

International Colloquium:  
*Protecting Public Health  
in Small Water Systems*

Bozeman, Montana, USA  
May 9-12, 2004

I'm here to present the findings and recommendations of a group of high-powered folks who deliberated a long slate of questions in intense, focused sessions last spring.

# Today's Summary Presentation

- How the colloquium came about
- Who participated
- Format
- Findings
- Recommendations



# The impetus for the colloquium

- Tim Ford – water microbiology expert
- Center for Biofilm Engineering – leader in research on distribution-system biofilms
- Montana Water Center – research and training tools for small public systems
- Special grant from U.S. EPA to the Water Center

People at Montana State University who work in different parts of the drinking water industry organized this event.

Purpose. to share observations  
*internationally* about what works  
and what doesn't, to inform the  
making of policy and procedures in  
the developed world

Not all approaches will  
work in all jurisdictions,  
but some are transferable,  
and in the U.S. there has  
been little consideration of  
how small systems are  
treated in other nations.



Scientists confer among themselves internationally, but in the US, those involved in policy and procedures and operations mostly just talk among themselves, with very little connection to their peers who are trying different approaches in other countries.

The public-health issues of the developing world are somewhat different, so this meeting focused on those of the developed world.

# Who attended?

Invited experts in drinking-water microbiology, regulation, operation and management from 15 developed nations – 50 professionals and six graduate students



US organizations that were formally represented: EPA, ASDWA, Rural Water, RCAP, USDA Rural Utility Services, NDWAC, Indian Health Service, Centers for Disease Control & Prevention, AWWA.

Nations represented: US, Canada, Puerto Rico, Scotland, Ireland, England, Sweden, Denmark, Finland, Russia, Germany, South Africa, Australia, New Zealand, Egypt, Estonia.

# The colloquium format required everyone to work!

- Extensive background reading
- Introductory public address by a water dignitary
- Three moderated working groups deliberated for two-and-a-half days
- A detailed set of questions and issues was considered by each group



This is a format used in learned societies to achieve consensus regarding the 'state-of-the-science'

# What's a small system?



- Regulatory definitions differ around the world
- This group preferred a functional definition: systems that have a hard time providing safe water, in a sustainable way

Some nations regulate water quality delivered by individual wells to private homes, others do not regulate if there are fewer than 50 customers or a certain number of connections. The systems of concern here were those within any jurisdiction's authority that have difficulty meeting requirements of delivering safe water. Individual dwellings were not considered. For the most part, systems that have serious difficulties are small; they're often rural and/or poor.

# Findings – Health Risks

- Small systems may serve a large transient population, because of tourism and seasonal agricultural activities
- There may be less access to health care than in populations served by larger systems
- Zoonoses may be more of a problem than in large systems, because of the proximity of animal agriculture

In some places chemical characteristics caused by the local geology pose health risks via drinking water (F, As, Mn). Corrosion of water lines releasing Pb or Cu can also be a problem. But in general acute infectious disease is more of a risk.

# Findings – Management

- The public health risks and the vulnerability to contamination are often not well recognized
- Frequently an assumption that groundwater is safe & pure; poor recognition of what influences source water quality
- All levels of management may not be committed to running a high-quality system
- The per-household capital, operations and monitoring cost is high, willingness to pay may be low



Understanding of risks to public health is limited - among consumers, utility personnel and local officials. There is widespread complacency.

# Management - continued

- Personnel are not part of regional professional networks
- There's often an inability to affect events in the watershed or the aquifer zone of contribution; no political power
- There is generally poorer communication among utility, lab, regulators and public health agencies
- There is often no provision for regular and event-driven communication with consumers

Lack of political power is a problem for smaller systems

Communication with consumers and collaborators is often viewed as onerous, so when there is an event that jeopardizes water quality, the needed communication doesn't happen.

# Management - continued

- There is often a limited ability to respond to unexpected events
- Management & operational skills may not be sufficient
- Small utilities are frequently without a business plan
- System personnel don't take advantage of operating and monitoring data – don't understand why they are collecting results or how to use them

Contamination often results from specific events – like flooding – and the colloquium participants viewed the widespread lack of event planning among small systems as very dangerous.

