communications & Meeting	General Persistence	Total
Monetary							
Personnel & Consultation	4	2	1	5	3	6	21
Construction	3	1	1	3		1	9
Supplies	3	2	1		1	1	8
Equipment				1	1		2
Non-monetary							
Regulatory		1				5	6
Public Ignorance		4		1		1	6
Delays	1	2			2		5
Legal					1		1
Time			1				1
Staff Availability				1			1
Total	11	12	4	11	8	14	60

therefore, the research method consisted of interviews with water system managers about their subjective assessments of the water conservation programs and procedures. We found that 58 of 59 managers felt that overall the benefits achieved justified the program effort. This is a strong endorsement by a group that has historically been skeptical of the benefits of water conservation. Based on actual experience with conservation programs, their reports included many different positive effects which are presented in Table 20.

Table 20

Benefits of Water Conservation Reported by Water System Managers

42	Water savings
36	Public relations improvements
27	Operations costs reductions
26	Waste load reductions
5	More service potential
4	Quality improvements
1	Fire protection improvements

Thirty-three of the 59 local systems reported lacking necessary kinds of State assistance in implementation of water conservation. Requests were for funding, technical information, and regulatory reforms. Clearly the state is already involved in each of these areas , though perhaps not sufficiently or with the full awareness and participation of the local systems. These findings are potentially useful as feedback to State policy makers as they consider future refinements of rules and regulations governing water conservation.

Finally, twenty-one managers volunteered constructive suggestions on improvements of the current system. We have made no attempts to screen these suggestions for their feasibility or impacts. Rather we simply report these comments as an additional kind of feedback on the programs (see Table 21).

Table 21

Suggestions on Water Conservation

11	Support water conservation with State-run public education programs
3	Institute a management system and follow-up procedure
3	Include a progressive pricing program as part of the bonus point system
2	Backstop local efforts with a Statewide management information system

Group Comparisons

Tables 20-26 dissect the general patterns in the data as given above to explore possible systematic differences between those in the Control Group, Priority Group, and Special Situations. The results and their interpretations are largely self-evident. Table 22 shows that for the 14 systems in which the bonus points were particularly important in obtaining the grant award, each adopted at least one form of conservation. The priority group, however, was less involved than the control group with respect to information, education, and rate reform programs. The special situation group was consistently the most active in water conservation but for reasons that can only be clarified by case-by-case analysis.

Note in Table 23 that the special situation group was particularly sensitive to the problems of regulation and alleged public ignorance. Tables 24 and 26 clearly demonstrate the needs and desires of all groups for educational and public relations assistance.

Table 22

Implementation Rates for Conservation Programs by Group

(in Percent)

	Control Group (n=40)	Priority Group (P) (n=14)	Special Situation* Group (S) (n=5)
Water Loss Prevention	77.50	69.23	80.00
Information & Education	65.00	46.15	80.00
Implement N.C. Plumbing Codes	55.00	53.85	60.00
Infiltration/Inflow	67.50	69.23	80.00
Rate Reform	20.00	7.69	20.00
Planning	7.50	7.69	.00
Allocation	7.50	.00	.00

*unstable % due to small group size

Table 23

Problems Encountered by Group

	Control Group	Priority Group	Special Situation Group
Monetary			
Personnel & Consultation	90.00	69.23	60.00
Supplies	35.00	30.77	20.00
Equipment	10.00	15.38	.00
Construction	42.50	46.15	20.00
Non-Monetary			
Time	5.06	.00	.00
Regulation	22.50	15.38	40.00
Public Ignorance	20.00	7.69	40.00
Personnel	2.50	7.69	.00
Contractor Delays	5.00	.00	.00
Legal	2.50	7.69	.00

Table 24

Kinds of Solutions Implemented by Group

	Control	Priority	Special Situation
Education & Public Relations	12.50	13.58	20.00
Political	2.50	7.69	.00
Industry	2.50	.00	.00
Bond Issue	5.00	.00	.00
Organizational Reform	.00	7.69	20.00

Table 25

Perceived Benefits by Group

	Control	Priority	Special Situation
Water Savings	72.50	53.85	100.00
Public Relations Improvements	52.50	69.23	100.00
Reduction of Costs of Apparatus	45.00	53.85	40.00
Waste Load Reductions	47.50	38.46	40.00
More Service	5.00	15.38	20.00
Quality Improvements	5.00	15.38	.00
Fire Protection	2.50	.00	.00

Table 26

Kinds of Assistance Desired by Group

	Control	Priority	Special Situation
None	32.50	38.46	60.00
Funding	30.00	23.08	.00
Technical Assistance and Information	20.00	30.77	20.00
Regulatory Reform	10.00	.00	.00

Table 27

Program Suggestions by Group

	Control	Priority	Special Situation
Public Education	20.00	15.38	.00
Better Management & Follow-Up	5.00	.00	20.00
Price Reform	5.00	.00	20.00
Management Information	2.50	7.69	.00
Target Industry	2.50	.00	.00
End Program	2.50	.00	.00

Conclusions and Recommendations

The Departments of Human Resources and Natural Resources and Community Development in their first attempt have produced program incentives for water conservation that are both administrable and effective. A variety of conservation approaches have been tried with good results. They include public education, leak detection, N.C. Plumbing Code enforcement, infiltration/inflow detection, rate reform, allocation, and planning. The benefits of these programs include water savings, improved community relations, reductions in operating costs, waste load reductions, extended service opportunities, quality improvements and improved fire protection. Given the early successes of this program, State leaders should be encouraged to keep it strong and where possible extend and broaden it so the positive effects can be enjoyed by a larger number of citizens and industries.

A variety of recommendations are posed here for consideration by appropriate State personnel. In making these recommendations, we appreciate the wisdom of not tampering with success. Also we are aware that the successes

of the water conservation programs notwithstanding, there remain strong adversaries of water conservation who could attempt to kill the program under the guise of reform. Recommendations:

1. Encourage adoption of a standard record-keeping system as part of the State Grants program.
2. Study further the impacts of conservation actions including voluntary rate reforms to assess their merits for inclusion in the State's incentives program.
3. Implement a State-run technical and informational service for local governments. The core of such a system might be a computer-based management information system focused on the high volume information and processing requirements of water management. Other special situations could be targeted for action by a manned-system of assistance. These systems would mitigate the problems of regulation, communications, and technical support which frustrate water managers and lead to less effective programs of conservation.
4. Provide that funds received under the Bond may be applied to non-structural (conservation) programs as well as structural ones, and thereby ease the monetary problems of conservation.
5. Support strategies to involve volunteer workers in conservation programs at the local level.
6. Support local public education and information functions with a variety of conservation materials and publicity. Many conservation materials are already developed and available through State and Federal agencies. The primary role of the North Carolina program in this regard would be to coordinate actions through appropriate State agencies and arrange for utilization of public information outlets of State-based media, television, radio, and newspaper.

