The Midwest Technology Assistance Center (MTAC) was established October 1, 1998 to provide assistance to small public water systems throughout the Midwest via funding from the United States Environmental Protection Agency (USEPA) under section 1420(f) of the 1996 amendments to the Safe Drinking Water Act. This report summarizes progress made since funding was received from the USEPA in November 1998.

MTAC is a cooperative effort of the ten states of the Midwest (congruent with USEPA regions 5 and 7), led by the Illinois State Water Survey, an affiliated agency of the University of Illinois. The participation of each state in MTAC is led by the Director of their Water Resources Institute. John Braden and Kent Smothers were the Principal Investigators for this project. Kent Smothers serves as the Managing Director of the Center, and is responsible for conducting routine activities with the advice and council of John Braden. Richard Sparks is also actively involved in the business of MTAC, as he is the current Director of the Water Resources Institute at the University of Illinois.

Competitive Grants

The competitive grants have initiated work, and there do not appear to be any major problems with any of the projects meeting deliverables at this point. The Native America Technical Assistance and Education project was delayed somewhat in starting work since many of the participating Native American Community Colleges are not active during the summer months. However, work has commenced and seems to proceeding in a satisfactory manner at this time. We have asked each of the principal investigators to submit an interim report summarizing their progress to date. The information presented below for the three projects is a concise review of content of those reports. The Appendices A-C contain the full text of each report submitted to our office.

Benchmark Investigation of Small Public Water System Economics
Roger Beck, Ben Dziegielewski, Tom Bik
Southern Illinois University
Departments of Agribusiness Economics and Geography

This project has seen considerable progress towards completion of several of the primary deliverables. The annotated bibliography of almost thirty of the most relevant publications provides a good overview and introduction of the economics, problems, and distribution of small water systems. Several papers that detail the procedures and intricacies involved in the process of benchmarking are included as well. Additionally, the authors have provided a topical listing of
additional references. The authors selected publications for inclusion in this review based upon their relevance to the following topics:

- factors that contribute to the "small system problem"
- the economics of small community water systems
- national statistical survey of community water systems
- different approaches to small system self-assessment
- benchmarking techniques and measures - empirical benchmarking studies
- empirical studies exploring the causal relationships between system performance and benchmarking measures

An expert panel was consulted to help select those issues that are most important and relevant to economic benchmarking in small water systems. The expert panel survey was initially sent to sixty-five people, and those individuals identified an additional eight people that might be able to provide valuable input. Results of the consultation were used to develop five recommendations for the design and implementation of the survey and the interpretation of the responses. Those recommendations (Appendix A) are detailed below:

1. Respondents recognized the need to survey both small and very small systems, including systems serving homeowners associations and mobile home parks. Service population and number of connections were the most frequently cited measures of size. Comments on the sampling frame, suggests two approaches that could be used: a proportional stratified random sample of water supply systems serving 25 to 500, and 501 to 3,300; or a proportional stratified random sample of systems serving from 15 to 200, and 201 to 1,000. Respondents also suggested the inclusion of systems up to a service population of 10,000.

2. The consultation produced several valuable suggestions on what categories of systems should be distinguished in the benchmarking analysis. The most frequently mentioned dimensions included source of water (groundwater, surface water, purchased water), system ownership (public, private), and system size. A good way to approach the categorical grouping is to perform the statistical tests of significance on various categories and retain the categories for which separate benchmarking measures may be most appropriate.

3. An exhaustive list of factors that contribute to the success of small water systems was provided by the panelists. Good financial performance (especially adequate cash flow), effective management and good technical performance (consistent production and delivery of water meeting MCL’s) were seen as the most critical elements in a successful system. Factors associated with troubled systems were: lack of a certified operator, poor or co-mingled accounting system, under-priced water, inability to generate reserves for capital improvements, and noncompliance with water quality standards.

4. The best indicators of performance of small water systems suggested by the panelists include: unit cost of water production, retail price of water, debt service coverage ratio, availability and size of the reserve fund, system water loss ratio, age of system components, frequency of loss of service events, number of customer complaints, and quality of finished water.
5. The majority of panelists believed that there is a need for benchmarking tools by small system managers. Availability of useful benchmarks would allow system managers to communicate the need for improving the quality of service and financial position to the decision-makers. Rather than being used as a viability test, the most useful role of benchmarking may be to provide a system with information regarding its relative position with respect to its peers. Also, while panelists voiced a real need for the development of benchmark measures for system managers, the “most likely users” of the measures were overwhelmingly identified as regulatory officials, rating services, and water boards and councils.

The benchmark team will also conduct at least two focus group meetings to discuss the project prior to initiating the survey of the small systems. The first of these meetings has been scheduled for October 21, 1999 at the Illinois American Water Works Association’s Small System Conference. This group will consist of small system managers that have direct involvement in the financial management of their systems.

**Technical Assistance and Education for the Native American Nations In Kansas, Nebraska and South Dakota**

Bruce I. Dvorak, Jennifer Miller, and DeLynn Hay  
University of Nebraska-Lincoln  
Bill Welton  
Haskell Indian Nations University

The University of Nebraska and Haskell University that will collaborate with four native american community colleges to present a total of ten workshops. These colleges are Nebraska Indian Community (Nebraska), Little Priest College (Nebraska), Sinte Gleska University (South Dakota), and Ogalala Lakota College (South Dakota). All are 1994 (Tribal) Land Grant Colleges. This project will help them enhance their extension service capabilities. A specific faculty member at each college has been identified to perform the project work. The faculty members are currently being contacted to schedule dates for visits and seminars.

The Workshop Preparation Seminar where the tribal representatives meet with University of Nebraska, Haskell University, USEPA, and MTAC personnel is scheduled for October 22-23, 1999; the seminar will likely start on a Friday evening and run through a Saturday afternoon. This seminar will cover two days, consisting of 8 to 10 contact hours, and will be held in Lawrence, Kansas (at Haskell University). The goal of this seminar is to help prepare the tribal college faculty to prepare the content for the workshops that they will be presenting during the fall of 1999 and spring of 2000.

The Workshop Preparation Seminar will consist of a combination of presentations on drinking water issues by UNL faculty, examples of technical assistance presentations given by Haskell extension personnel, and small group discussions among the project. A list of potential topics was developed through discussion with tribal faculty, and during a conference call of the advisory group on October 12, 1999. This advisory group consisted of Bruce Dvorak, DeLynn Hay, Tom Shoreman from the University of Nebraska, Gary Carlson from USEPA Region 8, and Kent Smothers of MTAC. The list of topics developed is detailed below:

- Building General Public Awareness (focusing on primary school students)
Study of Corrosion Control in Small Public Water Systems

The project team includes:
Professor Jae K. Park, University of Wisconsin Department of Environmental Engineering
Abigail Cantor, P.E., Process Research (engineering consulting firm)
Professor Sangil Choi (visiting professor from Korea)
Prasit Vaiyavatjamai (student assistant)

The study design has been finalized, two study sites have been selected, pipe loops have been installed, and sampling has commenced. Two different water qualities will be used for the study. One system (Dane, Wisconsin) has a relatively hard, alkaline water supply that employs two wells without either chlorination or fluoridation. The other system (Lone Rock, Wisconsin) has a softer, less alkaline water quality; and while it does not chlorinate, it does fluoridate the water. Each site has will test three different pipe loops (steel, copper, and lead) under three different scenarios. This will result in a total of eighteen pipe loops.

The design of the pipe loop is similar to the American Water Works Association Research Foundation Pipe Loop Model as detailed in their publication *Lead Control Strategies*. The size was scaled down for economy, and to allow the loops to fit into available space since there were a total of nine pipe loops installed at each site. Sample collection began on August 7, 1999 and will continue through August 29, 2000.

Web Site

The MTAC web site (http://mtac.sws.uiuc.edu) addresses areas of interest to small systems, is fully functional and has had several hundred visitors since early June. The Technical Needs Assessment document is now posted on the web page. We have also added a search engine to the site to assist visitors with accessing information at the site quickly and efficiently. We will continue to provide updates and links to valuable information. Appendix D contains a report that details web activity since July 1, 1999. We will posting the interim progress reports submitted by the three competitive grants on the web during October to allow interested parties to follow their progress. Once we have completed the evaluation of the results of our Technical Needs Assessment, we will post this information on the web site as well. We expect this analysis to be completed before submission of the next quarterly report is due.
Technical Needs Assessment

The Technical Needs Assessment for small systems in the Midwest has been mailed, and we have received a surprisingly large response from the small systems around the midwest. I have attached a copy of the Technical Needs Assessment document for your reference in Appendix E. MTAC mailed the survey to 100 small public water systems in each of the ten Midwestern states. We did a subsequent mailing of another two hundred surveys to reach our original goal of two hundred responses. Those states that have Native American communities surveyed a representative sampling of those systems as well. We have been in contact with the National Drinking Water Clearinghouse, and we intend to work with them to possibly expand the geographical scope of the study and publicize the results.

The table below summarizes the response rate by state and type of supply.

<table>
<thead>
<tr>
<th>State</th>
<th>Ground Water</th>
<th>Surface Water</th>
<th>Both</th>
<th>Native American Supplies</th>
<th>Total Survey’s Received</th>
</tr>
</thead>
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<td>1</td>
<td>1</td>
<td>0</td>
<td>27</td>
</tr>
<tr>
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<td>1</td>
<td>0</td>
<td>25</td>
</tr>
<tr>
<td>Total</td>
<td>178</td>
<td>11</td>
<td>11</td>
<td>3</td>
<td>200</td>
</tr>
</tbody>
</table>

Annual Conference

Planning has proceeded for the MTAC sponsored Small Systems Conference, which is scheduled for February 29, 2000 in St. Louis, Missouri. The meeting will be held at the Renaissance Hotel near the St. Louis Airport. The successful teams that were selected for funding in the Competitive Grants program will give updates on the progress of the projects. Kent Smothers will provide an update on the results of the Technical Needs Assessment and the Emergency Planning Guide. The workshop will co-hosted by Dr. Thomas Clevenger, the Director of the Missouri Technology Assistance Center. The afternoon session will be moderated by Dr. Clevenger, and he will present an overview of his Center’s programs and there will be talks on atrazine removal, UV disinfection, and the destruction of Cryptosporidium. We have invited
Staffing

Staffing remains unchanged since the last quarterly report. The part-time WEB administrator Kevin Merrifield continues development of the site. The Administrative Coordinator for the program, Cindy Hawkins, in addition to having experience in administering and coordinating a competitive grants program, has experience in designing and administering Web sites, and is assisting Kevin. Dr. John Braden is one of the Principal Investigators for the MTAC proposal, and continues to actively participate in Center activities. Dr. Richard Sparks, who replaced Dr. Braden as Director of the Water Resources Center at the University of Illinois, has been working closely with both Braden and Smothers on the project, and is coordinating interaction with the Management Committee. Dr. Sparks has provided valuable input to the Principal Investigators of the competitive grants, and is helping to increase the awareness of MTAC programs in small systems communities. Kent Smothers continues to serve as Managing Director, and remains in contact with local and regional EPA officials concerning MTAC activities.
APPENDIX A

Benchmark Investigation

of

Small Public Water System Economics
EXPERT PANEL CONSULTATION REPORT

PURPOSE

The principal purpose of the expert panel consultation was to solicit opinions on the important premises and requirements of economic benchmarking. The results of the consultation will provide guidance in the design of the survey instrument that will be used in the next phase of the research. A secondary purpose of the consultation was to make key members of the small water system community aware of the research project. Many of the individuals contacted during the survey will be play a role in the data collection effort that will be required in order to identify and test possible benchmark measures.

