# Summary of Chloramination of Public Drinking Water as of April 12, 2007

## National Trends on the Application of Chloramines as a Secondary Disinfectant

Chloramines (chemicals formed by combining chlorine and ammonia in water) have been in use in the United States since the early 20th century to treat drinking water supplies. The number of utilities using chloramines relative to those using free chlorine has fluctuated over time based on the state of the art, availability of ammonia for water treatment, and changes to regulatory standards. American Water Works Association (AWWA) conducted a survey in 1990 for systems serving 50,000 or greater and found that 99 of the 438 systems that responded (23%) used chloramines.

Since that time, chloramine use has risen, which is believed to be attributable to the concurrent increased stringency of water quality regulations addressing disinfection by-products and microbial quality in distribution systems. Simply put, substituting chloramines for free chlorine reduces the concentration of disinfection by-products (DBPs), which must be kept to a minimum due to their potential to cause carcinogenic and reproductive problems. Prior experience indicates common trihalomethane (one of the two major groups of DBPs) reduction of 40% and greater when free chlorine is replaced by chloramines as a final disinfectant. The public health benefits of DBP reduction was one of the primary reasons Champlain Water District (CWD) switched to secondary monochloramine disinfection.

A recent estimate by United States Environmental Protection Agency (EPA) indicates that over 50% of surface water systems and groundwater systems under the influence of surface water serving 10,000 or greater that add chlorine, use chloramines as a residual disinfectant, which is necessary to prevent bacteriological regrowth in extensive distribution systems. (Federal Register/Vol.71, No.2/January 4, 2006, p.414.) It is expected that on a national level there will continue to be an increase in the number of systems switching to chloramines in response to implementation of EPA's Stage 2 Disinfectants/Disinfection By-products Rule.

## WSD's Decision to Approve Use of Chloramines at CWD

In April 2005, the Champlain Water District submitted an application for a permit to construct to modify its disinfection process to add chloramines for use as a secondary disinfectant. The plant improvements consisted of a new bulk chemical storage tank for storing ammonium sulfate, chemical feed pumps, instrumentation, process piping and appurtenances. Prior to submission of the application, Water Supply Division (WSD) engineering and operations staff and the WSD's water chemist met with CWD officials and their consultant at CWD's water treatment facility in South Burlington. The meeting's purpose was to provide WSD staff an opportunity to gain a better understanding of the CWD's proposed physical and operational changes and the public notification effort being

undertaken. Going into the meeting, WSD had five principal concerns: (1) The steps being taken by CWD to notify those customers with special water uses, i.e., kidney dialysis facilities, fish rearing facilities, pet shops, seafood stores, etc.; (2) The effect chloramines would have on water corrosivity; (3) The potential for nitrification buildup at dead ends in the distribution system; (4) The potential for taste and odor problems caused by formation of less desirable forms of chloramine, and (5) The potential for chloramines to damage elastomeric materials used in plumbing fixtures.

CWD addressed the WSD's principal concerns and covered a wide range of technical issues related to the process change. Below is a summary of key issues that were discussed:

- Objective of reducing DBPs to below 40/30 ppb trihalomethanes and haloacetic acids, respectively, which are known to cause adverse health effects
- Free chlorine to be maintained as primary disinfectant at 0.5 to 1.0 ppm
- To optimize particle removal, adsorption clarifier needs oxidant (Cl2) to keep particle count and turbidity down
- pH target of 7.6 for ideal zinc orthophosphate corrosion control
- Selection of analyzer tap location relative to mixing point is critical to obtain meaningful readings to allow for slower reaction time (5 to 10 times slower) during winter months
- Pacing of ammonium sulfate & sodium hypochlorite to maintain a 4 to 1 ratio of Cl2 to NH3 (as N), which is critical to avoid formation of di- and tri-chloramines, which are undesirable due to taste and odor problems associated with these chloromine compounds
- Distribution system sampling for free ammonia, total chlorine, monochloramine, nitrate and nitrite
- Public notification process
- Reaction w/rubber compounds
- Lead & copper – pilot testing was being performed – discussed system L&C monitoring
- No chloramine in backwash water, so no chloraminated water will be discharged to Potash Brook
- Targeting chloramine addition in Nov '05
- Plan to start w/higher initial chloramine residual and over time reduce residual based on HPC monitoring results

