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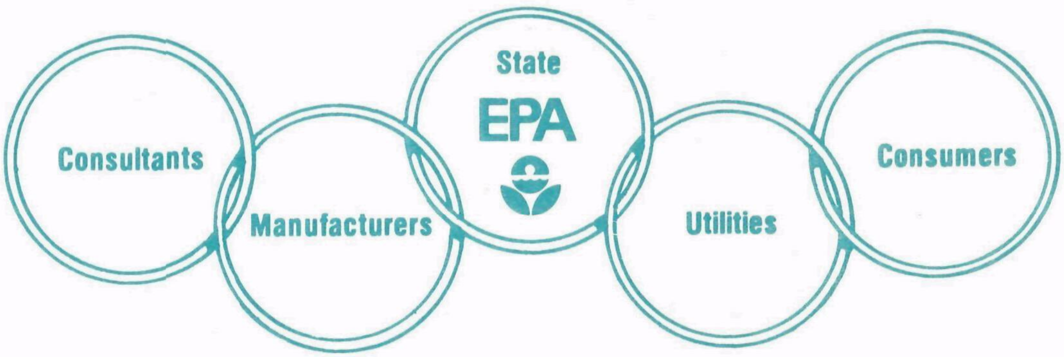
Small System Water Treatment Symposium

November 28 - 29, 1978
Report of Symposium Proceedings



SMALL SYSTEM WATER TREATMENT SYMPOSIUM
Cincinnati, Ohio
November 28-29, 1978

U.S. Environmental Protection Agency
Office of Drinking Water

REPORT OF SYMPOSIUM PROCEEDINGS

September 1979

MIDWEST RESEARCH INSTITUTE
Minnetonka, Minnesota

PREFACE

Small System Water Treatment Symposium

Studies and implementation programs for the Safe Drinking Water Act, initially enacted in 1974, have increasingly shown a preponderance of water quality problems in small water systems. These problems range from inadequate facilities and inadequate operation and maintenance to inadequate water quality monitoring and contaminant level violations.

In response to this important problem, EPA has conducted a number of fact-finding and research studies relating to available technology, economics and operational problems. As a result of these investigations and discussions with leaders in the field, it became obvious that expanded discussions involving state water supply engineers, manufacturers, consultants, utility representatives, consumer interests and others were needed to seek solutions and to plot a path for future actions.

The Office of Drinking Water sponsored this symposium to fulfill this need. It brought forth a commendable participation from all of the interest groups. It has highlighted major issues and potential pathways for improvement. The Office of Drinking Water is indebted to the symposium's advisory panel, speakers, work group chairmen and discussants, moderators, and other participants for making this a forward looking and productive meeting.

The *Report of Symposium Proceedings* contains presentations by representatives from government, consultants, manufacturers, utilities, and public interest groups. The first section includes individual presentations on the problems of small systems and the second section takes up available solutions. In the third section the seven work groups detail their discussions of the problems facing small systems and conclusions and recommendations as to future actions of the affected organizations. The final part highlights a panel discussion on the question: Where do we go from here?, followed by concluding remarks by Robert McCall, Director of Environmental Health Services for West Virginia.

Joseph A. Cotruvo
Conference Chairman

SPECIAL ACKNOWLEDGEMENTS

First recognition must go to the panel of experts who advised EPA on the planning and conduct of the symposium and who helped interpret the results. They are:

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James Ramsey
Carrollton Utilities, Kentucky

Floyd Taylor
EPA, Region I

Robert Wilfong
Chemical Engineering Corporation

Key members of the Office of Drinking Water headquarter's staff provided services beyond those recognized elsewhere in this document to help develop the symposium and prepare the Proceedings, as follow: Frank A. Bell, Jr., Planning Chairman; Hugh F. Hanson; Robert J. Hilton; Thomas H. Hushower; Patrick M. Tobin; and Craig Vogt. John P. Topinka provided editorial services.

Acknowledgement and thanks are also due to Francis Mayo, Director, and his staff of the Municipal Environmental Research Laboratory for their cooperation and support in the conduct of this symposium at their laboratory facilities in Cincinnati, Ohio. Special mention for yeoman services should be made for David Cowles and his staff, Kathryn Burleigh, Keith Walker, Virginia Van Ness, Bonnie Rhodes, Walter Thomas, Robert Davis and Vivian Lerch and her staff.

SMALL SYSTEM WATER TREATMENT SYMPOSIUM

EXECUTIVE SUMMARY

The health based National Primary Drinking Water Regulations, promulgated under the authority of the Safe Drinking Water Act, require that all public water systems with 15 or more connections, or which regularly serve 25 individuals daily at least 60 days a year, must meet minimum standards of quality. Secondary Regulations, covering taste, odor and other esthetic water characteristics, although not federally enforceable, add to the problem for small systems because consumers are more likely to notice and complain about these quality factors. To meet both standards, the small water supply system is confronted with difficult problems in providing necessary treatment, monitoring, funding, and management.

In addition to EPA, the various groups directly involved with this issue include consultants who design the systems, industry that manufactures the equipment, state authorities who must generally approve the installation and management approaches, utilities and water system owners who must operate and maintain the units and manage the institutions established, and the consumers who are served by these facilities.

The purpose of this symposium was to bring together representatives of various groups to discuss the issues and seek recommendations that would provide policy guidance to government and other interests for future action.

Some of the most talented and knowledgeable people on the subject were assembled to plan, present and participate in this symposium, including 51 representatives from state, local and federal government, consultants, manufacturers, education, utilities, professional and industry associations and consumer interests. Approximately 150 people with diverse backgrounds and interests from all parts of the nation participated in and assisted with the work of the symposium.

Statement of Problems

No effort was made in these proceedings to define small systems in specific detail. Regulatory officials may tend to focus on systems serving very small populations, less than 1,000, for example, representing about 10 percent of all people served and 80 percent of all public water systems. Due to smaller size and economic base, these systems may be expected to have a greater percentage of operational and water quality problems. On the other hand, manufacturers may argue for a higher population ceiling (for example, 10,000 persons, which would include over 90 percent of all public water systems serving about 20 percent of all people using public systems) on the basis that pre-engineered package plants may be a feasible alternative to solve treatment problems over this larger size range. (Pre-engineered systems may not be cost effective in areas serving more than 10,000 people.) Individual authors, government agencies, and work groups have expressed varying definitions of "small" but the symposium summary recognizes a range of sizes from less than 1,000 to less than 10,000 as appropriate to different considerations of problems and of applicable technology.

Small systems, unlike larger systems, have a basic problem rooted in their small size: specifically, a relatively limited economic base to deal with the water quality problems facing them. Concurrently, small systems provide the bulk of surveillance and control problems for state water supply agencies since they comprise 80-90 percent of all public systems, although they represent only 10-20 percent of all people served by public water systems. These problems have been documented in a variety of studies showing that small systems have a disproportionately higher incidence of drinking water quality and monitoring problems. While noting the general presence of many problems in small public water systems, one should be aware that this is not a blanket indictment since many small systems operate well, with a minimum of water quality and operational problems.

Symposium participants cited several problems generally found in small systems. They are listed below.

-- Operators may not be aware of water quality difficulties or even of the Safe Drinking Water Act, let alone have the training and knowledge to correct water quality deficiencies.

-- Owners may not have the financial capability to support capital improvements or to handle routine operation and maintenance adequately.

-- Owners may not have the background or experience to judge the acceptability of treatment equipment or their operator's ability to manage a treatment works, if installed.

-- State water supply engineers may not have the information needed to determine the acceptability of pre-engineered treatment plants or components designed to meet a variety of water quality problems and treatment needs; further, the criteria for acceptability of treatment designs vary between states.

-- Local fears of being absorbed by larger political entities may discourage multi-community cooperative arrangements.

-- Consulting engineers generally are not geared to rendering small-scale services so that appropriate, economical treatment solutions are difficult to achieve for the very small public systems; further, the incentive for development of innovative and cost-effective designs is lacking.

Key Symposium Conclusions and Recommendations

The following conclusions and recommendations represent a synthesis of ideas and approaches emanating from symposium speakers, work groups and the advisory panel that assisted in the planning and review of symposium results.

1. Multi-community Cooperative Arrangements (Regionalization). Because of the benefits of greater size and technical expertise, multi-community cooperative arrangements (MCA, was suggested as a more acceptable name than regionalization for the many forms of possible cooperation between communities), including physical and managerial consolidation, circuit rider and water service company approaches, was given strong endorsement as an alternate approach for solving water quality problems. Federal and state efforts should be stimulating and enabling, rather than mandatory; for example, seed money to stimulate MCA or the conduct of a state-of-the-art study on MCA approaches could be provided by one or more federal agencies.

2. Training/Technical Transfer. Conferees made it abundantly plain that a water plant operator cannot be expected to perform what he has not been trained to do. More training is available now than ever before, but training efforts need increased support and better direction at all levels--federal, state and local utility, including more attention to training methods and in the organization and evaluation of delivery systems and results. Mandatory certification and recertification by the state for water plant operators was strongly recommended. Manufacturers should provide detailed information on the operation of their devices and equipment to consultants and water utilities, and they should make available literature or actual training for the operators of newly purchased equipment.

3. Package Plants. Results of technical studies reported at the symposium showed a clear potential economic advantage for pre-engineered equipment or package plants over uniquely designed and constructed water treatment works for many small systems. Difficulties in testing and acceptance of pre-engineered equipment by state agencies led to a strong recommendation for establishing a third party, private sector, voluntary standards and certification system to avoid the difficulties of multiple

and differing state standards. Good operation and maintenance for pre-engineered equipment and package plants is essential since they may pose equal or greater operational problems than uniquely designed and constructed treatment works. In some very small systems consideration could also be given to point-of-use alternatives for meeting limited water quality problems on a cost-effective basis, so long as the devices are safe and effective and managed by the water utility.

4. Communications/Cooperation. Discussions during the symposium greatly stirred the need for better communications and cooperation among the varied interests; continuation of the collegiacy established at the symposium was strongly recommended. Improved communications between states, resulting in consistent interstate acceptance criteria for plant operator and laboratory certification and equipment standards, was considered essential. Improved methods for information dissemination such as a small systems newsletter or a series of occasional technical-guidance papers (simpler but similar to *Op-Flow*) were recommended for consideration of government and professional associations.

5. Administration. Small systems badly need guidance in accounting and administration procedures. The Standard System of Accounts, prepared by the American Water Works Association, should be revised to help provide this guidance. Use of centralized billing and administrative services for a number of small systems should be considered. Persons responsible for rate setting in small systems need more education on efficient rate-making concepts and other means of generating funds.

6. Consultant/Manufacturer/State Relations. One of the barriers to increased use of pre-engineered equipment and package plants appears to be inadequate consultant/manufacturer/state relations. Both innovative third party standards and certification requirements and new approaches to rendering services are needed to reduce conflicts in this area. Two possible approaches derived from symposium discussions emphasized the achievement of benefits of scale and providing the consultant with an opportunity to develop innovative, cost-effective designs that generally could be applied to a number of systems. In one approach a number of utilities in the same area could combine by contract with a single consultant for water and environmental advisory and design services. A second approach might involve some type of umbrella organization such as a county that might arrange a contractual agreement with several consultants whereby small systems could subscribe and be assigned to one of the consultants for specific environmental services. Both approaches should improve the access of small water systems to high quality advisory and design services at reduced cost and less red tape, as well as make the small systems market more attractive to engineering consulting firms.

7. Financial/Capital Improvement. A major financial point emerging from the conference was that many small systems were inadequately charging for water services and many, particularly small private systems, would be

unable to finance independently new technical equipment. In terms of new sources for financial support for small system improvements, the group's principal recommendation steered away from a large new federal financing program, advocating instead reliance on expansion of existing programs, particularly Farmers Home Administration's combined grant/loan assistance to water systems. The principal disadvantage of this approach is its inability to reach privately owned systems. Partially in response to this financial need, the group recommended a Federal Bond Bank similar to the Telephone Bond Bank, which had been a successful means of bringing telephone service to rural areas. An additional recommendation encouraged manufacturers, consultants and utilities to consider alternative means of financing capital improvements such as lease and lease-purchase arrangements.

8. Regulatory Options. Water utilities should be aware that the responsibility for the quality of drinking water rests with the water supplier. As a result, water should be priced commensurate with production and operating costs and the expense of financing needed improvements. To a great degree, the rate of improvement in small system water quality and operation is dependent on the vigor of enforcement provided by state and federal agencies. Further, since public notification requirements have had some stimulating effects on water system corrective actions, their continued implementation will be essential to any program for improvement of small water systems. However, there are practical limitations to using public notification to stimulate these actions that will take time to overcome. Regulatory options in the form of extending exemptions under the Safe Drinking Water Act beyond 1981 and greater latitude for state enforcement agencies were recommended because of small systems' lack of economic and practical capability to meet stated primary drinking water maximum contaminant levels.

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PANEL: WHAT ARE THE PROBLEMS?

Introduction

To meet the National Primary Drinking Water Regulations, many small water supply systems are confronted with a variety of difficult problems in providing funding, management, required treatment, operation and maintenance, and monitoring. To open the symposium a panel representing the views of government, the consulting engineers, manufacturers, utilities, and public interest groups outlined these problems according to their unique perspectives.

The panel was chaired by Robert McCall, Director of Environmental Health Services, West Virginia Department of Health. Panel members included:

Government:	Floyd B. Taylor, Chief Water Supply Branch EPA/Region I, Boston, Massachusetts
Consultant:	Ted Williams Williams & Works, Inc. Grand Rapids, Michigan
Manufacturer:	Robert M. Wilfong Chemical Engineering Corporation Churubusco, Indiana
Utility:	Richard Moser American Water Works Service Company Hadden Heights, New Jersey
Public Interest:	Arleen Shulman National Association of Counties Washington, D.C.

The text of each panelist's presentation follows.

NOTE: Figures related to the number of community systems used throughout these papers reflect those available at the time of the symposium. However, recent inventories have altered these earlier numbers to some degree. Data from the Federal Reporting Data System, May 23, 1979, reveals the following statistics:

Population Category	Total Number of Community Systems
<100	21,468
100-999	22,907
1,000-4,999	9,221
5,000-9,999	1,915
10,000-100,000	2,599
>100,000	269
	58,379

WHAT ARE THE PROBLEMS? THE GOVERNMENT VIEWPOINT

by

Floyd B. Taylor, P.E.

The Safe Drinking Water Act of 1974 and the promulgation of the Interim Primary Drinking Water Regulations focused the attention of public health and environmental workers and the general public on the issue of water supply, especially the quality of water supply. At present there are in the United States some 177 million people who are served by community water supplies. The great majority of these serve fewer than 10,000 people and, for the purposes of this symposium, are characterized as small. Small systems may also be defined as having a capacity of 3,800 m^3 or about 1,000,000 gallons per day. Even though they are so numerous, they provide water to only 21 percent of the total population. Table 1[1] is a frequency distribution of the public water supplies according to system size and in terms of persons served. There are 40,000 water

Table 1. Distribution of Community Water Systems[1]

Systems Size (persons served)	Number of Water Systems	Percent of Total Systems	Total Population Served (in thousands)	Percent of Total Population Served
25 to 99	7,008	18	420	0.2
100 to 9,999	30,150	75	36,816	20.8
10,000 to 99,999	2,599	6	61,423	34.6
100,000 and over	243	1	78,800	44.4
Total	40,000	100.0	177,459	100.0

systems in total. These are the community water supplies. The much larger number of some 200,000 non-community water supplies fall under the category of small systems and therefore will be affected to some degree by the results of this symposium.

The problem of small water supplies is more critical in certain EPA regions. For example in Region I, comprising the New England states, 76 percent of the community water supplies serve populations of less than 1,000, and the percentage of those serving less than 10,000 is about 97 percent, which is above the national average. This same problem is found in the Pacific Northwest region, including Alaska, and in Appalachia. As mentioned above, the problem will intensify with the regulation of non-community public water supplies effective June 24, 1979.

Finally, the work that has been done prior to and following passage of the Safe Drinking Water Act has shown that violations of MCL's and monitoring requirements are more numerous among small systems than in large ones. Also the disease outbreaks chronicled by Craun and McCabe[2,3] occur more frequently in small supplies.

Economics

As with large water systems, consideration of economic factors must include both construction and operation and maintenance. If large communities have difficulty in obtaining funds for plant construction and operation and maintenance, small communities experience even more difficulty. They are caught between the requirements of regulatory agencies and their inability to obtain funds to provide the degrees of treatment needed to meet new standards. This is especially true for construction. Another economic problem related to construction is that a small community, after obtaining the services of a consulting engineer, is often provided with plans and specifications for more than is really needed. Small communities need advice on how to select consulting engineers and this, itself, is a problem. Once the consultant has been retained, there is a need for coordination among the consultants, the fund granting agency and the regulatory and municipal officials in order that the town obtains the best plant designed for its needs.

The financial aid program of greatest assistance to communities under 10,000 population is the grant and loan provisions of the Farmers Home Administration. This agency is funded during the current fiscal year at over a billion dollars to be divided on the ratio of about 250 million for grants and 750 million for low interest loans. In the past to obtain these funds, a community had first to meet a cost sharing or minimum debt payment with requirements set at 0.75 to 1.25 percent of the median community family income depending upon the amount of that income. It is difficult for many small communities to do this; however, there is some indication that the Farmers Home Administration may be relaxing this requirement.

It may be possible for small communities to reduce costs through utilizing package plants and by innovation. For example, the small community of the Weirs on Lake Winnipesaukee, New Hampshire, had a severe water quality problem. By constructing from available materials a pressure type of activated carbon filter, designed mostly by a local engineer, the problem was solved at a cost of about $85,000.

In addition to costs of construction is the expense of operation and maintenance. Money normally obtained through some type of water rate in the small community that has had no treatment or very marginal treatment is insufficient to meet operation and maintenance costs. This is the reason for so many small communities operating with inadequate plants. Since water rate setting is regulated by state commissions, there is a need to develop a method whereby the small community can meet these costs.

Enforcement

As has been recognized by the Office of Water Supply and stated on various occasions by Thomas Jorling, Assistant Administrator for Water and Hazardous Materials, there is need for flexibility in applying the primary standards of EPA especially with regard to public notification. In New England the cost of public notification runs as high as $300 per violation of an MCL or monitoring requirement; this is an unsupportable amount from the small budgets that have been set at town meetings. There is also the need for modification of some of the primary standards themselves, turbidity for example. Requiring a surface water supply to be monitored daily places a large burden on the small town that can afford neither a turbidimeter nor a trained operator for it. Modification of the primary standard with regard to turbidity would greatly help communities of less than 1,000 population. Some small towns find themselves facing additional state regulations over and above those of EPA. For example the states of Connecticut and Massachusetts have a sodium standard not found in the EPA regulations, and Connecticut has a color standard also not found in the regulations. The cost of testing and monitoring for these constituents is an additional financial burden.

Alluded to above but worthy of more comment is the problem of the small community and especially the non-community water purveyor who has no capability for review of construction plans. They must have someone perform this service for them. One option is for the state regulatory agency or possibly a local government entity with engineering capability to provide this kind of a service.

Certain operation and maintenance reports are required to provide information to determine whether or not a water supply is meeting the regulations. Since many small communities, especially the large number under 1,000 population, lack full-time operators, completing cumbersome forms presents an obstacle, further complicated by the complexity of the reporting forms. Simplification of these forms is needed if people at the local level are to complete them. Again the state may provide some oversight that partially would relieve the communities of this burden. Yet some forms that must be filled out by the community and submitted to the state must be made simpler and fewer in number.

Operator Capabilities

Many operators of small community water supplies--and this will be especially true with non-community water supplies--have multiple duties.

In addition to the operation of the water supply they are responsible for the maintenance of grounds or of a public works effort of some sort, and they lack the time and training to do all of these jobs effectively. This attests to the great need for training programs designed specifically for the small water supply operator, which should be given as near to the community as possible. It has been found in some states that if a training course is held more than 50 miles from a community, it is unlikely that the operator of the water supply will attend. Under these conditions correspondence courses may provide some help. Without proper training provided either by means of short courses or correspondence, many small community and non-community water supply operators find it most difficult to pass licensing requirements. Currently 37 states have mandatory licensing requirements; when the large number of non-community water supplies are brought on line, there is going to be the need for a more practical method of licensing. Still another problem faced by the operator of a small water supply is the complexity of equipment. Even a chlorinator can present formidable obstacles to an untrained person. This highlights the need for simplification of small treatment systems to the highest degree possible.

Capabilities for Expansion and Regionalization

Along with the lack of funds for construction and operation and maintenance, the capability of a small community and non-community water supply to set aside funds for expansion is extremely limited if not absent altogether. One of the suggested solutions is regionalization, and the language of the Federal Safe Drinking Water Act and of various states stresses the idea of regionalization. However, regionalization may be found limited only to centralized management, consultant and laboratory services. The idea of physically connecting supplies that are isolated from each other by rugged terrain may sound attractive but in practice is most difficult.

Manpower Requirements for Federal and State Surveillance and Enforcement

The awarding of State Program Grant monies has enabled states to employ numbers and types of disciplines that are needed in order to carry out the provisions of safe drinking water acts as applied to the 40,000 United States community water supplies. The magnitude of the effort required in order to apply the regulations to five times that number of non-community water supplies possibly has not been fully realized. This, at least, is going to call for a practical arrangement of priorities so that those non-community water supplies most at risk will be handled first and that the others will come later. Even so, an expansion of staff will still be needed in order to do the work. One mitigation of this need may be the use of "in-place" programs that are primarily for regulating some other facet of the states' oversight. For example, the large number of water supplies that serve eating places may be handled by giving this function to that component of state government regulating rooming and eating places.

Laboratory and Monitoring Capabilities

The accomplishment of laboratory analyses and monitoring in a small community is frequently impractical except for sample collection or simple tests such as chlorine residual and, in some cases, turbidity. It is true that a small community water supply approaching the 10,000 population could have a small laboratory capable of other tests, but it is not practical at the other end of the spectrum, for systems serving less than 1,000 people. This, therefore, demonstrates the need for such services to be provided to them by state environmental or health agencies. The provision of laboratory support at the state level may be dependent upon state size. In New England, many states have chosen to do all the analytical work for a community. This, however, still may not meet entirely the needs of the small community, for there are certain day-to-day tasks which must be done at the local level.

Conclusions

Small water supply systems outnumber all others even though they serve a relatively small part of the United States population using public drinking water supplies. The problem of economics, enforcement of standards, operator capabilities, expansion, regionalization, and laboratory tests and monitoring are monumental and must be addressed if the system as a whole is going to work. The quality of water supply in the small systems or perhaps the lack of the supervison of that quality has resulted in the largest number of waterborne disease outbreaks. Fortunately, these waterborne disease outbreaks even in total do not account for any major share of the number of cases of waterborne diseases. Small communities have a great need for fiscal, technical, and managerial assistance, and the level of government most capable of providing this is the state regulatory agency.

References

1. *The Role of Technology in Small Water Systems Management;* Clark, R.M. Municipal Environmental Research Laboratory, Cincinnati, Ohio.

2. *Waterborne Disease Outbreak - A Review of the Literature 1971-1975;* Craun, G.F. Reprint from various journals of the Water Pollution Control Federation.

3. *Review of the Causes of Waterborne-Disease Outbreaks;* Craun, G.F. and McCabe, L.J., JAWWA 65:74, January 1973.

WHAT ARE THE PROBLEMS?
VIEWPOINT OF THE CONSULTING ENGINEER

by

Ted Williams

Let us start with a story about the sermon on the ultimate perfectibility of man. The minister got carried away with this sermon, he said he he wasn't perfect--nobody was perfect and anybody in the congregation who thought they were perfect should stand up. Lo and behold, one chap stood up. The minister said, "You mean to say you think you're perfect." "No," he said, "I'm standing up for my wife's first husband."

I'm here to speak on behalf of consulting engineers. We have not reached that state of perfection of the wife's first husband, but the attitudes expressed in the previous presentations have caused me a problem. There seems to be an opinion that consulting engineers habitually provide plans and specifications for more than is needed. There are occasions when consultants are guilty, but I submit to you that regulatory agencies as well as state and federal agencies must share blame.

There is in any advancement an element of risk--a benefit is to be gained, yet a potential for difficulty exists. The Safe Drinking Water Act can be of significant benefit to the people of this country. At the same time, this benefit undoubtedly will result in difficulty in implementation for all communities. Larger cities are reasonably well equipped to cope with problems because experienced staff and greater resources are available. Conversely, a new problem can place a tremendous strain on the staff and resources available in a small community.

It is important to consider the problems of the small community in complying with the Safe Drinking Water Act because of the number of people affected by the legislation. According to American Waterworks Association records, there are more than 37,000 water systems in this country that serve less than 10,000 people. If these systems serve an average of 3,000 people each, we're concerned with more than 100 million Americans. Even if the average population for each system is as low as 500, we're still talking about more than 18 million of our people.

It seems worthwhile to establish the context within which the problems of the small community will be enumerated. It is not the purpose of this discussion to argue the "reasonableness" of any of the regulations. The Safe Drinking Water Act is law and the regulations for its enforcement are in effect. As a result, the problems of the small community will be discussed only from the standpoint of finding ways to deal with them.

Most of the concerns of the consulting engineer can be divided into three general categories: 1. Technology, 2. Funding, and 3. Management.

Technology

The state of the art permits treatment plants to achieve virtually any level of treatment desired. However, a scaled-down version of a large plant is rarely the best solution for a small community because a facility that will work well and economically in a large city may be too expensive or require operator training that exceeds the level available in a small system. A small system is defined as serving a population of 10,000; however, a better definition of "small" ought to be less than 100,000 gallons per day. The community that has a system to serve a population of 10,000 would have plenty of money and capability if they just charged enough for water.

The disproportionate amount of water used for drinking and cooking in relation to the entire water supply can pose a problem for a small community. The entire supply must be of drinking water quality, but it is not all used for drinking. Much is used for watering lawns, showers, laundry and washing cars. Perhaps greater emphasis should be placed on various alternatives such as a dual water system.

A small system represents an excellent opportunity for the development and use of innovative techniques, yet obstacles to innovative techniques abound. Local residents may be reluctant to commit funds for innovative techniques. Regulatory agencies may be reluctant to give approval. Engineers may be reluctant to suggest new techniques or may have insufficient funds to develop techniques if the assignment is obtained on the basis of a low bid. If a new way of doing something is to be developed, somebody has to pay the person for the time sitting in the chair with feet up on the desk dreaming up the idea. If one is paid on a low price basis, there will be no time for that. What's more, there will not be any time to argue with the state regulatory people, explaining that this is a new method, a great improvement that ought to be approved. Chances are they will be reluctant to approve it since it has not been done before.

Funding

Financing water system improvements can be a significant obstacle for a small community. Since the economy of scale is not available to small communities, special attention must be given to costs and financing methods. Costs are spread over a fewer number of people, and any increase has a greater impact on the individual customer.

Utilization of federal and state financial assistance is a difficult process. The track record on most grant programs is marked with delay, frustration and cost increases. We have practiced with small communities; we have been through the EPA Construction Grant Program for wastewater treatment. The existence of financial grants is a political reality in pollution control programs, but I have witnessed a history of federal aid to communities slowing down the process. There is a wonderful little story that most of you in pollution control have probably heard. Federal aid is to progress and pollution control as pantyhose is to impromptu lovemaking. They do not make it impossible, but they sure as hell slow you down. Now I do not think developing a program that is meant to help but actually hinders is doing a job. If I do not do my job I do not stay in business. But what about governmental agencies--why can they get away without doing their job?

We have a problem with state laboratories. The State of Michigan and the State of Missouri are setting up big laboratories to do the laboratory analysis free. Those of us who must earn a living will have a hard time getting this work because it is being done free. Apparently it is better to charge tax money and use it to build a laboratory to give free service than it is to charge the people for the services rendered by private industry. That is something to argue about.

The development of a rate structure can be a difficulty because the philosophy behind the development of a rate to serve a small community differs from the requirements for a larger system.

Some smaller communities may quite possibly realize an economic gain from regionalization, but the benefit can be overshadowed by the strong desire for local autonomy and reluctance to relinquish local control.

The development of a program for compliance with the Safe Drinking Water Act will require the services of competent, dedicated, experienced professionals. However, a council can run the risk of getting less competence, less experience, less dedication due to pressures to select a consulting engineer on the basis of the lowest price.

Management

Operation and maintenance of a small system poses different obstacles because often times the few full-time staff people in a small system serve several functions. The sampling, testing, records, and reports required for compliance with the Act can result in higher costs. But these should be put in perspective.

I recently read a paper about the cost of testing programs, the cost of sampling, the cost of laboratory analysis, but the paper went on to state that the cost is about $2 per year per customer. Our city council recently had a public hearing on the increase of the monthly cable TV charge from $6.50 to $8.50--no one came. And that's an increase of $24.00 a year. The annual rate will be over $100 for each customer. When we pay that much for TV, isn't it worth $2 per year per customer to sample and find out if the water is good?

