State of Connecticut
HOUSE OF REPRESENTATIVES
STATE CAPITOL
HARTFORD, CONNECTICUT 06106-1591

REPRESENTATIVE TERRY CONCANNON
THIRTY-FOURTH DISTRICT

76 TIMMS HILL ROAD
HADDAM, CONNECTICUT 06438
TELEPHONE
HOME: (203) 345-4141
CAPITOL: 240-8585
TOLL FREE: 1-800-842-8267

HOUSE CHAIR
APPROPRIATIONS SUB COMMITTEE ON
REGULATIONS AND PROTECTION

MEMBER
APPROPRIATIONS COMMITTEE
PROGRAM REVIEW & INVESTIGATIONS COMMITTEE
PUBLIC HEALTH COMMITTEE

January 22, 1996

Gerald Iwan, PhD
Chief, Water Supplies Section
Depart of Public Health
150 Washington Street
Hartford, CT 06106

Dear Dr. Iwan:

As co-chairs of the Water Quality Task Force, we wish to extend to you our deepest appreciation for your hard and diligent work over the past several months as our committee worked to evaluate the microbial status of Connecticut's drinking water and develop fair and equitable recommendations on this quality issue.

We believe that the attached report, which will be presented to the Public Health Committee in February, is one in which you can take great pride. It is our hope that the General Assembly will look favorably on the recommendations, finding them to be valuable and viable.

Again, we thank you for all that you brought into this endeavor.

Sincerely,

Terry Concannon
State Representative
34th Assembly District

Edward F. Rossomando, PhD
Director, Waterborne Disease Ctr.
UConn Health Center

TC/EFR:mpa

REPORT OF THE TASK FORCE

TO STUDY AND EVALUATE THE MICROBIAL QUALITY OF PUBLIC DRINKING WATER IN CONNECTICUT

PREPARED FOR THE CONNECTICUT LEGISLATURE

REPRESENTATIVE TERRY CONCANNON, CO-CHAIR
PROFESSOR EDWARD F. ROSSOMANDO, CO-CHAIR

JANUARY 1996

EXECUTIVE SUMMARY

In June of 1995, the Connecticut Legislature passed a bill authorizing the formation of a Task Force "to study and evaluate the microbial quality of public drinking water in Connecticut" (see appendix A). The impetus for this study arose from current concerns about public drinking water and media attention surrounding the waterborne diseases, cryptosporidiosis. In Milwaukee in 1993, some 400,000 people sickened and nearly 100 died due to the presence of *Cryptosporidium* in the drinking water following earlier outbreaks in Oregon and Georgia, as well as one in Danbury in 1987 which was caused by the presence of another parasite, *Giardia*. This gave reason for increased concern about the microbial levels in our public drinking water including the protozoan parasites, *Cryptosporidium* and *Giardia*. Segments of our population with immunodeficiency symptoms including persons with AIDS and HIV, those with organ transplants, and those on chemotherapy as well as the very young and the elderly are especially susceptible to gastrointestinal infection caused by these parasites for which there is no recognized treatment. Healthy people usually do not succumb to the infection, but cryptosporidiosis can be fatal to the immunocompromised.

The task force included scientists, public health officials, and representatives of water utilities and authorities, who collectively possess a depth and breadth of knowledge ideally suited for the purpose of the study(see appendix B).

The task force began meeting at regular intervals in September of 1995 and divided into three work groups. The work groups each studied elements of the problem and prepared reports that formed the basis of the task force's final report. (see appendices H,I,J).

This report begins with a review of the sources of Connecticut's public drinking water and provides an overview of Connecticut's lands devoted to watershed uses and the multiple barriers in place to protect them. The section on drinking water regulations reviews the federal laws and regulations that govern the drinking water industry in the US. The section on pathogen monitoring explains the monitoring in use today and describes some of the advances that are expected in the future. The section on microbial risk is discussed with an emphasis on *Cryptosporidium* and describes the proactive program for risk communication that is in place at the present time.

Cryptosporidiosis was added to the list of reportable diseases in Connecticut in January 1994. Therefore statistics are only now being collected, managed, and monitored. Altogether, 55 cases of cryptosporidiosis were reported in the state between January 1, 1994 and November 1, 1995. Most of these cases have been in adults who are HIV-infected. These cases have been widely distributed and have no apparent geographic or temporal pattern.

The task force concluded that Connecticut utilizes an advanced multi-barrier system to protect its drinking water supplies. This system includes three essential components: source protection (including a mandatory sanitary survey program and a unique prohibition against the discharge of sewage into a public drinking water supply); treatment (including mandatory filtration and disinfection of all surface water supplies); and distribution system maintenance (including cross connection and flushing programs). Monitoring of water quality at each barrier is an essential tool needed to assess the effectiveness of each barrier in preventing or removing microbial contamination.

The task force also concluded that while the multi-barrier system in Connecticut has been effective so far in preventing the transmission of cryptosporidiosis through public drinking water, some aspects of the system must be improved to assure continued public health protection in the future.

Specifically, the source protection and the monitoring elements must be made more effective. Thus, while the waste discharge ban effectively prevents point source discharges of sewage, the fecal contamination of drinking water supplies from non-point sources (septic systems, and manure run-off) is an ongoing reality that creates unnecessary risks. Pollution prevention and pollution abatement mechanisms must be strengthened (see appendix K).

The task force concluded that it cannot accurately assess the effectiveness of source protection and treatment barriers against contamination by *Cryptosporidium* because of the lack of suitable monitoring technology. Because we cannot accurately assess water quality relative to this pathogen, we cannot accurately determine the health risks associated with the potential exposure of various populations to this agent via public drinking water.

RECOMMENDATIONS

The task force recommendations are arranged under the following headings: Source Protection and Environmental Monitoring; Clinical Disease Diagnosis and Laboratory Testing; Public Notification; and Water Utility Plant Operation and Safety.

Source Protection and Environmental Monitoring

•The task force recommends that a cooperative effort between the various stake-holders and the state institutes of higher learning be initiated to avail of their scientific and technical expertise. A cooperative effort between state and local health and environmental agencies, water utilities and academic institutions shall provide continuing oversight and recommendations for improving the process of protecting the quality of potable water supplies. The cooperative effort shall be coordinated jointly by DEP and DPH.

•While the task force agrees that there is clearly a need for obtaining *Cryptosporidium* occurrence information, the inadequacy of the testing method that is currently mandated by the Environmental Protection Agency's (EPA) Information Collection Rule (ICR) presents several serious concerns relative to the use of potentially inaccurate data that could derive from this method. Therefore the task force recommends that EPA continue to delay the microbial monitoring requirements of the ICR until a suitable method is developed. We further recommend that the resources previously designated for ICR microbial monitoring be refocused on method development.

•The task force recognizes the need for new technology that accurately and reliably monitors drinking water sources for pathogenic microorganisms, such as *Cryptosporidium* and *Giardia*. The task force acknowledges that expertise is present within Connecticut to develop this technology. Therefore the task force strongly recommends that Connecticut's Department of Economic Development collaborate with the state's government, the academic and the industrial sectors to promote the development of monitoring and analytical technologies. Positive results from Connecticut's collaborations should be shared on the national level in the interests of advancing technological knowledge of microbial contamination.

•The task force recognizes that there is a need for technology to remove *Cryptosporidium* and agents of other waterborne diseases from water sources. The task force recommends that Connecticut's Department of Economic Development collaborate with the state's government, the academic and the industrial sectors to promote the development of technologies for the satisfactory removal of *Cryptosporidium* and infectious agents of other waterborne pathogens from water sources. Positive results from Connecticut's collaborations should be shared on the national level in the interests of advancing technological knowledge of microbial contamination.

Clinical Diagnosis and Laboratory Testing

•The task force recognizes the importance of risk assessment. However, at this time, the assessment of risk for a potential outbreak of cryptosporidiosis in Connecticut is inexact. Part of the problem is that the present diagnostic test is time-consuming, labor intensive, costly and not widely used by clinicians. To improve our ability to assess risk for cryptosporidiosis, the task force recommends that efforts be made to encourage health care providers to test for cryptosporidiosis more often.

•The task force recommends that the Public Health Committee endorse the need for additional epidemiological research at the national level to determine an appropriate health standard for *Cryptosporidium* and other waterborne pathogens.

Public Notification

•The task force recognizes the importance of risk communication and recommends a regulation amendment to the Public Health Code, Ct. Regs. §19-13-B102, to include local health departments in the notification process when a problem is reported by a water utility.

•The task force recommends the creation of an easily understood reporting method for public notification which clearly indicates the level of public health concern expressed by DPH.

•The education of the public about *Cryptosporidium* and waterborne diseases needs to be continued and expanded. The task force recommends the development of a proactive plan to (a) educate watershed residents and business operators about water supply protection methods and about sources of contamination (e.g. failed septic systems and manure piles), (b) inform health care providers regarding the importance of and the means to diagnose, cryptosporidiosis, and (c) inform members of the high risk groups.

•The task force recommends that the media be expected to print announcements of public health concerns as part of the DPH's program of risk communication.

Water Utility Plant Operation and Safety

•The task force acknowledges the importance of the safe operation of water utility plants in the maintenance of potable water quality. Therefore, the task force endorses the expansion of high quality in-service training programs for industry personnel and other methods to ensure the highest standards of water utility operation.