METHOD

Selection of the Expert Panel

Panelists were selected from several groups of people knowledgeable about small community water systems. These consisted of:

- Authors of research articles about benchmarking and small system economics
- State drinking water regulatory offices
- State and national offices of the National Rural Water Association
- State and national offices of the American Water Works Association
- State offices of the Rural Development Administration/Rural Utilities Services
- Regional offices of the Rural Community Assistance Program
- Rural Water Education and Research Foundation
- USEPA national and regional offices
- Financial consultants

Panelists and their email addresses were identified through a review of the literature and the web sites of national and state organizations.

Consultation Process
The method used in this consultation can be described as a modified Delphi approach. It consisted of two rounds of email messages that were sent to knowledgeable members of the small water system community. In the first round, panelists were sent a short background description of the problems of small water systems, and the proposed use of financial benchmarking as one strategy to address these problems. A series of questions and statements about the development and use of benchmarking, and a list of pertinent documents and publications followed the background section.

Panelists were asked to respond/react to the questions and statements in any way they saw fit. The email message requested that panelist submit their replies within one week (responses were actually collected for nearly two weeks). The responses from the panelists were next summarized, and a working list of survey questions, based upon the summaries, were developed.

In the second round of the consultation, panelists were sent the summary of the first round responses along with the working list of survey questions. They were once again asked to respond as they saw fit. The responses of the second round were combined with those of the first round, and a series of recommendations for further research was developed based upon this information.

The first email message sent to panelists appears in Appendix B-1. A complete listing of the responses received appears in Appendix B-2. The second email message sent to panelists appears in Appendix B-3. The responses from the second round appear in Appendix B-4.

Consultation Respondents

The survey was initially sent to 65 people. Of these four were returned. Email addresses were corrected on two and resent. The other two appear to have been sent to individuals who had changed their e-mail address and their names were deleted from the mailing list. Eight people were either referred to us by respondents and were sent copies of the email survey, or had been sent copies of the survey by those in the initial mailing. There was some indication that the email was also forwarded to other members of the small water systems community. The total number of possible respondents was 73.

Twelve surveys were returned from the first round. Of these two contained no comments and but requested a copy of the final report. Ten contained comments that were used to develop the summaries and questions for the second mailing.

All 73 panelists received copies of the second round email message. Second-round comments were received from four panelists.

Recommendations

The results of consultations with experts in the fields of small water system evaluation and benchmarking produced a set of recommendations for the design and implementation of the
survey of small public water supply systems and the subsequent analysis of survey results. Recommendations that are most relevant to the present study are summarized below.

1. Respondents recognized the need to survey both small and very small systems, including systems serving homeowners associations and mobile home parks. Service population and number of connections were the most frequently cited measures of size. Comments on the sampling frame, suggests two approaches that could be used: a proportional stratified random sample of water supply systems serving 25 to 500 customers, and 501 to 3,300 customers; or a proportional stratified random sample of systems serving from 15 to 200 connections, and 201 to 1,000 connections. Respondents also suggested the inclusion of systems up to a service population of 10,000.

2. The consultation produced several valuable suggestions on what categories of systems should be distinguished in the benchmarking analysis. The most frequently mentioned dimensions included source of water (groundwater, surface water, purchased water), system ownership (public, private), and system size. A good way to approach the categorical grouping is to perform the statistical tests of significance on various categories and retain the categories for which separate benchmarking measures may be most appropriate.

3. An exhaustive list of factors that contribute to the success of small water systems was provided by the panelists. Good financial performance (especially adequate cash flow), effective management and good technical performance (consistent production and delivery of water meeting MCL’s) were seen as the most critical elements in a successful system. Factors associated with troubled systems were: lack of a certified operator, poor or co-mingled accounting system, under-priced water, inability to generate reserves for capital improvements, and noncompliance with water quality standards.

4. The best indicators of performance of small water systems suggested by the panelists include: unit cost of water production, retail price of water, debt service coverage ratio, availability and size of the reserve fund, system water loss ratio, age of system components, frequency of loss of service events, number of customer complaints, and quality of finished water.

5. The majority of panelists believed that there is a need for benchmarking tools by small system managers. Availability of useful benchmarks would allow system managers to communicate the need for improving the quality of service and financial position to the decision-makers. Rather than being used as a viability test, the most useful role of benchmarking may be to provide a system with information regarding its relative position with respect to its peers. Also, while panelists voiced a real need for the development of benchmark measures for system managers, the “most likely users” of the measures were overwhelmingly identified as regulatory officials, rating services, and water boards and councils.

Acknowledgements

We would like to thank the following members of the small water community who allowed us to invade their e-mail boxes to request their help during this consultation.
Bob Elston
Jim Williams
John Overstreet
Julie Gillenwater
Pat Crotty
R. Bruce Robinson
Rick Harmon
Wm. Pappathopoulos
Acord Cox & Company, CPAs
Ellen Miller
Peter E. Shanaghan
Robert M. Clark
Haig Farmer
Bill Jarocki
Bob Dunlevy
Dorothy Bradley
Heather Himmelberger
Michael Luger
Ouida Meier
Tom Clevenger
William J. Sullivan
Yuefeng Xia
Elizabeth Oakland
G. Richard Dreese
Gerald Doeksen
Janice Beecher
Jeffrey Jordan
John Cromwell
Raymond Supalla
Richard N. Boisvert
Sharon Rollins
Thomas Arn
Don Stricker
Elmer Ronnebaum
Gary Williams
Mike Keegan
H. Diane Snyder
Mark Dickey
Michigan RWA
Nebraska RWA
Peggy Burden
Ruth Hubbard
Tom Duck
Al Lao
Bob Baumeister
Christine O'Brien
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Jack Daniel
Joe Stuart
Karl Mueldener
Lou Allyn Byus
Roger Sellburg
D. Clark Thomas
Dorman Otte
We would also like to thank the following organizations for taking the time and effort to send us copies of documents that relating to this research endeavor.

Hagler Bailly Services, Inc.
Community Resource Group - Southern RCAP
Iowa Department of Natural Resources
Malcolm Pirnie, Inc.
Integrated Utilities Group Inc
Kansas Rural Water Association
Planning and Management Consultants
Department of Agricultural Economics Institute of Agriculture and Natural Resources University of Nebraska-Lincoln
The USEPA Office of Water and Groundwater Website

APPENDIX A

EXPERT CONSULTATION MAILING - PHASE 1

Part 1. Introductory Letter

Dear Colleague:

We are conducting research under the sponsorship of the Midwest Technology Assistance Center (MTAC), one of nine centers that were established and funded under §1420(f) of the 1996
Safe Drinking Water Act Amendments. The mission of these Centers is to address the needs of small public and Native American water systems.

We are writing to ask you to participate in a volunteer "expert panel" consultation. Input from this consultation will guide the development of benchmark indicators that will allow the managers of small community water systems to obtain the information they need to ensure the long-term financial integrity of their systems.

Participants in this expert panel consultation will be asked to respond to several statements and questions regarding the development and application of financial benchmarking tools for small water systems.

Participation in this consultation is voluntary. To participate, you only need to continue reading this email message. Please let us know if you decide not to participate.

This project has been reviewed and approved by the SIUC Human Subjects Committee. Questions regarding your rights as a participant in this research may be addressed to the Committee Chairperson, Office of Research and Development Administration, Southern Illinois University, Carbondale, IL 62901-4709; phone (618) 453-4533.

Other questions or comments regarding this expert panel consultation, or the Benchmark Investigation, may be directed to Tom Bik at 618-453-1118, or <smallsys@siu.edu>.

Thank you for your assistance.

Sincerely,

Dr. Roger Beck Dr. Ben Dziegielewski
Associate Professor Associate Professor
SIUC Agribusiness Economics SIUC

Part 2. Objective, Instructions, and Background

Benchmark Investigation of Small Public Water System Economics
Expert Panel Consultation

Objective

The objective of this consultation is to clarify issues related to the development and use of benchmarking tools for small water systems, and to develop specific recommendations for obtaining additional information through survey research.

How This Information Will Be Used
Final responses from the panel will be used to guide the research team in the development of a survey of approximately 1,000 water systems in the 10-state region covered by MTAC. A written report of the expert panel consultation will also be submitted to MTAC. All participants will receive a copy of the final consultation report via email, and the option of receiving a copy of the final research report.

**Consultation Instructions**

A brief background of the situation leading up to the development and use of benchmark indicators appears below, followed by a list of statements and questions.

Using the "reply" function of your email software, please respond as you see fit. Add, modify, or change the statements, or provide whatever information that you feel is relevant. It is not necessary to comment on every statement. Type your comments directly onto this email.

We will begin to collect and summarize responses 7 days after sending the initial email. Participants will receive a draft report via email one week later, and will be given the opportunity to provide additional follow-up responses.

**Background**

Surveys and research reports have repeatedly cited the economies of scale inherent in traditional water treatment technologies, and the inverse relationship between water system size and the number of non-compliance incidents. A variety of factors have combined to leave many small systems without adequate financial resources to respond to changing socioeconomic, regulatory, and technical demands.

The 1996 Safe Drinking Water Act Amendments attempt to specifically address the need to improve small community water system performance, and have charged state regulatory agencies with the responsibility of making judgments about the technical, managerial, and financial capacity of water systems, a task that has not traditionally been a part of the drinking water program.

While efforts on all three capacity dimensions are necessary, some observers have suggested that improved financial performance is the key to break the cycle of failure experienced by many small water systems. Previous efforts to improve water system financial performance have included subsidies, training programs and self-assessment checklists.

More recent efforts have followed the lead of credit rating services such as Moody’s, in seeking to establish ranges of “benchmark” indicators that can alert regulatory officials and water system managers to impending problems, and direct them to appropriate courses of action to avert failure. Benchmark indicators can be developed by collecting and comparing water utility data from a large sample of water systems.
Part 3. Questions and Statements

QUESTIONS AND STATEMENTS

“Small” water systems have been identified in several different ways by agencies and researchers. What measure(s) of size should be used to identify those community water systems that are most typical of the problems attributed to small systems? (e.g., pumpage, number of connections, number of customers, size of total assets, etc.).

The smallest community water systems are often excluded from studies because of problems with data collection and accuracy. How important is it to include these systems in efforts to develop benchmark measures for small water systems? Should special efforts be made to ensure their inclusion?

Small water systems are very different in terms of size, organization, type and quality of source water, age, customer characteristics, etc. Can a single set of benchmark indicators be used by all systems, or should separate sets of benchmarks (or ranges in benchmark values) be developed for different categories of water systems? What categories might be most important in grouping systems for a benchmarking analysis?

Benchmarking practitioners recommend that benchmarks be linked to a business’s “critical success factors.” What are the most critical factors to the success of small water systems? What is causing the most trouble for small water systems?

“Performance” benchmarking requires the selection of a set of observable/measurable indicators that water system managers can easily access or compute. It also requires that these indicators are logically (and statistically) related to measures of performance. What is the best measure(s) of the performance of small community water systems?

“Process” benchmarking seeks to improve internal programs and processes by learning how the "best" organizations conduct similar activities. Would small systems benefit from efforts to organize a network that would help small water system managers to identify the best practices of other water systems?

