1. PUBLIC HEALTH STATEMENT

This public health statement tells you about chlorine dioxide and chlorite and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites make up the National Priorities List (NPL) and are the sites targeted for long-term federal cleanup activities. Chlorine dioxide and chlorite have not been found in any of the 1,613 current or former NPL sites. However, the total number of NPL sites evaluated for chlorine dioxide and chlorite is not known. As more sites are evaluated, the sites at which chlorine dioxide and chlorite are found may increase. This information is important because exposure to chlorine dioxide and chlorite (or chlorine dioxide by-products or derivatives) may harm you and because these sites may be sources of exposure.

When a substance is released from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. This release does not always lead to exposure. You are exposed to a substance only when you come in contact with it. You may be exposed by breathing, eating, or drinking the substance, or by skin contact.

If you are exposed to chlorine dioxide and chlorite, many factors determine whether you'll be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with them. You must also consider the other chemicals you're exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT ARE CHLORINE DIOXIDE AND CHLORITE?

Chlorine dioxide is a yellow to reddish-yellow gas that can decompose rapidly in air. Because it is a hazardous gas, chlorine dioxide is always made at the place where it is used. Chlorine dioxide is used as a bleach at pulp mills, which make paper and paper products, and in public water treatment facilities, to make water safe to drink. In 2001, chlorine dioxide was used to decontaminate a number of public buildings following the release of anthrax spores in the United States. Chlorine dioxide is soluble in water and will rapidly react with other compounds. When it reacts in water, chlorine dioxide will form chlorite ion, which is also a very reactive

compound. Because chlorine dioxide is a very reactive chemical, it is able to kill bacteria and microorganisms in water. About 5% of large water treatment facilities (serving more than 100,000 people) in the United States use chlorine dioxide to treat drinking water. It is estimated that about 12 million people may be exposed in this way to chlorine dioxide and chlorite ions. In communities that use chlorine dioxide to treat water for drinking uses, chlorine dioxide and its by-product, chlorite ions, may be present at low levels in tap water.

In this profile, the term "chlorite" will be used to refer to "chlorite ion," which is a water-soluble ion. Chlorite ion will combine with metal ions to form solid salts, (e.g., sodium chlorite). In water, sodium chlorite is soluble and will dissolve to form chlorite ions and sodium ions. More than 80% of all chlorite (as sodium chlorite) is used to make chlorine dioxide to disinfect drinking water. Sodium chlorite is also used as a disinfectant to kill germs.

1.2 WHAT HAPPENS TO CHLORINE DIOXIDE AND CHLORITE WHEN THEY ENTER THE ENVIRONMENT?

Chlorine dioxide is a very reactive compound and will not exist in the environment for long periods of time. In air, sunlight will quickly break apart chlorine dioxide into chlorine gas and oxygen. In water, chlorine dioxide will react quickly to form chlorite ions. In water treatment systems, chlorine dioxide will not form certain harmful compounds (e.g., trihalomethanes) when it reacts with dissolved organic compounds. Chlorine dioxide does form other disinfection by-products, such as chlorite and chlorate ions.

Like chlorine dioxide, chlorite is a very reactive compound. Since chlorite is an ion, it will not exist in air. In water, chlorite ions will be mobile and may move into groundwater. However, reaction with soils and sediments may reduce the concentration of chlorite ions capable of reaching groundwater. For additional information about what happens to chlorine dioxide and chlorite when they enter the environment, see Chapter 6.

1.3 HOW MIGHT I BE EXPOSED TO CHLORINE DIOXIDE AND CHLORITE?

Chlorine dioxide is added to drinking water to protect people from harmful bacteria and other microorganisms. Most people will be exposed to chlorine dioxide and its disinfection by-product, chlorite ions, when they drink water that has been treated with chlorine dioxide. The EPA has set the maximum concentration of chlorine dioxide and chlorite ion in drinking water at 0.8 and 1.0 milligrams per liter (mg/L), respectively. However, the concentrations of chlorine dioxide and chlorite ion in your drinking water may be lower or higher than these levels. For additional information about how you might be exposed to chlorine dioxide and chlorite, see Chapter 6.

1.4 HOW CAN CHLORINE DIOXIDE AND CHLORITE ENTER AND LEAVE MY BODY?

Chlorine dioxide and chlorite usually enter the body when people drink water that has been disinfected with chlorine dioxide. It is not likely that you would breathe air containing dangerous levels of chlorine dioxide, but if you did, it could be absorbed across your lungs. You are not likely to encounter chlorite in the air you breathe. It is not known whether chlorine dioxide or chlorite on your skin would be absorbed to any great extent.

Both chlorine dioxide and chlorite act quickly when they enter the body. Chlorine dioxide quickly changes to chlorite ions, which are broken down further into chloride ions. These ions are used by the body for many normal purposes. Some of these chloride ions leave the body within hours to days, mainly in the urine. Most of the chlorite that is not broken down also leaves the body in the urine within a few days following exposure to chlorine dioxide or chlorite.