REFERENCES

Abbott, H. E., Cook, K. C., & Sleight, R. B. Social aspects of urban conservation. Washington, D.C.: Office of Water Resources Research, U.S. Department of the Interior, 1972.

Abelson, R. et al. Theories of cognitive consistency. A Sourcebook. Chicago: Rand McNally and Company, 1968.

The American City. April, 1972, pp. 72-73.

The American City. November, 1974, p. 98.

Anthony, R. N. Planning and control systems: A framework for analysis. Boston: Harvard University Graduate School of Business Administration, 1965.

Baker, L. K., Bailey, H. E., & Sierka, R. A. Household water conservation effects on water energy and wastewater management.

Baker, F., & O'Brien, G. General systems approach to complex organizations. In F. Baker (Ed.), Organizational systems. Homewood, Ill.: Richard D. Irwin, Inc., 1973, 84-92.

Bandura, A. Analysis of modeling processes. In A. Bandura (Ed.), Modeling conflicting theories. New York: Lieber-Atherton, 1974.

Becker, L. J., Seligman, C., & Darley, J. M. Psychological strategies to reduce energy consumption. Project summary report. Princeton, N.J.: The Center for Energy and Environmental Studies, 1979.

Bell, P. A., Fisher, J. D., & Loomis, R. J. Environmental psychology. Philadelphia: W. B. Saunders Co., 1978.

Bem, D. Self-perception theory. In L. Berkowitz (Ed.), Advances in experimental social psychology, Vol. 6. New York: Academic Press, 1972.

Berrien, F. K. General and social systems. New Brunswick, N.J.: Rutgers University Press, 1968.

Blackburn, A. M. Journal of the American Water Works Association, February 1978, 70, 51-59.

Bobbitt, H. R., Breinholt, R. H., Doktor, R. H., & McNaub, J. P. Organizational behavior: Understanding and prediction. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1974.

Bollman, F. H., & Merritt, M. A. Paper presented at Fall Conference of the American Water Works Association, San Jose, Ca., October 10, 1977.

Brigham, A. P. Proceedings of Conference of the American Water Works Association, Minneapolis, MN, June 8-13, 1975, #8-3A.

Brigham, A. P. Paper presented at Conference on Planning Alternatives for Municipal Water Systems, Oct. 1976.

Brigham, A. P. Journal of the American Water Works Association, 1976, 68(12), 665-668.

Buckley, W. Sociology and modern systems theory. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1967.

Byrne, D., & Clore, G. L. A reinforcement model of evaluative responses. Personality: An International Journal, 1970, 1, 103-128.

Canby, T. Y. The year the weather went wild. National Geographic, 1977, 152(6), 799-829.

Canby, T. Y. Our most precious resource: Water. Washington, D.C.: National Geographic Society, 144-179.

Churchman, C. W. The systems approach. New York: Dell Publishing Company, Inc., 1968.

Cline, N. M. Planning for water reuse. Chicago: Maaroufa Press, 1978, 127-138.

Coffey, R. E., Athos, A. G., & Raynolds, P. A. Behavior in organizations: A multidimensional view. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1975.

Cohen, S., & Wallman, H. EPA-670-74-071. Groton, CT : General Dynamics, 9/74.

Craik, K. H., & Zube, E. H. Perceiving environmental quality. New York: Plenum, 1976.

Dill, W. R. Environment as an influence on managerial autonomy. Administrative Science Quarterly, 1958, 2, 409-443.

Dill, W. R. The impact of environment on organizational development. In S. Mailick, & E. Van Ness (Eds.), Concepts and issues in administrative behavior. Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1962, 29-48.

Dunlap, R. E., & Van Liere, K. D. The new environmental paradigm. Journal of Environmental Education, 1978, 9(4), 10-19.

Ecological Analysis Incorporated. Washington Suburban Sanitary Commission's Water-Saving and Waste-Reduction Program, October, 1977.

Environmental Protection Agency. Residential water conservation: An annotated bibliography. Washington, D.C.: Office of Water Program Operations, WH-595, March. 1980.

Environmental Protection Agency et al. Water conservation 81: A national conference, Denver, Colorado, April 14-15, 1981.

EPA. The alternative is conservation. Washington, D.C.: Office of Water Program Operations, August, 1980.

EPA. Flow reduction--methods, analysis procedures, examples. Washington, D.C.: U.S. Environmental Protection Agency, March, 1981.

Evan, W. M. The organization-set: Toward a theory of interorganization relations. In J. D. Thompson (Ed.), Approaches to organizational Design. Pittsburgh: University of Pittsburgh Press, 1966, 173-192.

Evans, J. A. In P. K. Piele (Ed.), Social and technological change implications for education. Eugene, Oregon: Center for the Advanced Study of Educational Administration, Oregon University, 1970, 67-68. ED 044 233

Ference, T. P. Organizational communications systems and the decision process. Management Science, 1970, 17, B83-96.

Flack, J. E., Weakley, W. J., & Hill, D. W. Achieving urban water conservation: A handbook. Fort Collins, Colorado: Colorado Water Resources Research Institute, Colorado State University, 1977.

Friedmann, J. Retracking America: A theory of transactive planning. Garden City, N.Y.: Anchor Press/Doubleday, 1973.

Friend, J. K., & Jessop, W. N. Local government and strategic choice. London: Tavestock Publications, 1969.

Gibson, J. J. The perception of the visual world. Boston: Houghton Mifflin, 1950.

Granger, G. A. Journal of the American Water Works Association, February, 1955, 17, 122-123.

Griffith, E. L. Journal of the American Water Works Association, February, 1978, 70. 74-78.

Grigg, N. Senate Committee Hearings on Amendments to the Water Resources Planning Act of 1965, September 20, 1979.

Grimsley, J. Water: Key to North Carolina's future. Speech addressing N.C. Water Resources Research Institute, December 3, 1981.

Groopman, A. Journal of the American Water Works Association, January, 1968, 60, 37-47.

Haberstroh, C. S. Organization design and systems analysis. In J. G. March (Ed.), Handbook of organizations. Chicago: Rand McNally, 1965, 1171-1211.

Hanke, S. H. Water Resources Research, October, 1970, 6, 1253-1261.