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1.1 CONNECTICUT'S PUBLIC DRINKING WATER SUPPLY PROFILE

Public drinking water supplies serve a large percentage of Connecticut's population. Surface water is the primary source of the drinking water for the majority of this population. The relatively preserved and protected watersheds of most of the surface supplies, combined with the ongoing move towards filtration of all surface sources, are two barriers crucial to providing the state's residents with safe and reliable drinking water. The most fundamental element of Connecticut's multi-barrier approach is the state's prohibition of the direct discharge of waste, regardless of treatment, into existing or potential public water supplies. Connecticut and Rhode Island are the only two states to mandate complete segregation between waste-receiving streams and the sources of public drinking water. This powerful anti-degradation prohibition greatly reduces risk of microbial contamination in from *Cryptosporidium*, particularly for surface water supplies.

PUBLIC WATER SUPPLIES STATISTICS:

- approximately 83% or 2.7 million of the state's population of 3.2 million people are on public drinking water.
- approximately 17% of the population obtain water from private domestic wells of which there are roughly 225,000.
- 603 active community water supply systems in Connecticut provide drinking water to those residents on public supplies.
- 512 of these systems are small, serving populations less than 1,000 while 91 medium and large active community systems serve populations greater than 1,000.

SOURCES AND WATER SUPPLY WATERSHED LAND STATISTICS:

- Most small systems rely solely on ground water while surface water comprises the majority of the supplies for the medium and large water supply systems.
- 68% of residents on public water are dependent on surface water supplies from 156 active surface water sources. The remaining 32% of the population are dependent on public water from about 1500 wells.
- 128 of the state's 169 municipalities have water supply watershed land within their boundaries.
- 17% or 824 square miles of Connecticut's total land area is water supply watershed (appendix C).
- 76% of existing water supply watershed lands are relatively undeveloped and forested indicating a high level of source protection in these areas.

1.2 MULTI-BARRIER PROTECTION: CONNECTICUT'S DRINKING WATER REGULATIONS

Connecticut utilizes a multi-barrier system to protect its water supply. This system includes three essential components: (a) source protection (including a mandatory sanitary survey program and a unique prohibition against the discharge of sewage into a public water supply stream); (b) treatment (including mandatory filtration and disinfection of all surface water supplies); and (c) distribution system maintenance (including cross connection and flushing programs).

The Department of Public Health (DPH) is the state's lead agency responsible for the adequacy and purity of drinking water. Responsibility for the protection of the state's drinking water resources, and achievement of statewide water quality goals, falls to the Department of Environmental Protection (DEP). Water utilities shoulder a large responsibility for preserving and protecting utility-owned land and for maintaining water quality through treatment and other

operating practices. Municipalities and local health departments also are involved in a number of different activities related to surface water source protection. The categories described below cover the most important elements of the multi-barrier approach under the domain of these stake-holders.

1.2.1 Watershed and Source Protection Connecticut's Clean Water Act and the DEP's Water Quality Standards and Criteria Program place primary importance on the purity of sources designated for drinking water. Annually, water utilities with surface supplies conduct comprehensive inspections of their water supply watersheds and take action against activities identified as harmful to the supply. State law controls the following activities on public supply watersheds; (a) pesticide and road salt applications; (b) erosion and sedimentation run-off; (c) recreational pursuits; and (d) sanitation of watersheds through regulation of separating distances for stormwater drains, agricultural structures used for husbandry, and sewage disposal systems.

The DPH and DEP have broad authority under state law to issue orders against actual or potential polluters to protect water supplies. State law authorizes local health directors to assess penalties for potentially polluting activities within watersheds and to seek legal remedies for polluting activities. Water utilities may also seek legal remedies for polluting activities.

1.2.2 Land Use and Planning State mandated permitting procedures preserve and protect water supply watersheds through regulation of the sale, use, and classification of water company-owned lands and control proper abandonment of public supplies. Seven of the state's largest water utilities, serving about 1.5 million people combined, own approximately 25 percent of their respective active reservoir watershed areas. Of the watershed lands owned by three of the large utilities, 35 percent are Class I and Class II. Class I and Class II lands encompass areas closest and most crucial to the protection of the source. Ownership and oversight of such high percentages of watershed land represent a significant protection barrier.

The state's nationally recognized utility and regional water supply planning processes, generally referred to as the Connecticut Plan, requires water utilities and other governmental and regional organizations with vested interests in drinking water, to develop long term planning documents with sections devoted to the preservation and protection of existing and potential drinking water supplies.

Several statutes allow state and water utility officials to provide input on local land-use development proposals that may impact public water supply watersheds as well as regulated activities on an inland wetland or watercourses in a water supply watershed. Connecticut water resources policy legislation specifically mentions drinking water source protection as one of its intended goals. The *Conservation and Development Policies Plan for Connecticut, 1992-1997* contains recommendations for local planning actions to be protective of water supply watersheds. The plan further establishes that State funds shall only be invested in projects which concur with statewide development policies.

1.2.3 Water Quality and Treatment Routine monitoring and testing of public water supplies is key to measuring the effectiveness of source protection efforts. Utilities test for possible microbial contamination (using a total coliform bacteria test), on a monthly or quarterly basis at various established locations in the distribution system. The number of required monthly samples is determined by the size of the population served. State and water utility officials work together taking prompt and appropriate action when acute coliform violations have been confirmed. In addition to coliform monitoring, mandated monitoring requires water utilities to test for 83 different contaminants that have Maximum Contaminant Levels set by the Federal Safe Drinking Water Act. In 1994, state regulators reviewed over 12,000 water quality reports for these parameters.

In certain cases where water supply watershed activities pose a serious threat to, or already have caused contamination of a source, the state can issue pollution abatement orders. In extreme cases where public health is seriously threatened, the state can intervene with a cease and desist order.

The task force concluded that while the multi-barrier system in Connecticut has been effective so far in preventing the transmission of cryptosporidiosis through public drinking water, some aspects of the system must be improved to assure continued public health protection in the future. Specifically, the source protection and the monitoring elements must be made more effective. Thus, while the waste discharge ban effectively prevents point source discharge or sewage, the fecal contamination of drinking water supplies from non-point sources (septic systems, and manure run-off) is an ongoing reality that creates unnecessary risks. Pollution prevention and pollution abatement mechanisms must be strengthened (see appendix K).

Filtration and disinfection are two essential barriers significantly reducing risks posed by pathogens in surface water. Twenty-five water utilities in Connecticut operate 43 treatment plants that disinfect and filter surface water through either rapid or slow sand filtration (see appendix D).

An estimated 10 percent of the approximately 2,165,050 consumers on surface water supplies currently receive unfiltered water. By the year 2000, all surface water sources directly supplying consumers in Connecticut will be filtered, disinfected as required by federal regulations for treatment of several different bacteria and viruses. To achieve this goal, seven utilities are in the planning stages or have begun construction of nine filtration plants to meet treatment mandates. Drinking water treatment plant operators must be certified by the State to operate such treatment plants. In total, there are 283 certified treatment operators in Connecticut.

1.2.4 Operations and Maintenance Proper maintenance of drinking water infrastructures is essential for sanitary conditions throughout the system. Conscientious maintenance and operation practices are proactive and preventive against deficiencies which can cause microbial contamination. On an annual rotating basis, the State inspects one-third of its 603 active community water systems. DPH regulators check the overall condition of the system, record violations which jeopardize public health, and provide technical assistance to utility operators for improvement of system performance and elimination of violations.

Water utilities must obtain State approval for most proposed infrastructure modifications. This review process maintains quality control over infrastructure changes which could impair water quality if not properly implemented.

Other required measures that protect against intrusion of microbial pathogens into drinking water are a standard for minimal water pressure, annual flushings of the distribution system, and cross-connection inspections. There are 247 state-certified distribution system operators overseeing distribution systems serving populations greater than 1,000. Finally, the State certifies 267 cross-connection control inspectors specially trained in the proper methods of preventing contamination between potable and nonpotable water systems.

1.2.5 Public Education and Community Outreach State issued publications such as *Protecting Connecticut's Public Water-Supply Watersheds: A Guide for Local Officials* and *Carrying Capacity of Public Water Supply Watersheds* contain comprehensive information for local officials and interested individuals on all aspects of source protection provided by regional planning organizations; the State university; multiple agencies in federal, state, and local governments; and the drinking water industry.

National Drinking Water Week events, held each year in May, communicate to a wide and diverse audience, the essentials of safe and adequate drinking water. The State maintains liaisons with drinking water professional

organizations and provides technical staff as lecturers and attendandees at professional conferences and outreach programs organized for and by water utilities.

1.2.6 Research Stake-holders draw on the resources of the Environmental Research Institute, and the Waterborne Disease Center, both of the University of Connecticut. These resources can assist stake-holders with identifying and implementing targeted research needs related to drinking water. Likewise, professional members of the water community keep abreast of emerging policy issues and technical concerns at the national, state, and local levels.

1.2.7 **Other Related Source Protection Requirements** Connecticut has well-established, nationally recognized mechanisms to redress the negligence of recalcitrant water systems and to minimize the proliferation of new water systems. Both measures serve source protection by diminishing potentials for contamination through irresponsible ownership and management of water systems.

System optimization to minimize risk of contamination is also underway in seven of Connecticut's largest utilities voluntarily participating in EPA's *Partnership for Safe Water.* In the partnership program, utilities enter into agreements with EPA that initiate extensive self-assessments of all phases of a utility's operations for purposes of optimizing treatment and minimizing risk from microbial contamination.