1.5 HOW CAN CHLORINE DIOXIDE AND CHLORITE AFFECT MY HEALTH?

Both chlorine dioxide and chlorite react quickly in water or moist body tissues. If you were to breathe air containing chlorine dioxide gas, you might experience irritation in your nose, throat, and lungs. If you were to eat or drink large amounts of chlorine dioxide or chlorite, you might experience irritation in the mouth, esophagus, or stomach. Most people will not be exposed to chlorine dioxide or chlorite in amounts large enough to damage other parts of the body, but if

you were, you might experience shortness of breath and other respiratory problems from damage to substances in the blood that move oxygen throughout the body.

To protect the public from the harmful effects of toxic chemicals and to find ways to treat people who have been harmed, scientists use many tests.

One way to see if a chemical will hurt people is to learn how the chemical is absorbed, used, and released by the body; for some chemicals, animal testing may be necessary. Animal testing may also be used to identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method to get information needed to make wise decisions to protect public health. Scientists have the responsibility to treat research animals with care and compassion. Laws today protect the welfare of research animals, and scientists must comply with strict animal care guidelines.

Animal studies show effects of chlorine dioxide and chlorite that are similar to those seen in people exposed to very high amounts of these chemicals. In addition, exposure to chlorine dioxide and chlorite in animals both before birth and during early development after birth may cause delays in the development of the brain.

1.6 HOW CAN CHLORINE DIOXIDE AND CHLORITE AFFECT CHILDREN?

This section discusses potential health effects from exposures during the period from conception to maturity at 18 years of age in humans.

Children exposed to large amounts of chlorine dioxide or chlorite would be expected to be affected in the same manner as adults. Exposure to chlorine dioxide gas might more quickly reduce the ability of the blood to carry oxygen in young children than adults, making breathing more difficult. If infants or babies still in their mother's womb were exposed to large amounts of chlorine dioxide, it might cause parts of their brains to develop more slowly. This has been seen in young animals, but has not actually been seen in humans.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO CHLORINE DIOXIDE AND CHLORITE?

If your doctor finds that you have been exposed to significant amounts of chlorine dioxide and chlorite, ask whether your children might also be exposed. Your doctor might need to ask your state health department to investigate.

Families that drink water treated with chlorine dioxide may reduce the risk of exposure to chlorine dioxide and chlorite ions by drinking bottled water that has not been treated with chlorine dioxide or chlorite ions.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO CHLORINE DIOXIDE AND CHLORITE?

Although no medical tests are available to determine whether you have been exposed to chlorine dioxide or chlorite, exposure to very large amounts may result in damage to red blood cells that may be observed through routine blood tests.

1.9 WHAT RECOMMENDATIONS HAS THE FEDERAL GOVERNMENT MADE TO PROTECT HUMAN HEALTH?

The federal government develops regulations and recommendations to protect public health. Regulations can be enforced by law. Federal agencies that develop regulations for toxic substances include the Environmental Protection Agency (EPA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA). Recommendations provide valuable guidelines to protect public health but cannot be enforced by law. Federal organizations that develop recommendations for toxic substances include the Agency for Toxic Substances and Disease Registry (ATSDR) and the National Institute for Occupational Safety and Health (NIOSH).

Regulations and recommendations can be expressed in not-to-exceed levels in air, water, soil, or food that are usually based on levels that affect animals; then they are adjusted to help protect people. Sometimes these not-to-exceed levels differ among federal organizations because of

different exposure times (an 8-hour workday or a 24-hour day), the use of different animal studies, or other factors.

Recommendations and regulations are also periodically updated as more information becomes available. For the most current information, check with the federal agency or organization that provides it. Some regulations and recommendations for chlorine dioxide and chlorite include the following:

OSHA regulates the level of chlorine dioxide in workplace air. The occupational exposure limit for an 8-hour workday, 40-hour workweek is 0.1 parts per million (0.28 milligrams per cubic meter [mg/m^3]). The EPA has set a maximum contaminant level of 1 milligram per liter (mg/L) for chlorite in drinking water and a goal of 0.8 mg/L for both the maximum residual disinfectant level for chlorine dioxide and the maximum contaminant level for chlorite in drinking water treated with chlorine dioxide as a disinfectant.

For more information on regulations and guidelines, see Chapter 8.

1.10 WHERE CAN I GET MORE INFORMATION?

If you have any more questions or concerns, please contact your community or state health or environmental quality department or

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE, Mailstop E-29
Atlanta, GA 30333
Web site: http://www.atsdr.cdc.gov

* Information line and technical assistance

Phone: 1-888-42-ATSDR (1-888-422-8737)
Fax: 1-404-498-0057

ATSDR can also tell you the location of occupational and environmental health clinics. These clinics specialize in recognizing, evaluating, and treating illnesses resulting from exposure to hazardous substances.

* To order toxicological profiles, contact

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Phone: (800) 553-6847 or (703) 605-6000