Harrington, J. E. Water conservation--an idea whose time has come. Paper presented at the North Carolina Conference on Water Conservation, Raleigh, North Carolina, 1975.

Harris, D. H. The human dimensions of water resources planning. Human Factors, 1977, 19(3), 241-251.

Hayman, J. L., Bacon, J. N., Ferrante, R., & Taffel, S. The status of management information systems in state departments of education: A national survey. Montgomery, Alabama: State Department of Education, 1973.

Heggie, G. D. Journal of the American Water Works Association, March, 1957, 49, 267-276.

Herr, L. A., Sonner, M. B., & Thompson, P. L. Co-Chairmen of the Conference on Water Conservation Needs and Implementing Strategies, Rindge, New Hampshire, 1979.

Hildum, D. C., & Brown, R. W. Verbal reinforcement of interviewer bias. Journal of Abnormal and Social Psychology, 1956, 53, 108-111.

Hoover, K. H., & Schultz, R. E. A factor analysis of conservation attitudes. Science Education, 1963, 47, 54-68.

Howells, D. H. Water resource problems and research needs of North Carolina. Raleigh, North Carolina: Water Resources Research Institute, North Carolina State University, 1976.

Hufschmidt, M. M. State water resource planning and policy in North Carolina. Raleigh, North Carolina: Water Resources Research Institute, North Carolina State University, February, 1979.

Ingram, H. The changing decision rules in the politics of water development. Water Resources Bulletin, 1972, 8, 1177-1188.

Insko, C. A. Verbal reinforcement of attitude. Journal of Personality and Social Psychology, 1965, 2, 621-623.

Isben, C. A., & Ballweg, J. A. Public perception of water resource problems. Blacksburg, Virginia: Water Resources Research Center, Virginia Polytechnic Institute, 1969.

Ittelson, W. H., Proshansky, H. M., Rivlin, L. G., & Winkel, G. H. An introduction to environmental psychology. New York: Holt, Rinehart and Winston, 1974.

James, L. D., & Andrews, W. H. Water conservation information dissemination during the 1977 drought emergency. Water Resources Planning Series, Report P-78-992. Logan, Utah: Water Resources Laboratory, Utah State University, June, 1978.

Jezler, H. Journal of the American Water Works Association, June, 1975, 67, 331-335.

Katz, D., & Kahn, R. L. The social psychology of organizations. New York: John Wiley and Sons, Inc., 1966.

Kelley, H. H. Causal schemata and the attribution process. In E. E. Jones et al., Attribution: Perceiving the causes of behavior. Morristown, N.J.: General Learning Press, 1972.

Kelly, J. Organizational behavior. Homewood, Illinois: The Dorsey Press, 1974.

Lahav, R. Water and sewage works. June, 1977, 124, 64.

Larkin, D. G. Journal of the American Water Works Association, 1978, 70(9), 470-474.

Latane, B., & Darley, J. M. The unresponsive bystander: Why doesn't he help? Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1970.

Lattie, J. E. When a manager talks to the public. Journal of the American Water Works Association, November, 1977, 580-583.

Laverty, G. L. Willing water. Journal of the American Water Works Association, December, 1977, 123-213.

Laverty, G. L. Journal of the American Water Works Association, February, 1979, 62-63.

Lawrence, P. R., & Lorsch, J. W. Differentiation and integration in complex environments. Administrative Science Quarterly, 1967, 12, 1-47.

Lord, W. B., Adelman, L., Wehr, R., Brown, C., Crews, R. M., Arvin, B., & Waterstone, M. Conflict management in federal water resource planning. The University of Colorado, Institute of Behavioral Science, 1979.

Lucas, H. C. Computer-based information systems in organizations. Chicago: Science Research Associates, Inc., 1973.

Maass, A., & Anderson, R. L. And the desert shall rejoice: Conflict, growth, and justice in arid environments. Cambridge, Mass.: The MIT Press, 1978.

MacCrimmon, K. R., & Taylor, R. H. Decision-making and problem-solving. In M. Dunnette (Ed.), Handbook of industrial and organizational psychology. Chicago: Rand McNally, 1976, 1397-1453.

McDonough, A. M. Information economics and management systems. New York: McGraw-Hill Book Company, Inc., 1963.

McWhinney, W. H. Organizational form, decision modalities and the environment. Human Relations, 1968, 21, 269-282.

Miller, J. G. The nature of living systems. In F. Baker (Ed.), Organizational systems: General systems approaches to complex organizations. Homewood, Illinois: Richard D. Irwin, Inc., 1973, 29-63.

Miller, R. L., Brickman, P., & Bolen, D. Attribution versus persuasion as a means for modifying behavior. The Journal of Personality and Social Psychology, 1975, 31, 3.

Miller, W. H. Journal of the American Water Works Association, February, 1978, 70, 60-63.

Mitchell, R. D. Journal of the New England Water Works Association, 1957, 71, 173-187.

National Research Council. Federal water resources research: A review of the proposed five-year program plan. Washington, D.C.: National Academy Press, 1981.

The National Water Council. The 1975-1976 drought. London: National Water Council, 1977.

New England River Basins Commission. Before the well runs dry. Boston, Mass.: New England River Basins Commission, August, 1981.

News and Observer. N.C. Wading in shallow future for water supplies, Sunday, July 12, 1981, page 1.

Newsweek. Special Report. The browning of America, February 23, 1981, 26-37.

North Carolina Clean Water Bond Act of 1977. Rules and regulations governing state grants for wastewater treatment works, wastewater collection systems and water supply systems.

North Carolina Department of Commerce. Economic Development Divisions. 1980 Annual Report.

North Carolina Department of Natural Resources and Community Development, Office of Water Resources. Personal memorandum. Communities identified with possible source problems.

Porter, L. W., & Roberts, K. Communication in organizations. In M. D. Dunnette (Ed.), Handbook of industrial organizational psychology. Chicago: Rand McNally, 1976, 1553-1589.

Prince, T. R. Information systems for management planning and control. Homewood, Illinois: Richard D. Irwin, Inc., 1975.

Rapaport, A. The promise and pitfalls of information theory. In W. Buckley (Ed.), Modern systems research for the behavioral scientist. Chicago: Aldine Publishing Company, 1968, 137-142.

Renshaw, E. F. Toward responsible government: An economic appraisal of federal investment in water resource programs. Chicago: Idyia Press, 1957.

Rice, I. M., & Shaw, L. G. Journal of the American Water Works Association, 1978, 480-482.

