IMPACTS OF WATER RE-USE ON DRINKING WATER TREATMENT PLANT PRACTICES

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As populations increase, discharges of treated wastewater into streams and lakes make minimal time lag raw water monitoring more important in maintaining drinking water integrity. Of a more acute nature, discharges of partially-treated or untreated wastewater have profound impacts on treatment schemes practiced by drinking water treatment facilities. Introduction of anthropogenic contaminants, such as increased total organic carbon (TOC), microbial components, non-specific increases in chlorine demand, ammonia are some of the factors which negatively impact the treatment scheme. This presentation will address both of these scenarios as well as actual effects on a treatment plant in metropolitan Atlanta and the responses of the drinking water treatment plants to the disruptions.

CURRENT CONCERNS

When considering water treatment, two interrelated areas are of interest; human health impact and regulatory concerns.

The initial impetus for advanced water treatment techniques arose from disease outbreaks from bacterial and protozoan pollution. Cholera, typhoid fever, amoebic dysentery and other water borne diseases are still major pathogens causing millions of deaths in areas having poorly or untreated water supplies.

In the United States, in recent years, several water-related outbreaks have been documented, of two previously rare agents responsible for the majority of these occurrences; species of *Cryptosporidium* and *Escherichia coli* O157:H7 (*ECOL157)*. Work is also being done by the United States Environmental Protection Agency (USEPA), Centers for Disease Control (CDC), American Water Works Association Research Foundation (AWWARF) to determine the incidence of viruses in raw and finished water.

In 1989, in Cabool, Missouri, *ECOL157*contaminated the drinking water supply of this city of 2090, causing 253 illnesses and 4 deaths. In 2000, Walkerton, Ontario, Canada suffered a similar incident, with 29 hospitalizations and 2 deaths. In both of these incidents, the municipal water supplies had been compromised by heavy rains and subsequent flooding. While not directly traceable to the wastewater treatment plants, these illustrate the susceptibility of systems not properly disinfecting the water supply.

Cryptosporidium outbreaks have been attributable to wastewater releases coupled with disruptions of the drinking water treatment processes. Several outbreaks have been documented, with the largest being in Milwaukee, Wisconsin in 1993. A combination of factors contributed to an outbreak in this city of approximately 800,000, there were 403,000 occurrences of bloody diarrhea attributable to cryptosporidiosis, 285 confirmed cases of cryptosporidiosis,[1] and 69[2] deaths resulted. In this incident, heavy rainfall coupled with the proximity of the city's water intake to the outfall of the wastewater plant led to high concentrations of the target organism in the source water. A disruption of the water treatment process led to penetration of the filter beds by the organism. When past the filter barrier, the organism is highly resistant to chlorine disinfection, therefore leading to the contamination of the municipal water supply.

Anecdotally, the James E. Quarles Treatment Division of the Cobb County – Marietta Water Authority (QTD-CCMWA), during the Information Collection Rule procedures in the mid-1990's, experienced one month in which *Cryptosporidium* was detected in the raw water supply (Chattahoochee River downstream of two wastewater treatment facilities) at a level of 9 oocysts/10 L. In review, it was determined that one of these treatment facilities had experienced a temporary failure in its

[1] MacKenzie, William R., Hoxie, Neil J, Proctor, Mary E., Gradus, M. Stephen, Blair, Kathleen A., Peterson, Dan E., Kazmierczak, James J., Addiss, David G., Fox, Kim R,, Rose, Joan G., Davis, Jeffrey P.,(1994) A Massive Outbreak In Milwaukee of *Cryptosporidium* Infection Transmitted through the Public Water Supply, New England Journal of Medicine, 331:161-167

[2] Phaedra S. Corso,* Michael H. Kramer,* Kathleen A. Blair,† David G. Addiss,*
Jeffrey P. Davis,‡ and Anne C. Haddix,, Cost of Illness in the 1993 Waterborne
Cryptosporidium Outbreak, Milwaukee,Wisconsin Emerging Infectious Diseases • Vol. 9, No. 4, April 2003

disinfection procedure several days prior to this sampling event. In this same sampling event, enteric viruses were detected at a level of 698 viral particles/L of water. Although not definitive as a causative factor, the release of several million gallons of partially treated wastewater is reason to believe this was the major factor in these occurrences.

From a standpoint of current chemical concerns, the increase that is seen in total organic carbon has an impact on disinfection by-product formation.

Currently, USEPA regulates two classes of disinfection by-products (DBP's); trihalomethanes and haloacetic acids. Four trihalomethane species are regulated; trichloromethane (chloroform), dichlorobromomethane, dibromochloromethane, and tribromomethane (bromoform). The sum of the concentrations of these four components has a Maximum Contaminant Level (MCL) of 80 g/L as an annual running average of the total number of samples required for compliance. Similarly, five haloacetic acid species are regulated; trichloroacetic acid, dibromoacetic acid, dichloroacetic acid, monobromoacetic acid, and monochloroacetic acid. The MCL for this group is 60 g/L. Revisions of these monitoring requirements and MCL's are being promulgated by USEPA.

For many years, generation of these compounds was thought to be mainly from reaction of natural organic material (NOM, one source of TOC) with chlorine used in drinking water disinfection. However, in recent years, research has shown increases in TOC in bodies of water receiving wastewater streams. Further work has shown that much of this carbon is highly reactive and will generate DBP's when exposed to chlorine. With an increase in this component, an increase in DBP formation is possible.

Dovetailing with the DBP issue is the increase in chlorine demand caused by partially treated wastewater. This demand is from both non-specific reactants and from one specific compound identified in a series of events by the QTD-CCMWA.

In January 2001, an upward change in the chlorine demand for treatment was noted. A spill from an upstream WWTP was documented, and the demand rose to a level of 3.99 mg/L three days after the spill. This was determined to be the approximate travel time from the WWTP to the drinking water intake. Demand decreased over time until it reached a low of 0.97 mg/L, with a mean value of 2.89 mg/L. On January 11, 2001, another spill of 22 MG occurred at the same WWTP, and three days later, demand rose from 2.89 mg/L to a high of 4.07 mg/L. This trend continued with two more spills, one of approximately 15,230 gallons and the next of 35.7 MG. The effect of these events was felt in a proportional manner, the smaller spill resulting in an increase of 0.5 mg/L demand and the larger an increase of 3.13 mg/L. Large increases in both total coliform bacteria and *E. coli* were also noted. It would be logical to suspect that along with the increases in chlorine demand and bacterial levels, there were increases in TOC, *Cryptosporidium* and viruses.

LONG-TERM CONCERNS

One focus of research currently is on the occurrence of pharmaceutical products, endocrine disruptors and personal care products in water. The presence of these compounds in natural waters indicates the potential for their transport into the drinking water supply as well as their effect on natural systems. In the drinking water arena, these compounds potentially can be linked to early-onset maturation, antibiotic and disinfectant resistant microorganism, potential carcinogenesis and other undesirable effects. Research has demonstrated that large numbers of these compounds are not easily removed by conventional drinking water processes, and can be transported into the drinking water supply.

The challenge to the drinking water industry is the identification and detection of these contaminants and subsequently, the most effective and efficient way to remove them.

IN CONCLUSION

In the past twenty five years, newly identified pathogens and chemical contaminants have emerged as real threats to the health and safety of the drinking water consumer. Currently, techniques and processes have been developed to adequately control these contaminants. The challenge to the industries of wastewater and drinking water is to remove as many of these threats as possible before they enter the waterways and to remove the remainder in the purification process, while continuing to be proactive in identifying future threats and technologies to control them in both the most effective, efficient and economical manner.