Once we did find out inadvertently that there was chrome six in a public water supply. When we found this out, we were fired by the community because they did not want to know; it upset their whole relationship with the local industry. They had a low water bill; they had all these good things going for them. A little bit of chrome six in their water did not really bother anybody. You ought to know what is in your water supply. The people ought to know and the sampling ought to be done. I think the sampling and reporting program is great. The public information and public disclosure of violations are also good elements of the program.

The consulting engineer is not involved in a community unless there is a problem the community cannot solve itself. A number of years ago, Jacob Bronowski, an English mathematician, author and dramatist, observed that there can never be a real answer to a problem until someone first asks an impertinent question. It is the intention of this discussion to ask "impertinent" questions so that progress can be made towards solving the problems of the small community.

Consultants do not have problems; clients have problems. We, the consultants, have an opportunity to solve other people's problems.

WHAT ARE THE PROBLEMS?
A MANUFACTURER'S VIEWPOINT

by

R. M. Wilfong

An assessment of a problem is best started with the gathering of all available data. When the data has been collected, classified and thoroughly studied, then and only then should remedial action be taken.

That is where we are at this moment. The responsibility of this panel is to address the problem from various points of view. My area of concern is that of a manufacturer. I sincerely hope that the real problems are ascertained through this process and once light has been shed on what the real problems are, that technically sound and fiscally responsible solutions are forthcoming. From a manufacturer's view, great consideration is invariably given to the question: "What is the size of the market?"

Presently small systems are classified as those that serve 10,000 subscribers or less. On the surface, that may not appear to be a very challenging market. Further evaluation will indicate that small systems represent in excess of 90 percent of all of the public water systems in the United States (or more than 30,000 systems). Add to that number approximately 200,000 public non-community water systems and all 230,000 plus systems are mandated by the Safe Drinking Water Act (PL 93-523) to meet the minimum standards for water quality.

The magnitude of the market balloons in size almost beyond comprehension. The magnitude is further enlarged as one recognizes that few of these small systems can comply with the Act due to the inadequacies of existing plants. If that were the only problem, it would be a marketing manager's smorgasbord, but that, obviously, is not the end of the problem. In fact, it's not even the beginning of the problem. But let us assume that the market manager of a water treatment equipment manufacturer, having seen the size of the market, continues in his own efficient manner and calls a meeting of staff and other department heads to involve them in this unique opportunity on behalf of his firm.

One could imagine that his opening remarks would go something like this: "Here we stand with a potential market in excess of 230,000 systems none of which can meet the minimum standards for water quality. We have the opportunity to design, build and market a turnkey water treatment plant capable to meet the most demanding of the primary drinking water standards and capable of being expanded as far as demand is concerned. They should be designed so that incrementally additional treatment processes can be added through the simple addition of units, all of which are designed to fit as neat as hand in glove with the other. Another requirement is that all components be of standard design and as nearly uniform in size as possible to minimize spare parts requirements."

To this challenge engineering responds: "It is entirely within our capability. We understand the maximum contaminant levels (MCL's) and possess the technology to meet them. Further we concur with standardization of components for the minimization of spare parts back-up requirements and ease of maintenance."

Sales people, not lacking in traditional enthusiasm, rally to the opportunity and come up with some excellent ideas such as the need for simplified instruction manuals, an operators training course by correspondence or classroom work. For those operators of systems too small to justify their own on-site operators, a circuit rider concept could be provided. This circuit rider could do testing for those systems having full-time operators but not possessing necessary laboratory equipment to conduct the tests required by the Act.

High spirits prevail. The opportunity is most challenging. Then another question is raised: "How many different standards and criteria would it be necessary for us to meet if we are to market such a turnkey system throughout the United States?" There is a pause...and the corporate counselor responds: "Gentlemen, it could be as many as 50 different standards or approvals that would be required." To which the chief financial officer of the corporation responds: "Gentlemen, do you realize that it would take untold sums of money to gain acceptance of such a system if that many approvals are required, to say nothing of the time that could be wasted in pursuing approval in some areas of the country. In my judgment, gentlemen, we had better go slow. This project may be beyond our capabilities."

With that statement the spotlight of reality has highlighted one of the major problems confronting small water treatment systems, or better stated, confronting the manufacturers capable of serving the small water treatment system.

The cost of gaining approval from the myriad of state agencies for the design concept often exceeds all other attendant costs to developing innovative, technically advanced systems. It is not this panel's responsibility to provide solutions, so at the risk of encroaching on the responsibility of later panels, allow me to ask a question: Would not a third party validation of equipment, designed and manufactured against stringent consensus standards alleviate this element of the problem?

The manufacturing firm we are using for our example is a typically strong-hearted, gutsy type of firm not to be undaunted by the first problem it encounters. And so the meeting of staff and department heads continues and as might be expected, another question is raised to the corporate financial officer. "What is the financial capability of the municipalities and private operators of small water treatment systems? Could they buy our turnkey plant?"

Once again corporate counsel responds by saying: "My research indicates that most municipalities of all sizes have reached the saturation point of their tax base. In fact, if Proposition 13 is any indicator, the constituents of most taxing bodies are saying that taxes have exceeded their level of tolerance for further taxation." There may be no solution to this tax problem.

Next engineering offers a suggestion: "Gentlemen, why don't we design our turnkey plant to provide only adequate quantity of supply, primary filtration, and disinfection. My experience indicates these are critical areas of concern. Most small water systems are growing and are invariably short of adequate quantity of supply. We can take care of basic requirements at point source much more economically than we can the more sophisticated treatment required for the MCL's of trace elements. This, gentlemen, is particularly true since only one-half of one percent of the total product of the plant used by the customer would be benefited by the treatment (control) of these trace elements. Could not these MCL's be met with point-of-use treatment for these constituents when they are present? Established point-of-use service outlets can be employed to maintain and service this concept. Charges for this service could be part of the basic water bill, placing the control of this type of service in the hands of the system operators, where it should be."

I hope our attendance at this theoretical meeting has served to highlight some of the manufacturer's problems. Needless to say, the meeting is far from ended. It will have to go on through discussion of research and development, prototyping, in-field testing, development of consensus standards jointly with other manufacturers, if that should be a potential solution to that element of the problem. Certainly there will be development of necessary financing to fund the development and marketing of such a system.

In summation let me leave you with the following points:

1. Technology is available to meet the MCL's.

2. Small as well as large systems need to come into compliance.

3. There is urgent need for uniform standards for testing performance, for only then will the manufacturers' community be unshackled to apply their expertise through innovative products.

4. There is critical need for the development of a sound fiscal approach to this problem.

5. There is a need to continue basic research into many of the trace elements and their effects, good or bad, on the health and welfare of our population.

6. It is imperative that all methods and technologies be carefully explored to insure that the best interest of the consumer is served. This certainly would include consideration of point-of-use treatment at some level.

7. Solutions to these and other problems yet to be delineated must be found, or a market exists only in the desires of men.

WHAT ARE THE PROBLEMS?
WHAT ARE THE SMALL UTILITY PROBLEMS IN COMPLYING WITH THE NATIONAL PRIMARY DRINKING WATER REGULATIONS?

by

Richard Moser

Envision a village in the foothills of Kentucky. The people are miners and everyone knows each other. Total population is only a thousand or two. No tourists come to this town, so all the folks are just hard-working people who travel very little, if at all. The town has a mayor, a police chief, a fire chief and a water plant superintendent--all the same person. Of those duties, he tends the water plant the least. And why not? The plant almost runs itself. "That creek has always been good, except when there's a heavy rain; then it's only mud, which will pass in time," he says. His duties as mayor, policeman and fireman are far more crucial to the welfare of the townsfolk than wasting time at the water works. If he checks the plant early in the morning to mix chemicals, wash filters (if any) and test a sample for pH, that is certainly sufficient. Oh, once a month he will collect two bacteriological samples to be sent to the state health department and fill out a report (probably at home at night) that fulfills his requirement as water plant operator. He does not have the time to devote any more attention than that. Water bills are paid at the town bank or hardware store, which then turns all revenue over to the mayor's secretary. The small amount of money left over after paying the normal expenses of operating the water system would never pay for a major pipeline break or any other unusual significant expenditure. This exaggerated hypothetical town is now pictured in your mind. While I have used a town as an example, this could be a private water company with the same set of circumstances.

Without losing this first image, consider now that there is a new set of water standards adopted by the EPA with proposals for adopting others. Sure, the standards were published in the *Federal Register*. Sure, informative seminars were held at strategic large cities across the country. Sure, there is need to monitor for all these potential health-related contaminants. But how does this man-of-all-trades become aware of these standards and then learn the significance of each of them in water? How is he to know if his water supply is susceptible to these trace organics and inorganics that have strange names that only a chemist could understand? If our man cannot spend the time to become knowledgeable himself, then can he blindly rely upon his consultant or a supplier of equipment to make his water safe? Perhaps he should not even be concerned, since his mountain water is surely better than those city rivers for whom the new regulations are probably intended anyway.

But let's assume the consultant advises that there are deficiencies and a capital expenditure is required. Perhaps filters are needed to lower turbidity--a major expenditure to say the least, especially since many states do not permit direct filtration, and therefore would require sedimentation as well.

Now he is trapped. Even if the new plant were to be built, it would probably require another person for operations because he doesn't understand sedimentation and filtration. But the town or company now has to decide a course of action. More than likely the financial status of this system will not allow for the sale of sufficient bonds to pay for such a needed improvement. Shall the town attempt to attract investors by offering a high rate of return and skyrocket its water rates to the customers who can ill afford it? And shall the private company offer returns at the maximum rate allowed by the public utility commission? Or shall it attempt to sell its system to a larger authority or private company, that, because of its size, can better attract investors? Or shall it simply ignore the regulation for as long as possible on the grounds that it is too expensive?

I submit that while the last alternative does not provide the health protection intended by the regulations, this may well be the choice made by this small utility! One hopes this symposium will make it easier for those small systems to become aware of the current concern over water quality and to decide on a proper course of action.

WHAT ARE THE PROBLEMS?
THE PUBLIC INTEREST

by

Arleen Shulman

The task of representing the public interest at a symposium is an onerous one because there is no such thing as THE public interest. If there were, solutions to the problems of small drinking water systems might be found more easily. Conflicts between competing national goals, or between national standards and local needs, or between competing local needs are inevitable.

There is *a* public interest in providing safe drinking water for people. There is *a* public interest in providing services at a cost people can afford. These public interests are expressed at the federal, state and local levels. Problems arise when determinations of public interest conflict.

What is Safe?

Surveys conducted in the early 1970's indicated that the percentage of people who perceived water as a threat to health was very small--about 6 percent. People in small communities were found less likely to perceive pollution as a threat to the safety of their drinking water than those in larger communities, even though small systems may have more problems with quality more often.

Other surveys indicated that people may be willing to pay more for better tasting water than safer water, and that there are differences in what is perceived as "good water." For example, a small community advertising itself as having the best tasting coffee in the world attributed this to a quality of their groundwater they called "body," which was traced to a plume of pollution from the site of an old livery stable.

The federal definition of safe is now established by the National Interim Primary Drinking Water Regulations. The regulations and the standards they set are based on the knowledge we had at the time, and are being revised as more information is obtained on the health effects of drinking water contaminants. They have been met with some support and with some resistance.

Perhaps the Safe Drinking Water Act should have been called the "Act to Reduce Unreasonable Risks from Drinking Water Taking Available Technology and Costs Into Account." What the Act will not do is provide absolutely safe drinking water; what it will do is ensure safer water by assessing health risks against other considerations. The assessment of how much risk we are willing to take is always a policy decision, not a matter of scientific judgment.

Setting standards under these conditions inevitably makes any numerical maximum contaminant level subject to controversy. Adding to this problem is the fact that the policy decision is not made by the local water system but by state and federal governments.

We have all heard the stories about the senior citizens who say that they have been drinking the water for 70 years and are still around; they are pointed to as the most visible evidence that contaminants in drinking water are not as serious a health problem as federal law might have you believe.

The lack of understanding of the difference between safety and risk assessment is a significant obstacle to support of the federal drinking water regulations in all communities, but especially in small communities where technical expertise may not be available.

Variances and exemptions to the drinking water regulations may be granted by the state or EPA if there is "no unreasonable risk to health." Local officials may ask, if there is no unreasonable risk to health, why are these contaminants regulated in the first place?

The scientific knowledge with which standards must be set creates a climate of skepticism and uncertainty. A community may complete a new water system but the public officials are worrying that the federal government will change the regulations and make their water system obsolete, devastating to a small community at the limit of its financial resources.

The setting of national standards in itself has led to problems of public support, not just in small communities. But the problem of acquiring public support will be greater in small communities because often the costs are so much greater.

What Is A Cost People Can Afford?

It is at the local level that priorities for public services are set. Local officials must balance federally and state mandated standards with local needs and must choose among different kinds of needs to address with limited resources. The choice must often be made between better water or other essential services, like police, education, sewage treatment. The common denominator of these choices is often money.

The absolute cost per capita may make water system improvements unfeasible because they are beyond the citizen's willingness or ability to pay for safe drinking water. Local officials may underestimate the public's willingness to pay for service improvements. Tax reform-type measures and the attitude they engender may make it impossible to pay for improvements that are desired.

National surveys have indicated that people in rural communities do pay more for community supplied water than people in urban communities. The reasons for this are several: problems of diseconomies of scale for smaller systems, inappropriate technology, and of the difficulties of administration.

The institutional arrangements for providing water in this country are varied--from individual systems, to private water companies and associations, water districts, irrigation districts, cities, counties, regional agencies. The public responsibility for drinking water is not uniform. The financial risks and problems faced by small communities vary with the institutions that supply water, with the economic conditions of the area, with the state legal framework and with other factors. Financial problems may exist whether a community decides to invest in a central system or chooses alternative solutions.

Problems of Small Communities Are Varied

When big-city technology is applied to small communities indiscriminately, the community may find a big-city price tag attached. With its smaller financial resources, and possibly smaller per capita income, the area ends up with more than it can pay for, not just in capital investment but in operation and maintenance expenses. O&M may become the larger problem, especially since passage of the Safe Drinking Water Act because, although there is some outside aid for capital expenses, there is less for operation and maintenance.

In rural areas experiencing growth, the transition from individual wells to a community system may be hard because the investment must be made before revenues from the growth are realized. And, all of a sudden, the community is faced with federal and state regulations with which they must comply.

Communities in some areas that buy their water from larger towns pay more for their water than do residents of the city, and the officials must weigh the costs of getting into the utility business against the costs of not being in control of their own water rates. Or the responsibility for drinking water may be so variable or undefined that communities developing water systems may not be able to secure enough customers and thus enough revenues to pay for the system.

Administrative problems for small communities may be of a different order than those of highly urbanized areas. For example, the problems of operator training have been discussed, but an additional problem is affording and keeping a qualified operator. The salary of a public works director in a county of 100,000 to 250,000 people is about $25,000 and in a county of under 2,500 may be about $10,000 a year.

Regionalization has been seen as the answer to problems of diseconomies of scale. In framing the Safe Drinking Water Act, Congress advocated the formation of regional water systems by requiring uniform national standards, standards geared to larger communities.

Regionalization in many of its manifestations is not a panacea. The loss of local autonomy, the complexities in ensuring equity for each community and the real loss in cost-effectiveness when distribution lines become too long are all disadvantages of regionalization. Some new evidence on Farmers Home Administration-funded systems has indicated that regional systems serving sparsely populated areas have encouraged rural sprawl, or pockets of urban development in rural areas, with the concommitant difficulties in providing other public services.

Even though EPA does not provide financial assistance to communities for water systems, there are several federal agencies that do. The Economic Development Administration and Department of Housing and Urban Development have missions of community development; however, meeting the requirements of the Safe Drinking Water Act is not a high priority with either. Nor do they target aid specifically to communities with drinking water problems.

The Farmers Home Administration has a program for water and sewer system development and has recently signed an agreement with EPA to give priority to those systems with problems meeting the requirements of the drinking water act. This type of coordination is a great step in the right direction, although the majority of Farmers Home Administration aid is in the form of loans rather than grants. More agreements of this kind should help to rectify the problem of conflicting agency requirements and eligibility priorities at the federal and state level.

Conclusions

There may well be a difference in expectations between the federal government and small public systems, both in the definition of "safe" drinking water and in the costs people should be willing to pay for safe water. This has given rise to the sentiment that what the federal government requires, the federal government should help pay for.

A federal grant program targeted to helping communities comply with the Safe Drinking Water Act would not solve the problems of small communities, though it would help. The problems with the sewage construction grant program serve as a well-publicized example. Many of the problems would still exist, as they existed before passage of the Act.

A continued public education effort is necessary to help citizens understand the goals of the Act, and the opportunities they have to determine the price they want to pay for safe drinking water. It is hoped that this education effort would not stop with operator training, but include local elected officials and the people to be served by small systems.

It is hoped that this symposium will point the way to making safe drinking water an affordable commodity for everyone. It is also hoped that this symposium will not find THE answer to the problems of small water systems, but that it will shed light on a variety of solutions. Within the framework of national standards, maximum flexibility and creativity toward finding those solutions should be allowed.

Solving the problems of small systems will be impossible without public support, without a clear understanding of the rationale behind safe drinking water regulation, and without the flexibility allowing each community to solve its drinking water problem for the public interest.

SOLUTIONS AVAILABLE FOR THE SMALL SYSTEM TO MEET THE NIPDWR

Introduction

In this section three papers are presented that deal with available solutions for small systems to meet the drinking water regulations. The first paper defines the role of government efforts to help small systems meet these requirements. The second presentation addresses possible solutions from the point of view of very small systems, those serving 500 customers or less. In the final paper, the various technological considerations for small systems are detailed. The authors and titles of the presentations are listed below:

What Can Government Do?	by	Alan Levin, Director and Hugh F. Hanson, Sanitary Engineer State Programs Division Office of Drinking Water EPA
Institutional Aspects	by	John Montgomery, General Counsel National Rural Water Association and John A. Garrett, Executive Vice President Alabama Rural Water Association
Technical Aspects	by	Robert M. Clark Engineering Systems Analyst Municipal Environmental Research Laboratory Office of Research and Development EPA/Cincinnati, Ohio

SMALL WATER SYSTEMS / WHAT CAN GOVERNMENT DO?

by

Alan Levin and Hugh F. Hanson

When the National Interim Drinking Water Regulations were promulgated in late 1975, an estimated 40,000 community water systems were providing drinking water to 177.5 million people.[1] Of this total, 37,000 systems served populations less than 10,000. Therefore, the vast majority of water systems must be considered small systems. An economic analysis of these smaller systems shows that systems serving 25-100 persons will need to spend $6.2-$9.1 million per year on monitoring, capital investment, operation, and maintenance to meet the drinking water standards.[2] A similar estimate of $109.4-$151.3 million has been made for systems serving 100 to 9,999 persons.

These large numbers certainly justify asking the question: "What can Government do?" However, to answer this question we must look behind these large sums to many problems that must be solved and are represented by the proposed expenditures. These problems include operator training, capital expenditures, monitoring, new technologies, operating procedures and costs, recordkeeping, public notification, increased regulation, and many more. In all these areas federal, state and local governments can and will be of assistance. This assistance will take many forms. The most familiar types of assistance are those activities that are specifically directed toward problem areas, such as technical assistance, demonstration projects, contracts and studies, and emergency assistance.

Direct Activities

Technical assistance, the most direct activity, is a continuous function taking place every day at regional and state offices. Water supply personnel in these offices work directly with utilities to answer questions about the Safe Drinking Water Act (SDWA), contaminant removal techniques, laboratory methods and many other technical items. Additionally, during sanitary surveys and inspections, the one-to-one relationship allows for information transfer and communication about all types of water supply concerns. This assistance will continue and probably increase as more utilities become affected by the SDWA.

In cooperation with various states and utilities, the EPA has many active demonstration projects. These projects include development of contaminant removal technologies such as granular activated carbon (GAC) for organics removal and direct filtration for asbestos removal. Additional projects include the Model State Information System, Fluoride Removal Methods, Nitrate Removal Systems, pre-engineered filter plants, simplified laboratory methods, The Rural Water Association Training and Technical Assistance Project, home treatment devices, and others that are designed to assist states help smaller water utilities.

Of particular interest to small rural water systems is the National Rural Water Association Training and Technical Assistance Program (NRWATTAP).[3] The National Rural Water Association (NRWA) was formed to assist its member organizations in dealing with the increasing complexity and number of regulations, rules, and restrictions placed upon rural water supplies. In the initial trial period 11 states were funded; the NRWA was used to provide local training sessions and direct technical assistance on the SDWA. The objective of the program is to have a full-time rural water system trainer working within a state, under the guidance of the Board of Directors for the State Rural Water Association. In the second part of the program, the emphasis will be to continue this work in the initial 11 demonstration states and to focus on strengthening and expanding the training and assistance efforts. New activities will include increasing state financial support, providing additional technical support to the original states, developing information on small water systems, and developing new strategies for helping small systems based on the pilot experience. Lastly, additional states will be included in the program at essentially the same level as was experienced in the demonstration period. In the demonstration states, the National Rural Water Association Training and Technical Assistance Program has become an extension of the efforts of both Safe Drinking Water agencies and Regional EPA Offices. More importantly, it is a grass roots effort that is self-starting and self-initiating with only a limited need for help from EPA.

In addition to this type of demonstration project, the Agency is continually involved in direct support of states and utilities through contracts and grants. Since the inception of EPA in 1970, over 1,000 grants and contracts have been awarded for research and information retrieval in conjunction or cooperation with the states.[4] Before that time the USPHS, USGS, USDA, HUD, FmHA, HEW, and the numerous state agencies and water districts attempted to assist small water supply systems and the public by conducting studies about water, water contaminants, treatment technologies, and the quantity of water available.

One such grant is the Rural Water Survey. Congress directed that a special effort be made to ascertain the quality, quantity, and availability of rural drinking water.[5] Five million dollars were authorized for this effort, but not appropriated; however, other grant and contract monies within the ODW have been used to fund the grants and contracts of the overall Survey. An Interim Report (background study) is nearing completion and the National Statistical Assessment of Rural Water Supplies is underway. The NSA will survey 2600 rural households spread over 400 counties throughout the 48 contiguous states.[6] The data obtained from this assessment will be used to estimate characteristics of rural drinking water related to quality, quantity, availability and affordability. Demographic data, socio-cultural traits and physical environmental conditions will be examined to try to relate these characteristics to the nature of rural drinking water supplies. This statistical assessment should yield an accurate picture of the types of households that are experiencing problems and the sections of the country in which they occur. This information should provide many useful insights that can be used in planning efforts to correct drinking water supply problems. After the National Statistical Assessment is completed, a final report, with recommendations, will be made to the Congress on the state of rural drinking water in America.

In addition to the assistance that can be made to improve our knowledge about water and water related concerns, all levels of government are actively involved in response to emergencies. The response record to natural and man-made disasters over the last decade will show the concern and dedication of government to water utilities during and after emergencies. This assistance includes such items as disaster assistance funds, direct relief, National Guard activities, damage assessment, mitigation of spills, and legal enforcement activities.

This outline of direct assistance activities demonstrates that governments are concerned with small water supplies and, most assuredly, these activities will continue to grow as good quality water becomes an increasingly scarce resource.

Regionalization and Consolidation

Other governmental activities are of a less direct nature, but do affect small water supplies. One impact is the encouragement of regionalization and consolidation. Clearly, realizing economies of scale and concentration of water supply talent are admirable goals. The House of Representatives report on the SDWA specifically recognized this fact and advocated regional systems and discouraged the creation of very small water systems.[7]

It is also clear that a unilateral policy of regionalization or consolidation is not always appropriate for reasons of geography, political jurisdiction, local autonomy, and personal preference. However, local and state planning agencies have made some efforts to achieve the goals of efficiently using the available limited resources. Likewise, Sections 201 and 208 of P.L. 92-500 call for area-wide sewage planning, and have caused many local governments to reevaluate all of their service delivery systems.[8]

EPA has begun to realize the impact of the 208 planning effort and the EPA/state agreements which also call for area-wide planning of environmental concerns. These programs encourage coordination of federal programs with state programs and plans, and specify federal laws that must be integrated into any comprehensive plan, such as the Solid Waste Disposal Act, the Clean Water Act, the Coastal Zone Management Act, the Safe Drinking Water Act and others.[9] Under Section 209 of P.L. 92-500 (the water basin portion of the Act) the designated area-wide planning agency must include seven different water related concerns in its plans, which include water withdrawals, water quality, watershed management and land treatment measures, energy development and others.[10] The results of these efforts are encouraging, but there is a need for all levels of government to address this utilization problem. New and innovative approaches such as increased use of packaged plants, combined management for multiple small systems, the circuit riding operator or engineer have begun and will continue to develop as more attention is given to the problems of smaller systems.

Economic Assistance

The commanding problem with coordinated planning and government regulations is their ultimate cost. The SDWA called for a joint federal and state program to assure compliance with the NIPDWR.[11] Unlike the Federal Water Pollution Control Act Amendments of 1972, however, no grant funds were provided for upgrading or constructing water treatment systems under the SDWA. Congress felt that the ultimate responsibility would rest with the local public water supplier and the user through appropriate user charges.

The House of Representatives' Committee on Interstate and Foreign Commerce, in its report on the SDWA, recognized that reasonable costs for large metropolitan (or regional) public water systems may not be reasonable for small systems that serve relatively few users.[12] In order to assure the quality of the nation's drinking water, however, the Committee advocated that water systems be organized to be most cost-effective. Particularly, the Committee advocated regional and consolidated systems, provided for variances and exemptions to the SDWA, and directed EPA to study the need for new legislative authorities to reduce the burden of the regulations in the SDWA on small systems.

In response to this mandate, EPA has adopted a four phase program to better understand the situation of small systems. This program includes (1) developing financial profiles of 1,250 small water systems, (2) conducting a compliance monitoring study of 1,000 small systems, (3) determining the cost of improvements required by the SDWA, (4) and using the results of the previous studies to reevaluate the financial impact of the regulations on small systems.

There appears to be a great deal of pressure for the Agency to initiate a subsidy program for utilities to defray the cost of meeting the Interim Primary Drinking Water Regulations. This interest is evidenced by the introduction of HR 12131 and HR 11967 regarding the establishment of a construction grants type program for water supply systems. It is the Agency's position that such a program is premature. A more conclusive basis will be available with the completion of the subsidy study currently being conducted by ODW (mandated by Section 1442 of the 1977 Amendments to the Act and scheduled for completion in May 1979). In the interim, the Agency is working with other federal agencies which provide grants or loans for public water supply systems such as FmHA, EDA, HUD, Appalachian Regional Commission, Coastal Plains Regional, and many others. Recently, EPA and FmHA have signed a memorandum of understanding wherein FmHA agreed to give priority attention to water systems seeking financial aid in order to come into compliance with SDWA. We feel that this is an outstanding example of how government can help within the confines of existing legislation.

Most of this discussion has dealt with federal activities; however, there are some programs at the state level that provide innovative techniques in setting priorities and distributing available financial assistance to water supply systems. Two notable examples exist in South Dakota and Indiana. The South Dakota program was initiated in 1974 to provide loans for up to 10 percent of the project cost with a maximum amount of $300,000. The loans are available to nonprofit rural water systems to supplement Farmers Home Administration financial assistance.[13] Indiana provides loans for up to $150,000 to systems serving fewer than 40 residences and requires that the supplier show no other funding is available. The Indiana loans must be paid back over a period of up to twenty years with interest rates of 1.5 percent the first eight years and 5 percent the last twelve years.[14] Other innovative state programs include bond banks, grants, and matching funds. Some innovative programs being examined by states for small utilities include leasing, state and local take-overs, and technical assistance in the financial management of water supplies.

Finally, the states that have accepted Primary Enforcement Responsibility also have state grant funds available under the Safe Drinking Water Act to assist water supply systems to meet the NIPDW regulations. In 1978, EPA issued $19,884,300 in State Program Grants. The 1979 grants are anticipated to be increased by about 30 percent. These dollars are converted into sanitary surveys, technical assistance, the issuance of variances and exemptions, training, and other state programs that assist utilities to meet the NIPDWR's.

Variances and Exemptions

Of specific importance to the small water supply is the concept of variances and exemptions to the SDWA. The originators of the Act understood that a special burden would be placed upon the small system. While Congress insisted that the health of the consumer was paramount, they provided for variances when a contaminant could not be removed due to the condition of the raw water or for other good reasons, with the provision that the contaminant posed no specific health hazard. Exemptions were provided where economic considerations prevented a utility from immediately making necessary system corrections. The exemption requires that no health hazard exist and that it be limited in duration.[15]

These variances and exemptions, whether issued by the states or EPA, provide a context for discussion and cooperative planning by the utilities and the regulatory body to find solutions to problems. As over 300 exemptions have been issued since the NIPDWR's took effect in 1977, one can see the impact this provision has had on small water utilities. Government has an extremely important role in these processes, and it is incumbent upon the regulator to assure that the health problems are addressed in a manner that produces minimum disruption of the local community. To assure this, EPA has been involved in extensive training of regional and state people on how to issue variances and exemptions. Additionally, on the national level we have paid particular attention to the process in an attempt to make sure that the procedures are uniform and fair for all utilities.