DPH made cryptosporidiosis a reportable disease in 1994. The State now has the ability to begin collecting and assessing data relating cryptosporidiosis occurrences to possible contamination of surface water supplies by *Cryptosporidium.*

The mandated components of the multi-barrier approach, located in different sections of the state's regulatory agencies, provide comprehensive protection against microbial contamination of public drinking water supplies. The high quality of Connecticut's surface waters has spared the state from large scale outbreaks of waterborne disease. Although multi-barrier strategies cannot guarantee against occurrences of waterborne disease, the approach minimizes the risks of occurrence. Moreover, these protection measures must not be compromised in order to accommodate pressures created by local development, requests to intensify recreational activities on watershed lands, or efforts to alter the prohibition of the direct discharge of waste into public water supplies. Protection and potential growth of watershed lands are compatible with the long-term interests of the State. The task force strongly urges continued cooperation between all stake-holders in promoting multi-barrier protection. The task force recommends that the Connecticut legislature continue its support for, and enhancement of, the multi-barrier protection approach (see appendix K).

In 1996, water utilities in Connecticut will begin monitoring for *Cryptosporidium* as part of EPA's Information Collection Rule (ICR). This monitoring will pose analytical and regulatory challenges for Connecticut as well as the rest of the country. The rule focuses on the occurance of microbial and chemical contaminants. The task force concluded that the rule emphasizes water treatment at the expense of source protection. Treatment and source protection are not interchangeable methods for mitigating microbial contamination. Both are essential components of the multi-barrier program, and the Connecticut experience has proven that continued attention to , and reinforcement of, each component is instrumental in preserving the high quality of the state's public water supplies.

Additionally, the task force recommends that the a cooperative effort between the various stake-holders and the state institutes of higher learning be initiated to avail of their scientific and technical expertise. A cooperative effort between state and local health and environmental agencies, water utilities and academic institutions shall provide continuing

oversight and recommendations for improving the process of protecting the quality of potable water supplies. The cooperative effort shall be coordinated jointly by the DEP and DPH.

1.4 STATE PUBLICATIONS RELATED TO MULTIPLE BARRIER PROTECTION

Carrying Capacity of Public Water Supply Watersheds: A Literature Review of Impacts on Water Quality From Residential Development (Department of Environmental Protection, Bulletin No. 11, 1990).
Conservation and Development Policies Plan for Connecticut 1992-1997 (Office of Policy and Management, 1992).
Non Point Source Pollution: An Assessment and Management Plan (Department of Environmental Protection, 1989).
Protecting Connecticut's Water-Supply Watersheds: A Guide for Local Officials (Department of Environmental Protection, 1993).

2.0 EPA DRINKING WATER REGULATIONS

2.1 SAFE DRINKING WATER ACT OF 1974

Passage of the Safe Drinking Water Act (SDWA) in 1974 heralded the development of the nation's first set of uniform drinking water regulations that were enforceable throughout the United States. Prior to the SDWA, public water systems (PWS) were regulated largely by various state public health agencies following the 1962 US Public Health Service regulations for drinking water used in interstate travel. At the time when the need for a SDWA was being debated in Congress, government and industry surveys revealed that a number of PWS were deficient in providing safe and acceptable drinking water. Among the major deficiencies noted throughout the US were inadequate treatment and distribution systems, poor bacteriological water quality, inadequate monitoring, inadequate operator training, inadequate operation and maintenance of treatment facilities and insufficient state resources to adequately address these deficiencies.

The SDWA mandates specific roles for the federal and state governments and for the public water suppliers. The Act authorizes the federal government to set national drinking water regulations, conduct research and special studies, provide technical assistance, and oversee implementation of the SDWA. The states, through their various health departments and environmental agencies, have primary responsibility for implementation and enforcement of the SDWA's provisions. Finally, the public water suppliers are responsible for meeting the regulations on a day-to-day basis. The SDWA applies to all community and non-community systems, including those which are publicly or privately owned. Community water systems are defined as those systems with 15 or more service connections or serving at least 25 people year round. Non-community systems include restaurants, campgrounds, factories, schools, and motels which own their own water supplies and are not community systems. In Connecticut there are 603 community water supply systems and approximately 3,000 non-community water supply systems.

2.2 CURRENT REGULATIONS FOR PUBLIC DRINKING WATER SYSTEMS

Today, the SDWA regulates 83 drinking water contaminants. The most significant SDWA regulations, with respect to the protection of public health from microbial risk, are the Total Coliform Rule (TCR) and the Surface Water Treatment Rule (SWTR). There are no state or federal monitoring requirements for *Giardia*, *Cryptosporidium* and viruses. While public health is protected from the threat of *Giardia* and viruses by treatment techniques specified in the SWTR, these techniques do not provide protection against *Cryptosporidium*.

2.2.1 Total Coliform Rule The TCR, enacted in 1990, regulates the presence of total coliform bacteria in drinking water distribution systems. The TCR specifies the permitted level of coliform occurrences in any drinking water

system. The frequency of sampling is determined by the size of the population served. When these levels are exceeded a variety of mechanisms are available for correction including (a) a check on the sanitary integrity of the system, (b) public notification, and (c) mandated enforcement actions.

The total coliform bacteria group are regarded as indicator organisms, where their presence may signal operational problems or possible fecal contamination within a PWS. Total coliform bacteria are not necessarily the best indicators of fecal contamination. Therefore, the final TCR included a requirement that samples that test positive for total coliform must then be tested for fecal coliforms (*Escherichia coli*), in order to detect or rule out fecal contamination. The finding of fecal contamination in a PWS distribution system constitutes an acute violation of the TCR and requires notification of the DPH within 24 hours. Because the fecal coliform test is subject to false-positive results, many regard the presence of *E. coli* as the only true indicator of fecal contamination. No correlation was found between the recent waterborne *Cryptosporidium* outbreaks and the occurrence of total coliform group bacteria and *E. coli*.

2.2.2 Distribution System Biofilms A relatively common and perplexing problem facing some public water supply systems is related to the immobilization of bacteria in the organic and inorganic matter commonly found in water distribution systems. Immobilized bacteria, and the substrate matter on which they reside collectively, are known as biofilm. When this formation occurs, coliform bacteria may exceed the TCR's allowable monthly limit. Biofilm activity is most pronounced during the summer and fall months.

While the exact mechanisms of biofilm formation and control in drinking water systems are unknown, it is widely believed that the complex interaction of environmental conditions (e.g., water temperature and rainfall), nutrient availability, disinfection practices, water-main corrosion, and distribution system hydraulics account for its presence. To date, no totally effective means to eliminate or control distribution system biofilms have been reported; however, systems utilizing monochloramine for post disinfection tend to be less predisposed to biofilm formation. Connecticut was instrumental in the recognition of systems that are prone to biofilms. In response to this, the EPA developed a stringent set of variance criteria whereby qualifying systems may exceed the allowable monthly limit of coliform bacteria. The variance criteria are intended to be as stringent as the TCR and provide the same level of protection where no unreasonable risk to public health exists. In order to qualify for and maintain a variance from the TCR, the affected system must demonstrate, based on at least daily monitoring, that it is free of fecal contamination, maintains adequate disinfection, complies with the SWTR turbidity requirements, and does not have a history of waterborne disease outbreaks. The South Central Connecticut Regional Water Authority, which serves 12 towns in the metropolitan New Haven area, has been granted a variance from the TCR based on its history of biofilm dating back to 1984. Throughout its 12-year history of coliform occurrence, there were no known or suspected outbreaks of waterborne disease associated with the presence of coliform bacteria in the distribution system. Further, the system must undergo an annual sanitary survey, maintain an acceptable cross-connection control program, and submit a biofilm control plan to its primacy agency.

2.2.3 Surface Water Treatment Rule The SWTR, enacted in 1989 and effective in June 1993, was designed to protect public health, to the extent possible, from waterborne disease. The rule requires all surface water supplies, and those groundwater under the direct influence of surface water, to remove or inactivate microbial pathogens. Microbial pathogen removal may be accomplished by filtration or inactivation by disinfection. Some surface water systems with high quality source waters may avoid filtration if specific avoidance criteria can be met relative to source water microbial quality, turbidity levels, and disinfection practices that achieve prescribed levels of inactivation. Under the SWTR, systems already filtering were required to meet more stringent operating conditions.

Specific treatment techniques for the inactivation of *Giardia*, the bacteria *Legionella* and viruses were established in lieu of maximum contaminant levels because of the inherent difficulties associated with the analysis of *Giardia* and viruses. The rule also established a limit for filtered water turbidity. Final disinfection, after adequate contact time,

must be capable of achieving inactivation or removal levels of 99.9 percent for *Giardia* cysts and 99.99 percent for viruses. Adequate disinfection is expressed as the algebraic product of the disinfectant concentration (C) and contact time (T), usually abbreviated as C·T, before the first consumer obtains the water. C·T values are determined by laboratory studies of microbial inactivation. Factors that influence C·T values are water temperature, disinfectant concentration, pH (acidity of the water) and water flow through the treatment plant. *Cryptosporidium* was not addressed by this rule because it was not recognized as a major waterborne pathogen when the rule was enacted.