Roberts, E., & Hagan, R. Energy requirements of alternatives in water supply, use, and conservation. A preliminary report. Davis, Ca.: California Water Resources Center, University of California, 1975.

Robie, B. R. Journal of the American Water Works Association, February, 1978, 66-67.

Roth, R. E., & Helgeson, S. L. A review of research related to environmental education. ERIC/SMEAC. Columbus, Ohio: Ohio State University, 1972.

Roth, R. E. Conceptual development and environmental education. Journal of Environmental Education, 1979, 11(1), 5-9.

Sharpe, W. E., & Fletcher, P. W. Water conservation and water-saving devices. Paper presented at the North Carolina Conference on Water Conservation, Raleigh, North Carolina, 1975.

Sharpe, W. E., & Fletcher, P. W. (Eds.), Proceedings--Conference on Water Conservation and Sewage Flow Reduction with Water-Saving Devices. Pennsylvania State University, July, 1975, Report #74.

Sharpe, W. E. Journal of the American Water Works Association, February, 1978, 93.

Sharpe, W. E. Journal of the American Water Works Association, September, 1978, 476.

Simon, H. A. Models of man, social and rational. New York: John Wiley and Sons, Inc., 1957.

Simon, H. A. The shape of automation for men and management. New York: Harper and Row, 1965.

Smith, F. J. Management information systems for water resources. Paper presented at Water Conservation 81: A National Conference. Environmental Protection Agency, Denver, Colorado, April 14-15, 1981.

Smith, F. J., & Hester, R. T., Jr. Community goal setting. Stroudsburg, Pa.: Hutchinson Ross Publishing Company, 1982.

Stone, B. G. Journal of the American Water Works Association, September, 1978, 484-486.

Thayer, L. Communication and communication systems. Homewood, Illinois: Richard D. Irwin,Inc., 1968.

Thompson, J. D. Organizations in action. New York: McGraw-Hill Book Company, Inc., 1967.

U.S. Army Corps of Engineers. The role of conservation in water supply planning. Institute for Water Resources, Contract Number DACW72-78-0022, April, 1979.

U.S. Geological Survey. Before the well runs dry. Alexandria, Va.: U.S. Geological Survey, October, 1980.

U.S. Water Resources Council. State water conservation planning guide. Washington, D.C.: U.S. Water Resources Council, October, 1980.

von Foerster, H. From stimulus to symbol: The economy of biological computation. In W. Buckley (Ed.), Modern systems research for the behavioral scientist. Chicago: Aldine Publishing Company, 1968, 170-181.

Wagner, T. P., & Ortolano, L. Analysis of new techniques for public involvement in water planning. Water Resources Bulletin, 1975, 11(2), 329-344.

Wallace, J. R., & Kahn, B. (Eds.). Water conservation and alternative water supplies: Proceedings of a southeast regional conference, Atlanta, Georgia, November 8-9, 1978.

Water Resources Council. Bibliography of water conservation, March, 1981.

Weick, K. E. The social psychology of organizing. Reading, Mass.: Addison-Wesley Publishing Company, 1969.

Wright, J. Evaluation of rural public participation strategies for water resources planning. Raleigh, North Carolina: Water Resources Research Institute, 1978.

Appendix A

MULTI-COUNTY PLANNING REGIONS

REGION A:
Southwestern NC Plng. & Econ. Dev. Comm.
Bill Gibson, Director
Route 3, Box 850
Bryson City, NC 28713
704-488-2117

REGION B:
Land of Sky Regional Council
Robert E. Shepherd, Exec. Dir.
25 Heritage Drive
P.O. Box 2175
Asheville, NC 28802
704-254-8131

REGION C:
Isothermal Plng. & Econ. Dev. Comm.
Paul D. Hughes, Exec. Dir.
306 Ridgecrest Avenue
P.O. Box 841
Rutherfordton, NC 28139
704-287-2281

REGION D:
Region D Council of Governments
Ronald A. McCreary, Econ. Dev. Planner
Executive Arts Bldg.
Furman Road
Boon, NC 28607
704-264-5558

REGION E:
Western Piedmont Council
R. Douglas Taylor, Exec. Dir.
P.O. Box 3069
Hickory, NC 28601
704-322-9191

REGION F:
Centralina Council of Governments
George Monaghan, Exec. Dir.
P.O. Box 4008
Charlotte, NC 28204
704-372-2416

REGION G:
Triad Council of Governments
Lindsay W. Cox, Exec. Dir.
2120 Pine Croft Rd.
Greensboro, Nc 27407
919-294-4950

REGION H.:
Pee Dee Council of Governments
N. Worth Chesson, Exec. Dir.
227 North Main St.
P.O. Box 728
Troy, Nc 27371
919-576-6261

REGION I:
N.W. Piedmont Council of Governments
Joe Matthews, Exec. Dir.
Government Center
Winston-Salem, NC 27101
919-722-9346

REGION J:
Triangle J Council of Governments
Raymond Green, Exec. Dir.
100 Park Drive
P.O. Box 12276
Research Triangle Park, NC 27709
919-549-0551

REGION K:
Kerr-Tar Regional Council of Governments
J. Don Everett, Exec. Dir.
238 Orange St.
P.O. Box 709
Henderson, NC 27536
919-492-8561

REGION L:
Region L Council of Governments
William E. Howell, Exec. Dir.
301 By-Pass South
P.O. Drawer 2748
Rocky Mount, NC 27801
919-446-0411

REGION M:
Region M Council of Governments
John H. Sutton, Exec. Dir.
130 Gillespie St.
P.O. Drawer 1510
Fayetteville, NC 28302
919-323-4191

Appendix A

REGION N:
Lumber River Council of Governments
John V. Highfill, Exec. Dir.
111 W. Fifth St.
P.O. Box 1529
Lumberton, NC 28358
919-738-8104

REGION O:
Cape Fear Council of Governments
Beverly Paul, Exec. Dir.
P.O. Box 1491
Wilmington, NC 28402
919-763-0191

REGION P:
Neuse River Council of Governments
J. Roy Fogle, Exec. Dir.
1404 Neuse Blvd.
P.O. Box 1717
New Bern, NC 28560
919-638-3185

REGION Q:
Mid-East Commission
Daniel Le Roux, Exec. Dir.
North Market St.
P.O. Box 1218
Washington, NC 27889
919-946-8043

REGION R:
Albermarle Regional Planning & Dev. Comm.
Bob Whitley, Exec. Dir.
P.O. Box 646
Hertford, NC 27944
919-426-5753

Appendix B

Hello, my name is _____. I am calling as part of a research project sponsored by the U. S. Department of Interior and the North Carolina Water Resources Research Institute. We are trying to find out what North Carolina citizens think about water resources and their conservation. Your household was one randomly selected in your community to participate.