There is need for greater understanding and cooperation between the EPA, the states, and local government in the request for the issuance of variances and exemptions.

Operator Education and Certification

The key to the success of the SDWA for smaller water supplies will be increasing the level of understanding and technical ability of utility operators and managers. While many systems now have excellent staffs, the small system has particular talent problems due to economic constraints. It is the task of government at all levels to demonstrate the need for high quality full-time water system operators. This goal has many obstacles, and creative and innovative approaches will be required to overcome them. However, the best tool presently available is mandatory certification. Great strides have been made toward universal certification. The numbers have increased from 10 states having programs in 1960 to 39 states in 1976; an additional 9 states have voluntary certification programs.[16]

The need for government activity and the opportunities for action are enormous; in no other area can such immediate gains be achieved. Presently, EPA is supporting activities to develop junior college curriculums in water technology and trainer training in the same area. Additionally, EPA has supported efforts to develop training courses in sanitary surveys for small systems, simplified testing methods, seminars for small system managers and operators on the SDWA, turibidity testing, and chlorine residual testing. More recently EPA has been working with Associated Boards of Certification and Conference of State Sanitary Engineers to develop "need-to-know" criteria for operator training and testing and a uniform set of tests for operator certification that can be used by all states. EPA will continue its present initiatives and will certainly be moving further to improve the delivery of education to operators and encourage mandated operator certification.

Summary

We have looked at many of the areas in which governmental units at all levels are working with water suppliers to improve the quality of America's drinking water. These efforts represent millions of dollars and thousands of man-hours. However, even the most optimistic would have to admit that the job has just begun. Government can lead the way in new techniques through research and demonstration projects, and of course, all levels of government will assist during emergencies. However, ultimately the bulk of the effort to improve the water we drink must be done by the local utilities and municipalities. Therefore, the answer to the question--"What Can Government Do?"--is that we shall continue our efforts in the areas that we have discussed, and shall look for new and better ways to assist the small systems to provide the highest quality water.

References

1. Energy Resources Company, Inc., Economic Evaluations of the Promulgated Interim Primary Drinking Water Regulations, U.S. Environmental Protection Agency, U.S. Department of Commerce NTIS PB 248 588, October 1975.

2. *Ibid.*

3. EPA Grant #T-900-826-010 to the National Rural Water Association for the "State Rural Water Training and Technical Assistance Programs."

4. EPA, Office of Research and Development, Unpublished Survey of Water Supply Grants and Contracts.

5. Report No. 93-1185 of the Committee on Interstate and Foreign Commerce (re: Safe Drinking Water Act). U.S. House of Representatives, 93rd Congress, 2nd session. 1974.

6. EPA Grant #R804-900-10 to Cornell University for the "National Statistical Assessment of Domestic Rural Water."

7. Report No. 93-1185 of the Committee on Interstate and Foreign Commerce, *op cit.*

8. Policies & Procedures for State Continuing Planning Process. *Federal Register,* Vol. 40, No. 230. November 28, 1975.

9. *Ibid.*

10. *Ibid.*

11. Report No. 93-1185 of the Committee on Interstate and Foreign Commerce, *op cit.*

12. Report No. 93-1185 of the Committee on Interstate and Foreign Commerce, *op cit.*

13. EPA Unpublished Draft Report. "Report to Congress on Financing Needs of Water Supply Systems." May 1971. Temple, Barker, and Sloan, Inc.

14. *Ibid.*

15. U.S. Statutes at Large. Public Law 93-523, An Act to Amend the Public Health Service Act. S. 433. 93rd Congress. December 1974.

16. "Operator Certification--1975 Status Report. ABC Report, *Journal Water Pollution Control Federation.* August 1977.

SOLUTIONS AVAILABLE FOR SMALL SYSTEMS TO MEET PUBLIC DRINKING WATER REGULATIONS--INSTITUTIONAL ASPECTS

by

John Montgomery and John A. Garrett

One of the key items to consider when discussing small systems is the definition of "small." Often a small system is identified as one serving 10,000 people or less. But systems that serve 5,000 to 10,000 people tend to have enough financial resources to hire personnel and to purchase equipment when needed. The authors therefore would like to concentrate on small systems as those that essentially serve crossroads communities, for example, systems serving 500 customers or less. It is these systems that the National Rural Water Association considers small.

Most of the growth in rural or small systems occurred in the 60s, which was also the time that the Farmers Home Administration (FmHA) initiated its loan program. In some communities aggressive individuals took the initiative and filed the loan applications for establishing their own water supply systems. In other areas, consulting engineers took the lead in assisting the development of small systems. As these systems grew, the same good samaritans who had helped in initiating the systems became the managers. Many of these people were volunteers who received only expense money. Some systems were manned by couples--the wife would keep books and records, and the man would do the maintenance and operate the system. In the 70s, when more money became available from FmHA, there was continued growth in the rural water systems.

The reasons for noncompliance among small water systems are numerous and include as a minimum their small size, geographic location, limited operation and management capacity, financial instability, limited funds available, and even inadequate knowledge of the Safe Drinking Water Act (SDWA) requirements. Many problems, such as those relating to availability of good water or lack of sufficient funds, will take long-term institutional assistance. However, the most prevalent problem, the lack of capacity to adequately manage and operate a system to meet the SDWA requirements, can and should be addressed immediately. Some of the most important elements in this lack of capacity will be discussed in the following sections.

Operator and Manager Training and Development

Most training efforts have not been designed to reach the smallest operators because of the great difficulty in understanding precisely the problems they face and how these might be solved. In addition, operators and managers have difficulty leaving their jobs to attend training sessions even when they are available. Many of these persons are part-time; most are not engineers nor have they participated in formal water treatment education or training, and they look on formal training as having limited use for their own work. Most of their day-to-day difficulties involve basic operational problems of water pressure loss, leaks, poor bookkeeping, and operation and repair of pumps and other equipment rather than engineering difficulties.

Programs designed for the special interests of rural water system managers that would include elementary sampling procedures, bookkeeping assistance, and funding information often lack these basic elements. On the other hand, this type of information is of little or no interest to larger system operators. There is a need to establish specific training and technical assistance programs for these small system operators separate from the traditional water operator training courses. Over the past year the National Rural Water Association (NRWA) has conducted 10 to 15 training sessions in each of 16 different states in an attempt to meet this need. On the average, there have been 30 attendees per session, and the number of systems participating has covered approximately 80 percent of the counties within each state. An evaluation of the effectiveness of the program is available from NRWA.

Consolidation and Regionalization

There is general agreement that consolidation of small systems improves cost effectiveness, upgrades water quality, and results in more efficient operation and management. In addition, there is a growing commitment among the major federal funding agencies that future construction of small water systems should be designed considering regional water supply and population distribution. Thus, in most cases, consolidation and regionalization are recognized as favorable objectives by rural water system supporters. There are problems, however, in determining exactly where regionalization is needed and on how to achieve it.

The best approach is to allow rural residents to work out these consolidation issues primarily by themselves with some leadership and guidance from others. The wrong approach is to impose these consolidations from the top. However, rural residents will need and tolerate legal, engineering, and other technical assistance necessary to agree on consolidations when requested by small systems.

Policies and efforts to require small systems to consolidate are counter-productive and cause small system boards of directors to "hunker down" and protect their existing status. In many cases, small systems are willing to consolidate if the interests of water users, board members, employees, and the system's financial obligations are protected. One continuing problem is found when a town or water system wants to consolidate only the densest portion of another system rather than absorb it all. This, of course, places an increased burden on the nonconsolidated portion of the water system. Thus, there needs to be a consistent policy in consolidations so that entire systems are consolidated and all long-term financial obligations are assumed by the new entity.

In most states, the design and construction of new systems is following a regional approach. Frequently, the reason given for the larger systems is to upgrade the quality of drinking water over a broad area. Increasingly FmHA grants and loan funds are being used to develop these larger regional water systems or to encourage consolidation. These unwritten policies of the FmHA are evolving because of the basic economic advantage those consolidated systems enjoy as costs for new systems increase. In addition, the recent joint agreement by FmHA and EPA is evidence that FmHA funds are to be given priority to solve drinking water problems, which often implies larger systems will be constructed. Thus, changing policies and increased economic viability of larger systems are expanding the use of regionalization in rural water without any need for additional new requirements from federal and state officials to encourage this process.

Operation and Maintenance by Regional Water Source Groups

The management structures or operational approaches used by small rural water systems vary widely. Most prevalent is the "Mom and Pop" approach, where a husband and wife work part-time to maintain the pumps and equipment, keep the books, read the meters, bill the customers. While this may appear inefficient, low pay and an enormous amount of unpaid overtime make this structure relatively inexpensive. In larger systems (over 1500 meters), a full-time accountant/bookkeeper is employed, as well as a full-time operator.

For medium size systems (between 300 and 1500), some of the services may be subcontracted, such as maintenance, billing, or even the overall management. For example, one contractor may agree to fix all lines for a set hourly fee or a bank will do the billing on their computer for a set fee. Frequently, a part-time person will then provide oversight of the subcontracting for the board of directors. Where this is done, it is not unusual to find the subcontractors for one water system contracting with other rural water systems to provide the same type of service. This has proven to be a very cost effective way of solving many small system management problems, and this trend toward subcontracting is establishing a base for the increased use of regional water service groups. Other factors affecting the trend include:

-- The growing recognition that operation and maintenance are a necessary cost, which means increased budgets for this purpose in many smaller systems that inadequately provided for these needs in the past. The traditional approach of using part-time or volunteer help caused budgeting insufficient money in the past to adequately finance the services of a Regional Water Service Group. There are no profits in operating rural water systems and, in most cases, there are inadequate funds to pay for proper operating and maintenance. Users are board members and their priority is not to raise their own or their neighbors' rates. Many of these rural folks work long hours for little money and they will place the same frugal standards on their water system operation.

-- Many systems built over the past 15 years are beginning to experience a greater need for better quality operation and maintenance services as they undergo increased repairs and face the need for expansion.

-- Most new FmHA funded systems are budgeting more money to finance operation and maintenance than in the past. In most states it has been determined that the historical record of operation and maintenance costs are not sufficient for present operation and maintenance needs. Allocating this money in the original loan agreement will make long-term service arrangements easier in newer systems.

Role of Rural Water Associations in Finding Solutions

There is a great need for these rural water associations to become more involved in advising small rural water systems and stimulating solutions for their problems. In the past, many water supply associations have attempted to identify the needs of rural water systems and to encourage rural water people to participate in water management training sessions designed primarily for larger systems.

While these sessions are well run and helpful, they often miss the unique needs of smaller systems. The best approach for solving these problems is to stimulate smaller rural water systems to design and carry out their own program for training and technical assistance. For these systems the needs go beyond the operation and maintenance priority of many water supply groups into areas such as bookkeeping, finance, and rate making. The following are some suggested guidelines for issues that water supply associations should consider:

-- Provide the advice and assistance on problem-solving at the grassroots level in the rural areas close to the rural residents affected;

-- Keep the advice simple, clear and useful. Most rural water systems are preoccupied with day-to-day problems and long-term solutions must be closely related to daily concerns in any training session;

-- Accept that there will be a significant diversity in approaches for solving problems. Problems vary greatly among geographic regions, states, and even substate regions, and solutions must be adopted to local circumstances;

-- Provide a forum for rural water operators, board members, and users to work together to fashion their own solutions within their own communities; and

-- Do not try to replicate what is already done well by others. For example, operator certification is usually well organized by a state agency and new courses for certification are duplicative. Rural water training sessions should upgrade the capability and interest of participants so they can and will participate in more sophisticated courses including those for operator certification.

There are no sweeping solutions for small systems meeting the Public Drinking Water Regulations. The real need is to assist individual systems where the problems occur and work to generally upgrade the management and operational capability of all small rural water systems. The manner in which this can be done depends on the needs within each state. Any group or organization interested in how this can be done in your state should contact the National Rural Water Association for a description of the problems encountered in trying to meet those objectives.

Summary and Conclusions

Some of the major problems associated with small and rural systems have been discussed. These problems are summarized below together with some conclusions based on the authors' experience.

Funding. Funds are available from FmHA and other agencies for construction only. Operating and maintenance funds have to come out of the rate structure. Therefore, rates should be set in such a way as to be able to cover not only the operating and maintenance costs, but future capital costs as well. This is an issue that many small systems are having difficulty in understanding. Occasionally, money is available from revenue-sharing funds but on a very limited basis.

Consolidation of Small Systems. Consolidation will be an important factor in increasing the operating efficiency of the small systems. This is particularly true where one of the larger systems absorbs the operations of the systems around it. Consolidation is coming and leadership should exist to implement regionalization in the most efficient way.

Purchase of Treated Water. With the consolidation and interconnection of small systems, the idea of buying treated water becomes more practical. Connecting the systems is extremely important so that there will be backup facilities, and more reliable water supplies will be established.

Continued Training for Operators and Managers. Training is a continuous and probably never-ending process because of turnover and changes in procedures and requirements. However, specific training should be directed toward the unique needs of the small system operators.

THE ROLE OF TECHNOLOGY IN SMALL WATER SYSTEMS MANAGEMENT

by

Robert M. Clark

Approximately 177 million people are served by community water supplies in the United States. Most community water systems are small in terms of the number of people served. Over 90 percent of the nation's supplies serve fewer than 10,000 people, but provide water to less than 25 percent of the total population (Table 1). In addition to the large number of small community water supplies in the United States, there are approximately 200,000 public noncommunity water systems. Most of these systems are privately owned and are found at service stations, motels, restaurants, rest areas, camp grounds, state parks, beaches, national parks, national forests, dams, reservoirs, and other locations frequented by the traveling public. Some schools and industries also are included in this category. Data on these systems are limited.

Table 1. Distribution of Community Water Systems[1]

Systems Size (persons served)	Number of Water Systems	Percent of Total Systems	Total Population Served (in thousands)	Percent of Total Population Served
25 to 99	7,008	18	420	0.2
100 to 9,999	30,150	75	36,816	20.8
10,000 to 99,999	2,599	6	61,423	34.6
100,000 and over	243	1	78,800	44.4
Total	40,000	100.0	177,459	100.0

Small water systems in general have problems associated with cost and water quality. They cannot benefit from economies of scale as do large urban systems because they are small in terms of the number of connections served. Certain types of services must be provided, no matter how few the number of connections, causing the unit costs to rise as the number of connections being serviced decreases. The initial construction cost of the treatment and distribution system also may be high relative to the number of connections.

An offsetting factor is that small systems may be relatively easier to operate because they are somewhat less complicated than larger systems. Nevertheless, the price paid for service is likely to be higher, sometimes much higher, than in urban areas.

The Safe Drinking Water Act may cause the small systems significant problems. The Act sets forth minimum standards for water quality and requires that states insure standards are met. In response states are revising their water works standards and imposing new reporting responsibilities on water system operators.

This litany of problems represents only a few of the difficulties facing small systems managers. Many of these problems can be solved by the proper application of available technology. The basis for the economic and water quality problems generally associated with small systems will be discussed in more detail in the following sections. Effort is being made to find workable technological solutions. Some of these efforts will be discussed later in this paper.

Economic Characterization of Treatment Technology

Small systems in many ways are the victims of their size. A prevailing characteristic of water supply technology is the effect of economies of scale (increasing unit costs with decreasing system size). In one of the first studies to reveal this phenomenon, Orlob and Lindorf examined treatment cost to determine its relationship to the cost of surface water transportation, reclamation of wastewaters, groundwater recharge, and any other alternatives available for increasing water supply to California.[2] Construction cost was theorized as a function of the explanatory variable, design capacity, as follows:

$$C_c = \alpha Q_n^{\beta} \qquad (1)$$

where C_c = total capital cost of a complete water treatment facility in thousands of dollars

Q_n = the design capacity of the plant in millions of gallons per day (mgd), and

α, β = constant

Estimation of the equation generated the following relationship:

$$C_c = 257\ Q_n^{0.67} \qquad (2)$$

The value of $\beta = 0.67$ implies that economies of scale may exist in treatment plant construction. Dividing both sides of equation 2 by Q_n yields:

$$C_c/Q_n = 257\ Q_n^{-0.33} \qquad (3)$$

The term C_c/Q_n is the unit cost of capacity, and the exponent of Q_n is less than 0. According to equation 3, unit cost therefore decreases with increasing Q_n or capacity, illustrating "economies of scale." Similar relationships have been observed in operating and maintenance costs.

Definition of Small

Perhaps one of the most difficult philosophical problems concerning small systems is the definition of "small." Equation 3 provides the possibility for an economic definition. Figure 1 is a plot of equation 3, and the tangents ℓ_1, ℓ_2, and ℓ_3 illustrate the difference in slopes of various curve segments. As can be seen, ℓ_1 fits the steepest portion of the curve; ℓ_2 has a smaller slope and is intermediate between ℓ_1 and ℓ_3 which has the flatest slope. The slopes change dramatically in the ranges 0-1 mgd, 1-20 mgd, and > 20 mgd. For example, the slope of equation 3 is given by its first differential with respect to Q_n which is as follows:

$$\frac{\partial(C_c/Q_n)}{\partial Q_n} = -84.8\ Q_n^{-1.33} \qquad (4)$$

Table 2 contains values for the right hand side of equation 4 at midrange points.

Table 2. Slopes of Equation 4

Q_n	Slope of Equation 4
0.5	-213.3
5.0	-10.0
50.0	-0.5

As can be seen from Table 2 and Figure 1, significant differences exist in the slopes of various curve segments. One possible definition for a small system is one with a high unit cost or equivalently one having a capacity putting it within the segment of the cost curve in Figure 1 having a maximum slope. Such a system would have a capacity of 1 mgd or less. Following this convention a system having approximately 1 mgd or less capacity would be considered small, systems greater than 1 mgd but less than 20 mgd are transitional and those systems of 20 mgd or greater are large.

Confirmation of Scale Effects

Recent studies conducted by EPA confirm these effects. Figure 2 shows the results from a detailed study of expenditure patterns over 10 years for 12 water utilities geographically scattered across the United States.[3] Both total supply cost and total treatment cost are shown.

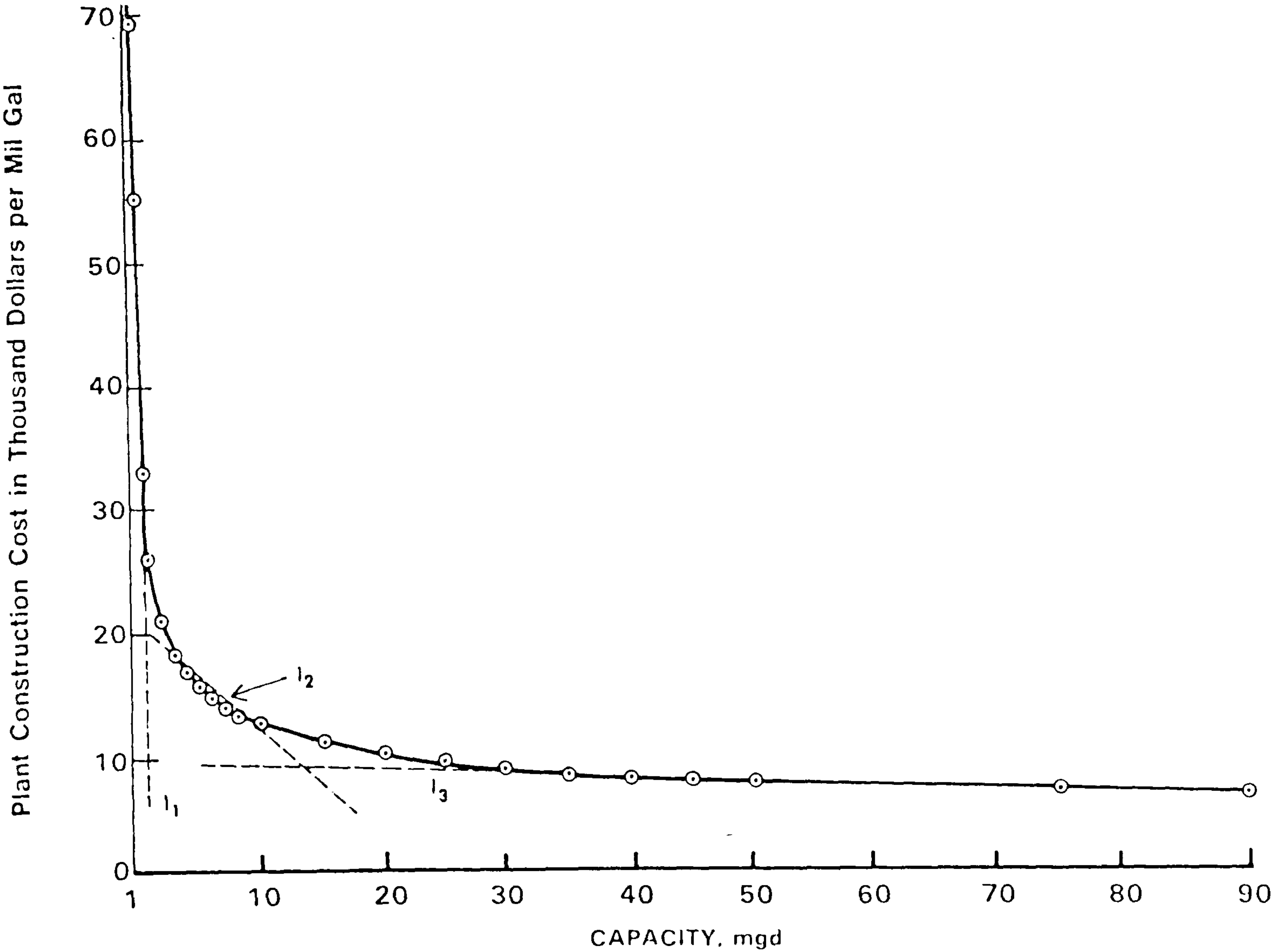

Figure 1. Unit Cost Curve for Water Treatment Technology

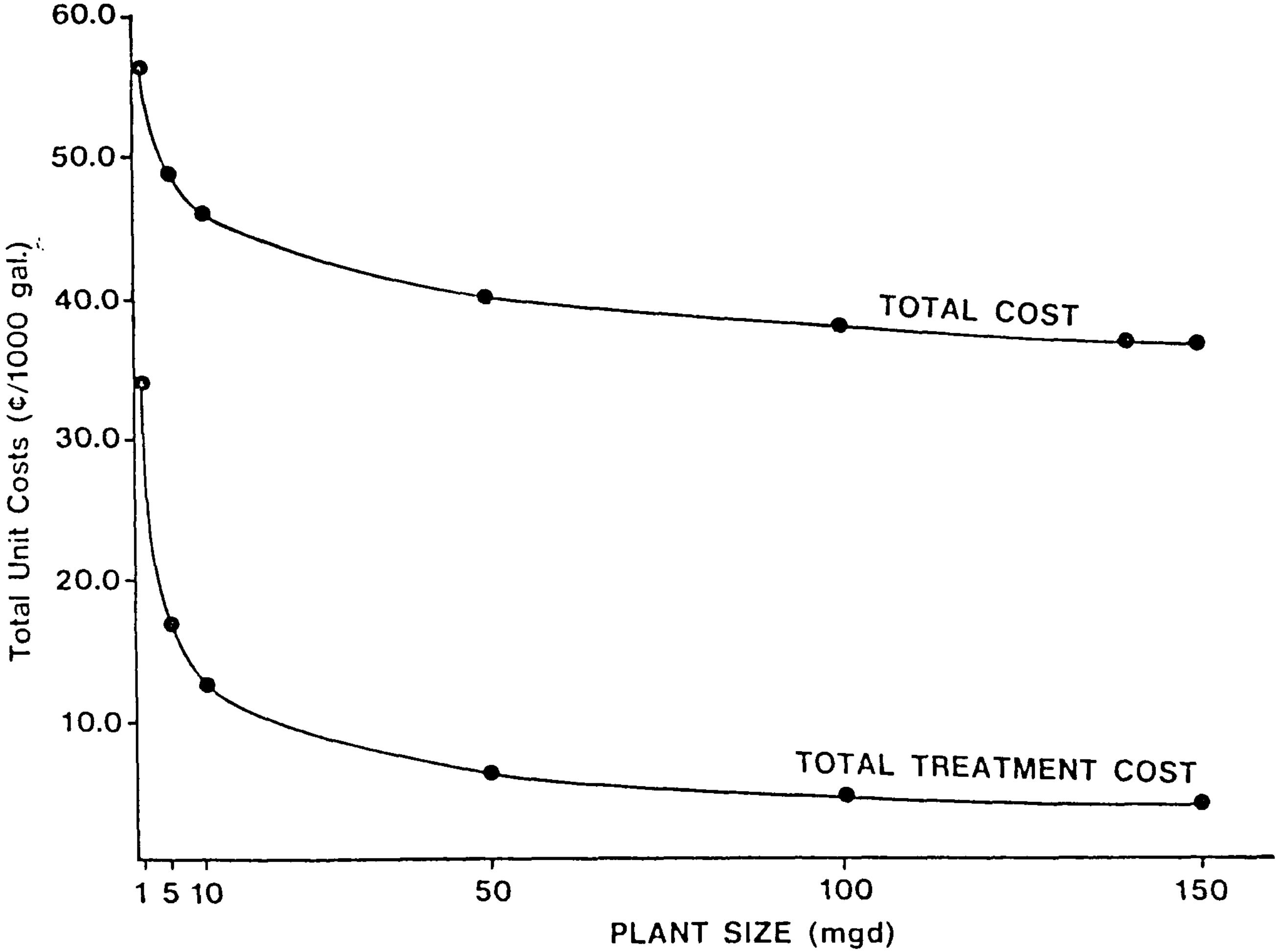

Figure 2. Total Unit Costs for Water Supply Systems and Treatment

Table 3 summarizes data collected by the Drinking Water Research Division on both large and small systems (1974 costs).[4] As can be seen, the average cost of 12 large water supplies (averaging approximately 85 mgd) is 42¢ per 1,000 gallons. The average cost for 30 small supplies (averaging approximately 1.7 mgd) is 85¢ per 1,000 gallons. Unit costs for the small systems are uniformly higher in all of the cost categories.

Table 3 and equation 3 illustrate the impact that the new regulations may have on small systems. Table 3 shows the high unit costs currently associated with small systems. Installation, operation, and maintenance of sophisticated control processes together with monitoring requirements may result in substantial total and unit cost increases for small systems. The combination of high existing unit costs coupled with the possibility of even higher costs that may result from installation of new technology are justification enough for concern over the small systems problem.

Water Quality Considerations

Not only do small systems have cost problems, but they also seem to have drinking water quality problems. Classical waterborne diseases of the past years--typhoid fever, amoebic dysentery, and bacillary dysentery--were brought under control by the use of sand filtration, disinfection, and the application of drinking water standards. Recent epidemiological evidence by Craun and McCabe shows the number of all water-borne disease outbreaks dropped from 45 per 100,000 in 1938-40 to 15 per 100,000 in 1966-70. The average annual number of outbreaks ceased to fall around 1951 and may have increased slightly since then for reasons unknown at this time.[5] Many of these outbreaks of communicable disease have occurred in small systems.[6]

The Bureau of Water Hygiene, Environmental Health Service, of the U.S. Public Health Service, with the cooperation of state and local health departments and water utilities, conducted a nationwide Community Water Supply Study (CWSS) during 1969 in eight Standard Metropolitan Statistical Areas and the State of Vermont.[7] The study of 969 water supply systems serving about 18.2 million people used the 1962 Public Health Service Drinking Water Standards as the basis for evaluating the performance of the systems.[8] Table 4 summarizes the water quality evaluation portion of the survey.

Table 4 shows that 41 percent of the systems exceeded either recommended or mandatory limits.[9] Table 5 shows the status of water supply system facilities.

Deficiencies included the following: inadequate source protection, improper disinfection or control of disinfection, inadequate clarification (removal of suspended matter) or control of clarification, and insufficient pressure in the distribution system. Table 6 shows that 90 percent of the supplies examined either did not collect sufficient bacteriological samples, or collected samples that showed poor bacterial quality, or both.[10]

Table 3. Costs for Large and Small Water Supplies by Function (1974)

Utility Size	Revenue-Producing Water (MGD)	Support Services	¢/1,000 gal				
			Acquisition	Treatment	Distribution	Interest	Total
Large	86*	9.9	5.4	4.8	12.7	8.7	41.5
Small	1.7**	15.0	12.9	8.8	35.3	12.9	85.4

*Average of 12 systems.
**Average of 23 systems.