2.3 PROPOSED DRINKING WATER REGULATIONS

The goals of the immediate federal regulatory agenda are focused on the control of disinfection byproducts (DBPs) to reduce lifetime cancer risk and the removal of microbial pathogens to minimize waterborne disease. To achieve these goals the EPA, with significant input from various stake-holder groups, began developing several major regulations in 1992 and 1993, namely, (a) the disinfection and disinfection byproduct rule (D/DBP), (b) the enhanced surface water treatment rule (ESWTR), (c) the information collection rule (ICR), and (d) the groundwater disinfection rule (GWDR).

2.3.1 Balancing Competing Risks For the most part, risks posed by the DBPs are considered to be chronic, while the risks associated with microbial pathogens are generally viewed as acute. In both cases, because of inadequate scientific data, the risks are not well defined relative to health effects and contaminant occurrence levels. The potential social and economic impacts related to the control of DBPs and waterborne pathogens are enormous. In the early stages of the regulatory development process, it was recognized that lowering disinfection levels to control DBP formation could increase microbial risk because of inadequate disinfection. The dilemma created by the need to balance chronic and acute risks led the EPA to use a regulatory negotiation process, known as "reg-neg". The reg-neg process was conducted under the auspices of two independent environmental dispute facilitators. The participants in the process included a variety of stake-holder groups, representatives of the public water supply industry, state drinking water administrators, public health officials, environmentalists, and consumer advocates. This represents the first time reg-neg was used in the development of drinking water regulation.

2.3.2 Information Collection Rule In the reg-neg process the negotiators quickly realized the need for DBP and pathogen occurrence data to aid in the standard-setting process. The occurrence data would be used to help set appropriate maximum contaminant levels for the DBPs and establish levels of pathogen removal or inactivation required through treatment and disinfection based on source water pathogen concentrations. When implemented, the ICR is likely to require all large systems serving more than 100,000 persons to provide monitoring results for *Giardia*, *Cryptosporidium*, viruses, a variety of DBPs and DBP-related parameters for an 18-month period. All systems will be required to provide detailed information on their water treatment processes so that different processes can be evaluated relative to the formation and removal of DBPs along with pathogen occurrence and removal efficiencies. Data from the ICR will be used to develop a national occurrence database. The resultant database will be analyzed and modeled by the EPA to determine appropriate treatment levels based on source water quality and treatment.

Originally, data collection under the ICR was to begin in October 1994; however, significant problems with existing analytical methods for *Giardia* and *Cryptosporidium* have delayed promulgation of the ICR until sometime in early 1996. Moreover, because of these methodological problems, it is possible that the final ICR may not include monitoring requirements for these pathogens. Overall, despite its flaws and delays, many regard the ICR as the starting point for the development of balanced regulations governing disinfection and the control of waterborne pathogens. However, an ICR that is unable to provide timely occurrence data for *Giardia* and *Cryptosporidium* would not be of much help to the regulatory development process (see section 3.2).

2.3.3 Disinfection and Disinfection Byproduct Rule The EPA proposed a Disinfection and DBP (D/DBP) rule in 1994. Under the proposed rule, DBPs will be regulated in two stages referred to as Stage I and Stage II. The Stage

I rule will be based on initial treatment goals developed from the assessment of currently available data. Stage II will be based on data and information collected by the ICR and related research. While Stage II will contain proposed maximum contaminant levels for a number of DBPs, these levels are considered to be "placeholders" subject to review and revision when the rule is formally proposed. The D/DBP rule will also limit the maximum concentration of various disinfectants that can be used in public drinking water supplies.

Disinfection byproducts are comprised of suspect and known human carcinogens that form from the reaction of naturally occurring organic matter with chlorine and other drinking water disinfectants. The first disinfection byproducts discovered were the trihalomethanes (THMs) in the mid 1970s. An interim regulation for the THMs was established in 1979. With the Total Coliform Rule (TCR) and the Surface Water Treatment Rule (SWTR) in place by the early 1990s, regulatory attention shifted to newly discovered disinfection byproducts, including those resulting from the use of ozone, monochloramine and chlorine dioxide.

Because of delays in promulgating the ICR, development of a firm implementation schedule for the Stage I and Stage II D/DBP rules has not occurred. It is likely that the EPA will delay this rule for 18 to 24 months, so that ICR data can be developed and analyzed.

2.3.4 Enhanced Surface Water Treatment Rule The Enhanced Surface Water Treatment Rule (ESWTR) will go beyond the existing SWTR to provides added protection from the threat of *Cryptosporidium* and other waterborne pathogens. Like the D/DBP rule, the ESWTR will likely be proposed in two stages, an interim ESWTR coinciding with the Stage I D/DBP rule to ensure that disinfection does not compromise microbial protection, and a final ESWTR developed from research and a full analysis of data collected under the ICR. The final ESWTR could remain the same as the interim rule, or it could be very different, depending on the outcome of the ICR data and research. Levels of treatment under the final ESWTR are likely to be based on source water quality. Utilities with degraded or poor quality water sources will be required to provide higher levels of pathogen inactivation compared with those required by the current SWTR. Because of delays with the ICR, the ESWTR implementation schedule has also slipped by about 18 to 24 months.

2.3.5 Groundwater Disinfection Rule Contrary to popular belief, groundwater is not sterile. According to EPA testing, a variety of viruses and bacteria can be found in many public groundwater systems. To reduce the potential risk of microbial disease in these systems, a draft Groundwater Disinfection Rule (GWDR) was circulated by the EPA in 1992. The GWDR is focused on preventing viral and bacterial disease in drinking water systems that rely on groundwater. Key to the development of an effective GWDR is a better understanding of natural disinfection for contaminated waters as they pass through the soil relative to the fate and transport of viruses. When implemented, the rule is likely to establish and define criteria for natural disinfection based on site specific conditions including contaminant sources, soil and aquifer settings, and land use patterns. Further, the rule is expected to include a disinfection requirement, regardless of demonstrated natural disinfection, to protect the distribution system from cross-connections, microbial regrowth and general water quality deterioration. At this time, the need for disinfection in Connecticut's public groundwater systems is determined on a case-by-case basis.

Since the 1992 draft, the rule has experienced several delays in its implementation schedule as a result of incomplete occurrence data and the lack of sound methods to determine which groundwater systems are most vulnerable to microbial contamination. Promulgation of the rule is not likely to occur before 1998. Because the data and research needed for this rule are incomplete, compliance cost estimates for this rule have not been finalized by the EPA.

2.4 FINANCIAL IMPACT OF NEW REGULATIONS FOR CONNECTICUT

Connecticut's drinking water suppliers, because of high quality source waters and comprehensive source protection regulations, are better positioned to provide microbially-safe drinking water at a lower cost compared to most of the nation. Nevertheless, many of Connecticut's public and investor-owned water supply systems will have to upgrade their treatment facilities to ensure compliance with the D/DBP and ESWTR rules. Using 1993 EPA cost-estimate data developed for the entire nation, conservative cost estimates for capital construction in Connecticut's public drinking water supply community to implement these rules could range from $100 to $350 million for the 25 systems that serve populations equal to, or greater than, 10,000 persons (see appendix F for details of these estimates). Annual operating and maintenance costs are estimated at $4 million. State-wide monitoring costs could reach $0.5 million per year, while regulatory oversight costs for the State of Connecticut are estimated at $0.5 million per year. The costs of these regulations will require the involvement of the Department of Public Utility Control in the rate setting process.

2.5 CONCLUSION AND RECOMMENDATIONS REGARDING DRINKING WATER REGULATIONS

To ensure that Connecticut's public drinking water supplies remain safe and affordable well into the future, the State, together with the public water supply community and elected officials, must continue to be proactive and aggressive in protecting its drinking water resources.

Connecticut's unique program of multi-barrier protection should be recognized within the elements of any future federal drinking water regulations. This is in order to avoid imposition of unnecessary federal mandates and to control costs for the public.

While the task forces agrees that there is clearly a need for obtaining *Cryptosporidium* occurrence information, the inadequacy of the testing method that is currently mandated by the ICR presents several serious concerns relative to the use of questionable data that would derive from this method. Therefore, the task force recommends that EPA delay the microbial monitoring requirements of the ICR until a suitable method is developed. We further recommend that the resources previously designated for ICR microbial monitoring be refocused on the development of methods for analysis of waterborne pathogens.

The maintenance of the water distribution system is important in maintaining the quality of Connecticut's drinking water supply. Accordingly, the task force recommends the support of additional research in the area of biofilms.

3.0 PATHOGEN MONITORING

3.1 PROBLEMS ASSOCIATED WITH MONITORING FOR PROTOZOAN PATHOGENS

Monitoring for waterborne pathogens is complex. This complexity is due in part to the variety of pathogens that can be waterborne. In addition, a method for monitoring waterborne pathogens must meet a number of criteria. These include (a) the requirement that the method be sensitive enough to detect even one pathogen in the sample tested; and (b) the requirement that the method be inexpensive, rapid, reproducible and accurate. To date, no method for protozoan pathogens satisfies all these criteria.