Operators may not really understand their systems.

# Findings – Operations

- Treatment provided may be insufficient
- Alternatively, treatment technique may be too elaborate and costly
- Operator boredom is a problem when water seems okay most of the time
- Operators may have too many unrelated responsibilities to devote adequate time and effort to knowing and understanding their systems



Choice of treatment method is often driven by the engineering consultant, and may not be made optimum for a utility with limited resources

# Training

- ***Greatest need*** identified at the colloquium
- Often insufficient training, knowledge and support among small-system operators
- Frequent turnover of personnel – loss of institutional memory – makes training vital



The participants lamented the rapid turnover of operating personnel in small systems, and the knowledge that is lost over and over again.

# Training - continued

- System personnel are trained in operations basics, but not in the potential risks to water quality, public health implications or risk management (preventive) approach
- There may be a need to study the backgrounds, abilities of system personnel, to tailor training & assistance better

# Findings - Regulation

- There needs to be strong government involvement to protect public health
- Both QA and QC are necessary, and should be addressed in regulations
- Both regulators and utility personnel often forget the point – the prevention of adverse health effects
- In many nations, regulation is moving towards water safety plans that emphasize operations and real-time control rather than retrospective water quality compliance

QA – what you do to prevent a contamination event. ‘Water Safety Plans’ are proactive – the QA emphasis. Their approach: risk assess the supply first, source to tap, then implement the relevant interventions, and then check the output quality as confirmation of the validity of the intervention. The contrasting approach is used in the US, where the emphasis is catching a system outside the regulations (QC). Both are necessary elements.

# Regulation -continued

- The interests of small systems are poorly represented when regulations are put in place
- The burden is difficult for small systems just about everywhere

# How are small systems funded, and what problems does this present?



- There is a serious diseconomy of scale in capital and operations costs for small systems
- Expenses are huge, but subsidies create disincentives for managers, consumers
- There is a mix of user-pay and public subsidy in most nations

Almost every nation combines a user charge with public subsidies for water systems (Ireland does not have a user fee for residential connections). There was very spirited discussion on the appropriate mix. When the regulatory entity and the federal government finance most of the costs, the owners and operators lose interest and perform poorly.

# Findings concerning system consolidation

- Main benefits – economy of scale and access to expertise
- Spans the gamut from sharing equipment or an operator to complete organizational and infrastructure integration
- Very time-intensive – local champion must work to build trust
- Not a panacea, but generally a very good thing



Consolidation is occurring everywhere, and was viewed as a positive development under most circumstances. Sometimes it is compelled from the federal level or funding agency, and sometimes it occurs spontaneously between utilities that recognize a benefit.

# The Scottish example: radical consolidation

- One public water utility serves most of the nation
- All public systems meet the same standards
- Everyone pays the same rate, i.e., the cities subsidize the poorer, more remote areas
- Total operating costs have diminished 20% since 2002, and water quality is improved



Trailer parks, bed & breakfast establishments, etc are not part of the giant water utility. Large-scale consolidation began in 1991, and Scottish Water came into being in 2002, to serve more than 600 communities. In Scotland professional pride is bolstered by competition between water districts, and between the public Scottish system and the many private companies that provide water to English consumers. The operators rotate among systems periodically, and they bring a fresh view to their 'new' systems.

# ***Recommendations*** - risk awareness and risk management

- Systems should be run within the risk management approach – proactively, not reactively
- Utilities should have access to and make use of up-to-date literature on health risks
- Operators use checklists to assess their systems for vulnerability



The colloquium participants came up with a long set of recommendations for measures they thought would be productive in most nations. The overarching recommendations concern health risks. They are the REASON for treating water, but are not now understood by the public and in some cases by regulators or utility personnel. Simplified checklists were recommended to aid the operator in evaluating the relative risks of each part of the system.