Table 4. Summary of Water Quality Evaluation[7]

	Population Group Served			
	Less Than 500	500-100,000	Greater than 100,000	All Populations
Number of Systems:	446	501	22	969
Study Population in each Group in thousands:	88	4,652	13,463	18,203
	Percent of Systems			
Evaluation of Systems:				
Met Drinking Water Standards	50	67	73	59
Exceeded Recommended Limits	26	23	27	25
Exceeded Mandatory Limits	24	11	0	16

Table 5. Water Supply Facilities[7]

	Population Group Served			
	Less Than 500	500-100,000	Greater than 100,000	All Populations
Number of Systems:	446	501	22	969
	Percent of Systems			
No Major Deficiencies	39	47	64	44
Some Major Deficiencies	61	53	36	56

Table 6. Bacteriological Surveillance Programs[7]

	Population Group Served			
	Less Than 500	500-100,000	Greater than 100,000	All Populations
Number of systems:	446	501	22	969
	Percent of Systems			
Met criteria	4	15	36	10
Did not meet criteria	96	85	64	90

Data in Tables 4, 5, and 6 clearly show that most of the quality and compliance problems occurred in small systems. For example, 96 percent of the systems serving less than 500 people did not meet the bacteriological surveillance criteria established for the survey.

Incremental Costs of New Technology

The discussions in the previous sections show that many small water systems may have difficulties in meeting the Interim Primary Drinking Water Standards of the Safe Drinking Water Act. An obvious solution to this problem will be to install the appropriate technology to assure that the finished drinking water will meet the standards. The addition of new technology may substantially raise the cost of the product to the consumer.

All of the information presented points toward potentially severe economic impacts on those small systems forced to make large investments to meet the Act's requirements. In order to provide some concrete information concerning adverse impacts, EPA conducted a study of selected small water supply systems. Twenty-three utilities were selected for intensive analysis in Regions III, V, and VI. A follow-up study of 25 small utilities has just been completed in Regions VIII, IX, and X. The analysis in this section is based on data compiled in the first study.

Information was collected for 10 years on four major operating maintenance (O&M) components, three other significant O&M elements, and the capital costs associated with depreciation and interest for each of the 23 utilities. The O&M cost components are acquisition, treatment, support services, and distribution. Chemicals, payroll, and power are three elements contained in each of the other four components, but are considered separately because of their individual impacts on operating expenditures. Depreciation expense for each major cost component was also obtained in order to examine the relative capital intensiveness of the system.

Revenue-producing water is used as the basis for all calculations since it represents the means by which utilities obtain their operating revenue. It provides a comparative basis between utilities, but may be easily converted to total treated water.

Cost-Quality Evaluation

In addition to cost data, raw and finished water quality samples were taken at each of the small utilities visited in the survey. A complete inorganic profile was developed and a comparative analysis of treatment removal efficiencies were made for each system. In some cases the existing treatment plant was failing to adequately remove constituents from the raw water causing the utility to fail to meet the Safe Drinking Water Act MCL's.[11] After examining the complete spectrum of chemical determinations for the raw and finished samples from each utility a decision was made whether a new treatment technology could be added so that finished water quality would meet existing MCL's. Cost estimates were made for the proposed technology at each affected utility. For example in Region III, one utility was identified as having a nitrate removal problem. After examining data from the raw and finished samples a hypothetical ion exchange system was assumed. Table 7 summarizes the cost calculations for an ion exchange unit to solve the utilities nitrate removal problems.

Table 7. Cost Estimates for Nitrate Removal by Ion Exchange

Item		Quantity	
Flow Treated (MGD)		0.11	
Capital Cost			
Construction Cost ($)		74,909	
Site Work ($)		3,745	
Engineering ($)		8,809	
Land ($)		0	
Legal, Fiscal, Administration ($)		3,823	
Interest During Construction (4)		1,131	
	Total	101,858	
Amortized Capital - 7%, 20 yr ($/yr)			9,615
Operating & Maintenance Cost			
Building & Process Energy @ 3¢/kw-hr ($/yr)		465	
Maintenance Material ($/yr)		2,798	
Labor @ $10/hr ($/yr)		11,010	
Chemicals* ($/yr)		6,801	
Total Annual O&M Cost			21,774
Total Annual Cost			30,689

*Regenerant @ $28.00/ton

In a similar manner cost estimates were developed for add-on technologies in the other utilities identified as having problems.[12] Table 8 shows utility designation, the region, the quality problem for each affected utility, and the types of treatment hypothesized for solution. Six utilities in all were identified as having water quality problems. For five of the six utilities, two types of treatment were considered. As mentioned earlier, Utility III-1 represents a problem in nitrate removal because the finished water nitrate level is very close to the allowable maximum contaminant level (MCL). The solid lines in Figure 3 depict the historical unit costs for Utility III-1. The dotted line represents the unit costs for the latest year including add-on technology. As can be seen, total unit cost to the consumer will increase by 194 percent. Costs are summarized in Table 9.

Table 8. Utilities Selected for Cost Impact Analysis

Region	Utility	Quality Problems	Hypothesized Treatment
III	1	Nitrate	Ion exchange
V	1	Manganese	Chemical oxidation; ozone
	2	Barium	Zeolite; lime softening
	3	Barium	Zeolite; lime softening
	4	Barium	Zeolite; lime softening
VI	1	Total Dissolved solids & fluorides	Activated alumina; reverse osmosis

In Region V, water utilities V-1, V-2, V-3, and V-4 were selected as representative of problems that could be corrected by additional treatment facilities. Utility V-1, as can be seen, is experiencing manganese problems. Chemical oxidation or ozone was assumed as a treatment technique. Utilities V-2, V-3, and V-4 are experiencing problems with barium removal. For barium removal the recommended treatment technique is Zeolite or lime softening. Table 9 contains the cost estimates for each alternative. Figure 4 shows the increases in unit costs that might result from applying chemical oxidation to Utility V-1. Of course in this case manganese is not one of the contaminants in the Primary Standards but is being considered as a Secondary Standards contaminant.

Utility VI-1 is experiencing problems with removing total dissolved solids and fluorides from the finished water. The treatment technique recommended and presented in Table 8 is activated alumina or reverse osmosis. Figure 5 shows the impact on unit cost from the addition of activated alumina.

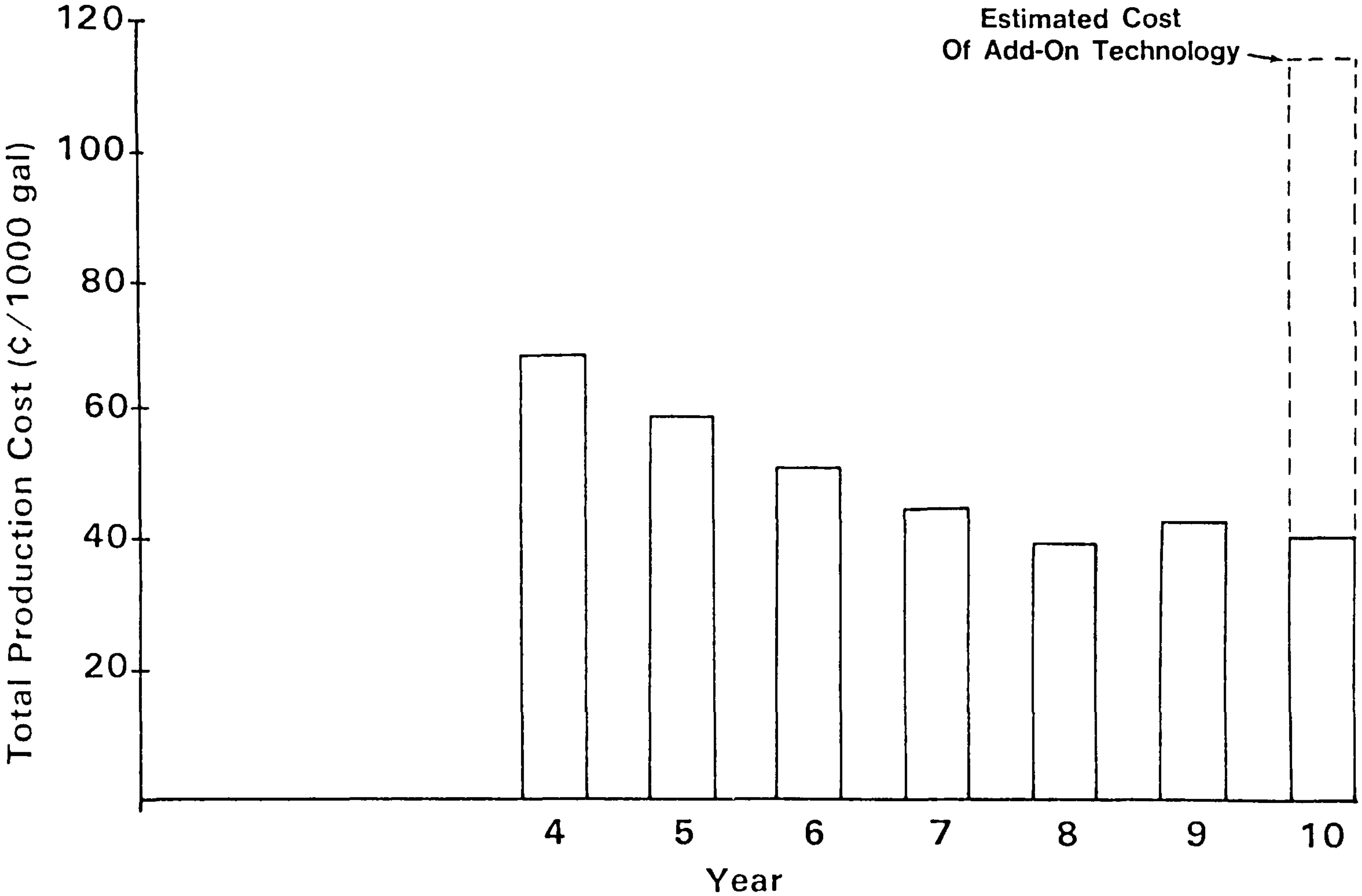

Figure 3. Unit Production Cost for Utility III-1 With Add-On Technology (Ion Exchange NO_3 Removal)

Table 9. Estimated Economic Impacts for Small Systems

Item	Utility III-1	Utility V-1		Utility V-2		Utility V-3	
Water treated (MGD)	0.13	1.17		0.41		0.45	
Revenue-producing water (MGD)	0.11	0.67		0.27		0.34	
Proposed treatment technique	Ion exchange (nitrate Removal)	Chemical Oxidation	Ozonation	Ion-Exchange Softening	Lime Softening	Ion-Exchange Softening	Lime Softening
Construction cost for proposed treatment ($)	101,858	5,913	71,744	137,000	622,152	141,512	643,792
Amortized capital cost for proposed treatment ($) (7% @ 20 years)	9,615	559	6,773	12,934	58,727	13,358	60,769
Annual operations and maintenance cost for proposed treatment ($)	21,074	2,528	7,136	28,547	80,628	30,094	83,462
Total annual cost for proposed treatment ($)	30,689	3,087	13,909	41,481	139,355	43,452	144,231
Current annual total cost for water supply ($)	16,559	299,387	299,387	69,328	69,328	46,470	46,470
Projected annual total cost for water supply ($) (with proposed treatment)	47,248	302,474	313,296	110,809	208,683	89,922	190,701
Current unit cost for water supply (¢/1000 gal)	40.1	121.2	121.2	70.3	70.3	37.4	37.4
Projected new unit cost for water supply (with proposed treatment - ¢/1000 gal)	117.7	123.7	128.1	112.4	211.8	72.5	153.7

Table 9. Estimated Economic Impacts for Small Systems (Continued)

Item	Utility V-4		Utility VI-1	
Water treated (MGD)	0.066		1.08	
Revenue-producing water (MGD)	0.055		0.78	
Proposed treatment technique	Ion-exchange Softening	Lime Softening	Activated Alumina	Reverse Osmosis
Construction cost for proposed treatment ($)	86,518	368,816	180,722	1,129,902
Amortized capital cost for proposed treatment ($) (7% @ 20 years)	8,167	34,814	17,057	106,655
Annual operations and maintenance cost for proposed treatment ($)	12,612	49,170	24,937	204,412
Total annual cost for proposed treatment ($)	20,779	83,984	41,994	311,065
Current annual total cost for water supply ($)	13,078	13,078	231,006	231,006
Projected annual total cost for water supply ($) (with proposed treatment)	33,857	97,062	273,000	542,073
Current unit cost for water supply (¢/1000 gal)	65.2	65.2	81.1	81.1
Projected new unit cost for water supply (with proposed treatment - ¢/1000 gal)	168.6	483.5	95.9	190.4

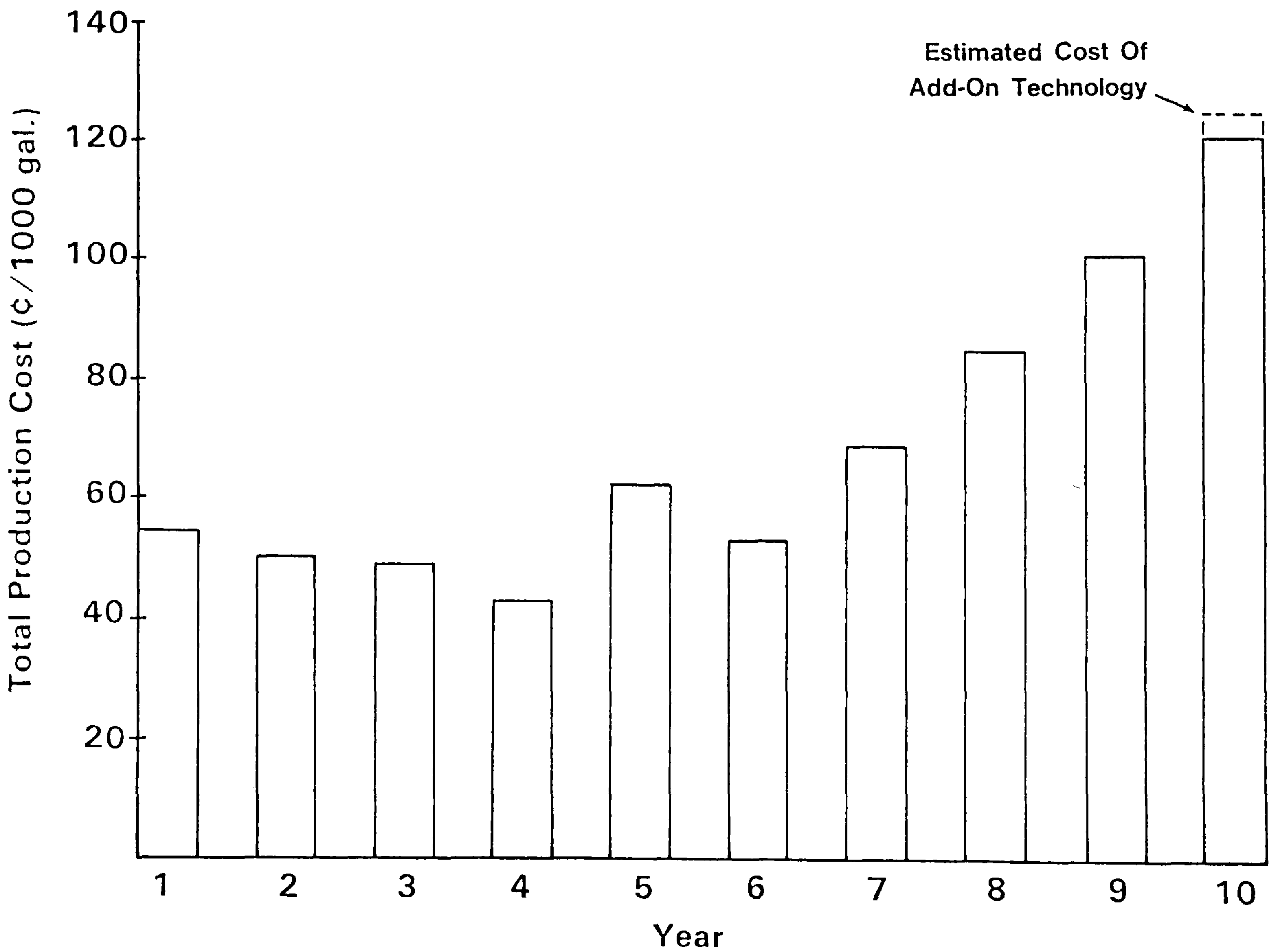

Figure 4. Unit Production Cost for Utility V-1 with Add-On Technology (Chemical Oxidation)

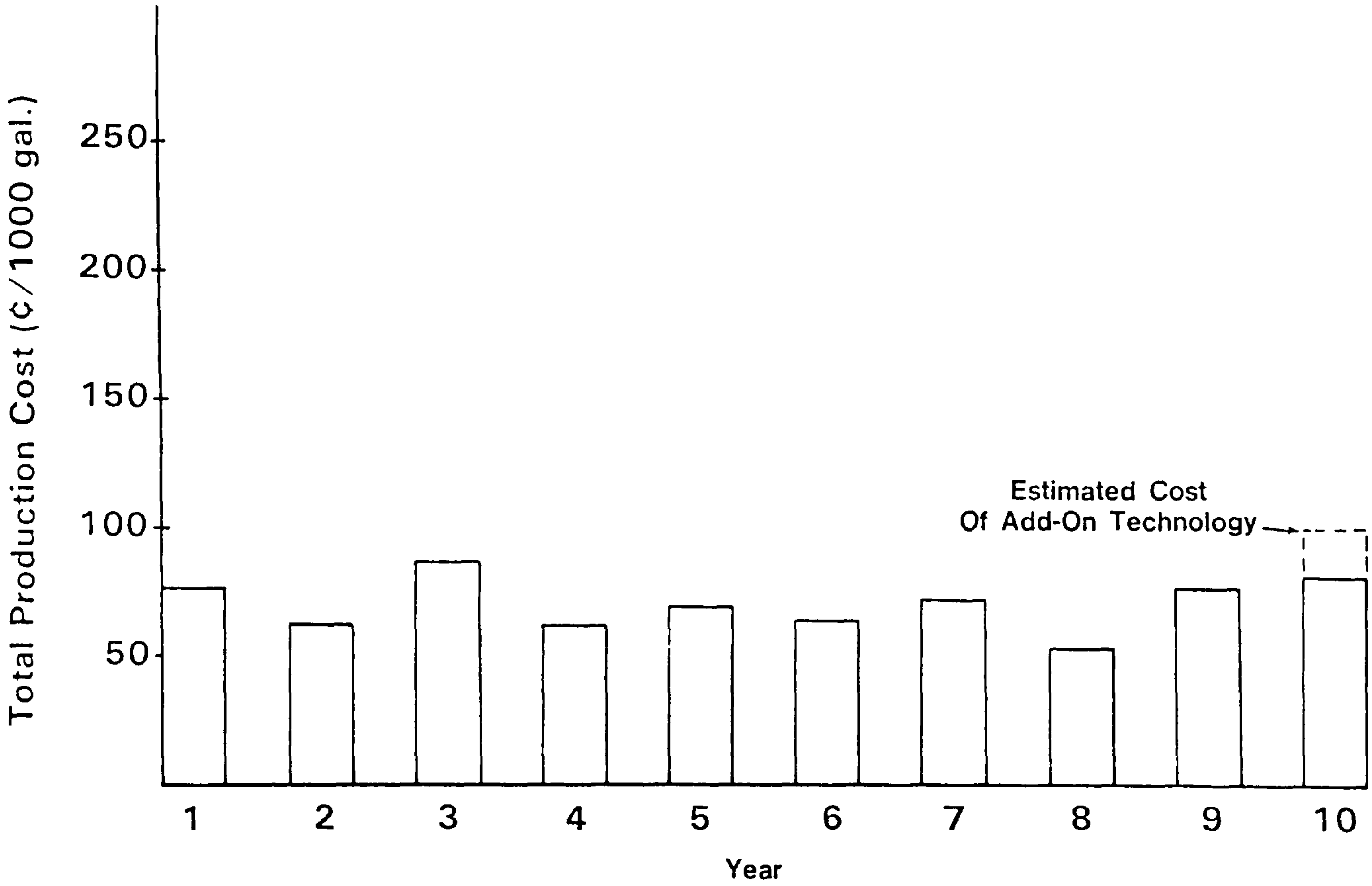

Figure 5. Unit Production Cost for Utility VI-1 with Add-On Technology (Activated Alumina)

This cost impact analysis is hypothetical, and as seen in Table 9, more than one type of treatment may be applied to solve the same problem, but depending on size, the costs associated with each technology can be very different. In Figures 4 and 5 the cheapest technologies were chosen for cost comparison. To properly select a treatment system for any utility requires many more extensive design considerations than is possible here. This analysis does provide, however, some realistic estimates of the potential costs that a small system might incur in attempting to meet the Safe Drinking Water Act requirements. Although current interest has centered on the costs associated with applying treatment technology for the removal of trihalomethanes and synthetic organics, the cost of meeting the existing interim standards in some small utilities may be high.

The solid line in Figure 6 shows the current average unit costs for all of the utilities studied over the 10-year time span. The average unit cost for meeting the standards for all of the utilities is shown by a dotted line in year 10. For the entire sample, the cost is increased by less than 5 percent but, as shown by Figure 3, cost increases for some utilities may be significant.

The above analysis is intended to put the small system problem into perspective. There are many more small than large systems in the United States. Identifying those systems in and out of compliance will be a difficult task. Once the systems are identified and their particular problems categorized, a technological or management solution may be found.

Technological Solutions for Small Systems Problems

Much effort has been and will continue to be expended in attempting to find solutions for small system problems. The problems of individual utilities must be identified. The possibilities associated with using existing or new technology for solving the problems must be explored. Any technology once it is applied must be managed properly to be effective. The following sections will explore these issues.

State and federal efforts at identifying small system problems will be discussed. EPA's in-house small systems research program will be described. Results from a study intended to determine cost effectiveness of package plants in small systems will be presented. Some possible techniques for effectively managing technology, including regionalization and management support systems will also be examined.

Identifying the Problem

Recently, the Farmers Home Administration (FmHA) and EPA signed a joint policy agreement providing priority FmHA funding (grants and loans) to water systems presently unable to meet the health related standards of the Interim Primary Drinking Water Regulations.

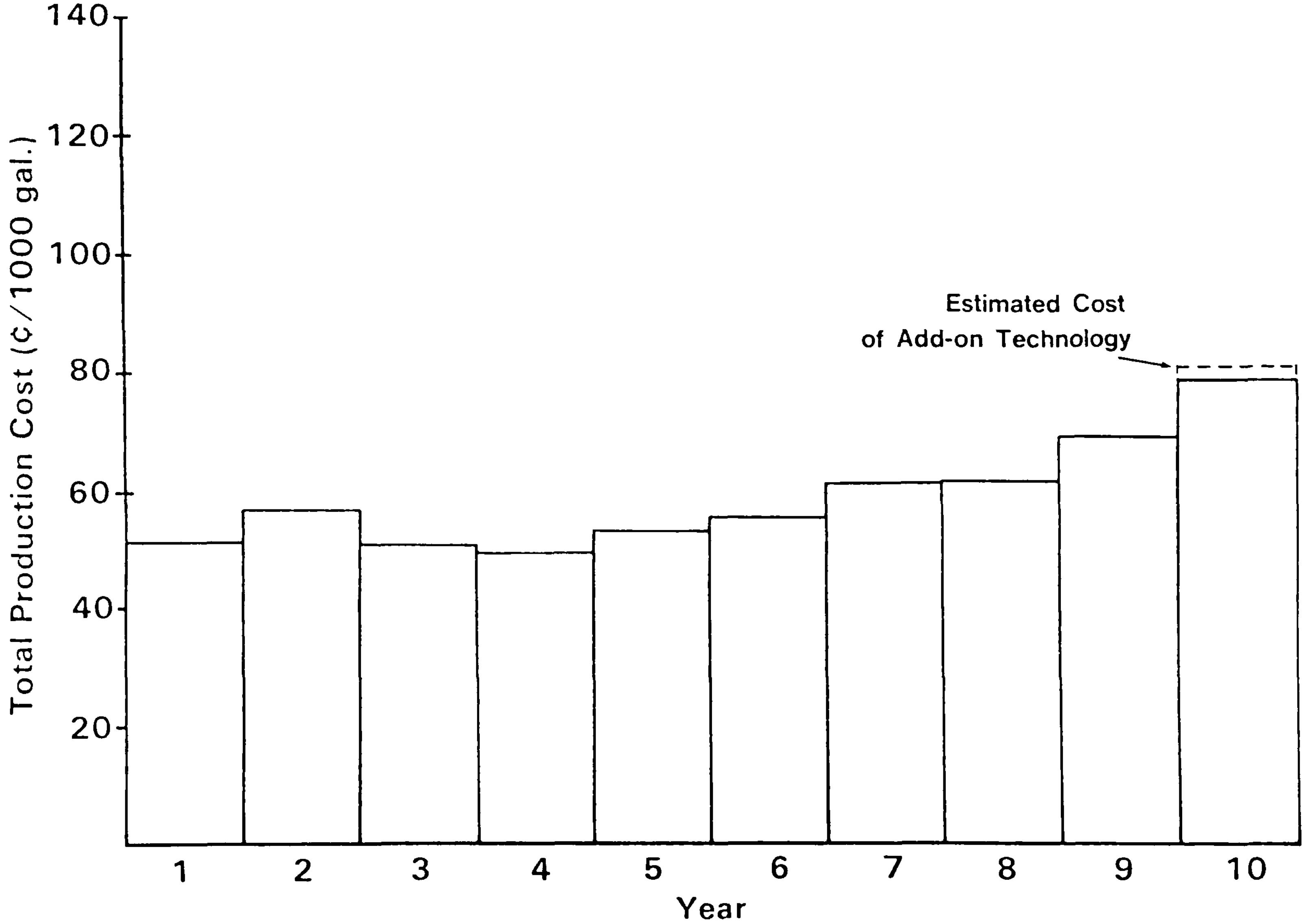

Figure 6. Average Production Cost for All Utilities With Estimated Cost of Add-On Technology

Given the state-of-knowledge concerning small systems and their diversity of problems, a necessary first step in implementing a program is to identify the small systems with compliance problems. The EPA regional offices are developing programs to review the various small systems in their regions for compliance. If they are not in compliance, an effort will be made to determine the reasons. Many of these systems are consistently failing the bacteriological MCL's in the SDWA.

Typical of this kind of effort is a study being initiated by EPA's Region VIII office to review drinking water systems in Utah that serve less than 200 people.[14] The purpose of this study is to document reasons for small systems failing to meet requirements of the SDWA.

The study, handled by contract, will consist of meetings with appropriate federal, state, and local officials, a review of water sources for susceptibility to contamination, review of the distribution system, review of existing bacteriological monitoring programs, and a review of existing chlorination practices. The contractor will prepare a report containing the following information: description of water sources, existing bacteriological monitoring programs, and existing chlorination practices.

From these data regional office personnel can assess the range of problems facing small system managers in their attempt to achieve compliance. Realistic plans can then be made to help bring the problem systems into compliance.

Treatment Technology

As described earlier, many of the problems associated with small systems compliance are related to the proper use of existing technology. EPA is, therefore, conducting research into the various treatment techniques that might be appropriately applied to the broad range of small system contaminant removal problems.

<u>EPA's Small Systems Research Program</u>. Monitoring requirements outlined in the SDWA are leading many small water utilities to sample their water sources for inorganic contaminants for the first time. These monitoring data will no doubt reveal many new problems, particularly for small communities. Upon discovering that their supplies do not meet the regulations, many small communities will very likely first seek an alternative source of supply. If an alternative source is not available, treatment of an existing supply may be considered. In recognition of this problem, EPA's Drinking Water Research Division has been conducting research into removal of inorganic substances, the contaminants most likely to be a problem to these communities. Most of this research has been directed toward the removal of eight heavy metals.

The research program is evaluating the effectiveness of conventional coagulation and lime softening processes for removal of these metals. If they are found to be ineffective, then ion exchange and reverse osmosis will be examined. Research is conducted in two phases: 1) a series of laboratory jar tests to determine the critical variables, such as pH, coagulant type and dose, and contaminant concentration, affecting the removal of contaminants from water, and 2) pilot plant tests to verify laboratory results. Results from these studies have been presented in a series of papers.[15,16,17] Other current research relates to removal of organics and radioactive substances in small systems.[18]

Point of Use Technology. Point-of-use alternatives can provide treatment to either one or a small number of homes. For single contaminant removal, a frequent problem in very small systems, these alternatives may be economically feasible. Figure 7 shows comparative costs for a package plant softening system and an ion-exchange softening system.[12] As can be seen by the dotted lines at 0.075 mgd and 0.20 mgd, the single purpose ion-exchange softening system is considerably cheaper at small flows than is the package plant softening system. But as capacity increases Figure 7 shows that the curves come together and will eventually cross. This analysis points to the possibility that special purpose point-of-use units might be more economical at low capacity requirements than more conventional units. EPA is currently conducting research into the microbiological characteristics of point-of-use systems for individual home use. Preliminary analysis indicates that these household systems may have problems.[19]

Package Plant Technology. Package water treatment plants, consisting of prefabricated and largely preassembled clarification and filtration units, are commonly used in some sections of the United States by small water systems. EPA has recently completed a systematic study of the cost effectiveness of existing package water treatment plants. Visits were made to 36 package plants in Kentucky, West Virginia, and Tennessee. Of the 36 plants visited, data from 31 municipal and recreational plants were used for analysis.