Do you believe that there is a "felt need" for benchmarking tools for financial analysis? Are small water system managers already engaged in an informal use of benchmarking? In your interactions with small system managers, what measures are they likely to use to describe the performance of their water systems?

Which member of a small water system organization is most likely to be the best person to contact regarding information that can be used in the development of benchmarks (e.g., manager, operator, consultant, mayor, etc.)? Who are the most likely users of benchmarking tools?

What do you think is the potential value of systematic benchmarking for the small water system community?
Please add any additional comments, or suggest questions or issues that you would like to see addressed in a survey of small water systems.

If you know of researchers, government officials, or non-governmental organizations that might wish to be included in this consultation, please type in their names and/or email addresses below, or simply forward this email message to them.

Do you wish to receive a copy of the final report of the "Benchmark Investigation of Small Water System Economics"? (please check below)

Yes ____ No ____ Paper ____ or PDF ____.

If paper, please type your mailing address below:

References

List of Documents Reviewed for This Consultation

Some of the documents that were reviewed in the preparation of this consultation appear below. Please add your own suggestions of other relevant publications.


APPENDIX B

EXPERT CONSULTATION MAILING
PHASE 1 RESPONSES

The exact wording of the questions and statements sent to the panelist appears in Appendix B-1 (above). The responses of panelist are presented below, under brief headings that identify each group of questions and statements. Responses have been edited slightly to maintain confidentiality and correct spelling. Panelists were assigned a respondent number, which shown in parenthesis at the beginning of each response.

Part 1. Comments on: BACKGROUND:

(#8) There has probably been too much emphasis on the use of financial benchmarks as indicators of trouble. It might be more productive to consider turning the focus around the other way - documenting the financial profile of successful/sustainable small systems of different types to provide benchmarks of financial health as targets to strive for. Moreover, the objective should not be to focus on financial health or ill health per se, but rather to use financial benchmarks as indicators of sustainability - what does it take to know that you are sustainable?

Part 2. Comments on: DEFINING SMALL WATER SYSTEMS

What measure(s) of size should be used to identify those community water systems that are most typical of the problems attributed to small systems?

(#1) Pumpage & number of customers

(#2) Any of these will do. You need to be a little careful with number of connections or customers because there are a few systems that serve only industrial parks or complexes that have very few customers but produce large quantities of water and have substantial revenue and assets.

(#3) Small water systems are considered to serve <3300 population; more recently, we've seen some use 10,000. Small in Kansas is <500 connections that comprise approximately 90 percent of all systems

(#4) Pumpage and number of connections.

(#5) Number of connections has always made the most sense to me for small water systems.

(#6) Probably number users or number connections.

(#7) Pumpage and number of connections are relatively good indicators. Size of total assets can be very misleading, especially when most small systems don't have a clue as to the value of their system. Number of customers (assuming you mean connections x number of people per household, etc.) is also misleading to some extent and difficult for small systems to ascertain. Otherwise (active) connections and customers are the same.

(#8) I think the number of connections is the most important variable because it relates directly to cash flow which I believe to be the most important indicator. As I recall the story, the EPA started using the 3,300 person cut-off for two reasons: 1) it was a proxy for 1,000 connections (implying 3.3 persons/hh - higher than today's average) and 2) the EPA community water supply survey indicated that below 1,000 service connections the average system had a staff of less than one full-time equivalent. This staffing cut-off is an interesting "structural" boundary to consider. There may be big differences in the efficacy of operations and maintenance (and financial management) above and below this threshold.

(#9) Pumpage is the best indicator, because it captures economies of scale; connections (with a cutoff of about 1,000) is also a reasonable proxy.

(#10) Number of connections and pumpage

Part 3. Comments on: INCLUSION OF VERY SMALL WATER SYSTEMS

How important is it to include these (smallest) systems in efforts to develop benchmark measures for small water systems?

(#1) Important for them to see how other larger systems operate.

(#2) It's important to try to get information about the very small systems (e.g., mobile home parks). However, from the data and studies that I have reviewed, it is safe to conclude that the very small systems are no better (and may be worse) than the smallest systems you can get data for. So, by excluding the very small systems, your results will be conservative (that is, they will make the industry look better than it is).

(#3) Very important to include - or at least an agency or organization which can appraise their needs and interests.
Yes they should be included, small systems are different and need their own benchmarks. It will take a special effort to collect the data.

I think the only way to get input from most small systems will be to go in person to interview them, a very expensive proposition I wouldn't recommend. The best source of information will be the technical assistance providers who deal with them on a regular basis, such as the Rural Community Assistance Program (RCAP), National Rural Water Association (NRWA), and possibly the National Environmental Training Center for Small Communities (NETC).

There are more small systems, in number, than large systems. Probably should be included.

It is extremely important that the very small systems be included. This is where you commonly find minimal capacity to meet SDWA requirements and have the greatest need for infrastructure development. Special efforts should be made to include these systems, though this will be the most difficult group of water systems to gain credible/reliable information. This effort may require other partners established within the targeted states that regularly provides service to these size systems.

I recall one student of this problem who wrote a paper on “the particle physics theory of small water systems.” In this theory, it is argued that below 200 connections, all bets are off and even experienced technical assistance field hands cannot tell what's going to happen next in a water system in this super small size range. I think there is truth in this. It reinforces another saying I’ve heard - that these should not be thought of as small water systems but as “small clusters of homes.” Our data shows that cash flow is still the most important concept in these systems and it is possible to get income statement data even in this micro size range. (forget the balance sheet, however.) This is an extremely important category for study. Of the 50,000 odd small systems that EPA counts nationwide 40,000 or so serve fewer than 500 connections. Some simple benchmarks relating to revenue and expense relationships could provide them with simple easy to follow operating guidance.

Yes - with some random sampling. This could be done in conjunction with assessments for non-transient non-community systems, which face many of the same problems.

It is important. I suggest you use the limit of 500 customers for the smallest group.

Part 4. Comments on: CATEGORICAL GROUPING OF WATER SYSTEMS

What categories might be most important in grouping systems for a benchmarking analysis?

Water sources (Wells or Surface) (Treated or Purchased). Growth of system. Storage capacity. Age and type of distribution lines.

The biggest fundamental difference I have found is between systems that use surface water, those that use groundwater, and those that purchase water from another system. Each of the three categories of water source has different cost and asset characteristics. Other than that, I think that you can capture the differences (for example, different mix of residential/commercial/industrial customers) in the benchmarks.

Perhaps financial analysis can be common. Size of system, date of construction, debt load per tap, water source/type, etc. All impact financial position.

I see small systems being somewhat similar and one set of benchmarks being adequate.

You must use a range of benchmark values, as the size and complexity of “small” systems has such a large range. Surface water vs. Ground water systems, treatment method, number of connections.
One set of characteristics will not likely fit all. The grouping we use is to separate systems that are not combined with other utility systems such as sewer. Water systems that are combined with other utilities have unique financial and operational characteristics. We then separate the systems into two groups. One group is those systems that produce/treat their own water. The second group is those systems that purchase treated water and function primarily as a distribution system only. In small systems the trend is toward buying treated water from a central source.

A separate set of benchmarking may be appropriate, depending upon how the indicators are identified and structured. If there is to be a breakout, I would suggest the following:
- 25-500 persons
- 501-3,300 persons
- 3,301-10,000 persons
- 10,001-500,000 persons
- 500,000 and above persons

These variables are important to sort out. Refer to the PA benchmarks study (editorial note, see: John E. Cromwell III, Scott J. Rubin, Frederick A. Marrocco, and Mark E. Levan., “Business planning for small system capacity development,” Journal of the American Water Works Association 89, no. 1 (January 1997): 47-57; and John E. III Cromwell and Scott J. Rubin. Development of Benchmark Measures for Viability Assessment. Bethesda, MD: Prepared for the Pennsylvania Department of Environmental Protection. Apogee Research, Inc. 1995) to review the various hypotheses were tested (all of them, I believe). Once you have the data (and QA it - no small task), it is a simple matter to run the stats to test them all. I would recommend looking at all of them. It is, of course, essential to keep the different ownership categories separate throughout due to different accounting conventions.

Some simple benchmarks could be developed (already have been!) That will be highly correlated. Some are generic across types of systems. Some type-specific measures could be used. Avoid looking at rates or prices; they are almost meaningless.

I would suggest the use of benchmark ranges. A set of criteria to judge the financial and planning health of small utilities was developed by Integrated Utilities Group, Inc. It provides a set of criteria to use to determine if (outside) assistance is desirable for financial planning and utilizes a numerical scoring mechanism. (editorial note, see: C. (Kees) W. Corssmit. Fiscal Health Scoreboard for Water and Wastewater Utilities. Based on a Publication in “The Newsletter of the Special District of Colorado.” Prepared by Integrated Utilities Group, Inc., Denver, Colorado. 1996).

Part 5. Comments on: WHAT TO BENCHMARK

What are the most critical factors to the success of small water systems?

Management and Water Treatment

They key factors are the system's financial performance (net revenues, positive cash flow, return on investment, etc.), the quality of its management, and the quality of its technical performance. A system that is deficient in at least one of these areas will have problems. A system that is deficient in two or more is probably in serious trouble.

Effective management and strong governance positions. Generally, there are fewer and fewer “sparkplugs” in small communities …. those who possess or are willing to exert leadership roles. What is causing the most trouble for small systems? I think it is being told that they considered to be a problem when in reality they are not. Too many regulators seem to not be able to accept that when a small system is performing its function which is to provide quality and quantity of water system, then they need to allow that system and its neighbors to be left alone.
Trained operators, proper replacement/maintenance and system financial performance are most critical. Trouble is caused by; low salaries resulting in poor operation/maintenance, lack of political fortitude charge appropriate user fees.

Most critical factors are pricing the water at a cost sufficient to allow for proper operation, maintenance, and expansion. I believe that small systems continually underprice water and are unable to operate effectively. Giving these systems tools to help get a grip on these issues is critical. If there is an adopted standard for operational dollar needs, the burden would be lifted from the operator/manager somewhat .... kind of a scapegoat. This is a big problem!

1. Poor or inadequate accounting systems. Many systems use cash accounting. 2. Failure to segregate water system funds from other funds. Doesn't allow accumulation of reserves to make major capital improvements if funds are commingled with operational funds of other accounts that tend to get spent. 3. Water Rates. Not understanding how to price the product.

Most Critical Factors: 1) Financial stability; 2) System reliability (operations); 3) Consistent production of water meeting MCLs; and 4) Certified operator. Causing the greatest problems: 1) Compliance issues e.g., (testing/monitoring/reporting); 2) Lack of financial resources; 3) Lack of certified operator(s); and 4) Operational problems.

Cash flow is a well-established indicator. Cost based pricing is the key input to long-term sustainability. The ownership and management must provide clear accountability. My own bias is toward economic regulation as a means to ensure capacity, because it is comprehensive.

Lack of management skills; lack of financial resources.

Part 6. Comments on: PERFORMANCE MEASURES

What is the best measure(s) of the performance of small community water systems?

1. Water Production cost/1000 gallon. 2. Retail water sale cost /1000 gallon. 3. Water loss for system.

See the benchmarking work done in Pennsylvania. (editorial note, see reference in Part 4 above).

First, are the customers happy? Is there water in the system? Are the rates affordable? Is service a top priority with management/governance or do problems go unattended? Water loss ratios below 15 percent, prudent fiscal management, etc. All contribute to a system's viability. Financial statements will tell the story. We strive for systems to have a debt service coverage ratio of 1.25.