# Risk - continued

- Mandatory risk assessment/risk management training for regulators is recommended
- Surveillance for waterborne disease should be improved

There is a strong role for professional societies and universities in developing educational materials concerning the potential health risks associated with public water systems. Several innovative ways to monitor among consumers for waterborne illness were proposed.

# Management recommendations

- Base O&M on Water Safety Plans
- Knowledge of the system is crucial to preventing contamination events
- Systems should always be optimized as is before upgrading or expanding
- Systems should have succession plans, to deal with turnover of personnel

WHAT ARE WATER SAFETY PLANS? WHERE ARE THEY USED?  
Need help here.

# Management - continued

- Centrally-managed point-of-use and point-of-entry devices probably have merit for small utilities, but management issues must be considered very carefully
- Give engineering consultant financial incentives to design simpler systems

POU and POE devices are not standard components in the public water systems of any nation that was represented at the colloquium.

# Recommendations concerning operation of small systems

Australia & New Zealand are familiar with water safety plans for risk management -emphasis on real time process control and verification of performance - and have adapted the features most useful for water systems

- HACCP-like approach in a small water system is based on a thorough, up-to-date sanitary survey
- This is a proactive framework for identifying & controlling risk, not *post facto* establishment of compliance (or non-compliance)

Hazard Analysis and Critical Control Point identification comes from the food-safety business; it is based on knowing the system and identifying the critical risk points, then targeting resources to those points to diminish risks. It's used in several countries, including South Africa, New Zealand and Australia.

# Operations - continued

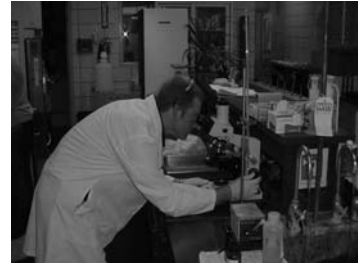
- Each system should have well-documented operating procedures.
- Also needed: a clear, current, documented multi-agency emergency plan
- An annual self-audit is recommended



Operational documentation can help overcome the problem of personnel turnover. This must include clear definition of roles & responsibilities. The emergency plan needs to be distributed to all the key people, and practiced periodically. A self-audit would be an internal sanitary survey, and would compel active management.

# Recommendations regarding monitoring

- Requirements should diminish with good sanitary survey results
- Should be tailored to the actual health risks in the system
- We should only monitor that which we can manage
- Small systems can be partnered w/ larger ones to ameliorate high monitoring costs (esp. biological)
- Real-time performance monitoring should be emphasized



The conferees favored less compliance monitoring and more monitoring for performance control. Initial parameters for monitoring should be simple screening tests, to be followed, according to a decision tree, with more specific, more expensive tests. Assays for *C. perfringens* and enterococci are well-established and cheap and would be good indicators of fecal contamination or ground water influenced by surface water.

# Monitoring - continued

- Monitoring frequency, parameters should follow the occurrence of hazardous events
- Disease surveillance systems need improvement – we're not now able to learn from most events
- Monitoring needs the flexibility of alternative techniques, e.g. H<sub>2</sub>S sensors



A very large proportion of contamination events are associated with heavy rainfalls, snowmelt or flooding. Operators should be alert to the heightened risk at these times, and monitor appropriately.

# Recommendations regarding training

- For successful operator training, the necessary competencies and skills should be defined
- Operators have difficulty applying classroom concepts to their systems – field training is essential
- Experts should periodically review case studies, distribute with recommended best practices



Operators, managers and public health officials all need periodic training. One very good format would be the review of recent case studies, with recommended 'best practices' for preventing the types of events described.

# Training - continued

- Training that concentrates on the purpose, risks of public water supplies is needed
- The sanitary survey is an excellent format for teaching mgmt/operations in the public health context. Focus - identifying potential hazardous events that could compromise water safety. Also – a natural approach for prioritizing risks.



Members of water boards and local public-health commissions especially can use training. The vulnerability to contamination of the distribution system should be stressed, along with basic information on the fecal-oral route of disease transmission.