Q_1 Are you over 18?

Q_2 IF NOT, Is there someone I can talk with who is over 18?

INTERVIEWER

1. IF YOU ARE SPEAKING WITH A QUALIFIED PERSON PROCEED TO FOLLOWING PARAGRAPH.

2. AFTER APPROPRIATE RESPONDENT COMES TO PHONE, READ FIRST PARAGRAPH OF INTRODUCTION AND PROCEED TO FOLLOWING PARAGRAPH.

3. IF AN APPROPRIATE RESPONDENT IS NOT HOME, SAY: When will someone be home? So that I will know who to ask for when I call back, what is (his/her) first name? Thank you, I will call again Day/Time.

I will need about 7 minutes of your time. Before we begin, I'd like to mention that I'll be happy to answer any questions that you may have about our study either now or later. All responses will be confidential.

1 What is the biggest problem facing your municipal water system that you would like the State or Federal Government to do something about? (Describe it clearly in the space below.)

_____ ___

_____ ___

_____ ___

2 What kinds of State or Federal Government assistance would be most beneficial to your water system? (Describe clearly in the space below.)

_____ ___

_____ ___

_____ ___

3 Have you taken any actions in your home with the specific intention of conserving water? (RATE NO = 0; YES = 1.) ___

(IF YES) What were they?

_____ ___

_____ ___

_____ ___

(IF YES) In doing so, were you responding to any particular event, request for voluntary conservation, mandatory control or other? (Describe clearly in the space below.)

_____ ___

_____ ___

_____ ___

4 How <u>important</u> are the following in causing you to be more active about saving water? (RATE HIGH IMPORTANCE = 3; MODERATE IMPORTANCE = 2; LOW IMPORTANCE = 1.)

a. Higher water prices. Is this very important, moderately important, or not important? ___

b. Threatened water availability. (PROMPT AS REQUIRED) ___

c. Mandatory conservation regulations with strong enforcement and penalties. ___

d. Opportunity to join with other citizens in voluntary conservation actions. ___

e. Other _____ ___

5 Has there been a water shortage in your community in the past five years? (RATE NO = 0; YES = 1.) ____

(IF YES) What did you do differently, as a result?

_____ ____

_____ ____

_____ ____

(IF YES) Do you continue these conservation measures beyond the period of water shortage?

_____ ____

6 What, in your view, would signal the beginning of a drought which would require special action?

_____ ____

_____ ____

_____ ____

7 How would you recommend that water managers and citizens communicate with each other on matters relating to water management and conservation?

_____ ____

_____ ____

_____ ____

8 Have you ever seen or heard any helpful information on water conservation? (RATE NO = 0; YES = 1.) ____

(IF YES)

a. Newspaper. Did you get helpful information <u>from the newspaper</u>? (RATE NO = 0; YES = 1.) ____

b. TV (PROMPT AS REQUIRED) ____

c. Radio ____

d. Printed material (brochures, etc.) ____

e. Enclosures with water bill ____

f. Friend ____

g. Other _____ ____

9 How helpful would you find the following kinds of information in support of increasing your conservation of water? (RATE VERY HELPFUL = 3; MODERATELY HELPFUL = 2; NOT HELPFUL = 1.)

a. Information on conservation equipment for home toilets, shower heads, faucets, etc. Would this be very helpful, moderately helpful, not helpful? ____

b. Information on efficient ways to use water in daily activities in the home. (PROMPT AS REQUIRED) ____

c. Information on repairing leaky plumbing. ____

d. Information on efficient ways to irrigate lawn and garden space. ____

e. Other _____ ____

10 In your view how much do each of the following contribute to the problems of water shortages? (RATE VERY MUCH = 3; MODERATELY = 2; NOT MUCH = 1.)

a. Weather. It contributes very much, moderately, not much. ____

b. Industrial wastefulness (excesses). (PROMPT AS REQUIRED) ____

c. Public wastefulness (excesses) ____

d. Poor planning. ____

e. Poor management of water resources. ____

f. Other _____ ____

11 Rate the degree of responsibility of each group for insuring proper management of water resources. (RATE HIGH RESPONSIBILITY = 3; MEDIUM RESPONSIBILITY = 2; LOW RESPONSIBILITY = 1.)

a. Federal government. Is it very responsible, moderately responsible, not responsible? ____

b. State government. (PROMPT AS REQUIRED) ____

c. Local government. ____

d. Water utilities ____

e. Business and industry. ____

f. Citizens. ____

g. Other _____ ____

12 Would you characterize the extent of your knowledge about how to conserve water as knowing very little, knowing some, knowing a lot? (RATE KNOW VERY LITTLE = 1; KNOW SOME = 2; KNOW A LOT = 3.) ____

13 Are you interested in knowing more? (RATE NO = 0; YES = 1.) ____

14 How would you propose your community deal with continued increases in demand for water and sewage treatment? Which would you favor most?

1. Build and pay for more capacity.
2. Conserve so the same capacity can accommodate more development.
3. Limit development. ____
4. Other _____

15 How would you propose your community deal with emergency shortages of water? Which would you favor most?

1. Rely on voluntary measures only.
2. Impose mandatory conservation standards only if voluntary measures have been tried and failed.
3. Impose mandatory conservation as soon as it is clear that a water shortage will result. ____
4. Impose extra surcharges for water in use in an emergency to discourage use.
5. Other _____

16 Demographic Information:

a. How old are you? ____

b. What is the last year of school you completed? (0 - 20) ____

c. Are you the head of the household? (NO = 0; YES = 1) ____

d. What does the head of your household do for a living? _____

e. How many people live in your house? ____

f. What is your race? _____

g. What is your household income? (0 - 9 ten thousands) ____

h. How much is your average monthly water bill? ____

i. Sex (Rate M = 1, F = 2) ____

j. Respondent clarity (Good = 1, Average = 2, Poor = 3) ____

INTERVIEWER _____

CODER _____

(Good morning/Good afternoon), is there someone in your office at this time who could answer a few questions I have about the water you use in your operations?

Hello, my name is _____. I am calling as part of a research project sponsored by the U.S. Department of Interior and the North Carolina Water Resources Research Institute. We are trying to find out what North Carolina industries think about water resources and their conservation. Your firm was one randomly selected in your community to participate.

Do you have a few minutes at this time that you could use to answer a short, 10 minute survey on water conservation?