Water quality, loss of service events, cash flow performance, investment in short and long-term asset replacement.

Compare cost of water to the final quality of the delivered product (quality measured in NTU, taste and odor, trihalomethanes). Any monitoring violations or customer complaints should also be considered.

Operational performance-meeting or keeping water quality standards, maintaining service. Financial Performance-cost of doing business factors-funding accounts including reserves for capital improvements.

1) MCL Violations/Reporting/Monitoring Violations, Administrative Orders, etc.; 2) Turnover rates of operators and/or extended time(s) without certified operators; 3) biannual/updated Capital Improvement Plan; 4) replacement reserve account (benchmark @ 10 percent of annual gross revenue); 5) “special” requirements on water operating permit; and 6) age of system components.

Cash Flow. These are too numerous too list here. But there are several key operational indicators. For very small systems, though benchmarking is difficult. Ratios like “employees per whatever” don’t really apply.

See the criteria used in the Fiscal Score Card referred to above.
Part 7. Comments on: PROCESS BENCHMARKING

Would small systems benefit from efforts to organize a network that would help small water system managers to identify the best practices of other water systems?

(#1) Illinois Rural Water Association is already in existence for this purpose. Many small systems not using their services.

(#2) Yes.

(#3) Not really - it is not generally the business of one system to worry about a neighboring system’s problems or operations.

(#4) yes, I believe MN rural water association. Is already filling this role in MN.

(#5) Sure, it may help operators develop and continue better operational guidelines through a spirit of competition. Publication of operational parameters would also help justify system expenses to customers

(#6) Already networks in place. Round Table and Illinois Rural Water Association. Also, water system operator’s meetings and conferences.

(#7) This is a toughie. The problem is that most, at this size, will not access the information or seek assistance. Reasons include: 1) the fear factor - “if things are wrong and somebody finds out, I could lose my job,” 2) lack of resources and time to stay current; and 3) the delivery mechanisms for such an endeavor need to almost be a one-on-one type approach.

(#8) most of the benchmarking literature is not relevant to the financial benchmarking that your research is intended to perform.

(#9) To an extent this would be helpful and it already occurs. But even best practices cannot overcome lacking economies of scale. I lean more toward restructuring and “out of the box” ideas (such as technology changes), which are not captured by this sort of benchmarking

(#10) Sure.

Part 8. Comments on: BENCHMARK NEEDS AND CURRENT PRACTICE

Do you believe that there is a "felt need" for benchmarking tools for financial analysis? What measures are they likely to use to describe the performance of their water systems?

(#1) (1.) Cost (Retail and Bulk or Wholesale); (2.) Water loss; and (3.) Operating cost comparison (repairs, insurance, electrical, chemical, engineer etc.).

(#2) I don't know enough to answer this.

(#3) The need for financial benchmarking is appreciated by industry organizations and associations, state and federal agencies (if they care). System managers see quality of service and financial position as primary measures of performance.

(#4) Yes, there is a need for benchmarking tools for financial analysis. I do not believe most small system managers are using benchmarking. My opinion is that most small system managers would describe their system performance by meeting SDWA standards and water is in the pipe nearly all the time.
I've seen a large range in financial responsibility of system management. Most on the poor end. The measures I would suggest are listed above.

Probably not “felt” as strong as it ought to. Most operators are more aware of operational issues and yes, they do some informal benchmarking.

Yes, there is the felt need for such tools. Most small systems do not have full-time personnel and financing issues are left up to others, i.e., city clerk, city council/water board. Little input is given by/received from water system personnel. Most are not qualified to conduct a financial analysis; they are not trained in this area. Capital Improvement Planning is the exception, not the rule. (Most don't even do rate studies or have a meter "change-out" program...simple activities). Small system water personnel are also not adept at communicating their needs with the policy/decision-makers; they do not have the experience or expertise to develop the information or materials they need to accomplish this. Also, many times politics determines whether rate increases/purchases/improvements are furthered. Water system personnel aren't elected; council members are. Per discussions with small system operators/managers, they utilize measures such as:

1) meeting budget(s)
2) keeping expenses down
3) keeping rate increases to a minimum
4) some relative cash flow

Lack of violations and low rates

This is old news. Good small system managers already do benchmarking, seek improvement. Some actually are pretty sophisticated.

Many managers will already use very informal benchmarking tools. Annual and monthly financial reports are often used.

**Part 9. Comments on: INFORMATION CONTACTS/BENCHMARK USERS**

*Who are the best sources of information about small systems? Who are the most likely users of benchmarking tools?*

The manager is most likely to have the information you need.

Manager/administrator/bookkeeper. Users of benchmarking? State and federal agencies, rating agencies, investors.

The operator and the city clerk would have the needed information. The most likely users would be city council, regulators and finance people.

I think your best contact would be technical assistance providers, as they have dealt with these communities as a whole. In most cases, the system operator/manager is the best contact otherwise

Operators, Mayors, Treasurers, Boards, IEPA, Lenders.

Most small systems are "one person operations" (the operator). These individuals are the ones closest to the action and can provide the most input with regards to information on operations. Most small systems use consultants/engineers only in times of need and usually don't have a engineering firm that is on retainers. Those systems that have some form of a manager would be useful as they probably have more capacity to understand the critical benchmarking needs. City clerks/office managers can provide some useful information as they are the ones usually in charge of overseeing the financial activities of small municipal water systems or private water systems.

Owner/Manager
Part 10. Comments on: POTENTIAL VALUE

What do you think is the potential value of systematic benchmarking for the small water system community?

(#1) Comparative analysis of one small system to another of similar kind.

(#2) I think it's an important piece of the puzzle, but not “the answer.”

(#3) Would allow for there to be a yardstick, if properly used, could be of assistance to all systems. Having such information would allow funding agencies to better understand overall needs, those who provide technical assistance could better target their efforts. Lastly, the individual systems should be able to see where they are spending more than necessary by industry standards.

(#4) To provide a touch of reality and information on what is needed for a water system to be sustained over the life of the community.

(#5) Helps establish a standard for proper operation of small water systems (good news). Justifies increased expense on system (bad news). Educates the system operator and the public.

(#6) Possibly.

(#7) With regards to long-term viability and increasing the capacity of water system personnel, the value is great. The greatest fear is employing a benchmarking system that is too complicated, obtrusive or overly structured with little flexibility. From our experiences with the development of the State’s Capacity Development Plan, small systems fear the Primacy Agencies will be too stringent in their application and the water system(s) will get caught up in a non-flexible system. The big question is. “Will the utilization of benchmarking apparatus’s be used to determine viability or provide guidance?” If the answer is guidance, the success of such an endeavor will be more likely.

(#8) Take a look at the percentiles and CDF graphs in the PA benchmark study (editorial note, see references in Part 4 above). That is the kind of output that lends itself to easy use by small systems. When you are having trouble and the percentiles are saying that you are consistently on the 10th percentile of 3, 4, or 5 key financial indicators, it tells you right where the trouble is. And it is something you can show to your board to help convince them you have to make changes to fix things. And, nobody has to tell you whether you are viable or non-viable or otherwise label you. The percentile comparison against your peers tells you all you have to know. This is especially critical because most states have no authority to intervene in financial management of these systems. So, a good thing that states can do is provide this type of impartial comparative information to allow people to make their own comparisons and draw their own conclusions. It is a market-oriented intervention. It is workable even under a Republican governor.

(#9) Very limited, to be perfectly honest. We know how to solve this problem - it is a matter of political will, not more surveying or benchmarking.

(#10) Could be quite high- there is very little available right now.

Part 11. ADDITIONAL COMMENTS

(#1) Computer mapping of rural systems needed to determine location, size of lines and capacity of system.
Generally, don't create a survey which begins with the cliché “As you know, small systems are a problem!” or any such connotation. If you want to help small systems, then help them - don't condemn them as some within the regulatory and bureaucratic community are constantly doing. Want to find some real problems? Have 50 samples run on bottled water - Kansas did that and found 15 percent of the sample contain contaminants which had they been detected in public water systems, would have caused EPA to shut them down.

Do small systems see themselves as being viable without continued subsidies from either the state or federal government.

Think that this is a very worthwhile project ... please keep me informed.

The development of a financial benchmarking initiative is definitely needed, no question. If for no other reason than to provide some level of guidance to small systems that wish to earnestly attempt to: 1) determine if they are financially fit; 2) identify financial problems/issues within their water utility; 3) identify approaches to make/take corrective actions; and 4) communicate more effectively with decision/policymakers.

Before you survey systems survey the states in the region to thoroughly understand their existing financial reporting requirements. These will exist in different agencies of state government. You may find one for investor owned systems, one for municipals, and another one for authorities/districts. They may be good (Wisconsin) or not so good, but they exist. They may not go all the way down the size gradient, but every little bit helps. I would see what's out there and see what you can learn from it before launching the survey effort. In addition, the existing state reporting mechanisms are your only shot at getting balance sheet data. In your broadcast survey, I would encourage you to focus only on the income statement. You will not get good balance sheet data except where it is already a required reporting item by states. Including balance sheet data will hurt your response rate and add bias towards getting responses from only well managed systems. Data quality is enough of a problem with just the income statement. One trailing thought, Peter Shanaghan of EPA headquarters has some pie charts showing the change in ownership mix as you progress through system size categories form 10,000 to 3300 to 1,000 to 500 to 100. The changes in ownership mix are quite drastic as you cut across this gradient.

This is deja vu all over again. I can see some incremental value in this but haven't we been here before? Is there much more to be said? Repackaging and dissemination, I guess, which keeps all of us going. I believe they are doing something similar in Texas - indicators of good performing systems (TNRCC).

The cost of clean water is very significant for small utilities. I have addressed this in several papers published over the last ten to twelve years. I am beginning to see these predictions coming true more often. User charge impacts of the Clean Water Act can be in the twenty to fifty dollars per month incremental impact range per household.

Part 12. SUGGESTED REFERENCES

I have reviewed most of these documents/articles in the past and find them to be, for the most part, relevent. One additional resource you may want to review is: USEPA. Office of Ground Water & Drinking Water. Partnership for Safe Water Voluntary Treatment Plant Performance Improvement Program Self-Assessment Procedures. October, 1995.


Fiscal Health Scoreboard for Water and Wastewater Utilities, Integrated Utilities Group Inc.
APPENDIX C

EXPERT CONSULTATION MAILING - PHASE 2

Part 1. Introductory Letter

Dear Colleague:

A short time ago we sent you an email message asking for your feedback on several questions regarding the development and use of benchmark measures for small community water systems.

You will find a summary of the responses that we received below. Based on these responses, we developed a number of questions for possible inclusion in a survey of small water systems in 10 Midwestern states. A working list of survey questions follows the response summary.

We would appreciate it if you could review the email message below. We invite you to comment on the summary of responses, as well as the working list of survey questions. Add, delete, modify, or criticize these as you see fit. Let us know what you think. Participation in the first round of this consultation is not a requirement for providing comments at this time.

Please submit your responses by using the “reply” function of your email program and typing directly into this message. All respondents will receive a copy of the final draft of this panel consultation via email (in MS Word format) during the first week of October.

Thank you for taking the time to consider our requests. Please contact us at any time if you have comments or suggestions regarding this research endeavor.