Many of WSD's above concerns were addressed by CWD at the meeting. Following the meeting in February 2005, CWD submitted the permit application. In conducting its technical review, WSD relied to a large extent on information contained in the American Water Works Association Research Foundation (AWWARF) manual entitled *Optimizing Chloramine Treatment - Second Edition*, which is recognized as the one of the most current resources on the subject.

Chloramination is recognized under federal rule as a Best Available Technology for consecutive water systems serving a population of 10,000 or greater. Water systems with extensive distribution must maintain a residual disinfectant throughout the system due to

the potential for re-growth of microbial pathogens. There are three types of disinfectants available for maintaining a residual in the distribution system: free chlorine, chloramines, and chlorine dioxide. Chlorine dioxide is the least commonly used due to the relative difficulty monitoring and controlling residual levels and the potential for it to cause taste and odor problems. For larger systems that have the technical capability to use chloramines vs. free chlorine, the major advantage is the reduction of regulated DBP levels and its greater persistence throughout the distribution system, while offering an economically feasible method of disinfection.

Based on the information provided by CWD, the proposed process change was found to comply with the Vermont Water Supply Rule and the Ten State Interim Standards for chloramination in public water supplies, and a permit to construct was subsequently issued May 26, 2005.

Following public notification by CWD, plant improvements were completed and the conversion to monochloramine as a secondary disinfectant went on-line in April 2006. In August 2006, WSD's review engineer and water chemist inspected the completed facilities and reviewed CWD's chloramination disinfection practice.

**Health Complaints Following the Introduction of Chloramines**

Shortly after chloramines were added to the water system in April 2006, CWD began receiving customer complaints about skin rashes and other health maladies with the belief that the health problems were attributable to chloramines. The level of chloramines is continuously analyzed by CWD as it leaves the plant and out in distribution and has been well below the 4.0 ppm standard established in the Vermont Water Supply Rule.

Beginning in April 2006, the Vermont Department of Health reviewed dozens of scientific and clinical studies on possible health risks of monochloramine in public water supplies. The Health Department reviewed the literature for toxicity of disinfection chemicals and their by-products. The review led the Health Department to conclude that the known risk of cancer and birth defects from exposure to chlorine disinfection by-products out-weighs the risk from common, unexplained irritative type symptoms that are only possibly associated with exposure to monochloramines.

The Health Department also determined that this conclusion will be reviewed, and may be amended, if new and compelling scientific evidence is presented for a safer alternative for Champlain Water District water disinfection.

In a WSD review of literature about other large water systems within the U.S. that have switched to chloramines, one case was found where complaints about skin irritation were received and investigated by local public health officials. The system, which serves approximately 2.4 million people in the San Francisco Bay Area of California, switched to chloramines in February 2004.

Some time after the conversion to chloramines, a small number of residents complained about skin reactions. Local public health officials responded by conducting a survey

between September 2004 and January 2005 to ascertain if there was a common cause for the symptoms and thus determine if an epidemiologic investigation would be justified. Only seventeen people responded and completed a questionnaire administered by the local health department. Based on those responses, health officials determined that overall results did not support the need for a wider study and no further investigation was performed. This case study was reported in a peer-reviewed article published in an on-line journal *Environmental Health*, dated June 9, 2006.

## Sources of Information

Source of information for this summary include EPA Region I; EPA; AWWA; AWWARF; Association of State Drinking Water Administrators; CWD; VDH; and *Environmental Health,* an on-line journal.

Honorable Jim Douglas, Governor George Crombie, ANR Secretary Laura Q. Pelosi, DEC Commissioner

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