If no, is there a time I can call back today or tomorrow, or is there someone else who would be qualified to answer these questions and has some time?

IF YES: Before we begin I'd like to mention that I'll be happy to answer any questions that you may have about our study either now or later. All responses will be confidential.

REGION _____

SIZE _____

1 What is the biggest problem facing your municipal water system that you would like the State or Federal Government to do something about? (Describe it clearly in the space below.)

_____ ____

_____ ____

_____ ____

2 What kinds of State or Federal Government assistance would be most beneficial to your water system? (Describe clearly in the space below.)

_____ ____

_____ ____

_____ ____

3 Have you taken any actions in your firm with the specific intention of conserving water? (RATE NO = 0; YES = 1.) ____

(IF YES) What were they?

_____ ____

_____ ____

_____ ____

(IF YES) In doing so, were you responding to any particular event, request for voluntary conservation, mandatory control or other? (Describe clearly in the space below.)

_____ ____

_____ ____

_____ ____

4 How important are the following in causing your firm to be more active about saving water? (RATE HIGH IMPORTANCE = 3; MODERATE IMPORTANCE = 2; LOW IMPORTANCE = 1.)

a. Higher water prices. Is this very important, moderately important, or not important? ____

b. Threatened water availability. (PROMPT AS REQUIRED) ____

c. Mandatory conservation regulations with strong enforcement and penalties. ____

d. Other _____ ____

5 Has there been a water shortage in your community in the past five years? (RATE NO = 0; YES = 1.) ____

(IF YES) What did your firm do differently as a result?

_____ ____

_____ ____

_____ ____

(IF YES) Do you continue these conservation measures beyond the period of water shortage?

_____ ____

6 What, in your view as an affected industry, would signal the beginning of a drought which would require special action?

_____ ____

_____ ____

_____ ____

7 How would you recommend that water utilities and industries communicate with each other on matters relating to water management and conservation?

_____ ____

_____ ____

_____ ____

8 Have you ever seen or heard any helpful information on water conservation? (RATE NO = 0; YES = 1.) ____

(IF YES)

a. Newspaper. Did you get helpful information <u>from the newspaper</u>? (RATE NO = 0; YES = 1.) ____

b. TV (PROMPT AS REQUIRED) ____

c. Radio ____

d. Enclosures with water bill ____

e. Trade organizations ____

f. Government agencies ____

g. Other _____ ____

9 How helpful would your firm find the following kinds of information in support of increasing your conservation of water? (RATE VERY HELPFUL = 3; MODERATELY HELPFUL = 2; NOT HELPFUL = 1.)

a. Information on conservation equipment for operations (flow restrictors, meters, etc.). Would this be very helpful, moderately helpful, not helpful? ____

b. Information on efficient ways to use water in daily operations in your firm. (PROMPT AS REQUIRED._ ____

c. Other _____ ____

10 In your view, as corporate representative, how much do each of the following contribute to the problems of water shortages? (RATE VERY MUCH = 3; MODERATELY = 2; NOT MUCH = 1.)

a. Weather. It contributes very much, moderately, not much. ____

b. Industrial wastefulness (excesses). (PROMPT AS REQUIRED.) ____

c. Public wastefulness (excesses). ____

d. Poor planning. ____

e. Poor management of water resources. ____

f. Other _____ ____

11 Rate the degree of responsibility of each group for insuring proper management of water resources. (RATE HIGH RESPONSIBILITY = 3; MEDIUM RESPONSIBILITY = 2; LOW RESPONSIBILITY = 1.)

a. Federal government. Is it very responsible, moderately responsible, not responsible? ____

b. State government. (PROMPT AS REQUIRED) ____

c. Local government. ____

d. Water utilities ____

e. Business and industry. ____

f. Citizens. ____

g. Other _____ ____

12 Would you characterize the level of effort by your firm given to conserving water as: (VERY LITTLE EFFORT = 1; SOME EFFORT = 2; A LOT OF EFFORT = 3.) ____

13 Is your firm interested in doing more? (RATE NO = 0; YES = 1.) ____

14 How would your firm propose your community deal with continued increases in demand for water and sewage treatment? Which would you favor most?

1. Build and pay for more capacity.
2. Conserve so the same capacity can accommodate more development. ____
3. Limit development.
4. Other _____

15 How would your firm propose your community deal with emergency shortages of water? Which would you favor most?

1. Rely on voluntary measures only.
2. Impose mandatory conservation standards only if voluntary measures have been tried and failed.
3. Impose mandatory conservation as soon as it is clear that a water shortage will result. ____
4. Impose extra surcharges for water in use in an emergency to discourage use.
5. Other _____

16 Demographic Information:

a. Years of related professional experience. ____

b. What is the last year of school you completed? (0-20) ____

c. What is your position in the firm? ____

d. What does your firm do? ____

e. How many people work for your firm? ____

f. What is your firm's gross yearly income? (0-99 ten thousands) ____

g. How much is your firm's average monthly water bill? ____

h. If your water supply were curtailed 50%, could you continue to operate? ____

i. If your water supply were cut off entirely, could you continue to operate? ____

Name Person _____ Planning Region _____

Position _____ Size _____

Yrs. Experience _____

INTRODUCTION:

Hello Mr., (Dr.), (Mrs.):

This is _____ calling for the Water Resource Research Project at NCSU. We want to thank you for responding to our earlier survey about management of your local system. We have some very helpful data from across the entire State and your cooperation was important in this total effort.

A few questions have arisen in the course of the research and analysis that we would now hope to resolve with your help. Can you spare 5-10 minutes now to help us settle these remaining issues?

Thanks.

	Citizen	Industry
1. What percentage of citizens (industry) in your service area do you believe have taken any actions in their home (firm) with the specific intention of conserving water?	____	____
2. How important do you believe citizen (industry) regard the following in causing them to be more active about saving water? (RATE HIGH IMPORTANCE = 3; MODERATE IMPORTANCE = 2; LOW IMPORTANCE = 1).		
a. Higher water prices. Is this very important, moderately important, or not important?	____	____
b. Threatened water availability. (PROMPT AS REQUIRED)	____	____
c. Mandatory conservation regulations with strong enforcement and penalties.	____	____
d. Opportunity to join with other citizens (firms) in voluntary conservation actions.	____	____
e. Other _____		

	Citizen	Industry
3. a. Has there been a water shortage in your community in the past five years? (RATE NO = 0; YES = 1)	____	____
b.1. What percent of the citizens (industries) would say that there has been a shortage in the past 5 years?	____	____
b.2. What percentage of citizens (industry) would say that they have taken conservation actions to deal with the shortage?	____	____
b.3. What percentage of the citizens (industries) who took conservation measures during the shortage would say that they still continue these measures?	____	____
4. What percentage of citizens (industry) would say they have seen or heard of any helpful information on water conservation?	____	____

a. For citizens, what percentage have benefitted from the following?

