

USEPA

Disinfection Byproducts: A Reference Resource

Disinfection byproducts are formed when disinfectants used in water treatment plants react with bromide and/or natural organic matter (i.e., decaying vegetation) present in the source water. Different disinfectants produce different types or amounts of disinfection byproducts. Disinfection byproducts for which regulations have been established have been identified in drinking water, including trihalomethanes, haloacetic acids, bromate, and chlorite.

Trihalomethanes (THM) are a group of four chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water. The trihalomethanes are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. EPA has published the [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) to regulate total trihalomethanes (TTHM) at a maximum allowable annual average level of [80 parts per billion](#). This standard will replace the current standard of a maximum allowable annual average level of 100 parts per billion in December 2001 for large surface water [public water systems](#). The standard will become effective for the first time in December 2003 for small surface water and all ground water systems.

Haloacetic Acids (HAA5) are a group of chemicals that are formed along with other disinfection byproducts when chlorine or other disinfectants used to control microbial contaminants in drinking water react with naturally occurring organic and inorganic matter in water. The regulated haloacetic acids, known as HAA5, are: monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. EPA has published the [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) to regulate HAA5 at [60 parts per billion](#) annual average. This standard will become effective for large surface water [public water systems](#) in December 2001 and for small surface water and all ground water public water systems in December 2003.

Bromate is a chemical that is formed when ozone used to disinfect drinking water reacts with naturally occurring bromide found in source water. EPA has established the [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) to regulate bromate at annual average of [10 parts per billion](#) in drinking water. This standard will become effective for large [public water systems](#) by December 2001 and for small surface water and all ground public water systems in December 2003.



Chlorite is a byproduct formed when chlorine dioxide is used to disinfect water. EPA has published the [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) to regulate chlorite at a monthly average level of 1 part per million in drinking water. This standard will become effective for large surface water [public water systems](#) in December 2001 and for small surface water and all ground water public water systems in December 2003.

Disinfection Byproduct Health Effects

Since the discovery of chlorinating byproducts in drinking water in 1974, numerous toxicological studies (studies on the health effects from exposure to high dosages contaminants usually involving animals in a lab) have been conducted. These studies have shown several [disinfection byproducts](#) to be carcinogenic in laboratory animals (e.g., including [bromate](#), certain [trihalomethanes](#) and [haloacetic acids](#)). Some disinfection byproducts have also been shown to cause adverse reproductive or developmental effects in laboratory animals (e.g., [chlorite](#) and certain [trihalomethanes](#) and [haloacetic acids](#)). However, there is considerable uncertainty involved the results of high-dose, toxicological studies of some byproducts occurring in disinfected drinking water to estimate the risk to humans from chronic exposure to low doses of these and other byproducts.

In the area of epidemiology (studies of the factors that influence disease in human populations), a number of studies have been completed investigating the relationship between exposure to chlorinated surface water and cancer. Some have suggested an increased cancer risk to those exposed to chlorinated waters while others have demonstrated none. In issuing the [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) based on evidence then available, EPA stated that while the agency cannot conclude there is a causal link between exposure to chlorinated surface water and cancer, these studies have suggested an association, albeit small, between bladder, rectal, and colon cancer and exposure to chlorinated surface water. There are fewer epidemiology studies evaluating the association between exposure to disinfection byproducts and reproductive and developmental effects. Again, some have suggested an increased risk from exposure to disinfection byproducts while others have shown none. There remains considerable debate in the scientific community on the significance of these contradictory findings concerning chlorinated water and disinfection byproducts. As with cancer, EPA stated in its [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) that, based on data then available, the agency can not conclude there is a causal link between exposure to disinfection byproducts and reproductive and developmental effects. In sum, EPA believes the weight-of-evidence presented by the available epidemiological studies on chlorinated drinking water and toxicological studies on individual disinfection byproducts support a potential hazard concern and warrant regulatory action at this time such as that taken in the [Stage 1 Disinfectants/Disinfection Byproducts Rule](#).

An extensive research effort ([1997 Update to ORD's Strategic Plan](#), [National Toxicology Program](#)) is currently underway to better understand the potential risks attending exposure to disinfection byproducts. While this research is being completed, an agreement among water suppliers, environmental groups, consumer groups, and regulatory agencies has been reached, resulting in the publication of a [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) by EPA in the Federal Register in December 1998. The participants recommended that while additional information, especially on health effects, is needed, the [Stage 1 Disinfectants/Disinfection Byproducts Rule](#) was considered the best course of action to reduce potential risks from disinfection byproducts in the near term.