Sincerely

Dr. Roger Beck
Associate Professor
Agribusiness Economics
SIUC

Dr. Ben Dziegielewski
Associate Professor
Geography
SIUC

Sponsored by the Midwest Technology Assistance Center http://mtac.sws.uiuc.edu
Conducted by Southern Illinois University Carbondale, Department of Agribusiness Economics and Department of Geography

Part 2. Summary of First Round Responses
Defining Small Water Systems

What measure(s) of size should be used to identify those community water systems that are most typical of the problems attributed to small systems?

The number of connections, population served and pumpage were all suggested as appropriate measures. Suggested values for these measures were: 1,000 connections and 3,300 customers. No range was suggested for pumpage.

It was noted that: some agencies use less than 10,000 customers as a measure of small systems; the great majority of systems serve less than 500 customers; and the number of connections is an inappropriate measure when small systems have a few large customers, or serve only industrial parks/complexes.

Inclusion of Very Small Water Systems

How important is it to include these (smallest) systems in efforts to develop benchmark measures for small water systems?

All of the respondents stated that it was very important to include even the smallest community water systems (CWS) in the study, in spite of the recognized difficulties with data collection. It was stated that these systems may be more likely to have minimal capacity, the greatest need for infrastructure improvement, and there are just so many of them.

Several respondents suggested working with partner organizations such as NRWA and RCAP as a way of improving data collection or getting some sense of the needs and interests of these systems. Others commented that a careful sample of smallest systems would be adequate.

Categorical Grouping of Water Systems

What categories might be most important in grouping systems for a benchmarking analysis?

Several critical distinctions between small water systems were suggested:

- water source (ground/surface/purchased)
- “size”
- system growth
- storage capacity
- date of construction / age and type of distribution lines
- treatment method
- combined (water and sewer) systems vs. water supply only
- debt load per tap

Responses were divided as the to need to develop separate benchmark ranges. Some respondents suggested that several simple benchmarks would be applicable across all categories; other suggested that these differences could be sorted out statistically once the data is obtained.
What to Benchmark

What are the most critical factors to the success of small water systems?

Many factors were suggested:
- management quality - effective management and strong governance
- technical performance (i.e., water treatment)
- financial performance
- lack of “sparkplug” leadership in small communities
- unnecessary regulatory mandates
- trained/certified operators
- low salaries
- operation/maintenance/replacement
- pricing/inappropriate user fees/water rates/cost-based pricing
- political fortitude
- inadequate accounting systems (i.e., cash accounting)
- co-mingled accounting systems (not separate from other municipal or utility budgets)
- testing/monitoring/reporting
- system reliability

Some specific indicators were suggested:
- net revenues
- return on investment
- regulatory compliance
- cash flow/ cash flow/ cash flow

Performance Measures

What is the best measure(s) of the performance of small community water systems?

Many performance measures were suggested:
- water production cost/1000 gallon
- retail water sale cost/1000 gallon
- water loss ratio (below 15 percent)
- affordable rates
- customer satisfaction/complaints
- debt service coverage below 1.25
- water quality (measured in NTU, taste and odor, trihalomethanes)
- loss of service events
- investments in asset replacement fund
- replacement reserve account (benchmark @ 10 percent of annual gross revenue)
- MCL /reporting/monitoring violations
- age of system components
- biannual/updated Capital Improvement Plan
- cash flow/ cash flow/ cash flow
Process Benchmarking

Would small systems benefit from efforts to organize a network that would help small water system managers to identify the best practices of other water systems?

Most respondents commented that “process benchmarking” is already done through the efforts of state Rural Water Associations. Several obstacles to this type of information exchange were mentioned: many very small systems do not participate in RWA programs; the fear factor - "if things are wrong and somebody finds out, I could lose my job;” small systems lack the resources and time to stay current; such programs would require an expensive one-on-one approach.

Benchmarking Needs and Current Practice

Do you believe that there is a “felt need” for benchmarking tools for financial analysis? What measures are they likely to use to describe the performance of their water systems?

Respondents were split as to whether or not small system managers were already using self-assessment measures. Examples of currently used performance measures included:
- cost (retail/bulk/wholesale)
- water loss
- operating cost comparison (repairs, insurance, electrical, chemical, engineer etc.)
- lack of violations/meeting SDWA standards
- “low” water rates; keeping rate increases to a minimum
- meeting budgets
- keeping expenses down
- cash flow

Most respondents replied that there was a recognized need for better financial management tools. Some suggested that small systems are better at handling operational issues and do not have the staffing and resources to perform even the most basic self-analysis, such as rate studies or capital improvement planning. Other comments pointed out that self-assessment, and the development of financial tools, may be hampered by poor communications between system personnel and policy and decision-makers. In particular, the honest evaluation of rate increases is hampered by the political process involved in raising rates in publicly operated systems.

Information Contacts / Benchmark Users

Who are the best sources of information about small systems? Who are the most likely users of benchmarking tools?

Suggested best sources of information at small systems are:
- manager/administrator
- operator
- engineer
- bookkeeper
- city clerk
- technical assistance providers
- mayors
- treasurer
- the one and only guy who runs the system part-time
- owner/manager

**Suggested “most likely” benchmark users:**
- financial sources
- water organization boards
- industry organizations and associations
- state and federal agencies
- rating agencies
- investors
- lenders
- city council
- regulators

**Potential Value**

*What do you think is the potential value of systematic benchmarking for the small water system community?*

Comments ranged from “great” to “very limited” and “not ‘the answer’.”

**The following phrases were used in responses to this question:**
- comparative analysis; a yardstick
- determine if systems are financially fit
- allow funding agencies to better understand overall needs
- target technical assistance
- provide a touch of reality
- information on what is needed for a water system to be sustained over the life of a community
- establishes a standard for proper operation of small water systems
- objective measures that operator/managers can use to support the need for sustainable water rates
- educates the system operator and the public
- identify financial problems/issues; has potential to tell you right where the trouble is
- identify approaches to make/take corrective actions
- allow managers to make their own comparisons and draw their own conclusions
- a market-oriented intervention
- communicate more effectively with decision/policymakers

**Implementation of benchmarking tools could be impeded by systems managers’ fear that:**
- they will be too complicated, obtrusive or overly structured with little flexibility
- will be used to determine viability rather than to provide guidance
- will be employed by primacy agencies, who will be too stringent in their application
**Additional Comments**

**These comments noted that:**
- the overall high quality of small water systems is misrepresented by the use of generalizations about the “small system problem”
- “ownership” (public/private) plays a critical role in small system financial performance
- state financial reporting agencies could serve as a major source of financial data for small systems and should be used in the study
- small water system managers should be surveyed to see if they believe they can remain viable without outside subsidies
- GIS/computer mapping can play a significant role in the improved management of small systems
- benchmarking research can only make minor contribution to improved system performance

**Suggested References**

**Three additional documents were suggested for review:**
- *Fiscal Health Scoreboard for Water and Wastewater Utilities,* Integrated Utilities Group Inc.

**Part 3. Working List of Mail Survey Questionnaire Items**

The survey questions that appear below were developed from the above responses. They are presented in draft format and those actually used in the survey will be reviewed for clarity and order of presentation. Note that information collected in the survey will be supplemented with data obtained from state regulatory and financial agencies.

Surveys will be sent to a sample of systems that serve less than 1,000 connections. The sample will be stratified by size (>200 connections, <200 connections), ownership type (public / private) and major source of supply (surface, ground, purchased).

Contact person(s): (Name(s), position(s) within the organization, training)

1) Regarding your supply system, what is your:
   a.) current number of active connections?
   b.) approximate current population served?
   c.) pumpage (finished water: average/day, max day)?
   d.) current water supply sources (surface water, groundwater, purchased water and estimated percent from each source)?
   e.) distribution system storage capacity?
   f.) estimated age of system components (source/plant/distribution mains)?
   g.) most recent estimate of distribution system water loss?
   h.) types of treatment processes?
2) What type of water supply service do you provide (estimated percent of: residential, commercial/industrial, wholesale)?

3) How is your water system organized? (private company, city department, county agency, regional authority, other)?

4) Who provides oversight of the water system management and operation? (elected board, appointed official, etc)?

   4a.) Is your system required to file routine financial reports with any state agency, funding agency, or lender?
   4b.) Are these reports available to the public?

5) What other information is collected routinely for use in the internal management of your system?

6) Do you keep a record of:
   a.) drinking water violations?
   b.) customer complaints?
   c.) boil water orders?
   d.) loss of service events?

7.) Do you, or another person, prepare an annual financial report for your system?

8.) Do you prepare an annual budget?

9.) How is your system funded (operating revenues, taxes, combination)?

10.) What is the basis of your accounting system? (cash or accrual)

11.) Is the financial management of your systems completely independent from other municipal operations, or other utility operations (i.e. wastewater)?

12.) Do you have a reserve fund that is used for replacement/expansion costs?

13.) Can you provide us with a current rate schedule? A history of rate changes?

14.) What type of funding mechanisms have you used to finance major infrastructure improvements and purchases? Can you provide us with a brief summary of your utility's grant and loan history?

15.) Who do you contact when you need technical, financial, or managerial assistance (NRWA, AWWA, RCAP, USDA Rural Development state regulatory agency, National Drinking Water Clearinghouse, other)?
16.) Is your utility a member of a water-related non-governmental organization? (state/national Rural Water Association, AWWA, other)?
17.) Have you recently performed an assessment of the affordability of your water rates? What was the basis of your assessment?
18.) Are you aware of any self-assessment programs for small water utilities in your state? Have you participated in any such program?

APPENDIX D

EXPERT CONSULTATION MAILING
PHASE 2 RESPONSES

Comments on: DEFINING SMALL WATER SYSTEMS

What measure(s) of size should be used to identify those community water systems that are most typical of the problems attributed to small systems?

(11) Suggest that the population served based classification system used by USEPA be retained as it is generally understood by PWSs: small = 25 to 3300; medium = 3301 to 10,000; large = > 10 k.

(12) We delineate systems by persons served: <500 = very small; 501-3300 = small; 3301-10,000 = medium; >10,000 = large. Measures for systems that are most typical of problems in small systems are (1) populations less than 500, and (2) operational control - whether they have a certified operator.

(13) I am familiar with the 10,000 figure. I think it is a good breakpoint with regard to a utility’s ability to retain expertise in house. Systems that are dominated by commercial or industrial water use probably should be classified separately regardless of whether the system is small. You might want to consider a domestic use ratio as a test. Arguably if more than 50 percent of the consumption is non-domestic many benchmarks may not work well.

Comments on: INCLUSION OF VERY SMALL WATER SYSTEMS

How important is it to include these (smallest) systems in efforts to develop benchmark measures for small water systems?

(11) Need to consider that small system operators tend to leave their position for a better paying job on a fairly frequent basis.

(12) It's vitally important to include the smallest systems in developing benchmarks. The greatest percentage of systems, in our state and nationally, are classified as small systems. Yes, special efforts should be made to ensure their inclusion.

(14) I would agree that it is important to include the smallest facilities since in our state, the largest number of facilities in non compliance is these facilities.

Comments on: CATEGORICAL GROUPING OF WATER SYSTEMS
What categories might be most important in grouping systems for a benchmarking analysis?

(11) The above categories all have a place in evaluation of a water system depending on the problem being analyzed - technical, financial or managerial.

(12) Separate sets of benchmarks should be developed for the various system types. Broad categories for system types are: Ancillary (homeowner's associations, prisons, mobile home parks); Municipality; Privately-owned system (private company which operates a supply).

(13) Consider adding ownership as a category-public vs. private.