1. Newspaper. Did citizens get helpful information from the newspaper? (RATE NO = 0; YES = 1) ____
2. TV (PROMPT AS REQUIRED) ____
3. Radio ____
4. Printed material (brochures, etc.) ____
5. Enclosures with water bill ____
6. Friend ____
7. Other _____

b. For industry, what percentage have benefitted from the following?

1. Newspaper. Did industry get helpful information from the newspaper? (RATE NO = 0; YES = 1) ____
2. TV (PROMPT AS REQUIRED) ____
3. Radio ____
4. Government agency ____
5. Enclosures with water bill ____
6. Trade association ____
7. Other _____

	Citizen	Industry
5. How helpful do you believe citizens (industry) would report finding the following kinds of information in support of increasing their conservation of water? (RATE VERY HELPFUL = 3; MODERATELY HELPFUL = 2; NOT HELPFUL = 1)		
a. Information on conservation equipment for home toilets, shower heads, faucets, etc. Would this be very helpful, moderately helpful, not helpful.	____	____
b. Information on efficient ways to use water in daily activities in the home. (PROMPT AS REQUIRED)	____	____
c. Information on repairing leaky plumbing.	____	____
d. Information on efficient ways to irrigate lawn and garden space.	____	____
e. Other _____		
6. In the view of citizens (industry) how much do each of the following contribute to the problems of water shortages? (RATE VERY MUCH = 3; MODERATELY = 2; NOT MUCH = 1)		
a. Weather. It contributes very much, moderately, not much.	____	____
b. Industrial wastefulness (excesses). (PROMPT AS REQUIRED)	____	____
c. Public wastefulness (excesses)	____	____
d. Poor planning	____	____
e. Poor management of water resources	____	____
f. Other _____		
7. Rate the degree that citizens (industry) hold each group responsible for insuring proper management of water resources. (RATE HIGH RESPONSIBILITY = 3; MEDIUM RESPONSIBILITY = 2; LOW RESPONSIBILITY = 1)		
a. Federal government. Is it very responsible, moderately responsible, not responsible?	____	____
b. State government. (PROMPT AS REQUIRED)	____	____
c. Local government.	____	____
d. Water utilities.	____	____
e. Business and industry.	____	____

Local Government Survey

1. Has your water (waste treatment) department taken any actions to foster water conservation in its service area? ____YES ____NO ____

   If YES, please describe:

   WATER LOSS PREVENTION ____ ____
   INFORMATION AND EDUCATION ____ ____
   IMPLEMENT N.C. PLUMBING CODES ____ ____
   INFILTRATION/INFLOW ____ ____
   OTHER _____ ____

   If NO, are you planning to do so? Explain:

   _____ ____

   _____ ____

   _____ ____

2. What costs were associated with these conservation activities?

   PERSONNEL ____
   SUPPLIES ____
   EQUIPMENT ____
   OTHER _____ ____

3a. What difficulties did your office encounter as you attempted these conservation activities?

   _____ ____

   _____ ____

   _____ ____

3b. How did you overcome them?

   _____ ____

   _____ ____

   _____ ____

4. What benefits resulted from these conservation activities?

   WASTE LOAD REDUCTIONS ____ ____
   WATER SAVINGS ____ ____
   PUBLIC RELATIONS IMPROVEMENTS ____ ____
   REDUCTION IN COSTS OF OPERATION ____ ____
   OTHER _____ ____

5. In your view do the benefits justify the effort?

____YES ____NO ____

6. What outside assistance might you desire?

_____ ____

_____ ____

_____ ____

7. Finally do you have any suggestion or comment about how to better implement the water conservation incentive program in connection with the State water (waste treatment) grant system under the North Carolina Clean Water Bond Act?

_____ ____

_____ ____

_____ ____

All responses will be confidential

WATER RESOURCES MANAGEMENT SURVEY

1 What is the biggest problem facing your municipal water system that you would like State or Federal Government to do something about? (Describe it clearly in the space below.)

2 What kinds of State or Federal Government assistance would be most beneficial to your water system? (Describe clearly in the space below.)

3 Has your municipality taken any specific actions to conserve water resources? (If yes, describe them clearly in the space below.)

4 Beginning below and continuing for Parts I through XIII you will see a list of kinds of information that may possibly be useful to you in carrying out your responsibilities for management of water resources. Please answer the five separate questions repeated across the top of each page for each kind of information listed. Using the scale associated with the question enter the scale number which best represents your opinion on the blank provided. When you finish, every blank should have a number.

	Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate your existing information for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
PART I WATER SERVICE POPULATION					
I. 1 Number of connections	_____	_____	_____	_____	_____
I. 2 Number of metered connections	_____	_____	_____	_____	_____
I. 3 Number of people served	_____	_____	_____	_____	_____
I. 4 Number of residential connections	_____	_____	_____	_____	_____
I. 5 Number of commercial connections	_____	_____	_____	_____	_____
I. 6 Number of industrial connections	_____	_____	_____	_____	_____
I. 7 Number of master meters	_____	_____	_____	_____	_____
I. 8 Number of accounts for water resale	_____	_____	_____	_____	_____

PART II TREATMENT SERVICE POPULATION

		Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate *your existing information* for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
II.1	Number of connections	_____	_____	_____	_____	_____
II.2	Number of metered connections	_____	_____	_____	_____	_____
II.3	Number of people served	_____	_____	_____	_____	_____
II.4	Number of residential connections	_____	_____	_____	_____	_____
II.5	Number of commercial connections	_____	_____	_____	_____	_____
II.6	Number of industrial connections	_____	_____	_____	_____	_____
II.7	Number of master connections	_____	_____	_____	_____	_____
II.8	Number of accounts for treatment from other sources	_____	_____	_____	_____	_____