The current analytical method for *Giardia* and *Cryptosporidium* is based on sampling a minimum of 100 liters of water through a cartridge filter, followed by a series of tedious filter washing and concentration steps and finally microscopic examination of the sample concentrate to identify and count the number of pathogen cysts present. The entire analysis process typically takes 8 to 10 hours to complete per sample at a cost of $300 to $400. It is costly because the current

method is labor intensive and cannot be automated. Numerous technical problems are associated with this method including:

- poor recovery of *Giardia* and *Cryptosporidium* from untreated and treated water samples
- interference from algae and particulate matter
- inability to differentiate between live and dead pathogens
- inability to determine if detected pathogens are capable of causing disease in humans

Recently completed recovery studies conducted by the EPA, with known amounts of *Giardia* and *Cryptosporidium* found poor precision and accuracy among ten expert laboratories. Only 23 percent of the laboratories detected *Cryptosporidium* in the sample, some reporting as much as 130 percent of the known amounts. Similarly only 44 percent of the laboratories detected *Giardia*, some reporting as much as 110 percent of the known amounts. A second recovery study, completed in the fall of 1995, found similar results. The EPA is conducting a study to test the method under worse-case field conditions. If this study further indicates poor recovery and interference problems for *Giardia* and *Cryptosporidium* testing, the EPA could elect to postpone the ICR until such time that a more reliable method is found or proceed without monitoring requirements for these pathogens. Some form of closure by the EPA on this controversial topic is expected early in 1996.

3.2 THE MONITORING PROCESS

The process of monitoring may be subdivided into two stages. In the first stage, the pathogen is captured and retrieved from the water while in the second, the pathogen is identified and quantified.

3.3 METHODS FOR CAPTURE AND RETRIEVAL AND CONCENTRATION

The method currently in use for capture, retrieval and concentration of *Cryptosporidium* and *Giardia* is filtration; and a variety of filters are manufactured for this purpose. The success of this method requires the selection of a filter with a pore size smaller in diameter than the pathogen to be captured. Clearly, because waterborne pathogens vary in size, ranging from the relatively large (3 to 15 micron) protozoans to the small submicroscopic (less than 0.1 micron) virus particles, a different filter must be selected for each pathogen. One problem with filters is that the pores become blocked with particulates present in the water and clearly the smaller the pore size the easier they become blocked. This blockage reduces the flow of water through the filter thus reducing the volume of water that can be filtered. Another problem is that damage to organisms may occur making them unidentifiable. Retrieval of pathogens from the filter depends on the type of filter used. The consensus method for both protozoans and viruses calls for use of a cartridge filter; the retrieval of the pathogens from such a filter requires cutting and macerating the filter fragments to facilitate extraction of the pathogen from the matrix of the filter material. Several controlled studies have been performed to evaluate this technology. All studies have revealed poor recoveries. Based on these findings, the decision to use current filtration technology for the capture and retrieval of *Cryptosporidium* is being reconsidered by EPA.

Recently, a new method for capture and retrieval has been introduced. An experimental method, called immunomagnetic capture uses magnetic microspheres coated with specific antibodies, to capture the pathogen from the water. The magnetic susceptibility of the microspheres makes them, and the sphere-bound pathogen, easy to retrieve from the water. This technique has the potential to satisfy the criteria for the development of an ideal capture and retrieval system.

3.4 METHODS FOR THE IDENTIFICATION AND QUANTIFICATION

There are several methods available for identification and quantification. These detection methods differ in the type of information provided about the organism. For example, some methods determine whether or not the pathogen can

produce disease (infective); whether the pathogen is alive (viable) or merely present (detection). The method in use today for *Giardia* and *Cryptosporidium* would be classified as a detection method as it provides no information about the infectivity or viability of the organism.

3.4.1 Infectivity Method At the present time, the method used to determine infectivity is to administer the pathogen to a subject (both animals and human volunteers have been used) and monitor the subject for symptoms of the disease or shedding of the organism. This approach is surprisingly accurate in its ability to determine if the organism is infective, and somewhat quantitative in that it is possible to estimate the minimal number of organisms necessary to induce the infection.

3.4.2 Viability Method A method for the determination of viability of protozoans is the use of dyes (stains) that are designed to demonstrate if the organism is alive or dead. Usually, when single celled organisms, such as *Cryptosporidium* die, its cell wall "leaks", and as a consequence, becomes permeable to specific dyes. Thus, the uptake of a specially designed dye, such as propidium iodide, would indicate the organism is dead.

Recently, another experimental technique called electrorotation has been introduced to determine the viability of *Cryptosporidium*. This method makes use of an as yet unverified observation, that, when placed in an electric field, live organisms (including *Cryptosporidium*) will rotate (turn) in a specific direction. The inventors claim this method can be used to determine viability.

3.4.3 Detection Two types of detection methods are in use. Those that rely on the attachment of dyes to specific proteins (antigens) on the surface of the organism, or those that rely on the presence of specific sequences of nucleic acids in the nucleus of the organism.

Those that make use of surface proteins are referred to as immunochemical assays and can be used for identification and quantification. The commonly used Enzyme- Linked ImmunoSorbant Assay (ELISA) is one example. Another is the Immunofluorescent Assay (IFA). Both methods identify the organism present and can be used for quantification. Those that rely on nucleic acids sequences include the polymerase chain reaction (PCR), and reverse transcriptase polymerase chain reaction (RT-PCR). While both PCR and RT-PCR can be used for identification at the present time, quantification with these methods is unreliable.

Detection can also be carried out by direct microscopic examination of the organism. In fact, both *Cryptosporidium* oocysts and *Giardia* cysts contain internal structural features that allow a trained microscopist to confirm the identity of the organism. This capability has been used by the EPA to subdivide those organisms identified into "presumptive" and "confirmed".

3.4.4 Problems Associated with Identification and Quantification A significant problem concerning identification and quantification of protozoa is the enormous amount of extraneous "background" material that can interfere with the analysis and produce false positives. Therefore most, if not all methods, incorporate a step (or steps) for separation of the organism from the extraneous matter.

Separation methods have been developed that take advantage of the difference in size and specific gravity between the organism and the extraneous matter. Other methods for separation utilize the fact that each organism has unique surface proteins (antigens) and that antibodies equally as specific can be produced against these antigens. The specificity of the binding between antigen and antibody has been used as the basis for separation methods.

One such separation process is flow cytometry. In flow cytometry, the surface proteins of the organism are first tagged with a fluorescent dye. Next these tagged components are passed through a device which selects those with the dye and separates the organism from the extraneous debris. In addition to separation, flow cytometry can be used for identification and quantification.

Another antigen-antibody based separation process is immunomagnetic capture. Again, the specificity of the capture means that only the organism will be attached to a magnetically susceptible particle. The application of a magnetic field will allow the organism to be separated from non-magnetic extraneous materials. Immunomagnetic capture can also be used for identification and quantification.

Any method that uses antibodies will only be as specific as the antibodies. Lack of specificity, referred to as cross-reactivity, will result in false positives. At the present time, the antibodies used in the immunofluorescent assay (IFA) consensus method do show cross-reactivity with certain strains of algae present in the water. However, more specific antibodies are under development.

3.5 PERFORMANCE UNCERTAINTY AND INTERPRETATION ISSUES

At the present time monitoring for the presence of *Cryptosporidium* is a tedious, labor-intensive, costly, and inexact process. Using the detection method for identification purposes provides no information on viability or infectivity. Monitoring is limited to raw water and *Cryptosporidium* concentrations within the distribution system and finished water are unknown.

3.6 CONCLUSIONS AND RECOMMENDATIONS REGARDING PATHOGEN MONITORING

The task force recognizes the need for new technology that accurately and reliably monitors drinking water sources for pathogenic microorganisms, such as *Cryptosporidium* and *Giardia*. The task force acknowledges that expertise is present within Connecticut to develop this technology. Therefore the task force strongly recommends that Connecticut's Department of Economic Development collaborate with the state's government, the academic and the industrial sectors to promote the development of monitoring technologies.

In addition, the task force recognizes that there is a need for technology to remove or inactivate *Cryptosporidium* and agents of other waterborne diseases from water sources. The task force recommends that Connecticut's Department of Economic Development collaborate with the state's government, the academic and the industrial sectors to promote the development of technologies for the complete removal of *Cryptosporidium* and other waterborne diseases from water sources.

4.0 ASSESSMENT OF MICROBIAL RISK AND RISK COMMUNICATION

It has been known for a long time that surface waters used for public drinking water supplies can carry potentially harmful micro-organisms. The State of Connecticut is a leader in the protection and preservation of the quality of our State's drinking water supplies.

4.1 RISK ASSESSMENT

4.1.1 Background Information about *Cryptosporidium* *Cryptosporidium* is an intestinal parasite that has only been recognized as a human pathogen since 1976. Between the years of 1976 and 1982 it was not commonly reported in

the medical literature. When cryptosporidiosis was diagnosed, it was usually found in immunocompromised individuals. Since 1982, the number of cases increased proportionately with the AIDS epidemic, and the number of cases among immunocompetent individuals also increased. In 1987, the first large waterborne outbreak was recognized. Currently, *Cryptosporidium* is considered by the Centers for Disease Control and Prevention (CDC) as an important emerging pathogen in the United States.

The most common symptoms of cryptosporidiosis are prolonged watery diarrhea, cramps, weight loss, nausea, vomiting, and sometimes fever. In immunocompetent individuals, the duration of symptoms may vary from 4 days to 4 weeks or more. In some cases, there is a relapse in symptoms. In general, this is a self-limiting disease among immunocompetent persons. Among immunocompromised individuals, cryptosporidiosis is a severely debilitating disease. The symptoms may persist for months, or for years, and can be fatal. Currently, there is no safe and effective treatment available for cryptosporidiosis. Research is continuing in this area, but has been unsuccessful to date.