The survey data demonstrate that package plants can meet traditional treatment goals for bacteriological removal and turbidity. Plants that were not meeting the National Regulations had problems caused by lack of operator attention, e.g., not varying chemical dosage to meet changing raw water quality, or they were not running for lengths of time sufficient to achieve stable operation. Many automatic features, such as backwashing, were neither installed nor used in many cases because operators were reluctant to rely upon them or felt them to be untrustworthy.

Eight of the plants did not meet the federal turbidity standard of 1 NTU. Table 10 lists the number of plants treating different ranges of raw water turbidity and whether or not they met the standard. One plant not meeting the 1 NTU standard used no chemical coagulants at all and is

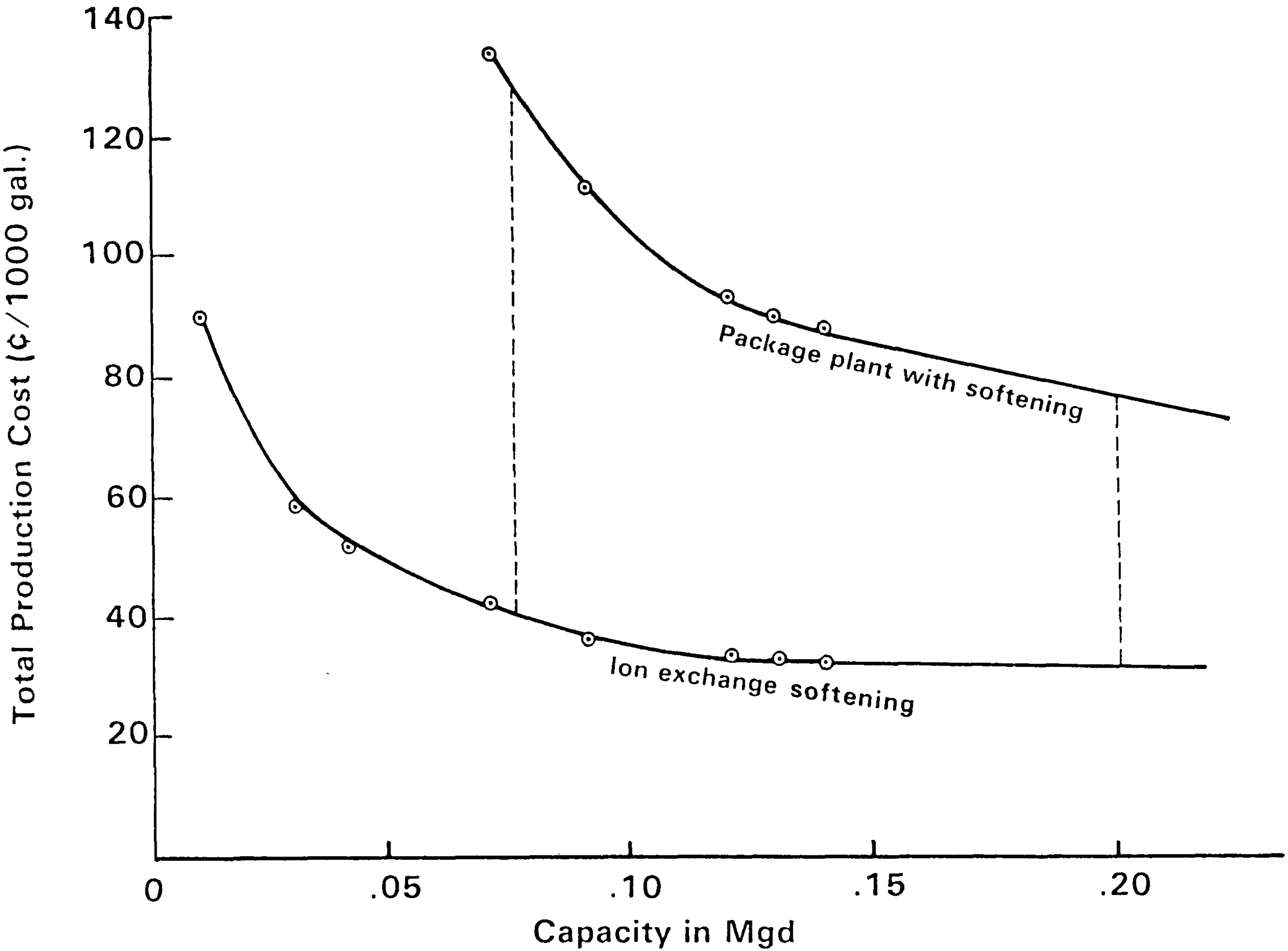

Figure 7. Comparative Costs of Package Plant and Ion Exchange Softening Systems

Table 10. Turbidity Measurements

Turbidity of Source NTU	Number of Plants	Finished Water ≥ 1 NTU	> 1 NTU
≤ 5	14	11	3
6 - 15	8	8	0
16 - 50	6	2	4
51 - 100	0	0	0
> 100	2	2	0

not included in the table. Of the plants not meeting the standard, only one operated more than four hours per day. The others not meeting the standard were oversized and thus were turned on and off throughout the day.

Samples were analyzed for trihalomethanes. Each sample was handled in such a way as to allow maximum contact times for THM formation. Chloroform was the only THM found, with one exception where dichlorobromomethane was also detected. No trihalomethanes were detectable in any finished water from the three plants treating well water.

Using the data from this study, researchers have developed statistical relationships suggesting that package plant systems can achieve cost economies in design and operation. From this analysis, their cost effectiveness in treating raw water may be compared to conventional treatment for small systems.

A few selected results give an indication of the existence of cost economies (standard errors in parenthese indicate significance at the 0.01 level):

$$UC_1 = 9556.8\ Q^{\underset{(0.043)}{-0.72}} \qquad (R^2 = 0.64) \qquad (5)$$

$$UC_2 = 17753.\ Q_A^{\underset{(0.057)}{-0.59}} \qquad (R^2 = 0.65) \qquad (6)$$

$$TC = 10739.7\ Q_D^{\underset{(0.064)}{0.65}} \qquad (R^2 = 0.76) \qquad (7)$$

where Q_A = actual flow (million gallons/year)

Q_D = design flow (million gallons/year)

UC_1 = total unit treatment cost ($/million gallons)

UC_2 = total system unit cost ($/million gallons)

TC = total package plant construction cost ($)

Figure 8 shows the total unit treatment cost for package treatment plants. Equations 5, 6, and 7 clearly indicate that economies of scale in capacity and costs exist for package plants built and operated in a range less than or equal to one mgd. In addition, a comparison of construction costs for a one mgd plant is provided in Table 11. This indicates that, based on construction costs alone, package plants appear to be a workable alternative for small systems.

Table 11. Construction Costs for 1 mgd Plant

Plant Type	Total Construction Cost
Conventional	$1,124,000
Package Plant	497,000

A conclusion of this study is that package plants not only can produce water for small communities that will meet the requirements of the national regulations, but also they can reduce the cost impact on small systems unable to achieve scale economies with conventional treatment. In addition, municipalities can, in many cases, purchase the proper capacity plant and do the necessary construction and connections for installation themselves.

Innovative Approaches. Many examples exist of citizens in small communities banding together to solve their water supply problems.[20] In some cases volunteers may help lay pipelines or prepare a treatment plant site or actually manage the water system. Citizens working with a sympathetic consulting engineer can often acquire an effective water treatment system at a very reasonable price.

Management of Technology

In addition to appropriate treatment technology, there are management techniques that might be applied to small systems. For example, the circuit rider concept has been proposed in which service would be provided to several plants that cannot individually afford a certified operator. The circuit rider would provide attention to a number of plants and his salary would be shared among them.

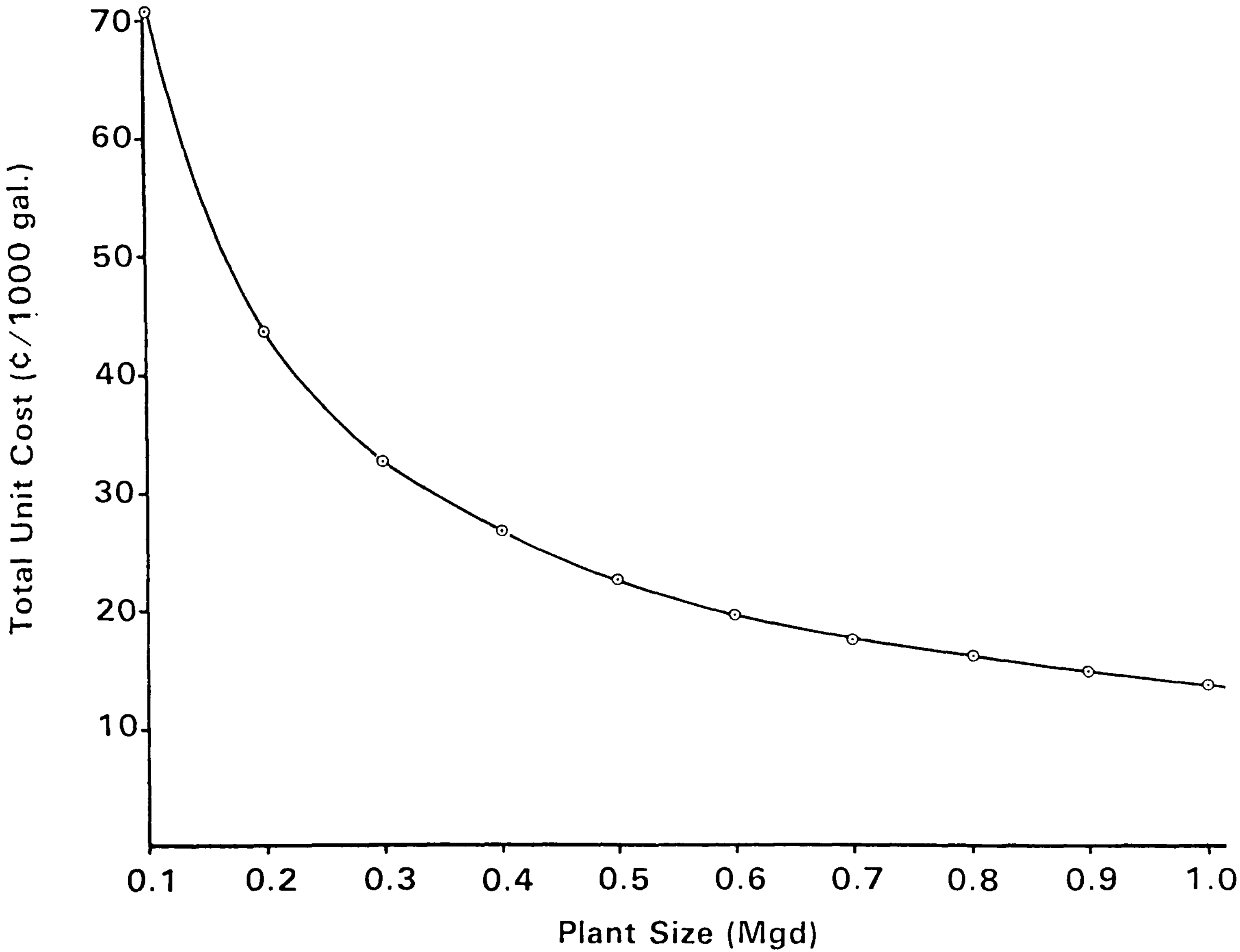

Figure 8. Total Unit Treatment Cost for Package Systems

As determined by EPA's small systems studies conducted in Regions III, V, VI, IX, and X, there is a noticeable lack of consistent and reliable data upon which one can make realistic decisions. In order to correct this deficiency, EPA is conducting research into the development of cost accounting systems that can be utilized by small system managers to manage existing and new technology more efficiently. EPA's survey of individual small water supplies found that records frequently were not kept on basic operating and capital expenditures. Often, when records were kept, they were retained as part of an overall municipal accounting system. Many times the municipal water supply managers kept no depreciation records and therefore based their charging schedule on operating and maintenance costs or on what an adjacent municipality was charging for water. When capital was required, it was often "folded in" with general municipal bond requests.

Cost Accounting Systems. One of the major problems associated with small systems is that of obtaining reliable cost data. Many small system problems could be resolved if the proper data existed to help managers in planning for new technology. A major tool in achieving cost effective management is a standardized cost accounting system.

EPA is attempting to assist small systems in meeting their management responsibilities by developing such a system. The system has been successfully implemented in Kenton County, Kentucky, and is designed to use the utility's existing chart of accounts and to determine costs on both a responsibility and product-costing basis. The following are six inputs to the system: payroll, work orders, inventory/material, accounts payable, property records (capital equipment), and billing information.

Using these inputs, costs may be assigned by major function within the utility: acquisition, treatment, delivery, support services, interest, and taxes. These costs are also allocated by service zone so that the manager can tell not only what his major cost centers are, but where they are occurring in the system.

Costs may be aggregated by major service function and area and engineering component as well as by organizational element. The utility manager can therefore determine his actual cost of service.

Once the cost accounting data base has been developed, financial reporting can become part of the accounting system. Financial reports can be generated that will allow the system manager to accurately assess the current and projected status of his system.

Regional Management. In some cases, a small community can join with other small communities or with a larger community to form a regional water supply. This concept is usually referred to as regionalization.[21] Two approaches can be considered when attempting to develop a regional compact or system. One approach involves the centralization of purchasing, maintenance and various management support items. Results from a series of utility case studies show that the management function for utilities exhibit economies of scale, as shown in the following equation:[3]

$$S_c = 141\, Q^{0.95} \qquad (R^2 = 0.94) \tag{8}$$

where S_c = The cost of support services or management in dollars/year

Q = Revenue-producing water in million gallons/year

Because the exponent of Q is less than 1, economies of scale exist in the management function.

Another approach involves physically interconnecting existing systems. The Safe Drinking Water Act, along with other environmental legislation, encourages the development of regional systems for managing water supplies. Regionalization has great appeal to regulatory groups because it reduces the number of individual entities with which they must work. Tables 4, 5, and 6 demonstrate that small systems tend to have more quality control problems than do large systems. A common argument is that regional systems hydraulically interconnected exhibit economies of scale, thereby minimizing costs to the consumer. The following section examines some of these issues.

Hydraulically Interconnected Regional System. The economies of scale argument holds for a limited set of circumstances, as demonstrated by the following data. Figure 9 shows unit costs of water treatment uncorrected for inflation for the Fairfax County Water Authority (Virginia) and for four other utilities over a 10-year period. The Fairfax County Water Authority was developed by acquiring individual water service areas around the original Alexandria Water Company and, as such, has become a regional water supply utility. These data support an economies of scale argument. Compared to the other nonregional utilities, the unit costs for the Fairfax Authority continuously declined between years 1 and 5, the periods of maximum growth. On the other hand, research conducted by EPA indicates that limitations to the economies of scale associated with regionalization may exist. In order to study the effect of regional solutions, EPA investigators have developed a computer simulation model for a municipal water utility. The cost output from the model may be employed to analyze the cost trade-off between the central plant and decentralized transmission components of a water utility.[2,3,22] Based on EPA in-house research, the total unit cost equation for water supply is:

$$TUC = 512.6 \left\{\frac{2\pi CK}{\lambda^2}\left[1-e^{-\lambda}(1+\lambda d)\right]\right\}^{-0.23} + 408.1\left[(CK)^{-0.18}\, e^{0.18\lambda d}\right] \tag{9}$$

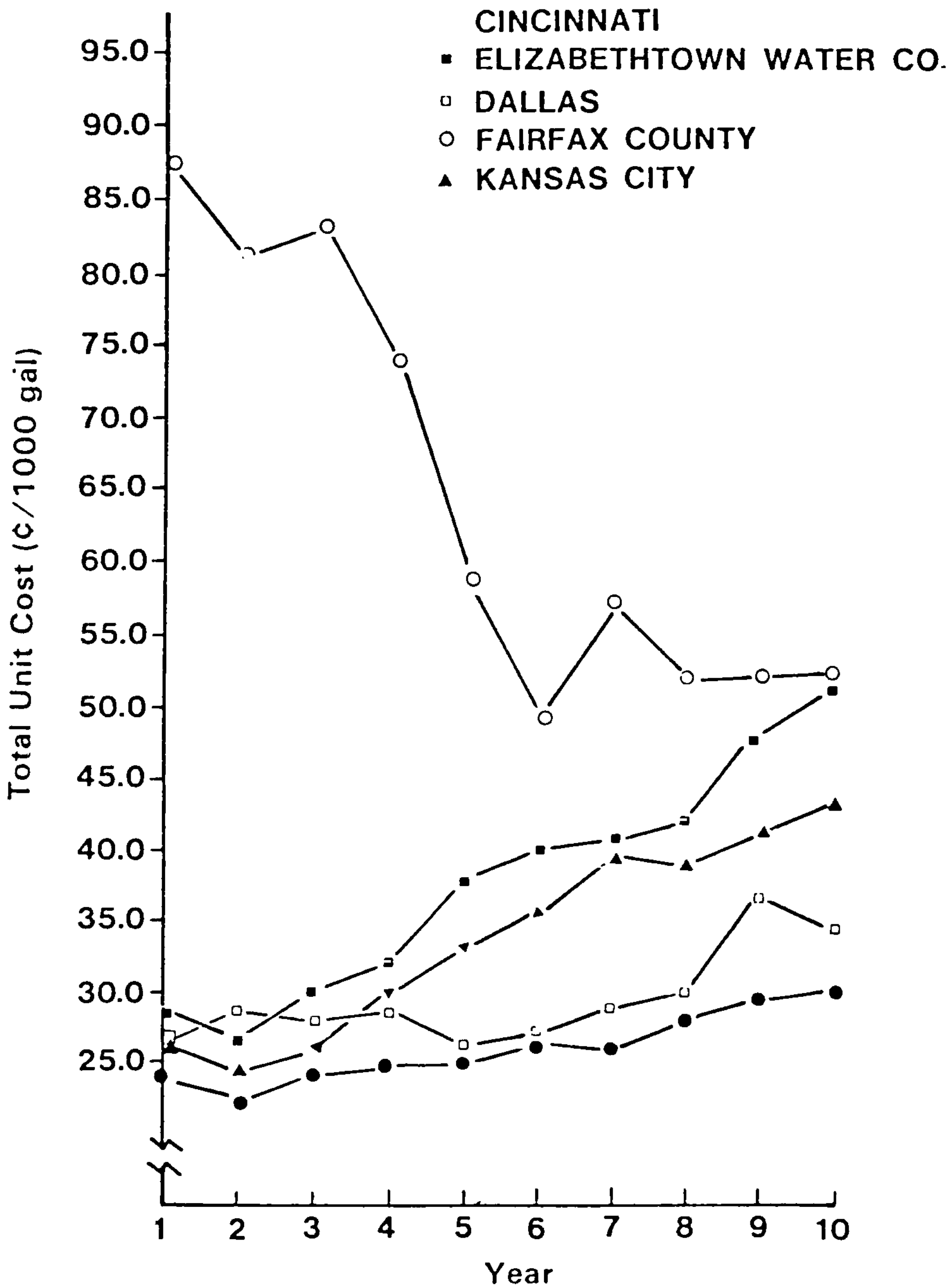

Figure 9. Total Unit Cost for Five Utilities

where TUC = total unit cost for water service in \$/million gallons.

C = yearly per capita consumption in million gallons.

K = initial population density at a reference point.

λ = percent change in population density over distance.

d = distance in miles from a central reference point.

The following typical values were assumed to illustrate the trade-off between cost and distance for a water supply service area:

C = 0.05475 million gal/capital year

K = 15,000 people/sq mi

$\lambda = 0.12$

Figure 10 shows how the unit cost varies over the service area with respect to the distance the water must be transmitted. As can be seen, the unit cost decreases until the 7 mile point, and then rises rapidly along this line as both quantity distributed and distance to the service area change. Figure 10 clearly shows that there are limitations to the least-cost size of a water utility service area. This demonstrates that a minimum unit cost of supply exists in relation to distance. The implication for regional water supply is that economies of market area gained by a centralized plant dissipate in the transmission/distribution system at about seven to eight miles from the plant. After that point, unit costs continue to rise. Therefore, regionalization of water utilities may not be a priority justified by the economies of scale argument. It depends upon how close the respective utilities are, as well as the difference between marginal costs of add-on treatment technologies and the additional costs of transmission/distribution system expanded to link the utilities.

Summary and Conclusions

Over 90 percent of the nation's supplies serve fewer than 10,000 people, but provide water to less than 25 percent of the total population served by community systems. Small systems in many ways are the victims of their size. They cannot benefit from economies of scale as large urban systems do because of their small number of connections. Small systems also seem to suffer from an inordinate number of finished water quality problems. All of these factors are compounded by the pressure for increasing water quality standards as exemplified by the Safe Drinking Water Act.

Based on results from an EPA study, the incremental unit costs of technology may be high for small systems that are forced to install new treatment systems. Many efforts are under way to find cost effective technological solutions for small systems problems. Surveys are being

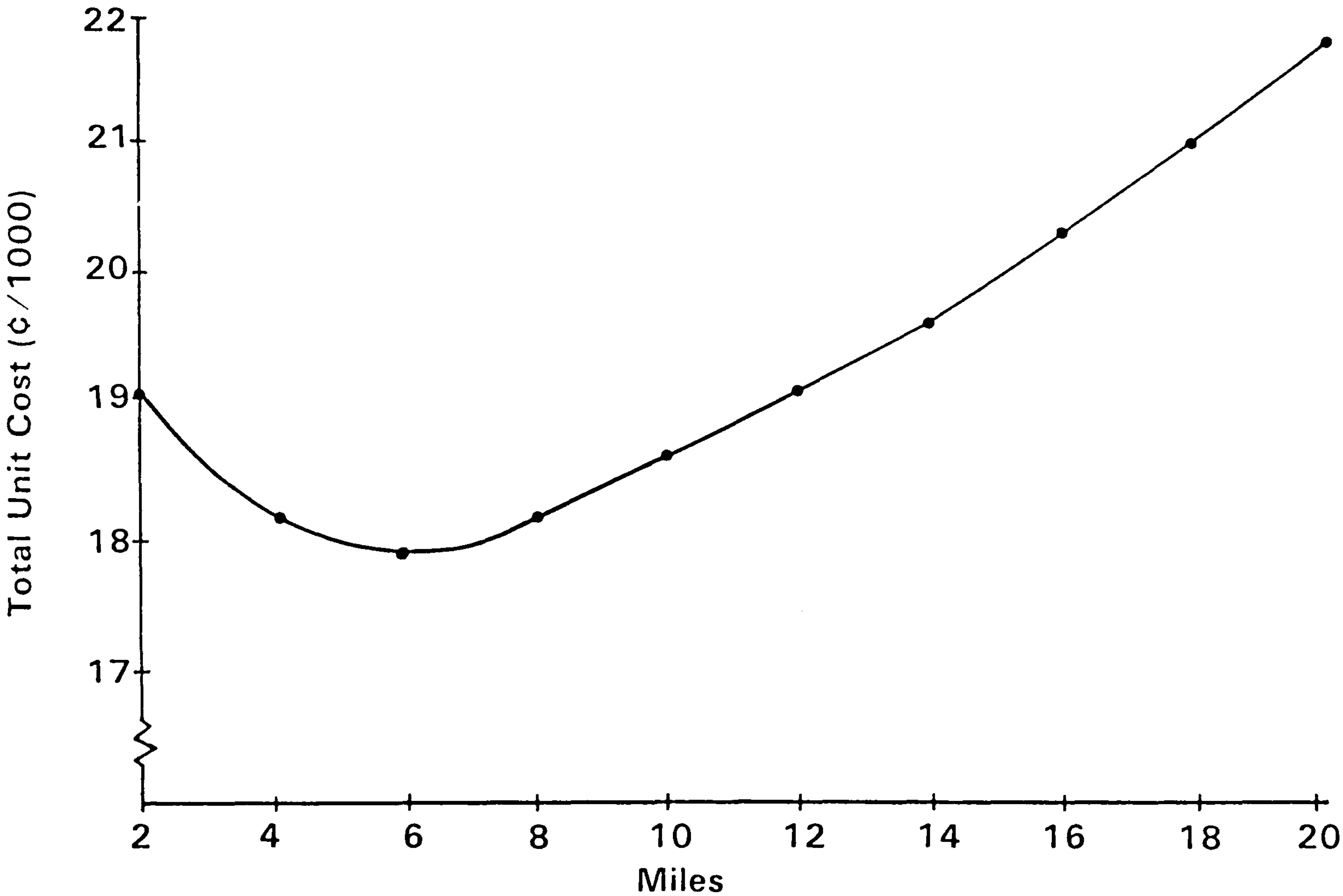

Figure 10. Cost of Water Versus Distance Transported

conducted by states and the EPA regional offices to more clearly define the compliance deficiencies. EPA is conducting research into technology for removal of specific contaminants, a problem frequently found in small systems. Package plants appear to be cost effective means of removing contaminants. Point-of-use systems may have limited application, and of course there are many possibilities for innovative solutions to small systems problems. Proper management of technology is another problem facing small systems. The circuit-rider concept, cost accounting systems, and regionalization may all play a part in solving small system problems.

Although helping small utilities achieve compliance with the Safe Drinking Water Act may be one of EPA's major problems, all is not hopeless. As seen by the results of the study cited earlier, only six out of 23 utilities studied had problems and needed technological solutions. Also several solutions are often available. Examination of Table 9 shows that five of these utilities probably are undercharging for water as compared to the data contained in Table 3. Even though cost increases are significant on a percentage basis, when calculated as a cost per family per month, the increases are not so dramatic. Table 12 summarizes these comparisons. Many small systems failing the national standards are not necessarily exceeding the MCL's, but simply are not monitoring their water adequately.

Above all, EPA must understand the diversity of problems that affect the ability of small systems to comply with standards promulgated under the Safe Drinking Water Act. Only with proper understanding can EPA develop a flexible and realistic policy concerning small systems and their problems. Achieving compliance will be a difficult and demanding, but not insurmountable, task.

Table 12. Comparison of Compliance Costs

Utility	Average Cost* of Small System Water Supply (¢/1000 gal)	Current Cost for Utility (¢/1000 gal)	Projected Cost for Utility (¢/1000 gal)	Increased Cost** per Family per Month ($/month)
III-1	85.4	40.1	117.7	9.44
V-1	85.4	121.2	123.7	0.30
V-2	85.4	71.5	112.4	4.98
V-3	85.4	37.4	72.5	4.27
V-4	85.4	63.8	168.6	12.75
VI-1	85.4	80.9	95.9	1.82

*Table 3

**Assumes a family of four consuming 100 gallons per capita per day.

Acknowledgements

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References

1. *Federal Register*, Vol. 40, No. 248, Wednesday, December 24, 1975, "National Interim Primary Drinking Water Standards," pp. 59582-59583.

2. Orlob, G.T., and Lindorf, M.R., "Cost of Water Treatment in California," *Journal of the American Water Works Association, 50* (January 1958), pp. 45-55.

3. Clark, R.M., Gillean, James I., and Adams, W. Kyle, *The Cost of Water Supply and Water Utility Management,* Vol. I and II, Water Supply Research Division, Municipal Environmental Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268, EPA-600/5-77-015a & b, November 1977.

4. Clark, Robert M., "The Safe Drinking Water Act: Its Implications for Planning," in *Municipal Water Systems: A Challenge for Urban Resource Management,* edited by David Holz and Scott Sebastian, Indiana University Press, February 1978, pp. 117-137.

5. McDermott, James H., "Federal Drinking Water Standards - Past, Present, Future," *Journal of the Environmental Engineering Division,* ASCE, Vol. 99, No. EE4, Proc. Paper 9924, August 1973, pp. 470-471.

6. Craun, Gunther F., and McCabe, Leland J., "Review of the Causes of Waterborne-Disease Outbreaks," *Journal of the American Water Works Association,* Vol. 65, No. 1, January 1973, pp. 74-84.

7. Community Water Supply Study: Analysis of National Survey Findings, U.S. Department of Health, Education, and Welfare, Public Health Service, Environmental Health Service, Bureau of Water Hygiene, July 1970, p. i.

8. *Ibid.*, p. ii.

9. *Ibid.*, p. v.

10. *Ibid.*, p. vi.

11. National Interim Primary Drinking Water Regulations, U.S. Environmental Protection Agency, Office of Water Supply, EPA-570 19-76-003.

12. Gumerman, Robert C., Culp, Russell L., and Hansen, Sigurd P., *Estimating Costs for Water Treatment As A Function of Size and Treatment Efficiency*, Drinking Water Research Division, Municipal Environmental Research Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268. EPA-600/2-78-182, August 1978.