PART III WATER SUPPLY SYSTEM

		Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate your existing information for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
III.1	Level of local support	_____	_____	_____	_____	_____
III.2	Revenue produced	_____	_____	_____	_____	_____
III.3	Assessed property valuation	_____	_____	_____	_____	_____
III.4	Raw water storage	_____	_____	_____	_____	_____
III.5	Finished water storage	_____	_____	_____	_____	_____
III.6	Safe yield of all wells	_____	_____	_____	_____	_____
III.7	Safe yield from each well	_____	_____	_____	_____	_____
III.8	Pumping capacity of all wells	_____	_____	_____	_____	_____
III.9	Pumping capacity of each well	_____	_____	_____	_____	_____
III.10	Estimated safe yield from surface waters	_____	_____	_____	_____	_____
III.11	Estimated safe yield from each surface source	_____	_____	_____	_____	_____
III.12	Amount received from other systems	_____	_____	_____	_____	_____
III.13	Energy requirements	_____	_____	_____	_____	_____

		Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate your existing information for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
PART IV	**WATER TREATMENT SYSTEM**					
IV. 1	Level of local support	_____	_____	_____	_____	_____
IV. 2	Revenue produced	_____	_____	_____	_____	_____
IV. 3	Assessed property valuation	_____	_____	_____	_____	_____
IV. 4	Raw waste storage	_____	_____	_____	_____	_____
IV. 5	Finished waste storage	_____	_____	_____	_____	_____
IV. 6	Treatment capacity of plants	_____	_____	_____	_____	_____
IV. 7	Safe yield of plants	_____	_____	_____	_____	_____
IV. 8	Amount received from other systems	_____	_____	_____	_____	_____
IV. 9	Energy requirements	_____	_____	_____	_____	_____
PART V	**SUPPORTIVE INFORMATION SYSTEMS**					
V. 1	Public opinion information	_____	_____	_____	_____	_____
V. 2	Economic information	_____	_____	_____	_____	_____
V. 3	Weather information	_____	_____	_____	_____	_____
V. 4	Hydrologic information	_____	_____	_____	_____	_____

		Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate your existing information for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
PART VI	**EMERGENCY PREPAREDNESS**					
VI. 1	Standby emergency plans	_____	_____	_____	_____	_____
VI. 2	Standby management authority to ration	_____	_____	_____	_____	_____
VI. 3	Standby intrabasin compacts	_____	_____	_____	_____	_____
VI. 4	Standby interbasin compacts	_____	_____	_____	_____	_____
PART VII	**COMPREHENSIVE PLANNING PRACTICES**					
VII.1	Public participation trends	_____	_____	_____	_____	_____
VII.2	Water use trends	_____	_____	_____	_____	_____
VII.3	Hydrologic trends	_____	_____	_____	_____	_____
VII.4	Demographic trends	_____	_____	_____	_____	_____
VII.5	Economic development trends	_____	_____	_____	_____	_____
VII.6	Directions of Federal policy	_____	_____	_____	_____	_____
VII.7	Directions of State policy	_____	_____	_____	_____	_____
VII.8	Unused capacity	_____	_____	_____	_____	_____
VII.9	Added capacity costs	_____	_____	_____	_____	_____
VII.10	Maintenance and replacement costs	_____	_____	_____	_____	_____

		Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate *your existing information* for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
PART VIII	**PRICING PRACTICES**					
VIII.1	Water service costs	_____	_____	_____	_____	_____
VIII.2	Water treatment costs	_____	_____	_____	_____	_____
VIII.3	Economies of scale	_____	_____	_____	_____	_____
VIII.4	High strength sewage costs	_____	_____	_____	_____	_____
VIII.5	Tap-on costs	_____	_____	_____	_____	_____
PART IX	**BILLING PRACTICES**					
IX. 1	Number of meters read	_____	_____	_____	_____	_____
IX. 2	Number of meters audited (user is primary reader)	_____	_____	_____	_____	_____
PART X	**TECHNICAL ASSISTANCE**					
X. 1	To establish improved pricing practices	_____	_____	_____	_____	_____
X. 2	To establish improved billing	_____	_____	_____	_____	_____
X. 3	To promote physical devices for water conservation	_____	_____	_____	_____	_____
X. 4	To promote water reuse	_____	_____	_____	_____	_____
X. 5	To promote greater citizen participation in conservation and planning	_____	_____	_____	_____	_____

		Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate your existing information for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
X. 6	For leak detection	_____	_____	_____	_____	_____
X. 7	For intrusion detection	_____	_____	_____	_____	_____
X. 8	To improve dissemination of information to service populations	_____	_____	_____	_____	_____
PART XI	**REGULATION & ENFORCEMENT**					
XI. 1	Number of violations of water ordinances or laws	_____	_____	_____	_____	_____
XI. 2	Number of violations of waste discharge ordinances or laws	_____	_____	_____	_____	_____
PART XII	**WATER USE**					
XII.1	Daily peak	_____	_____	_____	_____	_____
XII.2	Seasonal peak	_____	_____	_____	_____	_____
XII.3	Per capita sold (residential)	_____	_____	_____	_____	_____
XII.4	Per account sold (commercial)	_____	_____	_____	_____	_____
XII.5	Other sold (itemize)	_____	_____	_____	_____	_____
XII.6	Water unaccounted for	_____	_____	_____	_____	_____
XII.7	Leaks	_____	_____	_____	_____	_____

		Question 1 How important is it for you to have each kind of information? 1 = not important 2 = important 3 = very important	Question 2 How often would you use each kind of information? 1 = never 2 = annually 3 = monthly 4 = weekly 5 = daily	Question 3 How would you use each kind of information? 1 = in planning 2 = in operating 3 = in rate setting 4 = in making allocations 5 = in response to requests 6 = other (explain)	Question 4 How often should each kind of information be updated? 1 = biennually 2 = annually 3 = montly 4 = weekly 5 = daily	Question 5 How would you evaluate your existing information for each kind of information? 1 = nonexistent 2 = existent but poor 3 = good
XII.8	Anticipated growth in water usage in next five years (total)					
XII.9	Anticipated growth in water usage in next five years (residential)					
XII.10	Anticipated growth in water usage in next five years (commercial)					
XII.11	Anticipated growth in water usage in next five years (industrial)					
PART XIII	**WATER CONSERVATION**					
XIII.1	Number having reduced water use					
XIII.2	Number attending relevant meetings					
XIII.3	Number having water saving devices					
XIII.4	Number requesting assistance					
XIII.5	Attitude toward maintenance of reservoir levels					
XIII.6	Attitude toward protection of reservoir sites					
XIII.7	Attitude toward protection of ground water withdrawal					
XIII.8	Attitude toward protection of stream flows					

Thank you for your cooperation. Your responses will help us determine the types of information that should be collected and provided to water resource decision makers. If you have any comments about the survey or matters relating to water resources management and conservation, you may make them in the space below.

Enter your job title _____

Enter number of years
of water-related
professional experience _____