(14) Compliance status

Comments on: WHAT TO BENCHMARK
What are the most critical factors to the success of small water systems?

(11) See above.

(12) Critical success factors include certified operator, adequate funds, system design, expansion of private (unregulated) to public system, lack of adherence to construction standards. Areas which create the most trouble for small systems include lack of technical knowledge, lack of management, lack of certified operator, lack of adequate funds, lack of understanding of serious potential ramifications of their actions.

(13) Some of these work only if the utility is operated with rate payers- I think the indicators that work regardless of whether rates are charged are most valuable and can include systems serving industries and institutions better- look at expenditure per gallon produced, look at regulatory compliance.

Comments on: PERFORMANCE MEASURES
What is the best measure(s) of the performance of small community water systems?

(11) See above.

(12) The best measure of performance is compliance with the SDWA. Five categories included: critical problem (acute MCL); serious problem (non-acute MCL); minor problem (occasional monitoring violations); potential problem (no problem now, but one foreseen); and no problems (current and future compliance with SDWA). If a problem is identified, then classified, the willingness of the supply to work in correcting the problem is the next critical factor.

Comments on: PROCESS BENCHMARKING
Would small systems benefit from efforts to organize a network that would help small water system managers to identify the best practices of other water systems?

(11) Use of State RWAs could be effective if they have the funding to add staff for this type of work. However, small system employee retention could be a major factor.

(12) No, networking would not be beneficial. The circuit rider and peer review process has had minimal positive impact in the past. Small systems want to be told what needs to be done, how to do it, etc. Their water activities are often not their primary job, and both the time and funds are usually not available to have them get "best practices" from other supplies.
Comments on: BENCHMARK NEEDS AND CURRENT PRACTICE

Do you believe that there is a "felt need" for benchmarking tools for financial analysis? What measures are they likely to use to describe the performance of their water systems?

(11) State primacy agencies will have to use some of this information to implement the Capacity Regulations regardless of where it is developed.

(12) Yes, there is a need for benchmarking tools for financial analysis. No, small system managers aren't usually involved in the financial end very much - usually the city clerks in a small town have this responsibility. The measures they are likely to use in describing the performance of their system include whether they are in compliance with state regulations and complaints from customers on: (1) esthetic water quality parameters like iron, (2) service interruption, and (3) cost of water.

(14) Most of our small systems do not have a clue what their system costs are, except for the utility bill. Most do not have an understanding of what their future needs might be until system problems are encountered. It is very important to assist the small facilities with some kind of future planning tools. (“Other comments pointed out that self-assessment, and the development of financial tools, may be hampered by poor communications between system personnel and policy and decision makers.”) In most small systems, there won't be any difference in those personnel. (“In particular, the honest evaluation of rate increases is hampered by the political process involved in raising rates in publicly operated systems”) - generally with good education this isn't that much of a problem.

Comments on: INFORMATION CONTACTS / BENCHMARK USERS

Who are the best sources of information about small systems? Who are the most likely users of benchmarking tools?

(11) These sources may have the information, but are they will to share this information because of confidentiality or business considerations.

(12) For the financial and managerial benchmarks, the mayor/council chair for finances and budgets in muni supplies; the chair of non-muni supplies such as homeowners association; the owner of ancillary or private supplies. For the technical benchmarks, the operator would be the most likely person. The most likely users of benchmarking tools are the state and federal regulators, and the economic developers of the communities.

Comments on: POTENTIAL VALUE

What do you think is the potential value of systematic benchmarking for the small water system community?

(11) Pilot work is needed to be able to judge the value of the analysis and the responsiveness of a PWS to implement the recommended changes. Also need to determine why changes were not implemented and make adjustments or provide alternatives if possible.

(12) From a regulator's perspective, consistency in regulating the public water supplies

(14) If the small system will use these resources, it can potentially keep them out of trouble in the future. But, getting this information to the small system and its periodic use will be the greatest problem.

ADDITIONAL COMMENTS

(12) Differentiate into the three types of small systems, based on why they provide water: municipal, ancillary, and privately-owned (where they provide water, and are a for-profit entity). Non-transient non-community systems are also required to participate in capacity development, per the 1996 SDWA. Will they be addressed? Also, in our state, we're including transient non-community systems in the "new" systems strategy.
The TNCs actually take the most time from a compliance/enforcement standpoint. The non-municipal (ancillary) small communities have special needs that are different than small communities.

(14) If the research results in an easy but informative self-assessment tool, it will be worth the time invested.

Comments on: SUGGESTED REFERENCES

(11) These may be too complex for the small system operator/official and simplified versions will be needed.

Comments on: WORKING LIST OF MAIL SURVEY QUESTIONNAIRE ITEMS
(only questions that were commented on appear below)

1) Regarding your supply system, what is your:
   a.) current number of active connections?
   b.) approximate current population served?
   c.) pumpage (finished water: average/day, max day)?
   d.) current water supply sources (surface water, groundwater, purchased water and estimated percent from each source)?
   e.) distribution system storage capacity?
   f.) estimated age of system components (source/plant/distribution mains)?
   g.) most recent estimate of distribution system water loss?
   h.) types of treatment processes?
   i.) max\min pressure in the distribution system

6.) Do you keep a record of:
   a.) drinking water violations?
   b.) customer complaints?
   c.) boil water orders?
   d.) loss of service events?

   (11) Add water main breaks & locations and equipment failure.

15.) Who do you contact when you need technical, financial, or managerial assistance?

   (11) USEPA OGWDW web site and Safe Drinking Water Hotline

General Comments:

(13) These questions look like a good start.
APPENDIX B

Technical Assistance and Education
for the
Native American Nations
in
Kansas, Nebraska, and South Dakota
Progress Report for

Technical Assistance and Education for the Native American Nations
In Kansas, Nebraska and South Dakota

Submitted to
Midwest Technology Assistance Center
Kent Smothers
Illinois State Water Survey
2204 Griffith Dr.
Champaign, IL 61820-7495

by

Bruce I. Dvorak,
Jennifer Miller, and
DeLynn Hay
University of Nebraska-Lincoln

and

Bill Welton
Haskell Indian Nations University

September 23, 1999
The contract with the University of Nebraska was been signed and the project initiated in late May. The contract with Haskell Indian Nations University was recently finalized. The proposed project schedule has been delayed by approximately four months due to a combination of circumstances. The project paperwork for Haskell was not in late September (which was later than anticipated during the proposal preparation) due to misunderstandings between the Illinois and Haskell Grants Offices.

All four Tribal Colleges that will collaborate with UNL and Haskell University have been contacted concerning the funding of the proposal. The four collaborating colleges are Nebraska Indian Community and Little Priest College in Nebraska, and Sinte Gleska University and Ogalala Lakota College in South Dakota. All are 1994 (Tribal) Land Grant Colleges. This project will help them enhance their extension service capabilities. A specific faculty member at each college has been identified to perform the project work. The faculty members have been contacted in order to prepare them for the project.

University of Nebraska personnel to help the project’s Principal Investigators have been assigned to the project. A University of Nebraska Extension Educator has been assigned to help with the project. A part-time Extension Engineering has been hired by the University of Nebraska to work on this project during the fall of 1999.

The project Principal Investigators (Dvorak, Hay, and Welton) met on July 29th and created a draft schedule for the Workshop Preparation Seminar (attached). The “Workshop Preparation Seminar” is intended to allow the tribal representatives meet with University of Nebraska, Haskell University, US EPA, and MTAC personnel. It is tentatively scheduled for October 22-23. This seminar will cover two days and will be held in Lawrence, Kansas (at Haskell University). The goal of this seminar is to help prepare the tribal college faculty to prepare the content for the workshops that they will be presenting during the fall of 1999 and spring of 2000. During the summer of 1999, the University of Nebraska personnel have prepared additional material relating to municipal water distribution and supply systems for the seminar.

A list of potential workshop topics has been created after discussions with the tribal faculty members involved with the project.

- Building General Public Awareness (focusing on primary school students)
- Municipal drinking water treatment systems (overview)
- treatment for herbicides, nitrates, arsenic, and turbidity removal
- Municipal drinking water distribution systems (overview)
- Specific concerns relating to rural water systems
- Corrosion control methods
- Groundwater / surface water interactions
- Alternative Water Supply Options
- Private homeowner wells concerns:
  - Home treatment systems
  - Abandoned well plugging

In order to be sure that the workshop curriculum does not duplicate other existing programs and utilizes available resources, an outside advisory committee has being formed. This committee consists of seven members. Two representatives from the US EPA (Regions 7 and 8), one tribal representative, one representative of the Indian Health Service, one representative of the Bureau
of Reclamation (from South Dakota), and one at-large representatives (Mni Sose). The last member will be the director of the MTAC. The committee meeting is currently being arranged for mid-October 1999. A major issue for discussion by the advisory committee will be the schedule for the Workshop Preparation Seminar and resources that the tribal faculty members may want to use.

Tentative Workshop Schedule:

Friday, Oct. 22
7:00-9:00  Introductions, Icebreaker and Project Wet Example Problem

Saturday, Oct. 23
8:30-9:00  Medicine Wheel [George Godfrey]
9:00-9:12  Intro. to Project and Goals for Day [Bruce Dvorak]
9:12-9:20  UNL Overview [UNL Personnel]
  Break
9:30-9:45  Overview of Midwest Technical Assistance Center [Ken Smothers]
9:45-11:15 Overview of Tribal Drinking Water Issues and Concerns (15-min. presentations by each Tribal College Faculty member)
  Break
11:30-11:55 Project Wet Example
11:55-Noon Overview of Afternoon Session [Bruce Dvorak]

Noon-1:00  Lunch
1:00-1:10  Identify Priority Topics for discussion
1:10-3:00  Discuss Priority Topics [Moderator: Bill Welton]
  Break
3:15-3:45  Identify Resources Needed for Creating Presentations [Moderator: DeLynn Hay]
  Break
4:00-4:15  Create Timeline for completion of Project [Moderator: Bruce Dvorak]
4:15-4:30  Talking Circle [Bill Welton]
APPENDIX C

CORROSION CONTROL IN SMALL PUBLIC WATER SYSTEMS
# Table of Contents

**BACKGROUND OF STUDY** ...................................................................................................................... 0

**SCOPE OF STUDY** ................................................................................................................................. 0

**LITERATURE REVIEW** ............................................................................................................................. 0

**DESIGN OF EXPERIMENT** ...................................................................................................................... 0

**SITE SELECTION** ....................................................................................................................................... 0

**DESIGN, INSTALLATION, AND STARTUP OF APPARATUS** ................................................................. 0

**SELECTION OF CHEMICALS** ................................................................................................................... 0

**EXPERIMENTAL METHOD** ....................................................................................................................... 0

**RESULTS** .................................................................................................................................................. 0

**PROJECT SCHEDULE** ............................................................................................................................... 0

**ACKNOWLEDGEMENTS** ............................................................................................................................ 0

**REFERENCES** ............................................................................................................................................ 0

September, 1999
CORROSION CONTROL IN SMALL PUBLIC WATER SYSTEMS
SIX MONTH INTERIM REPORT

BACKGROUND OF STUDY

This study on corrosion control in small public water systems is funded by the Midwest Technology Assistance Center (MTAC). The organization provides technological assistance to small public water systems and water systems serving Native American communities. MTAC is described in its literature as "a collective effort of the University of Illinois and the Illinois State Water Survey in collaboration with the land grant universities of Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, Ohio, and Wisconsin. The mission of the Center is to provide small system administrators and operators with the information necessary to make informed decisions on planning, financing, and the selection and implementation of technological solutions to address their needs."1

The Center issued a Request for Proposal in December 1998 for a study "to address corrosion control in small public water systems." Specifically, the study is to "evaluate the effect of chlorine on small distribution systems that have not previously used chlorination for disinfection."2

The impetus for this study comes from two Federal drinking water regulations that apply to small public water systems. The first regulation, The Lead and Copper Rule, was implemented in 1991.3 Small public water systems, which are defined as serving less than or equal to 3300 people, have been involved in sampling for lead and copper as prescribed by the Rule. At this time, the systems have either been shown to have optimal corrosion control or have implemented corrosion control techniques bringing them into compliance. The concern is for the effect of the second regulation, The Groundwater Rule, which will be proposed in November 1999. The final rule will be implemented in November 2000.4 The Groundwater Rule will require all water systems to be reevaluated for disinfection needs. The majority of medium and large public water supplies already disinfect the water. A larger percentage of small public water supplies do not disinfect and will be most affected by this new regulation. The question arises as to if the introduction of chlorine as required by the Groundwater Rule will push a water system out of compliance with the Lead and Copper Rule. Concerns with corrosion of other metals in the system arise as well as the possible corrosive effects of chlorine addition are studied.