13. News of the Field - Update, *Journal of the American Water Works Association*, 70 (September 1978).

14. Personal communication with Dean Chausse, EPA Region VIII Office, and Bernard Sarnoski, EPA Region III Office.

15. Sorg, Thomas J., "Treatment Technology to Meet the Interim Primary Drinking Water Regulations for Inorganics," *Journal of the American Water Works Association*, February 1978, pp. 105-112.

16. Sorg, Thomas J., and Logsdon, Gary S., "Treatment Technology to Meet the Interim Primary Drinking Water Regulations for Inorganics: Part 2," *Journal of the American Water Works Association*, July 1978, pp. 379-393.

17. Sorg, Thomas J., Csanady, Mihaly, and Logsdon, Gary S., "Treatment Technology to Meet the Interim Primary Drinking Water Regulations for Inorganics: Part 3, Cadmium, Lead, and Silver," unpublished.

18. Sorg, Thomas J., Forbes, Robert W., and Chambes, David S., "Removal of Radium-226 from Drinking Water by Reverse Osmosis in Sarasota County, Florida," unpublished.

19. Personal Communication with Raymond Taylor, Drinking Water Research Division, MERL, USEPA, Cincinnati, Ohio 45268.

20. Personal Communication with Floyd Taylor, EPA, Region V Office.

21. Kneese, Allen V., "Analysis of Environmental Pollution," in *Economics of the Environment*, edited by Robert Dorfman and Nancy S. Dorfman, W. W. Norton & Co., New York, 1972, pp. 21-44.

WORK GROUP REPORTS

Introduction

During the afternoon of the symposium's first day, the participants formed into seven work groups, each addressing a specific problem facing small water systems. These groups were:

1. Technology/Modifications
2. Training/Technology Transfer/Technical Assistance
3. Consultant/Manufacturer/State Relations
4. Regionalization/Water Service Company/Circuit Rider
5. Point-of-Use Alternatives
6. Options for Regulating Small Systems
7. Financing Problems and Solutions

Each work group examined its topic in light of problems of small public water systems, discussed possible solutions, and offered recommendations for future action by the affected organizations. This section contains the reports of each work group. Prior to each report, the chairman, recorder, and discussants for the group are listed.

WORK GROUP REPORT ON

TECHNOLOGY/MODIFICATIONS

Chairman: Dr. Robert Baumann
Iowa State University

Recorder: Patrick M. Tobin
Office of Drinking Water
Washington, D.C.

Discussants: Thomas Sorg
U.S. Environmental Protection Agency

Dr. James Morand
University of Cincinnati

Henry Miller
Neptune Microfloc, Inc.

Dr. Nina McClelland
National Sanitation Foundation

The technology and modifications work group was responsible for examining the availability of treatment technology, identifying problems that limit its application, suggesting modifications, and providing an array of alternatives/recommendations to encourage small water treatment systems to employ the necessary technology to meet the requirements of the Safe Drinking Water Act.

Numerous studies have shown that small water systems (serving less than 1,000 people) are most often not in compliance with requirements of the Safe Drinking Water Act. However, further examination reveals that many of these systems are out of compliance because of a failure to either monitor or properly report results rather than for not meeting an MCL. Therefore, better education and proper bookkeeping procedures would be a major step forward in bringing many of the small systems into compliance.

Treatment technologies to reduce or remove a large variety of drinking water contaminants are readily available. However, in most instances, both capital and operational costs prohibit installation of this technology. In addition, state and local treatment design requirements often act as a disincentive for industry to develop alternative technologies. Although the primary drinking water standards are important from the public health perspective, many small water systems experience aesthetic problems with their drinking water and often these small communities seek new sources of water that may be of inferior quality, but more aesthetically pleasing.

In addition, the sizing of a distribution network for fire fighting protection in systems serving populations less than about 2,000 generally appears to be the overriding cost consideration when compared to the costs for providing just potable water to the consumer.

With this in mind, the work group examined the available technology and its performance capabilities, package water treatment systems, institutional constraints on developing and accepting new technology, and alternative treatment methods that may result in the acceptance and installation of the technology.

Discussion

After examining inorganic contaminants and their relationship to the drinking water source (surface versus ground), the group suggested several treatment technologies for the following contaminants occurring naturally in ground waters: arsenic, barium, fluoride, mercury, nitrates, selenium and radium 226. Some of these are listed below:

Treatment Technology	Substance Removed
Conventional Coagulation	Metals
Softening	Metals, including radionucleides
Activated Alumina	Selenium, Arsenic, Fluoride

Treatment Technology	Substance Removed
Reverse Osmosis	Metals, Nitrates, Fluoride
Reverse Osmosis (field study)	Radium-226
Ion Exchange	Nitrates

Chromium-6, mercury, and selenium-6 are some of the most difficult inorganic contaminants to remove. Research studies indicate that pH control is an important parameter in efficient removal of these chemicals. In addition, reverse osmosis is a practical treatment technique, especially on those water sources with high levels of radium. Well over 200 such systems have been installed in Florida. However, disposal of reverse osmosis reject water continues to be a difficult operational problem. Although reverse osmosis can be used for nitrate removal, anionic exchange is the most efficient and available treatment technique at this time.

For small systems using surface water sources, package treatment plants can provide adequate treatment. Studies have shown that package plants have relatively little decrease in efficiency after ten years of operation. Alum and alum plus polyelectrolytes are the most common chemicals used for suspended solids removal in these plants. Chlorine is generally used for disinfection. In most cases, package treatment plants operating with these chemicals and using chlorine as a disinfectant can meet coliform and turbidity requirements.

Regarding package treatment plants, the work group suggested that more independent data be developed on detention time and effective overflow rate and their correlation with water quality; direct filtration design criteria; filter media design and associated chemical costs; effluent quality as a function of filtration rate; and mixing time versus energy consumption.

Many surface water package treatment plants for small communities are designed to be on-off plants with no need to set chemical feeding frequently. Turbidity monitoring can be a control mechanism for plant start-up or shut down. Such a plant can be designed to have automatic backwash and can be factory assembled and tested. The work group suggested that chemicals be premixed to ensure proper usage. In addition, every operator should have adequate training, and a competent trouble shooter (a consultant, plant operator located elsewhere, or state or federal employee) should be available to help with unusual operating difficulties. The work group felt that treatment equipment should be designed to meet minimum water quality standards and not be subject to rigidly-controlled engineering design parameters such as detention time and filtration rate.

The work group recommended a package treatment system testing and demonstration program. A third party testing and evaluation program would appear to be appropriate. A standard performance evaluation program could be established by using committees composed of representatives from academia, regulatory agencies, manufacturers, and users. State and local governments could establish requirements for an independent approval mechanism. Industry could back the operation of package treatment plants with a guaranteed performance bond over a specific period of time.

Another item discussed by the group was the need to monitor the stability of water after treatment. Unstable water can lead to the leaching of heavy metals, corrosion, and the release of asbestos fibers from the distribution system. Standardized monitoring testing such as the calcium carbonate deposition test (CCDT) can be used to measure water stability.

The work group discussed that the primary concern should not be just the interim primary drinking water regulations (health-based standards) but the aesthetic quality of the water as well. Some people may choose aesthetically pleasing, but unsafe sources of water. Therefore, point-of-use treatment systems for public supplies may be the only applicable treatment and, perhaps, the most cost effective solution for some of these supplies. For improving the aesthetic quality of drinking water most of the economically feasible, customer desired package treatment systems are already in operation. This existing treatment technology is being applied for removal of iron, manganese, and suspended solids and for disinfection.

The major limitations in attaining the NIPDW standards by using existing package treatment technology applied for improved aesthetic water quality include the new proposed requirements for organic contaminants and some traditional inorganic standards for such metals as selenium, arsenic, barium, and mercury. The technology application parameters and treatment effectiveness of package plants along with other factors are either unknown or unclear.

Industry has not moved forward on new technology development and is apparently handicapped from new development for several reasons:

1. Market potential unknown;

2. Regulatory agencies tend to regulate both:

   (a) the quality, and
   (b) the process requirements to achieve quality.

Where there is no nationwide demand and a limited market, there will be a need to provide incentives in order to install the necessary technology. Such incentives will be needed for isolated cases to defluoridate water supplies, to reduce nitrate concentrations, or to achieve a specific MCL.

The work group discussed several approaches to technology application. The following three conceptual approaches were examined:

1. Conventional approach--a complete water system to provide distribution, fire protection, and treatment. This system is custom-designed by professional engineers.

2. Dual Systems approach:

   (a) one system of high quality water for potable uses;
   (b) one system for other uses (car washing, watering lawns).

3. Single system, excluding fire protection where two theoretical designs could be used:

   (a) central treatment composed of a package or a custom system for general treatment, or
   (b) a partial central treatment system in conjunction with point-of-use systems for specific contaminants such as organics and metals.

In deciding on the proper treatment application, small system operators confront two major questions:

1. What technology is applicable that can produce the required water quality?

2. How can the technology be applied at a cost that can be afforded by the system's customers?

The work group felt that costs will lead to the utilization of package treatment plants. Such plants will necessitate a system for equipment/process evaluation and approval.

The work group also felt that cost will and probably should lead to turnkey approaches. Such approaches will require delineation of design, construction and operation by either federal, state or regional authorities. In addition, the use of circuit riders or an on-call consulting engineer' or chemist for trouble shooting must be considered to ensure proper plant operation. There would appear to be a greater problem with monitoring rather than plant operation. For most small systems, the problem is knowing when, where, and why to sample. Because of this monitoring inadequacy, although not a consensus of the work group, there was strong opinion that either the states or the federal government should develop programs for sampling of small water treatment systems.

Conclusions and Recommendations

Federal Government

-- Industry should be provided with a knowledge of the market: number of systems out of compliance by contaminant and size of system.

-- Support should be given for technology development of innovative processes that do not have sufficient market for development by industry.

-- A standard performance testing program should be established for new processes or package plants to justify adoption for treatment applications.

-- Technology transfer should be promoted to disseminate information on applicable technology for removal of various contaminants, including data about process variables, effectiveness, costs, and design guidelines.

-- Guidelines should be published as to the proper decision-making processes to be followed in evaluating small water systems that:

- Provide for custom-designed, complete treatment needed to meet all quantity/ quality requirements;
- Provide for only the delivery of potable water excluding fire protection capabilities;
- Provide for dual water treatment versus using central treatment systems under two conditions:

  (1) conditions with treatment at source or
  (2) using systems with the only treatment (other than disinfection) at point-of-use.

-- The cost and effectiveness of point-of-use treatment systems should be evaluated.

State Government

-- In evaluating water treatment systems states should establish equipment performance specifications rather than rely on traditional design specifications such as rates of filtration and detention time.

-- Because of the limited training currently reaching the small system operator, he or she is often not meeting new sampling and monitoring requirements. A solution to this problem may be that sampling programs for such systems could be conducted by either the state or by EPA in those states that do not have primacy.

Manufacturers

-- Manufacturers should encourage adoption of new technologies based on process review and field prototype evaluation.

-- Manufacturers should support the operation of their package treatment system by providing a reasonable performance bond.

Utilities

-- If in any public water system point-of-use treatment systems are used to meet drinking water standards, such point-of-use systems should be owned and maintained by the water utility serving that public.

WORK GROUP REPORT ON

TRAINING/TECHNICAL TRANSFER/TECHNICAL ASSISTANCE

Chairman: David B. Preston
Executive Director
American Water Works Association

Recorder: Jack W. Hoffbuhr
Chief, Water Supply Section
U.S. Environmental Protection Agency, Region VIII
Denver, Colorado

Discussants: Mildred Matters
Arizona Department of Health
Phoenix, Arizona

Wilbur J. Whitsell
Office of Drinking Water
Cincinnati, Ohio

Douglas Oberhamer
Water Quality Association
Lombard, Illinois

With passage of the Safe Drinking Water Act and the numerous challenges facing water supply systems, effective training of water utility personnel is becoming increasingly important. This is especially true for small water systems since they generally have the greatest difficulty in meeting safe drinking water standards.

The work group's purpose was to discuss successes and failures of current training efforts in order to recommend actions needed to improve delivery of training and technical assistance to small water systems. The work group's panel included representatives of a state health department, EPA, and a national manufacturer's organization all involved in training or technical assistance. The remainder of the work group included a mix of state health department, EPA, and rural water system personnel.

Discussion

The work group defined small water systems more broadly than simply by population served or daily production. The following characteristics outlined the typical small systems and their problems:

1. Employ few or only part-time personnel.

2. Pay low salaries resulting in high turnover of personnel.

3. Do not take advantage of available training due to lack of resources or lack of interest.

4. Suspicious of government regulations and assistance.

Since many small systems do not exhibit any of these characteristics and are well managed, the training problem goes much deeper than apathy of small system personnel or poor wages. The existing methods of developing and delivering training by state, federal, and local organizations are partly to blame. The work group discussed the deficiencies of present training approaches and what has been learned.

1. Effective state surveillance programs are an essential foundation to training and technical assistance efforts. Such programs provide one-on-one opportunities especially valuable to small systems. The individual operator's problems are addressed on-the-job, fostering a sense of trust which will help in other state activities such as training courses.

2. Training must reach out to small system operators. There is still too much reliance on the traditional annual five-day operators' school held in a university setting. Most small system operators cannot attend such events because of travel costs and time involved. Therefore, training is much more effective when it is conducted in the field. For example, one state offers several one-day sessions located so no operator has to travel more than 50 miles one-way.

3. Training material and presentations must be geared to the operator's needs. Too many training courses are still emphasizing theory without relating it to the day-to-day challenges facing the operator: a primary reason why many operators lose interest in attending training. More emphasis on practical operation and maintenance subjects is needed since this is where most of the problems occur.

4. Training and technical assistance activities must be cooperative rather than competitive. Often two or three organizations conducting training within a state have not coordinated times, locations or material. Lack of coordination and integration of training events often causes confusion and frustration for everyone involved. Moreover, better coordination is essential to make the most effective use of the limited training resources.

5. Flexibility is essential and should be considered in the design of training programs and materials. Needs differ from state-to-state

and within states. Therefore, programs and materials should be designed to meet a wide range of situations.

6. Trainers themselves need training, especially in view of the large number of volunteers and others who have had no training experience. Good training materials are of little use if the presentation is not interesting or suited to the audience.

7. A training program must be planned rather than a haphazard presentation of courses during the year. Proper emphasis must be placed on the program so that coordinated, well-managed activities result. Training should be a budget item at all levels of government.

Conclusions and Recommendations

Government

-- EPA and the states need to assess each state's available training resources and training needs. The assessment should include information collected from organizations and utilities. Based on such evaluations priorities can be established for the development of training programs and materials.

-- Each state should establish a coordinating mechanism to insure that training efforts are not repetitive or counter-productive.

-- EPA should continue to fund development and field testing of training materials. Such materials should emphasize practical operational information. Innovative training delivery techniques should be explored.

-- EPA and the states must work together to see that available resources are used to support effective surveillance and training programs. Such programs should be routinely evaluated to improve performance.

-- EPA and the states should develop and strongly encourage trainer training.

-- EPA and the states should strongly support mandatory operator certification and continuing education requirements.

Manufacturers

-- Manufacturers should develop practical, easily understood manuals and instructions for their products.

-- Manufacturers should support and assist with operator training efforts.

Consultants

-- Consultants should impress upon their clients the importance of operator training and certification. Particular skills required to operate a system being designed should be pointed out.

-- Consultants should involve and train the operators during the construction and start-up phases of new water system facilities. In addition, practical operation and maintenance manuals should be developed and thoroughly discussed with the operators. These services should be included in the bidding documents.

Utilities

-- Utilities must encourage their operators to attend training programs and achieve certification. Financial support and other incentives should be provided.

-- Utilities should assist the states and organizations (such as the American Water Works Association) develop and present training programs. Larger utilities can act as a valuable training and technical assistance resource.

WORK GROUP REPORT ON

THE MULTIPLE CONSULTANT/MANUFACTURER/STATE RELATIONS

Chairman: John W. Hernandez
Dean, College of Engineering
New Mexico State University

Recorder: Hugh F. Hanson, Sanitary Engineer
Office of Drinking Water
Washington, D.C.

Discussants: Ted Williams, President
Williams & Works, Inc.

Robert M. Wilfong
Chemical Engineering Corporation

James L. Pluntze, Superintendent
Department of Social and Health Services
Water Supply and Waste Services
State of Washington

The intent of this work group was to examine the dynamics of the interrelationships among the manufacturers of water supply equipment, the consultants who design water supply facilities and specify manufactured units and equipment, and the state agencies that are responsible for approvals of designs and equipment application. Many in the water supply industry feel that lack of flexibility in these traditional relationships is partially at fault in preventing greater utilization of new and innovative treatment systems, equipment and technologies for the rapid improvement of the performance, operation and maintenance of small water utilities. The task before this work group was to examine the problem, to determine its nature, and to propose alternatives for selection and approval of equipment and technologies.

To accomplish this task the panel of discussants included representatives of the equipment industry, the consultant community, and a director of a state water supply regulatory agency. The remainder of the work group included representatives from the three interests plus several representatives of small water supplies.

Discussion

As a starting point for the work group, a small system was defined as one that served less than 2,500 people. The 10,000 population cutoff used by EPA includes systems that have significant in-house capability, so for the purposes of this discussion the 2,500 population number was felt to be more appropriate.

The problems encountered by states, manufacturers, and consultants when dealing with small utilities fall into several distinct categories. These include new technology and equipment, financing, training, and the reciprocity of approval and acceptance of laboratory results. The work group dealt with issues that were common to all the interested parties and attempted to delineate the common problems and identify mechanisms that work well.

New Technologies/Equipment. The majority of the discussion about new or innovative technologies and equipment centered on the question of state approval for use in water supply systems. Many small system problems could be solved by "off-the-shelf" equipment and technology presently available (or that could be rapidly developed) by the interested manufacturers.

The historic utility-consultant-state relationships tend to limit the degree to which pre-engineered systems can be used in dealing with small system problems. The present approach is for a community to utilize a consultant to design the needed facilities; this leads to the dependence of the small utility upon its consultant. This relationship offers many strengths, and there are serious concerns that modifications to this approach will result in reduced accountability and responsibility by consultants to clients. However, the application of pre-engineered systems and equipment can represent a significant savings for small utilities and perhaps should be encouraged by the consultant and the state where appropriate.

In order for this to occur, improved methods for selection and approval of package plants and pre-engineered equipment need to be developed. It is wasteful and unnecessary for a manufacturer to demonstrate the effectiveness of his equipment to the satisfaction of numerous engineers and state agencies. The work group recommended the creation of an independent third party approval agency or the use of an existing testing agency to evaluate new equipment and technologies against specific performance standards. By policy statement or other methods, such pre-tested equipment would require only minimal approval requirements by states after selection by consultants. The manufacturers would be expected to pay for such testing. It is hoped organizations such as the American Water Works Association (AWWA) and the Conference of State Sanitary Engineers (CSSE) will develop vehicles to make this information available to the water supply industry.

One additional discussion emphasized the general problems of operation, maintenance, and operator training. Manufacturers should provide detailed operation and maintenance guides with their equipment. The group also felt that consultants should insist on such guides being provided when a manufactured item is specified. Likewise, consultants and manufacturers should assure that sufficient start-up supervision and training is part of any offering to a water utility.

Financing. A detailed discussion of the financing problems of small water systems is included in another work group report; however, some of these problems were addressed. The most important of these issues is the question of bidding. If new technologies and equipment are to be used to help solve small system problems, then higher quality bidding documents must be used. Such documents would allow new and innovative methods and equipment to be offered and would provide for adequate training, start-up, and maintainability. It was recommended that EPA encourage or sponsor the development of sample documents in cooperation with the AWWA, the CSSE, the Water and Waste Manufacturers Association, and any other third party approval agency that might evolve as discussed in the previous section.

Also discussed were the traditional attitudes of how utilities finance new equipment. Leasing, lease-purchase, turnkey and service company concepts and techniques should be developed and implemented by equipment suppliers. Consultants and state agencies need to evaluate these proposals and encourage their use when appropriate, particularly where water utilities are unable to obtain capital financing. In the present economic situation, this type of proposal would be very attractive to small systems, if all those concerned could develop offerings that adequately deal with the questions of accountability and responsibility.

Training. Training was also discussed in detail in another work group. However, it was felt that consultants, states, and manufacturers all share responsibility for training, and that mechanisms for the delivery of this training are partly their joint responsibility. Manufacturers should take steps to assure that consultants are aware of the type and amount of training that is required with various pieces of equipment. Consultants should assure that the client is aware that operator training is required; consultants should take steps to assure that training is delivered, either by including appropriate requirements in the bidding documents, requiring that the manufacturer provide it with the equipment, or by providing initial training followed by self-paced courses with the equipment. State agencies should encourage training and include a recommendation in their review of plans and specifications. Training is an important element for all participants. Every effort should be made to assure that adequate training is provided.

Reciprocity

Reciprocity involves almost all of the items discussed previously. There is no doubt that a cooperative, rather than coercive, reciprocity is required among the various states for approval of equipment, laboratories, and certification of operators. There are few real barriers to such reciprocity, but appropriate forums do not exist where states can compare and evaluate each other's programs to determine the possibility of reciprocal agreements. Groups such as the Associated Boards of

Certification can help with the reciprocity for operators, and EPA can improve the situation for laboratories through its certification program. However, until more efficient methods are adopted by the states for acceptance of new equipment and technologies, the manufacturing community will continue to experience difficulty. The operation of a third party review agency may improve this situation, but the real need is for general standards to be universally adopted by the states with only minimal modification for particular regional problems. This universality would allow manufacturers to provide one basic design that would receive acceptance by a large majority of the water supply community. Similarly, the manufacturers can improve their own situation by adopting industry-wide standards and increasing standardization when possible.

Conclusions and Recommendations

Government

-- States should encourage the use of pre-engineered equipment and systems when appropriate.

-- The creation or utilization of a third party (neutral) review agency should be encouraged by both states and EPA.

-- The creation of uniform standards (to include performance criteria) should be sponsored by states and EPA.

-- EPA and states should cooperate in the development of model bidding documents to be used by utilities, states, and manufacturers in preparing and reviewing offerings for small systems. Such documents should assure the delivery of adequate training, operation and maintenance checklists, instruction booklets, and start-up supervision.

-- States need to evaluate the use of innovative financing methods for small systems and encourage use of such methods where applicable.

-- All levels of government should work toward reciprocity of operator and laboratory certification and equipment specification. Additionally, standardization of equipment for small water supplies should be encouraged.

Manufacturers

-- Manufacturers should encourage and sponsor the creation of a (or greater utilization of an existing) third party review agency for performance review of new equipment and technology.

-- Manufacturers should assure that consultants and utilities understand the complexity of the operation and maintenance of the proposed equipment and should recommend any necessary training required.

-- Manufacturers should provide data on operation and maintenance and start-up requirements in their literature and encourage the use of this information in bidding and contract documents for small systems.

-- Manufacturers should develop better financing tools for small systems such as leasing, lease purchase, and service company concepts.

-- Manufacturers should develop industry-wide standards for small water supply equipment and encourage greater standardization.

Consultants

-- Consultants should encourage pre-engineered equipment for small utilities where it can be used.

-- Consultants should include adequate start-up supervision in bidding documents, and inform their clients about the skills required to adequately operate and maintain the specified equipment.

-- Consultants should encourage the use of alternative financing methods such as leasing when proper capital financing cannot be obtained.

-- Consultant associations should help to develop and encourage the use of better quality bidding documents to improve the quality of offerings to small water systems.

-- The concept of reciprocity should be sponsored through consultant associations, and the consultants should encourage states to adopt universal design standards.

Utilities

-- Utilities should greatly increase the amount of time and money directed toward operator education.

-- Utilities should attempt to learn about operating and maintenance problems of new equipment and insist that consultants and manufacturers provide adequate instruction and start-up assistance with their proposals.

-- Utilities should encourage their consultants to review the possibilities of pre-engineered systems for specific situations.

-- Utilities should explore the possibilities of non-standard financing approaches such as leasing, lease-purchase, and water service companies.

-- Utilities should remember that the responsibility for the quality of water rests with the water supply and cannot be transferred to the consultant, the state or the manufacturer. The utility cannot be a passive partner in the selection of new equipment and technologies and must assure that quality equipment, specification, and review are being provided.

WORK GROUP REPORT ON

REGIONALIZATION/WATER SERVICE COMPANY/CIRCUIT RIDER

Chairman: Henry J. Ongerth
State Sanitary Engineer
California Department of Health

Recorder: Thomas N. Hushower, P.E.
Office of Drinking Water
Washington, D.C.

Discussants: Francisco Garcia
Environmental Improvement Division
New Mexico Water Supply Program

Lee Vinyard
Culligan International

Regionalization, water service company, and circuit rider management, operation and maintenance approaches can provide solutions to the problems confronting many small water supply systems in meeting the requirements of the National Primary Drinking Water Regulations (NPDWR).

The purpose of assembling a work group represented by various organizations having authority, responsibility, working relationships and interest in regionalization, water service company and circuit rider concepts and activities was to provide a forum for sharing their experiences. The discussion was to encompass the areas of experience of the attendees that might contribute to possible solutions to small water supply systems management, operations and maintenance problems.

The desired products of the group were a summary of the advantages and disadvantages of regionalization, water service company and circuit rider management approaches for the small water supply system, and the formulation of specific conclusions and recommendations applicable to government, manufacturers, consultants and utilities regarding their roles and responsibilities associated with regionalization, water service company and circuit rider concepts.

Discussion

The work group defined regionalization as the physical interconnection or the consolidation of management and operation and maintenance of two or more water supply systems. The operation and maintenance element, the work group concluded, encompassed the concept of circuit rider. While the circuit rider idea was a part of the subject matter assigned to the work group, time expired before the subject was discussed. No formal definition was developed. The circuit rider concept can include management, technical assistance, operation and maintenance functions. A consulting firm, equipment manufacturer, utility or other water supply authority, government agency, or other organization could perform these services by contract to each individual water supply, hired jointly by a group of water suppliers or retained on an as needed basis. The water service company was considered a regionalization operation and was not addressed directly.

The work group outlined the physical, political and financial factors favoring regionalization over the single systems:

-- Eliminates the problem of multiplicity of small, unsatisfactory units (the group considered small units as less than 1,000 population served).

-- Improves management and operations. (The group felt improved operations was the principal objective.); and

-- Secures economy of scale where physical interconnections are possible. The major savings would be in the elimination of duplicative equipment and facilities, not necessary management.

The focus of the discussion on regionalization was on management considerations rather than physical conditions between systems because of the work group opinion that management approaches have broader application and are less subject to the social objection to regionalization.

The group identified and discussed several types of regionalization operations:

Government Units--County governmental organizations, particularly, and special districts that have multiple systems under their surveillance and operation including all functions of management. Government units can be a full range of sizes and, as an extreme example, include military operations at remote sites around the world.

Investor Owned Utilities--Investor owned groups operating multiple systems, large and small, over a large or small geographical area. The group questioned whether the investor owned utility could financially afford to manage, operate and maintain the smallest size systems while charging reasonable water rates.

Equipment Sales Organizations--Sales organizations providing the facilities and equipment on a lease-purchase arrangement and the managing and operation and maintenance under a service contract. Equipment manufacturers have shown increasing interest in this concept, and the work group felt such an arrangement had good potential.

Consulting Organizations--Consulting organizations would manage, operate and maintain the systems under a service contract.

Not-for-Profit Organizations--Examples discussed were rural water associations that provide only a portion of the activity in relation to regionalization, namely training and consulting (but not operations); and development and support corporations that assist in the development of utilities and technical support of their operations. The development and support corporation deals with multiple systems writing individual contracts for work with each system. Their role can be purely advisory or they can have responsibility for the entire operation of the system.

The role of the state/local regulatory agency with respect to regionalization received particular emphasis by the work group. Effective enforcement was considered most essential to the success of the various types of regionalization operations discussed with the exception of the rural water association, which is organized to function independent of aggressive enforcement by a regulatory agency. Leadership and enforcement by the regulatory agency is particularly important to the equipment sales type of regionalization operation.

The advantages of regionalization were enumerated by the work group but no details were given. The advantages noted were:

-- Enhances performances,

-- Encourages organized planning,

-- Reduces regulatory workload,

-- Facilitates financing,

-- Reduces administrative needs, and

-- Lowers cost.

The work group members were unanimous in favor of regionalization.

The disadvantages of regionalization identified were that it may encourage urban sprawl and discourage pride of ownership. Members of one community may also object to a combined water system with a neighboring community because they feel that they have a better water or facilities than their neighbors.

Questions and comments to the chairman following his report yielded the following points of interest:

-- Requirements of the NPDWR will stimulate the small water supply system to become a part of a regional system.

-- Authorizing legislation may be needed by states to encourage and regulate regionalization.

-- An American Society of Civil Engineers' committee survey was cited that reported most states had some form of regulation enabling regionalization of water supply systems.

