1. PUBLIC HEALTH STATEMENT

This public health statement tells you about alpha- (α), beta- (β), gamma- (γ), and delta- (δ) hexachlorocyclohexane (HCH) and the effects of exposure.

The Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the nation. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. α-, β-, γ-, and δ-HCH has been found in at least 146, 159, 189, and 126, respectively of the 1,662 current or former NPL sites. Although the total number of NPL sites evaluated for these substances is not known, the possibility exists that the number of sites at which HCH is found may increase in the future as more sites are evaluated. This information is important because these sites may be sources of exposure and exposure to these substances may harm you.

When a substance is released either from a large area, such as an industrial plant, or from a container, such as a drum or bottle, it enters the environment. Such a release does not always lead to exposure. You can be 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 HCH, many factors will determine whether you will be harmed. These factors include the dose (how much), the duration (how long), and how you come in contact with it. You must also consider any other chemicals you are exposed to and your age, sex, diet, family traits, lifestyle, and state of health.

1.1 WHAT IS HEXACHLOROCYCLOHEXANE?

Hexachlorocyclohexane (HCH), formally known as benzene hexachloride (BHC), is a synthetic chemical that exists in eight chemical forms called isomers. The different isomers are named according to the position of the hydrogen atoms in the structure of the chemical. One of these forms, gamma-HCH (or γ-HCH, commonly called lindane), is produced and used as an

insecticide on fruit, vegetables, and forest crops, and animals and animal premises. It is a white solid whose vapor may evaporate into the air. The vapor is colorless and has a slight musty odor when it is present at 12 or more parts HCH per million parts air (ppm). γ-HCH has not been produced in the United States since 1976. However, imported γ-HCH is available in the United States for insecticide use as a dust, powder, liquid, or concentrate. It is also available as a prescription medicine (lotion, cream, or shampoo) to treat and/or control scabies (mites) and head lice in humans.

Technical-grade HCH, a mixture of several chemical forms of HCH, was also once used as an insecticide in the United States and typically contained about 10–15% of γ-HCH as well as the alpha (α), beta (β), delta (δ), and epsilon (ε) forms of HCH. Virtually all of the insecticidal properties reside in the gamma isomer. Technical-grade HCH has not been produced or used in the United States for more than 20 years.

The scope of this profile includes information on technical-grade HCH, as well as the α, β, γ, and δ isomers. Available information on the ε isomer is limited and is not included in this profile. Chapter 4 contains more information on the chemical and physical properties of HCH.

1.2 WHAT HAPPENS TO HEXACHLOROCYCLOHEXANE WHEN IT ENTERS THE ENVIRONMENT?

Although technical-grade HCH is no longer used as an insecticide in the United States, α-, β-, γ-, and δ-HCH have been found in the soil and surface water at hazardous waste sites because they persist in the environment. In air, the different forms of HCH can be present as a vapor or attached to small particles such as soil and dust; the particles may be removed from the air by rain or degraded by other compounds found in the atmosphere. HCH can remain in the air for long periods and travel great distances depending on the environmental conditions. In soil, sediments, and water, HCH is broken down to less toxic substances by algae, fungi, and bacteria, but this process can take a long time. Chapter 6 contains more information about the presence of HCH in the environment.

1.3 HOW MIGHT I BE EXPOSED TO HEXACHLOROCYCLOHEXANE?

You will be directly exposed to γ-HCH if you use a prescription medication that contains this compound in order to treat and/or control scabies and head lice. You can also be exposed to small amounts of γ-HCH and the other isomers (α-, β-, and δ-HCH) by eating foods that may be contaminated with these compounds. Exposure to the HCH isomers is also possible from ingesting contaminated drinking water, breathing contaminated air, or having contact with soil or water at hazardous waste sites that may contain these compounds. Exposure to α-, β-, and δ-HCH is less frequent than exposure to γ-HCH because these compounds are no longer used in the United States. Although γ-HCH is no longer made in the United States, it is still imported into the United States and formulated into products that are used here. Therefore, workers involved in the formulation or application of these products can be exposed to γ-HCH.

For more information on exposure to HCH, refer to Chapter 6.