4.1.2 The Process of Infection *Cryptosporidium* is obtained from the feces of infected persons or animals. Transmission can occur through several routes, such as (a) person-to-person contact, with care-givers contracting this disease from inadequate hand washing techniques; (b) ingestion of food contaminated by an infected person or animal; (c) ingestion of water containing viable oocysts from feces of infected persons or animals; and, (d) animal-to-person contact with feces from infected domestic animals including cattle. The latter route of infection is especially significant on dairy farms among calves that are newborn to 6 months old.

Cryptosporidium appears to be widespread in our environment and is believed to be resistant to chlorine, the disinfectant of choice used by most public water utilities. Filtration is the recognized "best available technology" for removing or inactivating this parasite at the treatment plant. The Centers for Disease Control (CDC) recommends boiling water as the only certain guarantee of complete destruction of this parasite.

4.1.3 Occurrence of Cryptosporidiosis in Connecticut Cryptosporidiosis was added to the list of reportable diseases in the State of Connecticut beginning January, 1994. Therefore, statistics are only now being collected, managed and monitored. Altogether, 55 cases of cryptosporidiosis have been reported in the state in the nearly 2 year period from January 1, 1994 to November 1, 1995. Most of these cases have been in adults who are HIV-infected. These cases have been widely distributed in the state with no apparent temporal or geographic pattern.

It is suspected that these numbers underrepresent the magnitude of the problem of cryptosporidiosis in Connecticut. Surveys of laboratories and of physicians were performed by the DPH Epidemiology Section in late 1994 and early 1995, respectively. In general, laboratories only formally test for *Cryptosporidium* when requested to do so, which amounts to about 5 percent of the time on samples for which examination for *Giardia* is routine. Laboratories do not order the test routinely because it is time consuming and costly, and has a low positive yield. On the other hand, nearly 50 percent of physicians believe that laboratories routinely examine stool specimens for *Cryptosporidium* and do not tend to order the test in part because they do not know enough about laboratory practices or cryptosporidiosis. Furthermore, a high percentage of primary care providers do not recognize that children are at risk for cryptosporidiosis, and don't often order the test when they suspect it. Even if physicians were more aware of cryptosporidiosis and current laboratory practices, it is likely that there will continue to be an under diagnosis of cryptosporidiosis. Given the current trends of medical cost containment and managed care, it is likely that health care providers will not be encouraged by the medical system to routinely request stool examination for *Cryptosporidium* on all persons presenting with gastrointestinal illness.

4.1.4 Cryptosporidiosis and the AIDS population The most meaningful surveillance data is the occurrence of cryptosporidiosis among AIDS patients. Cryptosporidiosis produces chronic symptoms in persons with advanced HIV

infection, thus it is likely to be diagnosed. Symptomatic infection with *Cryptosporidium* has been an AIDS defining disease since 1985. Because of the thoroughness of AIDS reporting, systematic information on all such cases has been collected since that time. Based on these data, there are no obvious indications of a serious problem in the Connecticut AIDS population. Only 1.1 percent has cryptosporidiosis compared to 2.5 percent of the AIDS population nationwide. The only predictive factor for cryptosporidiosis among those with HIV infection is that gay men are more than three times more likely to have cryptosporidiosis than intervenous drug users or persons who acquire their HIV infection from heterosexual contact.

4.1.5 Occurrence of *Cryptosporidium* in the Environment and Water Supplies *Cryptosporidium* is carried and multiplies in the intestines of animals. Outside of the intestinal environment, it can survive for days-weeks but does not multiply. It may be present in the environment wherever there is animal life and the potential for contamination from the feces. There is no reliable, practical test for detection of *Cryptosporidium* in source waters of public water supplies. Lacking such a test, *E.coli* and fecal coliforms are relied upon to indicate a possible presence of fecal microbial contamination. It is important to note, however, that since *Cryptosporidium* is chlorine resistant, the absence of current indicator micro-organisms that are effectively killed by chlorine may provide a false sense of security in the safety of chlorine-treated water.

The scientific research to determine a standard for *Cryptosporidium* in drinking water is incomplete. There is limited information as to how many oocysts are likely to cause illness (see appendix E). Also, if an accurate and reliable test for *Cryptosporidium* in a source water is developed and the parasite is found to be present in source water, the technology is not available to remove it completely.

4.1.6 Conclusions about Risk of Cryptosporidiosis From Drinking Water in Connecticut Given that the incidence of cryptosporidiosis among AIDS patients in Connecticut is low and does not cluster, it appears that immunocompetent persons in the state are not at exceptional risk of exposure to *Cryptosporidium*.

One indicator that sometimes has a correlation with the presence of *Cryptosporidium* in drinking water has been an elevated turbidity. The SWTR requires filtration of all public surface water supplies and public supply wells under the influence of surface waters. This process will minimize turbidity. Currently, approximately 10 percent of Connecticut's population on surface water supplies receive unfiltered water; the DPH Water Supplies Section expects that by the year 2000, 100 percent of public drinking water supplies from surface waters, or wells under the influence of surface waters, will be filtered. In the interim, those immunocompromised individuals who are concerned about cryptosporidiosis, have an effective option to boil their drinking water as a preventive measure.

4.1.7 Recommendations Regarding Risk Assessment for Cryptosporidiosis The assessment of risk for a potential outbreak of cryptosporidiosis in Connecticut is inexact. Data inadequacies in clinical, environmental, epidemiological and technological fields limit an accurate assessment of the risk of cryptosporidiosis.

Clinically, a less expensive and less time-consuming lab test for cryptosporidiosis diagnosis is needed to encourage routine testing of both immunocompetent and immunocompromised patients. Without such an improved test and its widespread application, the incidence data for Cryptosporidiosis among the general Connecticut population provides an incomplete disease assessment.

Environmentally, the development of accurate and reliable lab procedures to test source and treated waters for *Cryptosporidium* is needed. Lacking such data, the prevalence of *Cryptosporidium* in the surface waters of Connecticut remains speculation.

Epidemiologically, further research is needed to determine a health standard for *Cryptosporidium* in drinking water. Such a standard would provide a measurement tool for a scientific assessment of risk for both the public water industry and enforcement agencies.

Technologically, an effective means is needed to remove this parasite completely from source waters or to comply with an accepted standard (to be developed). Once the technology is developed, it must then be implemented in Connecticut's water treatment plants.

Lacking the scientific data, the task force strongly recommends a continued diligence in the protection of the watershed areas by maintaining the multi-barrier approach which has held us in good stead to this point. Although Connecticut has not had an outbreak of cryptosporidiosis to date, there is no assurance that it cannot happen here should protection of watersheds be relaxed.

4.2 RISK COMMUNICATION

There are two general types of situations to consider in risk communication about microbial water safety: (a) the usual baseline situation when nothing unusual is happening, and (b) the acute situation in which it is suspected that an unusual level of contamination may be occurring.

The DPH has taken a position on microbial safety of Connecticut public water supplies in the absence of an acute event and attempted to communicate this in the past year to water utility operators, local health departments, persons who provide health care to those with HIV infection, and persons with AIDS. DPH has developed a fact sheet and sent letters to each of the above (see appendix G). The letters and fact sheet provide information on actions individuals can take to minimize the apparently low risk of contracting cryptosporidiosis from public drinking water supplies, from person to person transmission and from swimming in recreational waters. It also provides advice to travelers. There have been very few inquiries from the general public or the media since these communications were developed and distributed.

A possible acute contamination situation might be recognized in several ways: as a result of an outbreak of human illness or as a result of abnormalities in the results of required monitoring of drinking water. An outbreak of human illness would prompt a standard epidemiologic investigation which would result in a need for public notification only when it became apparent that water was the most likely vehicle for the outbreak. Local health departments and water utility operators would be notified immediately for assistance with the investigation. If rapid notification of health care providers or persons with HIV infection or other forms of immunosuppression were then necessary, it is likely that it would initially occur via press release and press conference. If necessary, direct communication via telephone and fax would be done with hospitals and emergency rooms. As a backup, a mailing would be done to physicians in the affected area.

If there are abnormalities in the results of required drinking water monitoring and they reach a prescribe threshold level, regulations require public notification. The DPH Water Supplies Section has the regulatory authority for the enforcement of the Public Health Code, Ct. Regs. §19-13-B102. These regulations describe, in part, the required monitoring and reporting to the public when specific water quality conditions occur.

However, there is a missing connection to local governmental resources in the local health departments in this regulated path. Most states provide local health department services through county or regional health departments. Connecticut is unique in that local health department services continue to be provided by individual towns, cities and health districts.

When a problem arises which requires the notification of the public, an easily interpreted reporting method is recommended. Public notification is required by regulation for a variety of reasons. Some violations have public health significance and others clearly do not. Such a method could be used by the water companies, the media and local health departments, to communicate the level of public health risk that is associated with a given violation. The goal of risk communication is to bring the appropriate information, or level of concern, to the individuals that need to be informed and the task force recommends that the DPH consider this course of action.

There are several problems that result from the deletion of Connecticut local health departments from this communication loop including local health departments, the public health resource closest to a problem in the community, are not utilized for risk communication. Local health departments are well placed to contact boards of education, day care centers, food services, senior centers, home health care organizations, local physicians, long term health care facilities, etc. and to assist in public health education of potentially sensitive populations. They are also empowered and well-placed to investigate whether there are any human health effects from a suspected contamination event.