# Training - continued

- Training should cover each element of the multiple barrier concept
- Operators should learn how to use trend charts of performance data to make operational decisions
- Training and certification in monitoring is recommended
- Operators need to learn problem-solving skills as well

The conferees agreed that many small-system operators have only a very superficial understanding of their systems. There is a role for professional societies and for universities in developing training.

# Training - continued

- Favored methods for communicating with managers and operators: Local meetings or seminars, magazines, E-magazines, and web-based information
- Not just for operators – managers, regulators, local public health officials, and trainers need training

The lower-level regulatory officials who are the agency points of contact with water utilities may not be very knowledgeable, and could use intensive training themselves. Members of water boards and local public health officials need more training.

## Recommendations regarding interaction with the public

- Public health protection is enhanced when the local 'movers and shakers' are knowledgeable and actively involved
- What does the community at large need? There is insufficient education of water consumers
- Education about source water vulnerability could be the basis of a responsible, involved public

# Recommendations concerning regulation of small systems

- Evaluation of the feasibility of substituting a risk-management-based regulatory scheme in place of compliance-based regulation is strongly recommended.



Germany and New Zealand are two countries that have risk-based regulation. It is not necessarily less challenging, but it is more preventive and less reactive.

# Regulation - continued

- One size does not fit all
- Most nations need a better formal process to incorporate the interests of small systems into rule-making and implementation
- Systems should be required to notify authorities of events that could threaten water quality
- The same health standards should apply to all systems, regardless of size

How can it be done most effectively? Most jurisdictions distinguish between resource-rich and resource-poor systems in their regulations, which is good. A required notification step, when there's an equipment breakdown or another event, could prevent outbreaks of waterborne illness.

# Recommendations on funding small systems



- No consensus was achieved
- Federal subsidies have advantages
- Payment by the consumers also has substantial advantages
- a blend may be most appropriate to assure that water is valued but small systems can access assistance without disproportionate financial burden

The question is: what is the proper mix between user-pay and public subsidy? All agreed that each has advantages and disadvantages

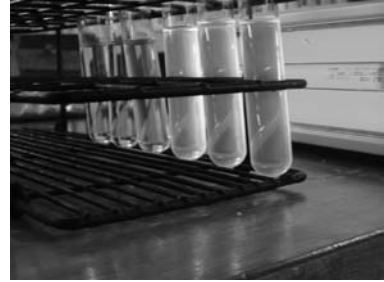
# Recommendations - funding

- When the user pays, there is much better public understanding of the challenges faced by the water system
- Also much less waste of water
- Consumers are vested-in an efficient system
- There is less likelihood of funding unneeded upgrades or expansions
- Operator status needs to be improved to recognize their key role as protectors of public health – cannot be achieved without some financial input

Water metering is essential – establishes the direct connection between use and expense.

# Research/demonstration recommendations – microbial risks

- Better evidence for the relationship between water quality indicators and public health risks
- Focus R&D efforts on the basics – operations and treatment
- Include small systems in research studies



What are the relative importance of conventional microbes, emerging pathogens and chemical hazards?

# Treatment & operations research/demonstration needs

- Automated, simpler treatment systems
- Centrally-managed POU treatment
- Lower-cost monitoring approaches, including advanced biological sensors



This could be a very long list. The technology research & development needs are not necessarily unique to small systems, but would yield the highest returns there. Affordable inline monitoring – for turbidity, biofilm, etc – need to be developed and deployed.

# Treatment & Operations - continued

- Remote monitoring and control of system operation has promise for small systems, needs more R & D
- Membranes in small systems
- Are natural, chemical-free systems possible? Research on bank filtration for small systems is recommended

Germany is using bank filtration successfully to diminish the need for chemical disinfection.

# Social-cultural-institutional research needs

- Social research into how the public views drinking water would benefit all communication and funding efforts
- Also – how is information MOST EFFECTIVELY communicated?
- Utilities could use guidance on the many players involved, who does what, sources of funds, etc.

For more information:

<http://water.montana.edu/colloquium/>



The colloquium website has a directory of participants, downloadable group presentations, and a listing of recommended resources.