1.4 HOW CAN HEXACHLOROCYCLOHEXANE ENTER AND LEAVE MY BODY?

γ-HCH and the other isomers of HCH can enter your body when you eat food or drink water contaminated with HCH. Inhaling γ-HCH or other isomers of HCH in air can also lead to entry of these chemicals into the lungs. γ-HCH can be absorbed through the skin when it is used as a lotion, cream, or shampoo for the treatment and/or control of scabies and body lice. In general, HCH isomers and the products formed from them in the body can be temporarily stored in body fat. Among the HCH isomers, β-HCH leaves the body the most slowly. α-HCH, δ-HCH, and γ-HCH, and the products formed from them in the body, are more rapidly excreted in the urine; small amounts leave in the feces and expired air. HCH breaks down in the body to many other substances; these include various chlorophenols, some of which have toxic properties. Chapter 3 gives more information on how HCH enters and leaves the body.

1.5 HOW CAN HEXACHLOROCYCLOHEXANE AFFECT MY HEALTH?

Scientists use many tests to protect the public from harmful effects of toxic chemicals and to find ways for treating persons who have been harmed.

One way to learn whether a chemical will harm people is to determine how the body absorbs, uses, and releases the chemical. For some chemicals, animal testing may be necessary. Animal testing may also help identify health effects such as cancer or birth defects. Without laboratory animals, scientists would lose a basic method for getting information needed to make wise decisions that protect public health. Scientists have the responsibility to treat research animals with care and compassion. Scientists must comply with strict animal care guidelines because laws today protect the welfare of research animals.

In humans, breathing toxic amounts of γ-HCH and/or α-, β-, and δ-HCH can result in blood disorders, dizziness, headaches, and possible changes in the levels of sex hormones in the blood. These effects have occurred in workers exposed to HCH vapors during pesticide manufacturing. People who have swallowed large amounts have had seizures; some have died. A few people who used very large amounts of γ-HCH or used it frequently on their skin developed blood disorders or seizures. However, no cause-and-effect relationship between exposure to γ-HCH and blood disorders in humans has been established. Animals that have been fed γ- and α-HCH have had convulsions, and animals fed β-HCH have become comatose. All isomers can produce liver and kidney effects. Reduced ability to fight infection was reported in animals fed γ-HCH, and injury to the ovaries and testes was reported in animals given γ-HCH or β-HCH. HCH isomers are changed by the body into other chemical products, some of which may be responsible for the harmful effects. Long-term oral administration of α-HCH, β-HCH, γ-HCH, or technical-grade HCH to laboratory rodents has been reported to result in liver cancer. The Department of Health and Human Services (DHHS) has determined that HCH (all isomers) may reasonably be anticipated to cause cancer in humans. The International Agency for Research on Cancer (IARC) has classified HCH (all isomers) as possibly carcinogenic to humans. The EPA has determined that there is suggestive evidence that lindane (γ-HCH) is carcinogenic, but the evidence is not sufficient to assess its human carcinogenic potential. The EPA has additionally

classified technical HCH and α-HCH as probable human carcinogens, β-HCH as a possible human carcinogen, and δ- and ε-HCH as not classifiable as to human carcinogenicity. Chapter 3 gives more information about the health effects of HCH isomers.

1.6 HOW CAN HEXACHLOROCYCLOHEXANE AFFECT CHILDREN?

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

The most likely source of exposure for children is from the use of shampoos and lotions containing HCH for the treatment of lice or scabies. HCH has also been found as a residue in food products; β-HCH isomer accumulates in animal tissue. In the body, α-, δ-, and γ-HCH are rapidly broken down and excreted. Although HCH is a restricted use pesticide in the United States, children could be exposed from eating foods grown in areas where HCH is still used or misused as a pesticide. HCH has also been detected in breast milk, resulting in a possible exposure pathway for infants and children.

It is not known for sure whether children are more susceptible than adults to health effects from exposure to γ-HCH. Limited information is available on the specific health effects resulting from HCH exposure in children. Health effects observed in adults should also be of potential concern for children. Children can experience convulsions from exposure to γ-HCH. Eating enough γ-HCH can kill a child. However, in a study performed on rabbits, young animals had higher death rates and greater sensitivity than adults when γ-HCH was applied to the skin.

It is not known whether HCH causes birth defects in humans. Technical-grade and γ-HCH do not cause significant birth defects in animals. Animals fed γ-HCH during pregnancy had an increased number of fetuses with extra ribs, which is a normal variation. HCH has been shown to cross the placenta in pregnant women. HCH is likely to be stored in fat. It has been measured in skin lipids and breast milk. In studies of rats, HCH has been shown to pass from the mother to newborns in the dam’s milk, causing neurological and hormonal effects. The male newborn

pups of female rats that had been fed HCH during lactation demonstrated a 50% reduction in testosterone levels and reduced testicular weight in adolescence and adulthood.