One solution is to require contact with local health departments. Currently Ct. Regs. §19-13-B102(h)(6)(B)(iii), states, "Each system, upon discovering that a waterborne disease outbreak potentially attributable to that water system has occurred, shall report that occurrence to the department as soon as possible, but no later than by the end of the next business day....". This section could be amended to include "and the local Director(s) of Health having jurisdiction in the affected community(ies)" after the words "the department".

An important element in risk communication and reduction is what takes place in the water utility plant. For example, the technical aspects of public water treatment require a significant level of expertise on the part of the water treatment plant operator. In light of the recent findings of the resistance of *Cryptosporidium* to state-of-the-art treatment, adequate in-service training of the plant operators is especially important. It is crucial that water utility plant operators be continuously updated on new methods and technologies and that procedures be in place to report malfunctions within plant operations. Given the critical role of properly functioning water treatment plants, it is to noteworthy that there is no requirement for random drug testing among water utility plant operators at the present time. Connecticut's water utilities should consider a formal training program that establishes a minimum standard of training needed for a water treatment plant operator.

Following the Milwaukee incident in 1993, there was a volume of public health information made available through the Connecticut Department of Public Health, Epidemiology Section. Outreach to the AIDS population was also made. However, as it is with most public health incidents, the level of public concern diminishes as public awareness wanes.

Therefore, the task force recommends a continued networking of the DPH, Epidemiology Section and the CDC which will culminate in routine information updating on *Cryptosporidium* to hospitals, health care providers, local health departments and groups that represent immunocompromised individuals. In particular, based on the Connecticut physician survey results, there is a need for more information targeted to them regarding groups at risk for cryptosporidiosis and diagnosis. The communication of information about waterborne pathogens should be encouraged in the medical, dental, and public health programs in Connecticut's Universities. It is important to note at this point that the CDC is currently creating a "notebook" for local health officials which provides a model for following up on a public waterborne disease outbreak. This notebook is should be available to all states in early 1996.

Currently, a significant defense in Connecticut against cryptosporidiosis lies with the empowerment of accurate and adequate risk communication. It will be important to communicate to those groups who have the greatest public health risk whenever there is evidence that their risk of exposure to *Cryptosporidium* is higher than currently suspected.

4.3 CONCLUSIONS AND RECOMMENDATIONS FOR ASSESSMENT AND COMMUNICATION OF RISK FOR CRYPTOSPORIDIOSIS

4.3.1 Recommendations for Improving Risk Assessment The task force recognizes the importance of risk assessment. However, at this time, the assessment of risk for a potential outbreak of cryptosporidiosis in Connecticut is inexact. Part of the problem is that the present diagnostic test is time-consuming, labor intensive, costly and not widely used by clinicians. To improve our ability to assess risk for cryptosporidiosis, the task force recommends that efforts be made to encourage providers to test for cryptosporidiosis more often.

The task force recommends that the Public Health Committee endorse the need for additional epidemiological research at the national level to determine a health standard for *Cryptosporidium* and other waterborne diseases.

The task force recognizes that there is a need for technology to remove *Cryptosporidium* and agents of other waterborne diseases from drinking water sources. The task force recommends that Connecticut's Department of Economic Development collaborate with the state's government, the academic, and the industrial sectors within our state to promote the development of technologies for the satisfactory removal or inactivation of *Cryptosporidium* and infectious agents of other waterborne pathogens from drinking water sources. Positive results from Connecticut's collaborations should be shared on the national level in the interests of advancing technological knowledge of microbial contamination.

4.3.2 Recommendations for Improving Risk Communication The task force recognizes the importance of risk communication and recommends a regulation amendment to the Public Health Code, Ct. Regs. §19-13-B102, to include local health departments in the notification process when a problem is reported by a water utility.

The task force recommends the creation of an easily understood reporting method for public notification which clearly indicates the level of public health concern expressed by DPH.

The education of the public about *Cryptosporidium* and waterborne diseases needs to be continued and expanded. The task force recommends the development of a proactive plan to (a) educate watershed residents and business operators about water supply protection methods and about sources of contamination (e.g. failed septic systems and manure piles), (b) inform health care providers regarding the importance of and the means to diagnose, cryptosporidiosis, and (c) inform members of the high risk groups.

The task force recommends that the media be expected to print announcements of public health concerns as part of the DPH's program of risk communication.

The task force acknowledges the importance of the safe operation of water utility plants in the maintenance of potable water quality. Therefore, the task force endorses the expansion of high quality in-service training programs for industry personnel and other methods to ensure the highest standards of water utility operation.

5.0 APPENDICES

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B. Task Force Members and Brief Resumes
C. Watershed Land Statistics
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E. Cryptosporidiosis and Public Health: Workshop Report
F. Cost Estimates for Disinfection/Disinfection By-Product and Enhanced Surface Water Treatment Regulation Compliance in Connecticut
G. Connecticut Department of Public Health Statement of December 16, 1994 on *Cryptosporidium* in Public Drinking Water
H. Transcript of Subject hearing Testimony
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J. List of People Testifying at Subject Matter Hearing
K. Multiple Barrier Protection in Connecticut—A Water Utility Perspective

TASK FORCE MEMBERS

Legislative Appointments
Rep. Terry Concannon, Co-Chair
34th Assembly District

Rep. Pat Widlitz
98th Assembly District

Darrell Smith
South Central Connecticut Regional Water Authority

UConn Health Center Waterborne Disease Center
Prof. Edward F. Rossomando, Co-Chair

UConn Marine Sciences and Technology Center (Avery Point)
Dr. Pieter T. Visscher

Yale School of Public Health
Prof. Jan Stolwijk
Department of Epidemiology

Large Investor-Owned Water Utility
John Herlihy
Bridgeport Hydraulic Company

Small Investor-Owned Water Utility
Randolph Kempain
Crystal Water Company

Municipal Water Utility
Laura A. Eddy
Town of Manchester

Municipal Health Department
Maryann Cherniak, Director of Health
Berlin Health Department

Regional Water Authority
Richard B. Allen
Metropolitan District Commission

Department of Public Health
Dr. Gerald Iwan, Chief, Water Supplies Section

Dr. James Hadler, Chief, Epidemiology Section

Department of Environmental Protection
Fred Banach, Asst. Director, Water Bureau

TASK FORCE STAFF

Linda Civitillo
Department of Public Health

Dr. Deborah Ducoff-Barone
Water Supplies Section
Department of Public Health

Atty. Matthew Ranelli
Office of Legislative Research

APPENDIX K. MULTIPLE BARRIER PROTECTION IN CONNECTICUT - A WATER UTILITY PERSPECTIVE

MULTIPLE BARRIER PROTECTION IN CONNECTICUT - A WATER UTILITY PERSPECITIVE

Maintaining a "multiple barrier" approach is critical to ensuring the purity of Connecticut's drinking water supplies. The multiple barriers include protection of the source through appropriate land use management, pollution abatement and education; optimal water treatment by filtration and disinfection; and proper operation and maintenance of the distribution system. Water quality monitoring is an important tool used to determine the effectiveness of each barrier. Attention to each of these elements of the multiple barrier approach is essential. Water utilities, municipal authorities including local health departments, the DPH, and the DEP all have vital roles and responsibilities in ensuring that the integrity of the multiple barriers is maintained.

Source Protection Barrriers

Water Supply Planning

The State's nationally recognized utility and regional water supply planning processes, generally referred to as the Connecticut Plan, requires water utilities and other governmental and regional organizations with vested interests in drinking water, to develop long term planning documents with sections devoted to preservation and protection of existing and potential drinking water supplies.

Land Use

Land Ownership

Seven of the State's largest water utilities, serving about 1.5 million people, own approximately 25 percent of the land area within their watersheds. State mandated permitting procedures preserve and protect water supply watersheds through regulation of the salc, use and classification of water company owned lands and control over proper abandonment of public supplies. Ownership and oversight of such a high percentage of watershed land represents a significant protection barrier.

Land Use Planning

The *Conservation and Development Policies Plan for Connecticut, 1992-1997* contains recommendations for local planning actions to be protective of water supply watersheds. While the State plan contains excellent policies, they are only recommendations and often there are large gaps between what the state recommends and what the municipalities implement. Municipalities are required to have local plans of development intended to serve as guidelines for decisions regarding future development. Local zoning and other appropriate ordinances are the mechanism by which such plans are implemcnted. The extent and type of development which is allowed within public water supply watershed varies considerably among municipalities.

Land Use Control

Development within public water supply watersheds is controlled at the local level through review of development proposals by planning, zoning and wetlands commissions and local health departments to ensure consistency with local development plans and compliance with applicable regulations, including the Public Health Code (PHC), intended to protect public health and the environment.

The PHC, under the authority of the DPH, establishes standards for subsurface sewage disposal systems. The DEP has authority over systems which exceed 5,000 gallons while the DPH has authority over smaller systems. The DEP also has oversight responsibility with respect to implementation of wetlands regulations and the DPH has oversight authority to ensure that local health departments properly apply the public health code.

Under State law, water companies must be notified of land use proposals within their watershed and are provided the opportunity to review and submit comments to the reviewing commission.

While there appears to be an adequate system in place to ensure that proposed development will not adversely affect human health and the environment, there is considerable variation among municipalities in the manner and effectiveness of implementation of those controls. Regulations are sometimes loosely applied or disregarded and, as a result, development approvals may be granted despite unsuitable site conditions or improper design. Water company comments may be effective at times, but at other times are disregarded.

Pollution Abatement

Water utilities with surface supplies conduct comprehensive annual inspections of their water supply watersheds and take actions to control or abate activities which may be or are a threat to the quality of the water supply.