The funding for this project was awarded jointly to Jae K. Park, Ph.D., professor of Civil and Environmental Engineering at the University of Wisconsin - Madison and to Abigail F. Cantor, P.E. of Process Research in Madison. Professor Park has a background in water chemistry and water treatment process design. Ms. Cantor has been a chemical engineering consultant in water treatment process design since 1980. She has run various corrosion control studies involving pipe loop apparatuses since 1992. A Masters Degree candidate from the Civil and Environmental Engineering Department at the University of Wisconsin - Madison, Prasit Vaiyavatjamai, is also on the project team. Mr. Vaiyavatjamai performs the weekly sampling of the apparatuses and analyzes the samples for various water quality parameters.
Scope of Study

The scope of work for this study as discussed in the MTAC's request for proposal is:

1. Conduct an extensive literature search of existing work relevant to this project.
2. Fully characterize the water quality information for each of the systems involved in the study.
3. Characterize the effects of the initiation of chlorination at the test sites.
4. Characterize the effects of introducing corrosion control techniques on the chlorinated water.
5. Develop Technical Briefs outlining the study findings for distribution through the National Drinking Water Clearinghouse and the Midwest Center.
6. Develop a consumer oriented informational product addressing these issues for distribution to systems experiencing or anticipating problems.
7. Prepare an interim report six and twelve months after award of the contract.
8. Report on the project at a conference of the Midwest Center.

Literature Review

The review of literature will not be discussed for this six-month interim report. The future review will be organized into the following categories:

1. Prediction of Corrosivity Based on Water Quality Parameters
2. Effect of Chlorine Addition on Corrosivity of Water
3. Effect of Stagnation Time on Corrosivity of Water

A good basic understanding of the issues involved in corrosion control studies can be obtained by reading the book, Lead Control Strategies, published by the American Water Works Association Research Foundation.5

Literature pertinent to the planning of this project will be cited within the discussion of this report.

Design of Experiment

The corrosivity of water is influenced by a large number of factors such as various water quality characteristics, water system configuration parameters, types of chlorination techniques, and types of corrosion control techniques. Based on time and budgetary constraints as there are in any project, choices had to be made as to which factors could be isolated for study in one experiment.
The first factors to be considered were water quality parameters of which there are many. Past research has shown that alkalinity and dissolved inorganic carbonate come to the forefront as water quality parameters that greatly influence the corrosivity of water.\textsuperscript{5,6} For that reason, two sites have been chosen in this project that differ in these concentrations.

At each site, it is desired to test the corrosivity of the untreated water and compare it to the corrosivity of the same water with chlorine added at the required disinfection dosage.

Three metals representative of typical residential plumbing materials have been chosen to be exposed to the water -- lead, copper, and galvanized iron. (Although lead piping has been banned in modern drinking water systems, some older systems remain in use. In addition, some older systems contain lead solder. The measurement of the leaching of lead into water also helps to compare the results of this study to past research.)

Finally, it is desired to demonstrate corrosion control techniques. Available corrosion control techniques include pH adjustment, alkalinity adjustment, and addition of corrosion inhibitors.\textsuperscript{5} For hard, alkaline water, pH and alkalinity adjustment is not an option because excessive precipitation of calcium carbonate can occur and diminish the hydraulic capacity of the pipes.\textsuperscript{5} Operators with this type of system water typically add a corrosion inhibitor.

Corrosion inhibitors create a passivating film on the pipe wall. This is a film that inhibits the electrochemical processes resulting in corrosion.\textsuperscript{5} One such corrosion inhibitor, silicate, has not been greatly researched. Plus, systems using silicate take a long time to come to a steady state where conclusions can be drawn about the chemical's effectiveness. Therefore, it was not chosen to study in this project.

Many water systems use a phosphate compound as a corrosion inhibitor. Blends of poly- and orthophosphates are commonly used. However, some studies have shown that polyphosphates can actually increase the leaching of pipe metal into the water under certain conditions.\textsuperscript{5,6,7,8,9,10} The conditions that this phenomenon occurs have not been identified by scientific means.\textsuperscript{7} Therefore, the use of polyphosphates for corrosion control is ambiguous and risky. They were not considered for this project.

Much success has been found with the use of orthophosphate as a corrosion control chemical for hard, alkaline water.\textsuperscript{7,11} An orthophosphate chemical was chosen to add into chlorinated water at the site with high alkalinity.

Orthophosphate has been found to be effective in lower alkalinity water also. However, in the interest of demonstrating a second corrosion control technique, pH adjustment using sodium hydroxide was chosen to add into chlorinated water at the site with lower alkalinity.

The following table summarizes the factors that are studied in this project:

<table>
<thead>
<tr>
<th>Run No.</th>
<th>Site</th>
<th>Chemical Treatment</th>
<th>Pipe Metal</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>High Alkalinity Site</td>
<td>Untreated Water</td>
<td>Lead</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>Copper</td>
</tr>
</tbody>
</table>
There are a total of eighteen pipe loops in this corrosion control study. The data from all loops will be compared with one another using nonparametric statistical procedures described in the literature. It should be noted that there are many factors in this type of experiment that cannot be controlled. For instance, the two sites differ in air temperature around the apparatuses and system static and dynamic pressures. There are also constituents in the water at the two sites that cannot be compared or held steady. For this reason, data on many extraneous factors are being recorded. Later, analysis of variance techniques will be applied to the data to observe a given factor's influence. Nevertheless, on-site pipe loop studies cannot be construed as rigorous scientific research. They are useful for generating theories about the corrosivity of water. They are also useful in monitoring corrosion in an individual water system.

### Site Selection

As described above, the experimental design for this project calls for two sites with different concentrations of alkalinity and dissolved inorganic carbonate. With the help of the Wisconsin Rural Water Association and the Wisconsin Department of Natural Resources, two such sites were found within fifty miles of Madison. The Village Boards and the Water Utility Managers of the two sites have been quite hospitable to the project.

The site with hard, alkaline water is the Village of Dane (population 620) located twenty miles northwest of Madison. The project apparatus draws water from their distribution system which is a mixture of water from two wells. The utility does not chlorinate or fluoridate the water.

The site with softer, less alkaline water is the Village of Lone Rock (population 630) located fifty miles west of Madison. The distribution system is composed of two wells, but the project apparatus draws water from Well No. 2 only. The pump for Well No. 2 is set to turn on every evening at 10:00 PM and run for about two hours until the water tower is filled. The apparatus is set to turn on at 10:15 PM and run for one hour ensuring that water only flows through the apparatus when the well pump is running. The utility does
not chlorinate but does fluoridate the water. The apparatus is tapped into the well pump discharge line upstream from the fluoride addition.

---

**Design, Installation, and Startup of Apparatus**

The apparatuses were designed similar to the AWWARF Pipe Loop Model. The AWWARF model is intended to simulate the plumbing of a residence.

One difference between the AWWARF model and this project's apparatuses is that the AWWARF model is designed for loops that can hold a liter of sample. This project uses loops that hold a little more than 250 mL of sample. The smaller loops are more economical and take up less space in this situation where nine loops are installed at each site.

Other differences with the AWWARF model involve the operating parameters of flow, pressure, and stagnation time. Because of site constraints, the flow in this project is 1.0 gpm per loop and 60 gallons per loop per day. The static pressure is 60 to 80 psig and the dynamic pressure is 10 to 35 psig. The flow and dynamic pressure values are at the lower end of the range that is seen in residential plumbing.

Because the apparatus at the Lone Rock site cannot operate unless the well pump is running, the experiment is restricted to operating only once for an hour a day. Typically, a pipe loop would be operated over a number of on and off periods throughout the day as is seen in a residence. This also implies that the water stagnation time in this project is 23 hours. The time that the water sits in the metal pipe loops effects the concentration of metal that is leached from the pipe into the water. At a later date in this project, stagnation time studies will be planned and data collected to look at the effects of stagnation time.

A schematic of the apparatuses is shown on three pages in Appendix A. Photos of the apparatuses installed at the two sites are also shown in Appendix A.

The apparatus at the Village of Dane is installed in a heated maintenance building and garage. The building's three-quarter inch galvanized iron water line running across the ceiling has been teed off to supply water to the apparatus. The waste from the apparatus runs a short distance across the floor to a floor drain.

The apparatus at the Village of Lone Rock is installed in the Well No. 2 pump house. The apparatus is tapped into an existing three-quarter inch copper pipe that in turn is tapped into the discharge line from the well pump. The waste from the apparatus is piped to a floor drain with at least a two-inch air gap.

Three safeguards have been installed to totally separate the public water supply from the processed water in the apparatuses:

1. A backflow preventer is located immediately after the tap to the public water supply.
2. A series of check valves throughout the apparatus also prevents backflow.
3. All chemical feed pumps include anti-siphon devices.

Installation and startup activities occurred as follows:

1. August 17, 1999 Installation at Village of Dane
2. August 24, 1999 Installation at Village of Lone Rock
3. August 26, 1999 Startup of both apparatuses
4. September 7, 1999 First sampling at Village of Dane
5. September 9, 1999 First sampling at Village of Lone Rock
6. September 14, 1999 Second sampling at both sites; begin routine weekly sampling of both sites on Tuesdays.

**Selection of Chemicals**

A chlorine residual of 0.2 mg/L is obtained in the experiment based on the U.S. Environmental Protection Agency's Proposed Groundwater Rule. The chlorine used is in the form of sodium hypochlorite with 12.5% available chlorine and a density of 10 lb/gal. The chemical was purchased from a local swimming pool supply store.

A dosage of orthophosphate of 1.0 mg P/L is obtained in the experiment based on optimum dosages discussed in the literature. The orthophosphate used is in the form of potassium orthophosphate with 27% total phosphate and a density of 12.7 lb/gal. The chemical was donated by the Carus Chemical Company.

A dosage of 50% sodium hydroxide was estimated using the RTW Model. Estimated water quality parameters from the Lone Rock Well No. 2 water were entered into the RTW spreadsheet. A dosage of sodium hydroxide (caustic soda) was changed until a maximum desired calcium carbonate precipitation potential (CCPP) of 10 mg/L was reached. Care is being taken to not exceed a recommended CCPP range so that excessive calcium carbonate does not precipitate out and clog the pipe loop apparatus. At Lone Rock, the pH is adjusted from about 7.7 to 8.2. The chemical was donated by the Carus Chemical Company.