More information on how HCH can affect the health of children can be found in Sections 3.7 and 6.6.

1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO HEXACHLOROCYCLOHEXANE?

If your doctor finds that you have been exposed to substantial amounts of hexachlorocyclo-hexane, ask whether your children might also have been exposed. Your doctor might need to ask your state health department to investigate.

There are two primary pathways through which families can be exposed to HCH. γ-HCH, which may be labeled as lindane, is used in shampoos and lotions for the treatment of lice. It is normally safe if used as directed, but may be misused. If you use shampoos or lotions containing γ-HCH, follow the directions carefully. Products containing lindane should never be used on infants. Shampoos or lotions that contain lindane should be stored out of the reach of young children to prevent accidental poisoning. You may expose your child to lindane if you use products that contain lindane to treat lice or scabies on your child's head or skin. Alternative treatments are available that do not involve the use of lindane. You should consult with your physician to discuss appropriate alternative treatments.

γ-HCH is a restricted use pesticide. Its allowed uses are very limited. Your children may be exposed to γ-HCH if an unqualified person applies pesticides containing it around your home. In some cases, the improper use of pesticides banned for use in homes has turned homes into hazardous waste sites. Make sure that any person you hire is licensed and certified to apply pesticides. Your state licenses each person who is qualified to apply pesticides according to EPA standards and further certifies each person who is qualified to apply "restricted use" pesticides. Ask to see their license and certification. Also ask for the brand name of the pesticide, a Material Safety Data Sheet (MSDS), the name of the product's active ingredients, and the EPA

registration number. This information can be important if you or your family react to the product.

1.8 IS THERE A MEDICAL TEST TO DETERMINE WHETHER I HAVE BEEN EXPOSED TO HEXACHLOROCYCLOHEXANE?

HCH isomers can be measured in the blood, urine, and semen of exposed persons. Samples of these fluids can be collected in a doctor's office and sent to a laboratory that has the special equipment needed to measure the levels of HCH. Although the amount of HCH isomers in blood, urine, or semen can be measured, it is usually not possible to determine the environmental levels to which the person was exposed or to predict the health effects that are likely to occur from specific concentrations. The products of HCH that are formed in the body and then found in the urine have also been measured to find out whether a person was exposed to HCH. However, this method cannot yet be used to determine exposure to HCH alone because other environmental chemicals produce the same end products. Chapter 7 contains more information on ways to measure HCH in human blood and tissues.

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

Regulations and recommendations can be expressed as “not-to-exceed” levels, that is, levels of a toxic substance in air, water, soil, or food that do not exceed a critical value that is usually based

on levels that affect animals; they are then adjusted to levels that will help protect humans. Sometimes these not-to-exceed levels differ among federal organizations because they used different exposure times (an 8-hour workday or a 24-hour day), different animal studies, or other factors.

Recommendations and regulations are also updated periodically 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 HCH include the following:

γ-HCH is categorized by EPA as a restricted use pesticide. It can only be used by licensed and certified applicators. EPA has also recommended guidelines on how much HCH can be present in drinking water for specific periods without producing health effects. EPA advises that children should not have more than 1.2 milligrams HCH per liter of water (mg/L) for up to 10 days. For lifetime exposure in adults, EPA recommends that there should not be more than 0.0002 mg/L of HCH in drinking water. EPA has classified HCH as a hazardous waste that must meet certain disposal requirements.

OSHA regulates levels of γ-HCH in the workplace. The maximum allowable amount in workplace air during an 8-hour workday in a 40-hour work week is 0.5 mg per cubic meter of air.

Chapter 8 contains more information about regulations and guidelines concerning HCH.

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 contact ATSDR at the address and phone number below.

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

Toxicological profiles are also available on-line at www.atsdr.cdc.gov and on CD-ROM. You may request a copy of the ATSDR ToxProfiles™ CD-ROM by calling the toll-free information and technical assistance number at 1-888-42ATSDR (1-888-422-8737), by e-mail at atsdric@cdc.gov, or by writing to:

Agency for Toxic Substances and Disease Registry
Division of Toxicology
1600 Clifton Road NE
Mailstop F-32
Atlanta, GA 30333
Fax: 1-770-488-4178

Organizations for-profit may request copies of final Toxicological Profiles from the following:

National Technical Information Service (NTIS)
5285 Port Royal Road
Springfield, VA 22161
Phone: 1-800-553-6847 or 1-703-605-6000
Web site: http://www.ntis.gov/