-- The Farmers Home Administration encourages county-wide water systems and expressed the need for technical, managerial and economic advice for the small water supply system to explain the how, why, costs and savings of regionalization.

-- Government grants for regionalization of water systems may be subsidizing landowners located between the systems that are interconnected. This could lead to urban sprawl and a shifting of who pays the cost.

Conclusions and Recommendations

On most issues discussed, the work group could not arrive at any specific conclusion and recommendations representing the consensus of the group. Other issues were only suggested and not discussed in any detail. The following conclusions and recommendations were reported by the chairman, although they may not, in some cases, represent a majority view of the work group.

Federal Government

-- Apply drinking water quality regulations equally to all sizes of water supply systems.

-- Provide seed money to encourage and support regionalization but do not assume a primary role.

-- Provide training in the management and technical operation and maintenance of regional water supply systems.

State Government

-- Provide the necessary enabling legislation to support effective state regulation of regionalization organizations.

-- Coordinate all funding for regionalization.

-- Provide and participate in training to encourage regionalization of small water supply systems and training for the management, operation and maintenance of regional water supply systems.

-- Develop and administer a management/operator certification program specific for personnel employed by regional water supply systems.

-- Provide technical assistance as required to the regional water supply systems.

Regional/County Organizations

-- Encourage and support the regionalization of water supply systems.

-- Promote circuit rider programs to operate and maintain the small water systems in the region/county.

Consultant

(The consultant was not represented on the work group, however, he has a definite role in regionalization.)

-- Consider regional systems in water resource development studies and in the design of water supply systems.

-- Promote operation and maintenance services for the small system.

-- Provide management and technical assistance services to the regional water supply system.

Utility

-- Support and apply for federal funding of improvements to small water supply systems.

-- Coordinate rural water supply association activities with state regulatory activities.

-- Consider the development of market and service agreements with manufacturers and consultants to manage, operate and maintain regional water supply systems.

-- Cooperate with neighboring utilities to overcome parochial barriers to regional water supply systems.

WORK GROUP REPORT ON

POINT-OF-USE ALTERNATIVES

Chairman: William A. Kelley
Division of Water Supply
Michigan Department of Public Health

Recorder: Frank A. Bell, Jr.
Office of Drinking Water
Washington, D.C.

Discussants: Jerry T. Hutton
Foremost Foods Company
San Francisco, California

Louis M. Kuh
Kuh & Associates
Stamford, Connecticut

Arleen Shulman
National Association of Counties
Washington, D.C.

Charges to this work group were to outline types, roles and opportunities for the various point-of-use alternatives, to consider claims, advertising, need for standards and potential regulatory approaches, and to discuss any problems related to their use. Historically, point-of-use water treatment has addressed esthetic parameters such as hardness, iron, manganese, and odor; in relation to health standards, it seems to have limited potential but presents questions and problems as well.

To accomplish its charges, the panel brought together a state water supply engineer as chairman and representatives from bottled water and home treatment equipment manufacturers, and a national counties association as discussants. The remainder of the work group included representatives from manufacturers, government and consultants and one person each from a public interest group and city government. This paper summarizes the basic points, discussions, conclusions and recommendations developed by the work group.

Available Alternatives

This symposium was mainly concerned with small water systems or small groups of people needing public water service, both located primarily in rural areas. As such, the economics of transportation, delivery and demand could work against the use of bottled water or vending machines on a broad basis.

Alternatives were outlined as follows:

Bottled Water. Bottled water can be used in emergencies to replace unsafe drinking water or to meet special situations such as providing nitrate-free water for babies where the public drinking water exceeds nitrate standards or to provide fluoridated water for juveniles where the public water is not fluoridated. In many rural areas it would be uneconomical for a supplier to serve scattered populations with bottled water.

Vended Water. Machines for providing vended water usually would be placed in or near major grocery stores or in high-density housing units and therefore will not provide a general alternative to public drinking water for scattered populations in rural areas. However, vended water may provide a useful alternative in emergencies or other special situations.

Point-of-Use Treatment. As a general rule, the public water system should meet all health and esthetic requirements for consumer use. However, unusual situations (such as high nitrates or fluorides) may present cost effective opportunities for point-of-use treatment, and as well, individual consumers have the right to improve esthetic qualities of water (such as taste, odor, and hardness) to meet their requirements. Point-of-use treatment could be installed at each household or at a control point where consumers could pick up their specially-treated water.

Concerns with Alternatives

The work group expressed a number of concerns with alternatives. They have been summarized in the following three categories:

Efficacy, Claims, Safety. Do point-of-use treatment units achieve their claims? What performance standards do they meet? Are they safe? The efforts of the National Sanitation Foundation (NSF) to establish a consensus standards and voluntary certification program and the EPA contract to study organics removal capabilities and bacterial aspects were mentioned. The Federal Trade Commission (FTC) currently has an action underway to investigate advertising. Current efforts in these areas need to be continued and strengthened.

Standard Plate Count (SPC) Bacteria. A representative of EPA expressed concern regarding SPC bacteria in bottled water and in effluents from point-of-use treatment units as well as in public drinking waters. These bacteria have proven to be secondary pathogens in hospital situations and might be harmful to the very old, very young or physically-stressed individuals. However, there are inadequate data to prove a health threat in non-hospital situations or to recommend definitive action at this time. No standard has been set for SPC bacteria in either the Interim Primary

Drinking Water Regulations (IPDWR) for public drinking water or in the Food and Drug Administration (FDA) standards for bottled water.

Operation and Maintenance of Home Treatment Units. The average home owner does not have the background or information to check the performance of his home treatment unit or to know when it should be replaced. For example, certain key organics may start passing through a filter long before taste and odor become problems. Where a public system has home treatment units installed in order to meet a primary standard as a part of its public service, it should also provide routine sample collection and analysis, maintenance and replacement. Manufacturers should provide performance data on their treatment units as well as unambiguous sales literature and advertising. Any standardization for home treatment units should require some indicator or label notification that will trigger replacement at the end of its useful life; this is essential for treatment units affecting primary contaminant levels.

Regulatory Aspects

Bottled water is regulated by the FDA for interstate producers and by individual states for intrastate producers. FDA utilizes the quality standards established in EPA's Interim Primary Drinking Water Regulations and has additional sanitary requirements related to the materials, facilities and means of production. Mineral water is not subject to FDA's quality standards for bottled water nor to EPA's primary drinking water regulations. No current information was available on state regulations.

Vended water has been classified as a non-community public water supply and therefore is subject to the Safe Drinking Water Act. However, the regulation of equipment manufacture and sale may be subject to Office of Pesticide Programs (OPP) regulations under the Federal Insecticide Fungicide and Rodenticide Act (FIFRA) if a pesticidal chemical is used or pesticide claims are made. One state has established regulations for vended water equipment and others are considering such action. This area may require governmental coordination in order to clarify regulatory roles. An NSF or other appropriate standards and certification program may be needed for vended water equipment.

Point-of-use water treatment units may be subject to OPP regulation under FIFRA where pesticidal claims or chemicals are involved; if medical claims are involved, they may also be subject to FDA regulation. Advertising is subject to the FTC and safety problems to the Consumer Products Safety Commission. However, these units are essentially unregulated as to minimum standards and efficacy for the majority of quality parameters of interest to the consuming public.

The work group was polled for its opinion on increased government regulations or an NSF standards and voluntary certification approach for point-of-use water treatment; by unanimous vote the latter was favored. The latter approach would require government attention to assure compliance with the voluntary program, and increased efforts would have to be devoted to public education on the meaning and utility of the NSF standards and certification.

With respect to governmental regulation, certain EPA/FDA coordination problems were mentioned and improved efforts toward interagency coordination and resolution of jurisdictional overlaps were urged. Improved public information on governmental programs was also requested.

Conclusions and Recommendations

Government

-- Give guidance on point-of-use alternatives to the public.

-- No regulatory additions or changes were recommended, but establishment of an NSF or equivalent standards and voluntary certification program for point-of-use water treatment units should be encouraged.

-- Problems of interagency coordination and jurisdictional overlaps should be resolved.

Manufacturers

-- Should support development of an NSF or equivalent standards and voluntary certification program for point-of-use water treatment units.

-- Should provide performance data and unambiguous advertising on their treatment units.

Utilities

-- Consider point-of-use alternatives as options for solving limited water quality problems on a cost-effective basis, at least temporarily. Operation and maintenance costs must be a part of the utility's consideration.

Consultants

-- Consider point-of-use alternatives as possible cost-effective options for solving limited water quality problems.

WORK GROUP REPORT ON
OPTIONS FOR REGULATING SMALL WATER SYSTEMS

Chairman: Donald A. Kuntz, Chief
Drinking Water Supply Program
West Virginia Department of Health

Recorder: F. Warren Norris, Jr., Senior Sanitary Engineer
Water Supply Branch
EPA Region VI--Dallas, Texas

Discussants: John Wilford, Assistant Director
Division of Water Resources
New Jersey Department of Environmental Protection

Lorraine Chang, Attorney
EPA Office of General Counsel
Washington, D.C.

R.M. Smith
Met-Pro Corporation, Systems Division
Harleysville, Pennsylvania

C. Robert Morris, Associate Executive Director
National Association of Water Companies
Washington, D.C.

A major feature of the Small Water Systems Treatment Symposium involved consideration of the regulatory options available for these supplies. Regulations may evolve from the federal, state, local or private sector. For the purpose of this symposium, the principal regulations addressed were those federal regulations under the Safe Drinking Water Act that drive similar state regulations under the various state water supply programs. Historically, regulators have been accused of operating in a narrow channel, divorced from real life. In reality, the art of regulating cuts across a broad spectrum of activities (facilities design, operations and maintenance, operator training, water quality and monitoring enforcement) that must be understood and placed in perspective.

The Safe Drinking Water Act set up a regulatory scheme to improve drinking water quality in all systems. This structure has placed an extra burden on small systems. Realizing the health problems encountered, the populations affected, and that available solutions vary significantly between small and large systems, the Regulatory Options Work Group set out to codify the problems and identify alternative solutions. By addressing the subject from the government, manufacturer, and utility viewpoints and with the contribution of fourteen other participants, the work group intended to define the methods available to small systems for assuring the delivery of safe drinking water.

Chairman Kuntz opened the meeting with a charge to the work group to drive through the identification of problems in regulating small systems and go right to solutions. Therefore, the goal of the work group was established as developing a list of options and directions for small water systems to satisfy existing or future regulations.

Discussion

The Regulatory Options Work Group considered its subject from three major viewpoints: government, manufacturer, and utility. The presentation by each discussant resulted in the highly practical and diverse nature of approaches that were eventually developed by the work group. As a prelude to these discussions, the legal aspects of the Safe Drinking Water Act and its applicability to small systems were explored. The intent of Congress in passing the Act was expressed as follows with respect to small systems:

(a) Improved water quality through cost-effective systems;

(b) Equal health protection for all; and

(c) Concern over cost outweighed by goal of public health protection.

The National Interim Primary Drinking Water Regulations (NIPDWR) are based on technology and economics as well as public health protection. However, feasibility is determined primarily by what is available to large systems, thus posing an obvious problem to small, often poorly funded, systems. Fortunately, the Act does provide some legal flexibility to small water systems. These were enumerated as follows:

-- Time frames for compliance with the NIPDWR (i.e., exemptions);

-- Flexibility in a regulatory context (regs can be changed to increase state discretion--i.e., proposed modifications of the regs);

-- Regionalization for more cost-effective systems (i.e., exemption compliance dates); and

-- Enforcement discretion given good faith efforts to comply (i.e., court actions versus administrative enforcement).

While the Act appears fairly rigid on the surface, it has within its framework certain legal flexibilities that will be helpful to small systems.

From the government viewpoint the basic purpose of a regulator of small water systems is to implement the Safe Drinking Water Act. In order to carry out this mandate in a more effective manner, the government representative highlighted the need for additional flexibility in implementing a primacy program and for carrying out associated state facilities planning programs. Specific changes were suggested to modify the maximum contaminant level, monitoring, and public notification requirements in the federal regulations and to modify the time limits on exemption requirements in the Act. Each of these changes would lead to increased state discretion and allow for establishing priorities for action. States could also help small systems by providing financial advice on utility revenue and rate structures, and improved technical assistance through training and laboratory services.

The manufacturer's viewpoint highlighted financial incentives to support product development, training needs for small system operators, and streamlined programs for equipment approval. The manufacturer must be able to realize a profit in order to stay in business. Therefore, in order for the manufacturer to develop those products especially designed to meet the needs of small systems, there must be a significantly available market to help the manufacturer realize his investment in that market. The point was adroitly made that effective equipment is currently available to support small system compliance under the Safe Drinking Water Act. However, that equipment may be, and often is, very expensive. Available solutions involve the use of turnkey plants and modular construction.

The approval or acceptance of new equipment by the regulatory agencies has long been a problem for the manufacturer. Manufacturers strongly endorse the idea of basing approval on the application of broad performance specifications rather than strict design and materials requirements. There is a need for standardized tests for various equipment categories under the auspices of an independent testing group, such as NSF or AWWA. Likewise, there is a similar need for accumulating pilot plant or other performance data and transmitting the data to regulatory agencies to expedite the evaluating process. The manufacturing community would support the use of performance bonds on new products in an effort to streamline and shorten the review/approval process and to protect the consumer from faulty products.

Operator training is a major area of concern on the part of the manufacturer, just as it is for the regulator. Operator education must be provided during the time the equipment is under construction at the plant site and on through equipment start-up. This education should be continued through the use of operation and maintenance manuals.

The utility viewpoint highlighted the training/public awareness and financial problems that exist in the small systems. Water system managers, operators, and consumers must be informed about the requirements of the Safe Drinking Water Act and, most of all, be provided with a layman's explanation of how the regulatory programs will help the water utility assure safe drinking water. This is critical to assure the proper distribution of information between the utility and the consumer, which will realize positive consumer response. The consumer principally is concerned about aesthetic water quality that can be detected by sight, taste, or smell. It is often difficult to generate an understanding and responsible concern for health related factors that are not readily apparent to human senses. Concurrent technical training on water system operation and maintenance is also critical for the operator.

The financial stability of the small system is always a factor in any action to expand or improve service. The demands being placed on small systems to meet the requirements of the Safe Drinking Water Act will, out of necessity, require additional expenditures from an already tight budget. The principal avenues of relief involve securing outside assistance in the form of a grant or loan or raising the water rate. Grants and loans are available but are often tied to selective areas of activity and are not consistently applicable to public or investor-owned systems. The water industry generally has not favored federal funding assistance programs because of the need for managerial independence necessary to sustain business-like operations. Whatever funding sources are made available, the utility consensus is that they be available to all. Utility actions to increase revenues through rate relief also has its own roadblocks in the form of public utility commission requirements and consumer objections. The utility consensus is that the red tape involved in acquiring rate relief should be streamlined to eliminate the normal regulatory time lags.

Throughout the work group session, three major themes reappeared under each viewpoint. The first of these was the need for greater flexibility or discretion in implementing programs or solutions particularly set at the state level. This was particularly evident in a great deal of the discussions that involved a lack of coordination/communication between various levels of responsibility. Considerable confusion was evident among the regulatory agencies, federal and state, over how various matters affecting small systems would be treated. Conversely, communication problems were evident among utilities, manufacturers, and regulators over new products and approval requirements. The second theme was the need for training at all levels of responsibility. Training would include both technical training for small system operators and public information dissemination for operators, consumers, manufacturers, and regulatory officials. The third area involved the financial needs of the small systems. The economics of the regulatory requirements, available equipment, and the rate structure of the utility are all major fiscal factors that affect the ability of the small systems to comply with the Safe Drinking Water Act.

Conclusions and Recommendations

The Regulatory Options Work Group developed a series of conclusions and recommendations closely following the three themes--flexibility, training, and financial--that permeated the meeting. There was unanimous agreement that problems of small systems were quite different from large systems. Therefore, regulatory actions under the Safe Drinking Water Act should be appropriately geared to small systems. The recommendations of the work group were as follows:

Government

-- Government should reexamine the exemption time frames in the Act and the MCL's, monitoring, and public notice requirements in the National Interim Primary Drinking Water Regulations and modify these requirements to increase legal flexibility for state regulators.

-- Discretion should be incorporated at all levels in federal or state regulatory programs.

-- Government should expand training courses for operators and provide laboratory services to utilities.

-- States should enact laws requiring utilities to separate water revenues from general fund.

-- Government should encourage regionalization and assist utilities in interaction with public utility commissions.

-- Government should stress economies of scale in the development of facilities for small systems.

Manufacturer/Consultants

-- The water supply industry must develop sufficient financial incentives in order to support manufacturer actions to produce new water treatment products.

-- Consultants should use turnkey plants and modular construction to reduce costs.

-- Utilities should recognize that low price decisions are not always best in water system construction.

-- Utilities should realize that costs escalate when treatment plants are scaled down for small systems.

-- Manufacturers and consultants should promote public awareness on the Safe Drinking Water Act for all segments of society.

-- Manufacturers should require training as part of equipment sales--construction through start-up followed by O&M manuals.

-- Manufacturers should urge state regulators to use broad performance specifications in reviewing new products to shorten review time.

-- Manufacturers should endorse the selection of an independent national approval group (NSF, AWWA, etc.) for reviewing new equipment.

-- Manufacturers should encourage the use of performance bonds on new equipment to protect the consumer.

-- Share new equipment data between affected groups.

Utility

-- Utilities should expand public awareness of the Act and should be more cognizant of consumer problems and potential health risks.

-- Utilities should increase technical training for operators and should promote trade associations.

-- Federal and state agencies should redesign funding assistance to provide equal benefits for investor-owned and municipally-owned systems.

-- Utilities should seek new funding initially from consumers and only pursue subsidies from federal/state sources as a last resort.

-- Utilities urged the creation of a bond bank at the federal level as a further aid to water utility construction.

-- Utilities should encourage the streamlining of rate relief decisions by Public Utility Commissions.

WORK GROUP REPORT ON
FINANCING: PROBLEMS AND SOLUTIONS

Chairman: John Clark, Jr.
33 Hayden Avenue
Lexington, Massachusetts

Recorder: Carl Kessler
Office of Drinking Water
U.S. Environmental Protection Agency
Washington, D.C.

Discussants: Cecil Rose
Farmers Home Administration
Washington, D.C.

Robert Symons
Milford Water Company
Milford, Massachusetts

John Garrett
Alabama Rural Water Association
Montgomery, Alabama

This work group was charged with examining the financing problems of small community water systems and reviewing possible solutions. The group's members brought several perspectives on the problem. Although only one member of the group actually represented a small water company, several state and federal industry experts in water system finances and operations took part in the discussions. Individuals from the Farmers Home Administration (FmHA), the EPA, and the Small Business Administration (SBA) actively shared their views. The state regulatory agencies of Alabama, South Carolina, and Minnesota were represented as were several manufacturers of water treatment equipment and consulting engineering firms. This wide diversity of perspective and experience led to a broad discussion of financing problems and solutions.

Since the problem has many dimensions, the group spent much of its time discussing how the financing problem differed for public and private systems, for very small versus medium-sized systems, and for systems in different regions in the country. As the conversation progressed, a number of possible solutions were suggested and debated.

The discussion led to the topic of new or expanded programs for direct financial assistance from the state or federal level as a potential means of solving the monetary problems of small systems. The advantages and disadvantages of approaching the solution without such aid were then discussed, along with the possible role of a federal bond bank in providing access to capital for utilities otherwise unable to find sources of funds.

Discussion

The group meeting began with a brief statement by each of the discussants on his views of financing needs. John Garrett of the Alabama Rural Water Association focused on three points. First, better management alone was frequently most needed, particularly for the smallest systems. Also, many systems should simply set water rates at adequate levels and inform customers of the necessity of these rates. Third, short-term interim financing is frequently required for systems in the process of obtaining long-term funds.

Bob Symons reviewed problems of financing for privately-owned small systems--particularly the difficulty of obtaining new equity funds when water company stocks are selling at prices below book value. He maintained that most small private systems can now obtain equity only from internally generated funds. In this category are many small private water purveyors (such as private real estate developers) who would be willing to sell their water systems or even give them away. As a separate point, he described the possibility of a federal water bond bank modeled on the Telephone Bond Bank which began in 1971. Such a program would provide loans (initially from federal seed money) to small water systems that would be expected to join the bank by reinvesting some 5 percent or so of the amount borrowed. Thus over time the bank would be owned by its members without additional federal funds.

Cecil Rose described the FmHA program that provides loans and grants to water systems serving fewer than 10,000 people. Begun in the early 1960's, the program has helped finance 11,000 water systems and uses approximately 1,800 county offices in 42 states for conduct of the program. Private systems operated for profit are not eligible for FmHA funding.

Following these presentations, the discussion turned to various categories of problems faced by small systems in raising capital. The group agreed that the major problem was access to capital, not the ability to raise adequate revenues to cover operating expenses. The group also acknowledged that private systems, particularly trailer parks and subdivisions, faced more difficult challenges than public systems.

Several elements of the problem of raising capital were noted. Small systems frequently lack established channels for capital--only 18 percent of systems serving fewer than 100 people have any loans outstanding. In addition, the collateral that small system owners can provide is frequently of limited value to lenders.

General Aspects of Assistance

The discussion then focused on the question of providing funds to solve some of these financing problems. Before reviewing the specific types of assistance programs that might be considered, the group specified several general aspects of any such program. The issue of flexibility of design was stressed, particularly a desire to avoid strict federal or state design criteria for treatment plants or other water system components.

The group was also concerned that any program provide equitable treatment of both public and private water suppliers and avoid duplication of administrative structure, such as might result if both EPA and FmHA organized similar assistance programs. The encouragement of good utility management by any potential program was also stressed. Good management should rely on community participation, which necessitates that community members perceive the need for adequate rates.

Finally, two other general points were brought out. Any program should allow for short-term financing and should provide means for small systems to be acquired, preferably at the local level.

Expanded Use of Existing Programs

The general consensus of the financing work group was that the best solution to financing problems involved expanded use of existing programs, perhaps supplemented by other non-grant programs such as training in management, technical assistance, and the creation of a federal bond bank. In particular, the group favored a continued FmHA loan-grant program with more publicity for this and other federal assistance programs from SBA, HUD, and EPA. A separate FmHA program of business and industrial guaranteed loans should also be made more known to the industry.

After citing these elements of the proposed expanded use of existing programs, the group listed the advantages and disadvantages of this level of assistance relative to some new type of assistance program. The major advantage was the low incremental cost to taxpayers since no new administrative structure would be involved. Existing programs were also thought to be flexible and to rely adequately on local autonomy. In addition, existing programs would be adequate to meet most water system financial needs.

Of the disadvantages, the group cited the continuing burden of operating and maintenance costs on small low-income communities. Existing programs--oriented toward providing capital but not operating funds--would not solve this problem, though the group felt that this was an infrequently occurring situation. In addition, it was agreed that existing programs providing the least help for the financially weakest, very small water systems that cannot quality for FmHA funds since many of these are privately owned. Though the group discussed these problems, the only suggestions offered for these difficult situations were takeovers by other authorities, regionalization, SBA loans, or a federal bond bank.

Finally, the group considered development of additional loan programs. While noting that some of the medium-sized systems could make use of industrial development bonds, the group also agreed that the establishment of a federal bond bank would be helpful to many systems.

Federal Bond Bank

As discussed by the work group, the federal bond bank for small water systems would be modeled on the Federal Telephone Bond Bank, which has operated successfully for some eight years. The bank would require an initial infusion of capital from the national budget, but would gradually become independent of new federal funding. Loans could be made at varying rates of interest depending on the financial conditions of the borrower. The utilities borrowing money would be required to provide equity to the bank--5 percent of the loan amount in the case of the telephone bank. The borrower actually purchases capital stock with this contribution and as a stockholder is empowered to elect directors to the bank's board. As these recontributed funds build up, future loans could be made from this source alone. Gradually, the bank would be entirely owned, funded, and perhaps operated by the water system to whom it had extended credit.

Several advantages of such a bank were pointed out. The bank could provide direct help to small private systems most in need and would do this at a relatively low cost to the federal taxpayer. Since the bank could determine rates of interest to be charged to borrowers, it could lower the rate for "basket-case" systems--those for whom repayment of higher interest and principal charges would be an excessive burden. The bank would need to assure repayment, though, and to accept loans only from systems with the ability to repay.

Only two disadvantages were noted. First, a new federal bureaucracy would be needed, though it would be small and could be phased out over time. The other concern was that some public systems that can now issue tax-free municipal bonds face higher interest costs under the federal bond bank structure. The resolution of this possible disadvantage would be for such systems to continue issuing tax-free bonds when it was to their advantage and to turn to the bank only when more favorable terms could be obtained.

Conclusions and Recommendations

Utilities

-- Financial help is needed by many small systems, mostly in the form of providing access to sources of capital. These systems lack established channels to capital funds and the ability to attract equity capital. Those most in need of financial assistance are the small private systems, particularly those, like trailer parks, formed for principal reasons other than providing water service.

Government

-- Adding new direct financial assistance programs was not considered the best means of meeting the financial needs of small public water systems. Expanded use and publicizing existing programs were preferred. These programs should include a greater emphasis on training, better management techniques, and adequate rates to cover present operating, maintenance, and debt service costs.

-- A federal bond bank could fill the gap in present assistance programs by providing aid to small private systems. A bond bank could be initiated with only a limited effect on the federal budget and could be structured for future ownership and operation by its members alone.

PANEL: WHERE DO WE GO FROM HERE?

Introduction

Near the close of the symposium, several participants representing government, consultants, manufacturers, and utilities discussed future involvement of their respective organizations. The following report highlights the views of each. The panel consisted of the following people:

Moderator: Dr. Joseph Cotruvo, Director
Criteria and Standards Division
Office of Drinking Water
EPA/Washington, D.C.

Panelists:

Government: James Pluntze, Head, Water Supply and Waste Section
Social & Health Services
Olympia, Washington

Consultant: Russel Culp, Vice President
Clean Water Consultants
El Dorado Hills, California

Manufacturer: Donald Porth, President
Culligan International Company
Northbrook, Illinois

Utility: James Ramsey, Manager
Carrollton Utilities
Carrollton, Kentucky

Small public water systems comprise 80 to 90 percent of the total public water systems on inventory. Conversely, this large number of small public water systems serve only 10 to 20 percent of the total population. As we know, the problems facing the small public water systems are many and varied. In the past, neither government, consulting engineers nor the water industry has emphasized adequately the dilemma of small water systems or allocated resources towards the solution of their problems. Government tended to focus attention on public water systems with the greater number of users, those systems that could cause the most visible problems. Because of the size of the small public water systems, consultants usually do not find them economically attractive for business. Since the purchasing power of the public water system is small, manufacturers are not inclined to make investments in the development of new equipment for small public water systems. However, with the advent of the Safe Drinking Water Act (SDWA) and its goal that all public water systems provide a uniform safe quality of drinking water, government, consultants and manufacturers must review their attitude towards the small public water system.

At the conclusion of the symposium a panel representing government, consultants, manufacturers and small water systems discussed their views as to future steps in meeting the problems of small public water systems. The following are summaries of their presentations.

Government

The state government representative stated that essentially the same approach government applies to large public water systems should be expanded to include the small public water systems. The first and foremost task of government is to assure that the public water system, especially the new system, is constructed properly and that it is adequate to meet the present and future needs of its service area. One of the major impediments in fulfilling this responsibility is inadequate funding for proper construction, operation and maintenance and management of the small public water system. State financial assistance should be considered as a positive incentive to improve facilities. Government must work in close cooperation with both the owners and users in order to secure the proper funding commitment before a public water system is constructed or expanded so today's problems will not be repeated tomorrow.

State government must provide competent staff to review the designs for new and expanding systems. The federal government should assist in meeting professional manpower needs through training grant programs. The staff must stay abreast of the new technology available from the water supply industry. Government policy needs to be made more receptive towards new concepts in water system management such as regionalization, satellite systems and circuit riders.

In the past the training of small public water system operators has been severely neglected. State and federal government must make a greater effort to rectify this situation. One possible solution to this problem is the enactment of mandatory certification requirements. In addition, government should become more involved in the development of training materials and programs for the small public water system. Well trained operators will help reduce the amount of direct involvement by government in enforcement, monitoring and technical assistance. In addition, a good training program will provide the small public water system with qualified personnel to manage, operate and maintain their systems.

In applying its regulatory powers, states should use common sense and not just blindly apply the rules--particularly in areas of public notification and response to acute health threats as compared to chronic health threats. Appropriate use of local health agencies to the limit of their capabilities should be made to assure safe public drinking water.

Consultants

The traditional role of the consulting engineer is to design treatment systems that will produce safe, quality drinking water. Small treatment plants present a special challenge to the engineering designer because they must be inexpensive, easily understood, and simple to operate and maintain. Many design options, construction techniques and control systems that are perfectly satisfactory for large flow plants are not suitable for application to small plants because of cost or complexity or both. Engineering costs for small systems represent a greater part of the total project cost for small jobs than for larger ones, and high engineering costs are one of the problems faced by the small public water systems. In order to render the needed public service, consulting engineers must do several things in their role as designers:

-- Apply existing treatment processes to their best advantage.