The PHC, under the authority of the DPH, establishes special sanitary conditions applicable within public water supply watersheds which regulate, among other things, sewage disposal systems and structures where animal manure accumulates. The PHC provides authority to local health directors for abatement of pollution. The DPH has broad authority under state law to issue orders against actual or potential polluters to protect water supplies. State law provides local health directors with authority to assess penalties for potentially polluting activities within watersheds and seek legal remedies for polluting activities. Water utilities may also seek legal remedies for polluting activities.

Education and Outreach

State issued publications such as *Protecting Connecticut's Public Water-Supply Watersheds:*
A Guide for Local Officials and *Carrying Capacity of Public Water Supply Watersheds* contain comprehensive information for local officials and interested individuals on all aspects of source protection. Resources and support are available from numerous organizations including regional planning agencies, the State university system, and various federal, state and local agencies. Many water companies offer education to their customers, watershed residents and businesses and local organizations through formal or informal education programs and literature. Water company staff routinely educate watershed residents and businesses through personal contact during inspections and by attempting to work out problems cooperatively. Although numerous resources are available, they are becoming increasingly limited due to budgetary constraints.

Pollution Monitoring

While not required by law or regulation, some water companies voluntarily sample watershed streams and reservoirs for indicators of pollution. The results of these samples are often useful in identifying sources of pollution. Generally, however, there is no requirement for owner or operators of potentially polluting activities such as farms or sites with domestic animals to monitor for potential threats to water quality.

RECOMMENDATIONS

Land Use Planning

Conservation and Development Policies Plan for Connecticut, 1992-1997 contains excellent policies regarding water supply protection, but there is a significant gap between what the state recommends and the municipalities implement. Strengthen the force of these policies and ensure that they are implemented at the local level, perhaps with new legislation establishing implementation authority.

- There is increasing pressure to develop "marginal' lands on which conditions are ill-suited for development and septic systems ultimately fail. Promote alternatives to "bad" development and create incentives which will encourage municipalities to favor preservation and appropriate development.

Land Use Control

- Provide greater involvement and oversight of local land use decisions by the state and/or an independent review body to ensure that PHC, wetland and planning and zoning regulations are consistently and rigorously applied during the review process for proposed development.

The DEP, through the establishment and enforcement of water quality standards for all waters in the state, has authority to protect the quality of water supplies. The DEP can issue pollution abatement orders where activities within watershed areas cause or threaten to cause pollution of the water supply. Drinking water supply is the highest use classification for waters under the water quality standards systems and thus is afforded the highest level of protection. An issue with this system in that the criterion for indicator bacteria (total coliform) is not a good measure of fecal pollution.

Local inland wetlands commissions have authority, delegated from the DEP, to undertake enforcement action where land use activities are adversely impacting wetlands or watercourses within their jurisdiction. Local zoning authorities may also have the ability to undertake enforcement action where land use activities which may adversely impact water quality are in violation of local zoning ordinances, such as those which regulate the number and types of domestic animals that may be kept at a site.

There are numerous mechanisms which exist in state law and state and local regulation to protect public water supplies from polluting and potentially polluting activities. Water companies have the responsibility of bringing such activities to the attention of the appropriate regulatory authorities. The first level of responsibility for controlling polluting activities lies with the local regulatory authorities. The oversight responsibility for ensuring that these mechanisms are properly applied lies with the DEP and DPH. The DEP and DPH also have broad powers to undertake direct enforcement actions to control pollution.

The implementation of the protective mechanisms at the local level varies among municipalities. In many situations, polluting activities are not aggressively pursued and applicable laws and regulations are inadequately enforced. Local authorities often have limited resources and technical expertise and may be unsure of the extent of their authority. Water companies' sole recourse for controlling such activities is legal action which, given the potential number of cases, could be exorbitantly expensive. The DPH and DEP have little experience with exercising their pollution abatement powers for protection of public water supply, and are hampered by the lengthy and resource intensive hearing process involved in issuing orders against polluters.

Implementation of the system of laws and regulations which would seem to provide for control of pollution within watershed areas, is in need of review and modification. The responsibilities and extent of authority of the various stakeholders, and the process for making this system needs clarification. The number of parties involved, the variety and cumbersome nature of applicable laws and regulations, and lack of a single entity for ensuring that the process is properly implemented raises concerns. As the development of Connecticut's watersheds continues, it is vitally important that the process for protecting drinking water supply sources be made more effective to reduce the risk of transmitting of waterborne diseases, such as Cryptosporidiosis.

Pollution Abatement

- Conduct a comprehensive assessment of the legal and regulatory framework for watershed protection to improve the effectiveness of the process.
  - Clarify stakeholder roles, authority and accountability.
  - Clearly establish the authority of water company personnel to enter properties for inspection and provide appropriate legal support.
- Provide greater involvement and oversight by state agencies to ensure that relevant statutes and the PHC are consistently and rigorously enforced at the local and state level to protect water supplies from actual and potential polluters.
- Ensure that water quality standards and appropriate legal and regulatory mechanisms are effective and implementable, so DEP can control non-point source of pollution.
  - Develop more appropriate water quality criteria for fecal pollution

Education and Outreach

- Intensify efforts to educate residents and businesses about the threat of fecal pollution from domestic animals including horses and cows and BMPs.
- Increase funding and role of soil and water conservation districts as a mechanism to provide technical support to property owners.
- Provide a mechanism for education and technical support to homeowners with failing septic systems within water supply watersheds.
- Provide funding for low cost loans to homeowners in need of assistance within public water supply watersheds to repair failing septic systems.

Pollution Monitoring

- Require periodic testing by owners and operators of waters surrounding sites where potentially polluting activities are conducted. Periodic testing of manure samples should also be considered to identify whether cryptosporidium oocysts are present.

APPENDIX I. LIST OF PEOPLE INVITED TO SUBJECT HEARING 10/17/95

(Testimony in file)

Lisa Santacruace
Clean Water Coalition

Lisa Santacruace
Connecticut Audubon Society

Kathi Traugh, Program Director
Healthy Connecticut Initiative

Dr. Novick (Yale)

Jim Monopoli
Connecticut Environmental Health

Elizabeth McLaughlin
Connecticut Environmental Caucus

Donald Strait, Executive Director
Connecticut Fund for the Environment

Claire C. Bennitt, President
Natural Resources Council of Connecticut

John Hibbard, Executive Director
Connecticut Forest & Park Association

Eileen Jokinen, Director
Institute of Water Resources

Mary Ann Nelson, Ex. Director
League of Women Voters of Connecticut

Vincent Majchier, Ex. Director
Consolidated Farm Services Agency

Mark Ruwett
Consolidated Farm Services Agency

Sierra Club

Judy Wreen
Connecticut Environmental Health Association

Ms. Katy Hanlon, President
Connecticut Diebetic Association

Louis Carbone
West Lake Laboratory

Campaign for Safe/Affordable Drinking Water

Connecticut Public Health Association

Ms. Shirley Farris, Commissioner
Department of Argriculture

Mr. Allen Bennett, Director
Connecticut Council on Soil & Water Conservation

Dan Straite
Connecticut Fund for the Environment

Natural Resources Defense Council

Mr. Kevin Walsh
The Connecticut Water Company

Catherine Fartin
Norwalk 2nd Taxing District

Earl Semmelrock
Connecticut Groundwater Association

Ms. Margo Wallace, State Conservationist
Natural Resources Convervation Service

Karl Wagner, Director
Connecticut Council on Environmental Quality

John Breakell, President
Connecticut Association of Conservation District

Thomas Turick
Environmental Council CBIA

Connecticut Conference of Municipalities

Joyce Brown
Department of Public Urtilities

Elsa Stone, MD President
American Academy of Pediatrics Connecticut Chapter

American Lung Association of Connecticut, Inc.
Southern Regional Office

Steven Huleatt, MPH RS President
Conn Association of Directors of Health

Robert E. Levitz, President
Connecticut Infectious Diseases Society

Steven Klobukowski, President
Conn. & Rhode Island Rural Water Asociation

AIDS Project Hartford

George Bucheli
AIDS Coalition to Unleash Power

National Kidney Foundation of Connecticut

Home Builders of Conn. Inc.

J. Thomas Cochran, Executive Director
Uniteds States Conference of Mayors

Steve Levy, President
Mid-Atlantic States Rural Water Assoc

Vanessa Leiby, Ex. Director
Association of State Drinking Water

Ardell Wilson, DDS, MPH
Department of Public Health

Richard Garibaldi, MD
UCONN Health Center

Tim Norbeck, Ex. Director
Conn State Medical Society

Tom Swan, Executive Director
Conn Citizens Action Group

Dr. Bernard Greenberg
UCONN Health Center

Dr. Peter Tukshika
UCONN Health Center

Dr. Naomi Rothfield
UCONN Health Center

Dr. Bruce F. Bower

(1/16/96)

APPENDIX J. LIST OF PEOPLE TESTIFYING AT SUBJECT HEARING

SUBJECT HEARING PARTICIPANTS

Norma O'Leary, President
Walter Welch
Connecticut Farm Bureau

Allen Hess
Connecticut Water Works Association

Thomas Marston
Connecticut Water Works Association

Leon Vinci
Connecticut Association of Directors of Health

Leon Vinci, M.P.H., Director
Department of Public Health

Steve Levy
Rural Water Association