**Experimental Method**

The following chart describes the sample taps on each apparatus.

<table>
<thead>
<tr>
<th>SAMPLE TAP</th>
<th>Site No.</th>
<th>No. of Taps</th>
</tr>
</thead>
<tbody>
<tr>
<td>INFLUENT</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>PROCESS WATER</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>LOOP EFFLUENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>LEAD</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>COPPER</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>IRON</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>LEAD</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>COPPER</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>IRON</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>
Samples to be taken from the sample taps during the study fulfill one of three goals:

1. Document influent water quality
2. Show that operational parameters are steady
3. Document the loop effluent metals concentrations and the factors that may effect them

The analyses to be performed per sample tap are:

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Influent</th>
<th>Process</th>
<th>Effluent</th>
</tr>
</thead>
<tbody>
<tr>
<td>PH</td>
<td>w2</td>
<td>w6</td>
<td>w18</td>
</tr>
<tr>
<td>Temperature</td>
<td>w2</td>
<td>w6</td>
<td>w18</td>
</tr>
<tr>
<td>Residual Chlorine</td>
<td>q2</td>
<td>w6</td>
<td></td>
</tr>
<tr>
<td>Total Phosphorus</td>
<td>q2</td>
<td>w6</td>
<td></td>
</tr>
<tr>
<td>DO</td>
<td>q2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TDS</td>
<td>q2</td>
<td>q6</td>
<td></td>
</tr>
<tr>
<td>Calcium</td>
<td>q2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Magnesium</td>
<td>q2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alkalinity</td>
<td>w2</td>
<td>w6</td>
<td></td>
</tr>
<tr>
<td>Chloride</td>
<td>q2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sulfates</td>
<td>q2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manganese</td>
<td>q2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iron</td>
<td>w2</td>
<td></td>
<td>w6</td>
</tr>
<tr>
<td>Lead</td>
<td>w2</td>
<td></td>
<td>w6</td>
</tr>
<tr>
<td>Copper</td>
<td>w2</td>
<td></td>
<td>w6</td>
</tr>
</tbody>
</table>

Legend: w = weekly sampling; q = quarterly sampling; the number indicates the number of sample taps to be monitored.

The following describes the procedure of obtaining weekly samples from the apparatuses:

1. The apparatuses should be off and sitting stagnant for 22 to 23 hours.
2. Record the flow meter reading. Check that 540 gpd (72.2 cfd) has been obtained daily since the last sampling event.
3. Record the pressure gauge reading from each loop for static pressure. (At Lone Rock, the pressure gauge will be recorded before and after well pump turns on.)
4. For each sampling loop, set out a clean, dry beaker, a thermometer and a 250 mL appropriately labeled
metals sampling bottle. (See metals sampling bottle cleaning procedure.)

5. Calibrate the pH meter with pH buffer 7.0 and 10.0
6. Obtain a 200 mL sample from each effluent sample tap using the appropriately labeled bottle.
7. Acidify the sample with 50% Nitric Acid. Put a cap on each sample bottle securely and place the sample in cooler with ice.
8. Obtain a 50 mL sample from each effluent sample tap in a clean, dry beaker. Stick a thermometer in each beaker.
9. Record temperature and measure and record pH for each beaker.
10. At Lone Rock, record the pressure gauge reading for static pressure while Well Pump No. 2 is operating. (Well Pump No. 2 operates a few minutes before the apparatus turns on.)
11. Wait for the apparatus system to turn on by the set timer.
12. Set out three beakers and thermometers.
13. Rinse the thermometer and beaker with the water to be sampled.
14. Draw a sample and record temperature and pH for the first process water sample tap. Repeat steps 12 and 13 for the other two process water sample taps. At the Lone Rock site, NaOH flow is adjusted, if necessary, and pH is rerun. It will be reported in "comments" section on the sampling sheet if changes are made.
15. Run a chlorine residual test by following the instructions in the Hach kit at each of the three process water sample taps and record the reading. Adjust Cl2 flow, if necessary, and rerun test. Note in "comments."
16. Obtain one orthophosphate sample and one alkalinity sample from each of the process water sample taps. Cap bottles securely and keep samples on ice.
17. Every three months, take a sample at each process water sample tap for TDS.
18. Record rotameter and pressure gauge (dynamic pressure) readings at all loops. Note: rotameters are read at the marking covered by the largest diameter of the float.
19. If flow meter and/or rotameters and pressure gauges are not at the proper settings, adjust flow and pressure as was done in startup. Record any comments and adjustments made to the system.
20. Take a metals sample from the influent sample tap. Acidify, cap the bottle securely, and place on ice.
21. Take an alkalinity sample from the influent sample tap.
22. Measure pH and temperature from an influent sample tap sample.
23. Every three months, extra samples will be taken at the influent sample tap for TDS, chloride, sulfate, and orthophosphate.
24. Every three months, also analyze the influent sample tap water for chlorine residual and dissolved oxygen.
25. Record chemical feed storage tank level. Determine if the supply needs replenishing.
26. Upon returning to the lab. Store samples in the refrigerator. Clean all equipment to prepare for the next sampling event.
27. Analyze for orthophosphate and alkalinity. Enter all data into the database.
28. Perform other analyses per Standard Methods. (See table.) Perform quality control analysis for each analyte. Enter all data into database.

* Because of the pulsating chemical feed pumps, all samples are obtained in an 80 mL beaker rinsed with that tap's water. The beaker is filled to the 80 mL line in 60 seconds.

**Analytical Methods per Standard Methods**

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<tr>
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<td>pH pH meter</td>
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<td>Phosphate, Ortho Ascorbic Acid Method 4500-P</td>
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<td>Sulfates Ion Chromatography 4110</td>
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<td></td>
<td>Temperature Thermometer</td>
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</table>

**Metals sampling bottle cleaning procedure:**

Step 1: Clean inside and outside of the sampling bottle with 20% ACS-grade Nitric Acid for 2 days.

Step 2: Fill the sampling bottle with 1% Trace Metal grade Nitric Acid, leave the acid in the bottle until used.

Step 3: Put the sampling bottle in the plastic zip bags.

Step 4: At site, dump the 1% Trace Metal grade Nitric Acid in the prepared container and immediately fill the metals samples into the bottle.

**Results**

The next report will show results. The metals samples from three weeks of sampling have not been analyzed at this time.

**Project Schedule**

The project schedule is:

1. August 7, 1999 First week of sampling
2. October 1, 1999 Six-month interim report
3. April 1, 2000 Twelve-month interim report
4. August 29, 2000 Final week of sampling

5. October 1, 2000 Final report

ACKNOWLEDGEMENTS

The authors wish to acknowledge the assistance of the following people:

- Mr. Dave Wipperfurth, Chairman of the Village Board, and Mr. Dave Koening, Water Utility Manager at the Village of Dane, for hosting the experiment

- Ms. Millie Rott, Mayor, and Mr. Tim Adams, Water Utility Manager at the Village of Lone Rock, for hosting the experiment

- Mr. Ken Blomberg and Mr. Joe Kniseley of the Wisconsin Rural Water Association for locating the sites

- Mr. Del Maag and Mr. Tom Stunkard at the Wisconsin Department of Natural Resources for confirming site data

- Mr. David Denig-Chakroff, Water Utility Manager at the Madison Water Utility, for loan of equipment

- Mr. Dan Lynch, Water Utility Manager at the Janesville Water Utility, for loan of equipment

- Mr. Dave Martelle, Technical Representative at the Carus Chemical Company, for donation of chemicals

References

4. Del Toral, M. Ready or Not -- More Regulations Are On the Way. 78th Annual Meeting of the Wisconsin American Water Works Association, Oshkosh (September 1999).
7. Cantor, A.F. ET AL. The Use of Polyphosphate in Corrosion Control. (To be published in Jour. AWWA).

APPENDIX A

Diagrams of Pipe Loop Apparatuses and Pictures of Project Sites
Connect to water distribution system.
9.0 gpm for one hour per day
540 gpd total

Three loop assemblies.
See page 3 for details.
1.3 gpm per loop
85 gpd per loop
10 to 50 psi per loop

Signaling chemical and chlorine feed.

P.O. Box 5355
Anderson, CA 93705
(949) 552-3911

Plan View of Apparatus

Part No. 310-06 Date: 2-3-96 Drawn: 2
Pipe loop apparatus at the Village of Dane Maintenance Building

Side view of the pipe loop apparatus at the Village of Dane. Along the back wall are chemical tanks and pumps for sodium hypochlorite and potassium orthophosphate. The timer which controls the drain line solenoid valve and the chemical pump electrical outlet is the rectangle on the back wall.
Prasit Vaiyavatjamai measuring pH of samples at the Village Dane site.

A close-up picture of the lead, copper, and galvanized iron pipe loops.
Pipe loop apparatus at the Village of Lone Rock Well No. 2 pump house. The loop racks extend along the side wall of the pump house. In the back corner are chemical tanks and pumps for sodium hydroxide and sodium hypochlorite.
A nother view of the pipe loop apparatus at the Village of Lone Rock. Well Pump No. 2 and discharge piping are in the forefront of the picture.
A close up view of a pipe loop rack at the Village of Lone Rock. The pipe above the floor drain discharges the apparatus' water. The rectangular box on the wall is the controlling timer. (The water on the floor comes from a dehumidifier in the left hand corner of the picture.)
Table of Contents

General Statistics ........................................................................................................................................ 3
Most Requested Pages .......................................................................................................................... 3
Top Entry Pages ..................................................................................................................................... 5
Most Downloaded Files ........................................................................................................................ 6
General Statistics

The User Profile by Regions graph identifies the general location of the visitors to your Web site. The General Statistics table includes statistics on the total activity for this web site during the designated time frame.

General Statistics
Date & Time This Report was Generated Friday October 01, 1999 - 10:57:51
Timeframe 07/01/99 00:00:00 - 10/01/99 00:00:00
Number of Hits for Home Page 352
Number of Successful Hits for Entire Site 6,584
Number of Page Views (Impressions) 1,530
Number of Document Views 1,312
Number of User Sessions 365
User Sessions from United States 0%
International User Sessions 0%
User Sessions of Unknown Origin 100%
Average Number of Hits Per Day 71
Average Number of Page Views Per Day 16
Average Number of User Sessions Per Day 3
Average User Session Length 00:06:36
Number of Unique Users 166
Number of Users Who Visited Once 115
Number of Users Who Visited More Than Once 51

Most Requested Pages

This section identifies the most popular web site pages and how often they were accessed. The average time a user spends viewing a page is also indicated in the table.

Most Requested Pages

- mtac.sws.uiuc.edu/
- counts.exe?link=mtac
- otherc.asp
- new.asp
- techasst.asp
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| Total For the Log File | 1,530 | 100% | N/A | N/A |
Top Entry Pages

This section identifies the first page viewed when a user visits this site. This is most likely your home page but, in some cases, it may also be specific URLs that users enter to access a particular page directly. The percentages refer to the total number of user sessions that started with a valid Document Type. If the session started on a document with a different type (such as a graphic or sound file), the file is not be counted as an Entry Page, and the session is not counted in the total.

![User Sessions Graph]

**Top Entry Pages**

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**Most Downloaded Files**

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