-- Build plants at the lowest possible costs, which will accomplish the water quality objectives.

-- Design plants that are easier to operate properly rather than improperly.

-- Seek and develop new processes, new construction methods, and new control systems that are specially suited to small systems.

-- Make the best use of free engineering information on new technology from professional engineering and scientific organizations.

The technology needed to solve todays water quality problems is available but to take advantage of it the consultant must dig it out, dust it off, and put it to use.

Consultants must find ways to reduce engineering costs within the traditional owner-consulting engineer-construction contractor relationships or devise a new arrangement for providing the engineering services required for good treatment plant design at lower costs.

Consultants may also assist by providing their clients with better information on maintenance requirements and operation and maintenance costs for water treatment installations.

The consultants should provide the owner/operator with detailed information on plant operation control, process monitoring, and equipment maintenance for the completed plant.

Participation by the consultant in the preparation of good operators' manuals, assistance with plant start up and operator training is especially important in small systems. The consulting engineer can assure some action in this regard by providing in his contract a definite amount of time that his engineering staff will spend in assisting with start up.

Also when preparing the project specifications, he can include in equipment specifications a definite amount of time to be spent by the material supplier or equipment manufacturer in assisting with plant start up and initial operation of equipment.

To be sure, small systems involve some very challenging and difficult technological and managerial problems for consulting engineers. However, by taking an active and coöperative role, consultants can play an important part in improving the quality of water delivered to the public by small systems.

Manufacturers

New technology has been developed that could dramatically increase the capability of economically serving the needs of many small public water systems. The next step for the manufacturers is to take this new technology from the laboratories and pilot plants and put it into the market place. The need for turn-key/modular packaged water treatment equipment is absolutely essential if many of the small public water systems are to meet the requirements of the Safe Drinking Water Act. Through the development of standard components, drawings, manuals and specifications, the manufacturers will be making a great contribution to the water treatment industry. For the consultant, greater flexibility will be available from the use of pre-engineered systems whose components are pre-fabricated. The benefit to the public water system would be lower capital costs since the system would not be uniquely designed.

Additional demonstration projects on the performance and application of point-of-use equipment, together with studies on monitoring and control techniques, are needed. The degradation of water quality in the distribution system is a problem plagueing many small public water systems. In many instances, the most economical, sometimes the only solution, would be to augment central treatment with treatment at the point of use. In other words, while central water treatment can remove tubidity and disinfect water so as to assure the removal of acute toxicants, alternatively, chronic toxicants may be removed more economically at the point of use.

Finally, manufacturers, consultants and government should be encouraged to work more closely in coordinating activities and introducing new equipment. Through such a working relationship manufacturers could increase their ability to serve the needs of the small public water system.

Small Public Water Systems

Next to having a well constructed system and an adequate supply of good quality raw water, the greatest needs of the small public water system are operator training, certification and periodic recertification. Without a properly trained operator, water quality and operations will suffer. However, when an operator is properly trained to operate his plant's equipment he will do a much better job, resulting in safe quality drinking water.

Because of the economic situation of many small public water systems, most of them must rely on training activities that are most readily available, whether or not they are suited to their needs. There is a great need for state and federal government, consultants and manufacturers to develop a system for providing information, training and technical assistance tailored to the special needs of the small public water systems.

However, the public water systems should be reminded that the responsibility for water quality rests with the public water system. Therefore, the public water system should take a more active interest in the selection of new equipment or technologies and must work with the manufacturers, consultants and government to assure that quality equipment, correct specifications and proper design review are being provided.

Public water systems should explore the possibilities of non-standard financing and management approaches such as leasing, lease purchase, and water service companies. In addition, public water systems should consider point-of-use alternatives as options for solving limited water quality problems and regionalization for solving raw water source and economics-of-scale problems.

Finally, the small public water system must participate in programs that encourage user awareness of the key elements of operations necessary for a public water system to provide a continuous supply of safe, quality drinking water.

Summary

Key points by the four concluding speakers were as follows:

-- Multi-community cooperative arrangements (regionalization) need to be used more extensively to achieve the benefits of larger size.

-- State governments need to take the problems of small systems more seriously and to provide more of the same kind of attention to them as they currently do to the large systems.

-- Training programs require expansion and should be made appropriate to the needs of the small systems.

-- Package plants and pre-engineered modular components are available for use by small water systems, but widespread use requires more uniform state design requirements or a third party program for standards and certification of equipment.

-- New and innovative approaches are required by consultants in rendering services to small water systems.

-- Small systems should be financed adequately prior to construction and should consider non-standard financing approaches such as leasing and lease purchase.

-- Point-of-use alternatives should be considered for solving limited problems.

-- Small systems should remember that in the end, they are responsible for the quality of water delivered to consumers.

CONCLUDING STATEMENT

Robert G. McCall

The organizers of this symposium are to be congratulated on their excellent foresight in developing the agenda and in bringing together the key groups that can help all of us concerned with the problems of small water systems. The interchange of fresh ideas and concepts by predominantly a new group will lead to a rich harvest of solutions. Probably the most outstanding feature of this symposium was the gathering of individuals who are directly involved with the issue including consultants who design systems, representatives of the manufacturers of equipment, state and federal regulatory personnel who must provide surveillance, water utility personnel who must build and operate small systems, and consumers.

I have had the opportunity to attend many meetings since I have been on the National Drinking Water Advisory Council and it was a pleasure to see the number of new faces that were considering this critical problem. It was particularly gratifying to see Mr. Dave Preston of the American Water Works Association participating and deeply involved in the workshop groups. It has been one of my efforts as a Director of the American Water Works Association to interest that group in expanding its activities into the small water treatment area. I believe that the presence of Mr. Preston at this meeting provides us a further entry into that important group.

It appears to me that the key observations of this seminar, which have been addressed in depth in the proceedings, include:

1. Populations of 10,000 are too large to be considered as a small water system. My feeling as well as many others is that 2,500 persons might be a better population figure to consider as a small water system.

2. Technology is available to enable these small systems to meet MCLs, if they can afford it.

3. Subsidies may be required for "basket case" systems with MCL problems.

4. Essentially the user must pay for improvements and the cost will be high.

5. Operation and maintenance and training of operators were considered the most critical problems.

6. Third party validation of new concepts in new treatment packages was a commonly expressed need.

7. Monitoring will probably have to be done by states, although private laboratories including consultants are encouraged to participate.

8. Regionalization, service groups or circuit riders, badly needed, are beginning to develop.

9. Education on Safe Drinking Water Act requirements, technology, funding and management are critical needs.

10. Point of use treatment and dual water systems have received considerable attention and need further investigation.

11. States need to improve on small system technology, approval procedures and management guidance.

12. Modifications to the interim primary regulations on public notification, bacteriological standards and turbidity monitoring would help alleviate some of the regulatory pressures and reduce operating cost.

13. Consumers are most concerned with aesthetic water quality.

I believe that the sense of this meeting was best stated by Mr. James Ramsey, Small Water Plant Operator, of Carrollton, Kentucky, who stated "Do for me, not to me."

LIST OF PARTICIPANTS

W. Kyle Adams
Program Manager
Act Systems, Suite 200
807 W. Morse Boulevard
Winter Park, Florida 32789
305/644-3900

William R. Albright
Vice President, Governmental Marketing
Culligan, U.S.A.
9322 Marycrest Street
Fairfax, Virginia
703/273-8135

E.A. Baldinger
Municipal Service Representative
Chester Engineers
845 Fourth Avenue
Caraopolis, Pennsylvania 15108
412/262-1035

Dr. M.G. Baldwin
Senior Research Associate
Rohm and Haas Company
Norristown & McKean Roads
Spring House, Pennsylvania 19477
215/643-0200 Ext. 1373

Michael Battaglia
Permit Engineer
Illinois EPA/D.P.W.S.
2200 Churchill Road
Springfield, Illinois 62706
217/785-0242

Dr. E. Robert Baumann
Professor of Civil Engineering
Iowa State University
1627 Crestwood Circle
Ames, Iowa 50010
515/294-4975

Dennis Beckmann
Sanitary Engineer
U.S. EPA
230 South Dearborn
Chicago, Illinois 60302
312/353-2151

Frank Bell, Jr.
U.S. EPA
Office of Drinking Water (WH-550)
East Tower, Waterside Mall
401 M Street, S.W.
Washington, D.C. 20460
202/472-6820

John F. Butcher
Executive Vice President
Related Products, Inc.
20 W. Ridgeway Road
Dayton, Ohio 45459
513/433-0114

P.S. Cartwright, Manager
Osmonics, Inc.
15404 Industrial Road
Hopkins, Minnesota 55343
612/933-2277

George M. Caughman, Manager
Division of Water Supply
South Carolina Department of Health and Environmental Control
2600 Bull Street
Columbia, South Carolina 29210
803/758-5544

Lorraine Chang
Office of General Counsel
U.S. EPA
Water Quality Division (A-131)
401 M Street, S.W.
Washington, D.C. 20460
202/755-0753

Cynthia Clark
Appalachian Water and Sewer Development Association
P.O. Box 1346
Logan, West Virginia 25601
304/752-6873

John Clark
Temple, Barker & Sloane, Inc.
15 Walnut Street
Wellesley Hills, Massachusetts 02181
617/237-4492

Dr. Robert Clark, Chief
Economic Analysis Section
Environmental Research Center
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7209

Dennis Clifford, Assistant Professor
University of Houston
Central Campus
Cullen College of Engineering
Department of Civil Engineering
Houston, Texas 77004
713/749-3171

John Cofrancesco, Acting Chief
Environmental Management Branch
U.S. Public Health Service
5600 Fishers Lane (Room 6A-54)
Rockville, Maryland 20857
301/443-1046

Foster D. Coleman
Environmental Engineer
South Carolina Department of Health
and Environmental Control
2600 Bull Street
Columbia, South Carolina 29201
803/758-5544

Dell Cornell, Manager
Construction Public Works
District #1
316 Nebraska
Columbia, Missouri 65201
314/449-8723

Russell Culp
Culp/Wesner/Culp
P.O. Box 40
El Dorado Hills, California 95603
916/677-1695

Gunther F. Craun, Chief
Epidemiology Branch
EPA/HERL
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7218

Dr. Joseph Cotruvo, Director
Criteria and Standards Division
U.S. EPA
Office of Drinking Water (WH-550)
401 M Street, S.W.
Washington, D.C. 20460
202/472-6820

Rick Damron
Appalachian Water & Sewer
Development Association
P.O. Box 1346
Logan, West Virginia 25601
304/752-6873

Richard M. Daum
Sanitary Engineer
U.S. EPA/ODW/TSD
5555 Ridge Road
Cincinnati, Ohio 45241
513/684-4209

Barry Davis
Sanitary Engineer
U.S. EPA/Region X
1200 Sixth Avenue (MS-412)
Seattle, Washington 98101
206/442-1280

L.L. Davis, Vice President
Water Pollution Control Systems, Inc.
3001 South State
Ann Arbor, Michigan 48104
313/662-1717

Donn R. Dresselhuys
Executive Vice President
Autotrol Corporation
5855 N. Glen Park Road
Milwaukee, Wisconsin 53209
414/228-9100

Richard Engelmann
Environmental Engineer
Wyoming Water Quality Division
933 Main
Lander, Wyoming 82520
307/332-3144

Mel Entingh, President
Enting Water Conditioning, Inc.
3249 Dryden Road
Dayton, Ohio 45439
513/294-5100

Walter Feige
Physical Scientist
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7496

A.J. Fleckenstein, President
L.W. Fleckenstein, Inc.
20580 Enterprise Avenue
Brookfield, Wisconsin 53005
414/784-4490

M. Fleischman, Associate Professor
Chemical Engineering Department
University of Cincinnati
Mail Location 171
Cincinnati, Ohio 40221
513/475-5742

J. Ray Foltz
Water-Systems-Planning
Pumps-Water-Treatment
3658 Turfway Road
Erlanger, Kentucky 41018
606/371-0660

John Foster
Director, Field Services
National Demonstration Water Project
1134 Corrugated Way
Columbus, Ohio 43201
614/294-5729

Kim R. Fox, Environmental Engineer
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7228

Francisco Garcia
Water Quality Section
New Mexico Environmental Improvement Division
P.O. Box 968
Santa Fe, New Mexico 87503
505/476-5271 Ext. 300

W.J. Gartner, President
Aqua Lab, Inc.
Route 20 at Valley Lane
Steamwood, Illinois 60103
312/289-3100

Edwin Geldreich, Chief
Microbiological Treatment Branch
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7232

Helene M. Genser
League of Women Voters and Environmental Advisory Council-City of Cincinnati
5536 E. Galbraith Road
Cincinnati, Ohio 45236
513/791-3417

Timothy S. Gimpel, Project Manager
Wright-Pierce
99 Main Street
Topsham, Maine 04086
207/725-8721

Paul D. Gosnell, Program Manager
North Carolina Rural Water Association
P.O. Box 540
Welcome, North Carolina 27374
704/731-6963

Lawrence C. Gray, Chief
Drinking Water Research Staff
EPA
401 M Street, S.W. (RD-682)
Washington, D.C. 20460
202/426-0288

Glenn Gruett, President
Water-Right, Inc.
303 S. Victoria Street
Appleton, Wisconsin 54911
414/739-9401

G.A. Guter, Director
Environmental Studies
Boyle Engineering
600 Shaw
Fresno, California 93704
209/224-8820

Hugh Hanson
U.S. EPA
Office of Drinking Water (WH-550)
East Tower, Waterside Mall
401 M Street, S.W.
Washington, D.C. 20460
202/426-3983

Theodore Helfgott, Ph.D., Director,
Division of Environmental Health
New York State Health Department
Tower Building, Room 495
Empire State Plaza
Albany, New York 12237
518/474-4241

William Henrickson
Senior Environmental Engineer
Midwest Research Institute
10701 Red Circle Drive
Minnetonka, Minnesota 55343
612/933-7880

Dr. John Hernandez, Jr.
Dean, College of Engineering
New Mexico State University
Box 3449
Las Cruces, New Mexico 88003
505/646-2911

Paul Hill
Appalachian Water & Sewer
Development Association
P.O. Box 1346
Logan, West Virginia 25601
304/752-6873

Jack Hoffbuhr, Chief
Water Supply Branch
U.S. EPA/Region Eight
900 Lincoln Tower Building
Denver, Colorado 80203
303/327-2731

Ralph L. Hogge, Chief SFC
Office of Environmental Health
P.O. Box 11340
Tucson, Arizona 85713
602/792-6664

Richard Huddleston, Engineer
U.S. EPA
230 South Dearborn (5WWS)
Chicago, Illinois 60604
312/353-2152

Tom Hushower, P.E.
U.S. EPA
Office of Drinking Water (WH-550)
East Tower, Waterside Mall
401 M Street, S.W.
Washington, D.C. 20460
202/472-6820

Jerry Hutton
Foremost Foods Company
1 Post Street
San Francisco, California 94104
415/983-8371

Harlan Johnson
Sewer & Water Specialist
Blue Valley Community Action
P.O. Box 273
Fairbury, Nebraska 68352
402/729-2278

R.L. Jewett, President
Waltham Chemical Pump Corporation
1396 Main Street
Waltham, Massachusetts 02154
617/899-8604

William Kelley, Chief
Division of Water Supply
Michigan Department of Public Health
3500 N. Logan
P.O. Box 30035
Lansing, Michigan 48909
517/373-1376

Carl Kessler
U.S. EPA
Office of Drinking Water (WH-550)
East Tower, Waterside Mall
401 M Street, S.W.
Washington, D.C. 20460
202/755-5643

Victor Kimm, Deputy Assistant
Administrator for Drinking Water
U.S. EPA (WH-550)
401 M Street, S.W.
Washington, D.C. 20460
202/426-8877

Thomas Klaseus, Supervisor
Public Water Supply Unit
Minnesota Department of Health
717 Delaware Street, S.E.
Minneapolis, Minnesota 55440
612/296-5227

George Klumb
Vice President, Environmental Affairs
Culligan International
1 Culligan Parkway
Northbrook, Illinois 60062
312/498-2000

Robert Kneipp, Mechanic
U.S. EPA
5555 Ridge Road
Cincinnati, Ohio 45268
513/684-8419

Tim Korver, Geologist
Cook Well Strainer Corporation
6330 Glenway Avenue
Cincinnati, Ohio 45211
513/481-8800

Louis M. Kuh
Kuh & Associates
61 Woodmere Road
Stamford, Connecticut 06905
203/357-1022

Donald Kuntz, Chief
Drinking Water Program
West Virginia Department of Health
1800 Washington Street
Charleston, West Virginia 25305
304/348-2981

Richard P. Lauch
Sanitary Engineer
U.S. EPA/MERL/DWRD
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7228

Stephen Leavenworth, Chief
Division of Water Supply
New Hampshire Water Supply and
Pollution Control Commission
105 Loudon Road
Concord, New Hampshire 03301
603/271-3503

John B. Lechner, Manager
Sales and Marketing
Stiles-Kem Division
Met-Pro Corporation
3301 Sheridan Road
Zion, Illinois 60099
312/746-8334

William A. Lee, P.E.
Chief, Engineering Services Section
Nebraska State Health Department
P.O. Box 95007
Lincoln, Nebraska 68509
402/471-2674

Alan Levin, Director
State Programs Division
U.S. EPA
Office of Drinking Water (WH-550)
401 M Street, S.W.
Washington, D.C. 20460
202/426-8290

Paul L. Liebendorfer
Sanitary Engineer
Office of Environmental Health
P.O. Box 11340
Tucson, Arizona 85713
602/792-6664

Doyle L. Lincoln, President
Assembly of Water Conditioners
600 North Sixth
Richmond, Indiana 47374
317/962-1538

Chris Lough, Program Coordinator
Small Systems Water Treatment Symposium
Midwest Research Institute
10701 Red Circle Drive
Minnetonka, Minnesota 55343
612/933-7880

Ben Lykins
Sanitary Engineer
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7209

Warren Lyman
Senior Consultant
Arthur D. Little, Inc.
Acorn Park
Cambridge, Massachusetts 02140
617/864-5770

Nancy Manley
Environmental Engineer
U.S. EPA/Region IV
345 Courtland Street, N.E.
Altanta, Georgia 30308
404/881-3781

P. Marchuk, Microbiologist
Sears Laboratories D/817
925 South Homan
Chicago, Illinois 60607
312/265-3987

Millie Matters
Arizona State Department of Health
1740 W. Adams
Phoenix, Arizona 85077
602/255-1254

Francis T. Mayo, Director
Municipal Environmental Research Laboratory
Environmental Research Center
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7951

Robert McCall, Director
Environmental Health Services
Department of Health
State of West Virginia
Charleston, West Virginia 25304
304/348-2981

Dr. Nina McClelland
National Sanitation Foundation
P.O. Box 1468
Ann Arbor, Michigan 48106
313/769-8010

Robert S. McEwen, Engineer
Ohio Environmental Protection Agency
P.O. Box 1049
Columbus, Ohio 43216
614/466-8307

J. Wayne Mello, Sanitary Engineer
U.S. EPA
5555 Ridge Road
Cincinnati, Ohio 45268
513/684-4445

Michael A. Miller
Market Development Manager
Union Carbide-Linde
P.O. Box 44
Tonawanda, New York 14150
716/731-7479

Bruce Minsley, Assistant Director
Kalamazoo Water Department
415 Stockbridge
Kalamazoo, Michigan 49001
616/385-8155

John Montgomery
National Rural Water Association
1776 K Street, N.W.
Washington, D.C. 20006
202/833-9481

C. Robert Morris, Associate
Executive Director
National Association of Water
Companies
1019 19th Street, N.W.
Suite 1110
Washington, D.C. 20036
202/638-3461

Richard Moser
American Water Works Service Company
500 Grove Street
Haddon Heights, New Jersey 08035
609/546-0700

Henry Mueller
Neptune Microfloc, Inc.
P.O. Box 612
Corvallis, Oregon 97330
503/754-7654

Olly Neal, Jr.
DUSCO, Inc.
530-A West Atkins Boulevard
Marianna, Arkansas 72360
501/295-6900

Jerry Nelson
Administrative Assistant
Montana League of Cities and Towns
P.O. Box 1704
Helena, Montana 59601
406/442-8768

Dr. Robert Norris
Research Chemist
FMC Corporation
Box 8
Princeton, New Jersey 08512
609/452-2300

Warren Norris
Water Supply Branch
U.S. EPA/Region VI
1201 Elm Street
Dallas, Texas 75270
214/729-2774

Dr. Duane Nowlin
Technical Director
The Lindsay Company
P.O. Box 43420
St. Paul, Minnesota 55164
612/739-5330

Douglas Oberhamer
Water Quality Association
477 E. Butterfield Road
Lombard, Illinois 60148
312/969-6400

Henry Ongerth
State Sanitary Engineer
California Department of Health
2151 Berkeley Way
Berkeley, California 94704
415/843-7900 Ext. 413

Quang Pham
Environmental Engineer
Oklahoma State Department of Health
Northeast 10th Street and Stonewall
P.O. Box 53551
Oklahoma City, Oklahoma 73152
405/271-6217

Dennis W. Phillips
Drinking Water Technology
Maine State Department of Human Services
State House Complex
Augusta, Maine 04333
207/289-3826

James Pluntze, Section Head
Water Supply and Waste Section
Department of Social and Health
Services
Mail Stop LD 11
Olympia, Washington 98504
206/434-5954

Donald Porth, President
Culligan International Company
1 Culligan Parkway
Northbrook, Illinois 60062
312/498-2000

David Preston
Deputy Executive Director
American Water Works Association
6666 W. Quincy Avenue
Denver, Colorado 80235
303/794-7711

Moreton B. Price
Vice President
Water Pollution Control Systems, Inc.
3001 South State
Ann Arbor, Michigan 48104
313/662-1717

William Prior, President
Kinetico, Inc.
Newbury Industrial Park
Newbury, Ohio 44065
216/564-2296

James Ramsey, Manager
Carrollton Utilities
Sixth and Sycamore
P.O. Box 277
Carrollton, Kentucky 41008
502/732-4221

Roger Recktenwald, Director,
Technical Assistance--Big Sandy Area
Development District
130 North Lake Drive
Prestonsburg, Kentucky 41653
606/886-2374

Jaime A. Referente
Sanitary Engineer
U.S. EPA/Region II, Room 937
Water Supply Branch
26 Federal Plaza
New York, New York 10007
212/264-1358

Peter Rekshan
Vice President
Water Pollution Control Systems, Inc.
3001 South State
Ann Arbor, Michigan 48104
313/662-1717

Kent Richardson
Environmental Engineer
Illinois Department of Public Health
535 W. Jefferson
Springfield, Illinois 62761
217/782-5830

Joseph D. Ritchey, Hydrogeologist
National Water Well Association
500 W. Wilson Bridge Road
Worthington, Ohio 43085
614/846-9355

Cecil Rose
Farmers Home Administration
South Agriculture Building, Room 5441
Washington, D.C. 20250
202/447-3395

Michael R. Ruge, Technical Specialist
Water Conditioning
4767 North 32nd
Milwaukee, Wisconsin 53209
414/442-3302

M.O. Satrom, State Director
Indiana Rural Water Association
P.O. Box 673
Salt Creek Park
Nashville, Indiana 47448
812/988-6631

John Scanlan, Manager
New Products
Culligan U.S.A.
1 West Culligan Parkway
Northbrook, Illinois 60062
312/498-2000

Joseph Schock
Director, Environmental Sanitation Program
National Park Service
1100 L Street, N.W., Room 3401
Washington, D.C. 20240
202/523-5152

Michael Sciacca
Engineer/Conset
National Demonstration Water Project
1134 Corrugated Way
Columbus, Ohio 43201
614/294-5729

Miles Seter, Vice President
Separmatic
7628 W. Florist Avenue
Milwaukee, Wisconsin 53218
414/466-5207

Ken Shields
Director of Economic and Community Development
Regional Development District of Hocking-Buckeye Hills Valley
Suite 410, St. Clair Building
216 Putnam Street
Marietta, Ohio 45750
614/374-9436

Arleen Shulman
National Association of Counties
1735 New York Avenue, N.W.
Washington, D.C. 20006
202/785-9577

A. Singhal
Associate
Ayres, Lewis, Norris & May
3983 Research Park Drive
Ann Arbor, Michigan 48104
313/761-1010

Duncan K. Smith, Assistant Director
Ontario Research Foundation
Sheridan Park
Mississauga, Ontario CANADA L5K1B3
416/822-4111

Robert C. Smith
Manager, Product Sales
The Carborundum Company
Buffalo Avenue
P.O. Box 1054
Niagara Falls, New York 14305
716/278-6363

R.M. Smith
Systems Division
Met-Pro Corporation
160 Cassell Road
Harleysville, Pennsylvania 19438
215/723-6751

Thomas J. Sorg
Research Sanitary Engineer
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7228

Mark Steichen, Program Director
South Dakota Department of Environmental Protection
Joe Foss Building #413
Pierre, South Dakota 57501
605/773-3754

Koge Suto, Jr.
Staff Engineer
U.S. EPA/Region III (3WA31)
Sixth and Walnut Streets
Philadelphia, Pennsylvania 19106
215/597-2786

Robert Symonds, Treasurer
Milford Water Company
Milford, Massachusetts 01757
215/597-2786

A.F. Tabri, Physical Scientist
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7394

Floyd Taylor, Chief
Water Supply Branch
U.S. EPA/Region I
Water Programs Division
JFK Federal Building
Boston, Massachusetts 02203
617/223-6486

James G. Taylor, Sanitary Engineer
U.S. EPA
5555 Ridge Road
Cincinnati, Ohio 45268
513/684-4211

Raymond H. Taylor
Research Microbiologist
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7204

R.C. Thornbury, Associate Director
National Demonstration Water Project
Appalachian Water & Sewer Development Association
P.O. Box 1346
Logan, West Virginia 25601
304/752-6873

Willard Titus
Environmental Protection Specialist
U.S. EPA/Region X
522 S.W. Fifth Avenue, Second Floor
Portland, Oregon 97204
503/221-3250

Patrick Tobin
U.S. EPA
Office of Drinking Water (WH-550)
East Tower, Waterside Mall
401 M Street, S.W.
Washington, D.C. 20460
202/426-8877

Jeanne Tomson
Environmental Protection Specialist
U.S. EPA/Region VI
1201 Elm Street
Dallas, Texas 75270
214/767-2618

Lowell Van Den Berg, Director
Technical Support Division
U.S. EPA/MERL
5555 Ridge Road
Cincinnati, Ohio 45268
513/684-4374

John W. Vaughan
Market Manager--Drinking Water
Culligan U.S.A.
1 Culligan Parkway
Northbrook, Illinois 60062
312/498-2000 Ext. 382

Lee Vinyard
Culligan U.S.A.
1 Culligan Parkway
Northbrook, Illinois 60062
312/498-2000

Craig Vogt
U.S. EPA
Office of Drinking Water (WH-550)
East Tower, Waterside Mall
401 M Street, S.W.
Washington, D.C. 20460
202/472-5030

Glen Walden
Farmers Home Administration
South Agriculture Building
Washington, D.C. 20250
202/447-5718

Steven Waltrip
Biological Technician
U.S. EPA
26 West St. Clair Street
Cincinnati, Ohio 45268
513/684-7386

Bob Weinstein
Operations Manager
Aqualux
15 Perry Avenue
Norwalk, Connecticut 06850
203/847-3637

Wilbur Whitsell
Technical Support Division
U.S. EPA/ODW
5555 Ridge Road
Cincinnati, Ohio 45268
513/684-4370

Lee Wikstrom
Research Manager
Aqualux
15 Perry Avenue
Norwalk, Connecticut 06850
203/847-3637

Robert Wilfong, President
Chemical Engineering Corporation
P.O. Box 246
Churubusco, Indiana 46723
219/693-2141

John Wilford, Assistant Director
Division of Water Resources
New Jersey Department of
Environmental Protection
Box CN 029
1474 Prospect Street
Trenton, New Jersey 08625
609/984-6858

Ted Williams, P.E.
Williams & Works, Inc.
611 Cascade West Parkway, S.E.
Grand Rapids, Michigan 49506
616/942-9600

A.R. Wilson, President
Better Living Labs
2873 Directors Cove
Memphis, Tennessee 38131
901/346-8610

Charles Withrow
Appalachian Water & Sewer
Development Association
P.O. Box 1346
Logan, West Virginia 25601
304/752-6873

Robert J. Yaekle
Research Associate
Ohio Legislative Service Commission
State House--Fifth Floor
Columbus, Ohio 43215
614/466-4573

J.A. Younts, Manager
Non-Profit Water, Incorporated
P.O. Box 308
Welcome, North Carolina 27374
704/731-4921

☆ U S GOVERNMENT PRINTING OFFICE: 1979 -281-147/121