

## 1. PUBLIC HEALTH STATEMENT

This public health statement tells you about cadmium and the effects of exposure to it.

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. Cadmium has been found in at least 1,014 of the 1,669 current or former NPL sites. Although the total number of NPL sites evaluated for this substance is not known, the possibility exists that the number of sites at which cadmium 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 this substance may be harmful.

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 cadmium or cadmium compounds, 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.

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## 1.1 WHAT IS CADMIUM?

<b>Description</b>	<p>Metal found in the earth's crust, associated with zinc, lead, and copper ores.</p> <p>Pure cadmium is a soft, silver-white metal. Cadmium chloride and cadmium sulfate are soluble in water.</p>
<b>Uses</b> <ul style="list-style-type: none"> <li>• <b>Manufacturing</b></li> <li>• <b>Consumer products</b></li> </ul>	<p>Most cadmium used in the United States is extracted as a byproduct during the production of other metals such as zinc, lead, or copper. Cadmium is also recovered from used batteries.</p> <p>Cadmium is used for the following:</p> <ul style="list-style-type: none"> <li>• batteries (83%)</li> <li>• pigments (8%)</li> <li>• coatings and platings (7%)</li> <li>• stabilizers for plastics (1.2%)</li> <li>• nonferrous alloys, photovoltaic devices, and other uses (0.8%)</li> </ul>

For more information on the properties and uses of cadmium, see Chapters 4 and 5.

## 1.2 WHAT HAPPENS TO CADMIUM WHEN IT ENTERS THE ENVIRONMENT?

<b>Sources</b>	<p>Cadmium is emitted to soil, water, and air by non-ferrous metal mining and refining, manufacture and application of phosphate fertilizers, fossil fuel combustion, and waste incineration and disposal.</p> <p>Cadmium can accumulate in aquatic organisms and agricultural crops.</p>
<b>Fate</b> <ul style="list-style-type: none"> <li>• <b>Air</b></li> <li>• <b>Soil</b></li> <li>• <b>Water</b></li> </ul>	<p>Cadmium (as oxide, chloride, and sulfate) will exist in air as particles or vapors (from high temperature processes). It can be transported long distances in the atmosphere, where it will deposit (wet or dry) onto soils and water surfaces.</p> <p>Cadmium and its compounds may travel through soil, but its mobility depends on several factors such as pH and amount of organic matter, which will vary depending on the local environment. Generally, cadmium binds strongly to organic matter where it will be immobile in soil and be taken up by plant life, eventually, entering the food supply.</p> <p>Cadmium exists as the hydrated ion or as ionic complexes with other inorganic or organic substances. Soluble forms migrate in water. Insoluble forms of cadmium are immobile and will deposit and absorb to sediments.</p>

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**1.3 HOW MIGHT I BE EXPOSED TO CADMIUM?**

<p><b>Food and smoking—primary sources of exposure</b></p>	<p>In the United States, for nonsmokers the primary source of cadmium exposure is from the food supply. In general, leafy vegetables such as lettuce and spinach, potatoes and grains, peanuts, soybeans, and sunflower seeds contain high levels of cadmium, approximately 0.05–0.12 mg cadmium/kg.</p> <p>Tobacco leaves accumulate high levels of cadmium from the soil.</p> <p>The national geometric mean blood cadmium level for adults is 0.38 µg/L. A geometric mean blood cadmium level of 1.58 µg/L for New York City smokers has been reported. The amount of cadmium absorbed from smoking one pack of cigarettes per day is about 1–3 µg/day. Direct measurement of cadmium levels in body tissues confirms that smoking roughly doubles cadmium body burden in comparison to not smoking.</p>
<p><b>Air</b></p>	<p>Except for people living near cadmium-emitting industries, inhalation of cadmium is not expected to be a major concern.</p>
<p><b>Water</b></p>	<p>Elevated cadmium levels in water sources in the vicinity of cadmium-emitting industries (historical and current) have been reported. Aquatic organisms will accumulate cadmium, possibly entering the food supply. People who fish in local waters as a means of food should be cautious and abide by any advisories.</p>
<p><b>Occupational exposure</b></p>	<p>Highest risk of exposure from processes involving heating cadmium-containing materials such as smelting and electroplating. Risk will vary depending on the workplace.</p> <p>Major route of exposure is through inhalation of dust and fumes or incidental ingestion from contaminated hands, food, or cigarettes.</p> <p>Exposure can be controlled through personal protective equipment, good industrial hygiene practices, and control and reduction of cadmium emissions.</p>

In Chapter 6, you can find more information on how you might be exposed to cadmium.

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**1.4 HOW CAN CADMIUM ENTER AND LEAVE MY BODY?**

<p><b>Enter your body</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li> <li>• <b>Ingestion</b></li> <li>• <b>Dermal contact</b></li> </ul>	<p>About 5–50% of the cadmium you breathe will enter your body through your lungs.</p> <p>A small amount of the cadmium in food and water (about 1–10%) will enter your body through the digestive tract. If you do not have enough iron or other nutrients in your diet, you are likely to take up more cadmium from your food than usual.</p> <p>Virtually no cadmium enters your body through your skin.</p>
<p><b>Leave your body</b></p>	<p>Most of the cadmium that enters your body goes to your kidney and liver and can remain there for many years. A small portion of the cadmium that enters your body leaves slowly in urine and feces.</p> <p>Your body can change most cadmium to a form that is not harmful, but too much cadmium can overload the ability of your liver and kidney to change the cadmium to a harmless form.</p>

More information on how cadmium enters and leaves the body is found in Chapter 3.

**1.5 HOW CAN CADMIUM AFFECT MY HEALTH?**

This section looks at studies concerning potential health effects in animal and human studies.

<p><b>Workers</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li> </ul>	<p>Breathing air with very high levels of cadmium can severely damage the lungs and may cause death.</p> <p>Breathing air with lower levels of cadmium over long periods of time (for years) results in a build-up of cadmium in the kidney, and if sufficiently high, may result in kidney disease.</p>
<p><b>Laboratory animals</b></p> <ul style="list-style-type: none"> <li>• <b>Inhalation</b></li> </ul>	<p>Damage to the lungs and nasal cavity has been observed in animals exposed to cadmium.</p>

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<b>Humans</b> <b>• Oral</b>	<p>Eating food or drinking water with very high cadmium levels severely irritates the stomach, leading to vomiting and diarrhea, and sometimes death.</p> <p>Eating lower levels of cadmium over a long period of time can lead to a build-up of cadmium in the kidneys. If the build-up of cadmium is high enough, it will damage the kidneys.</p> <p>Exposure to lower levels of cadmium for a long time can also cause bones to become fragile and break easily.</p>
<b>Laboratory animals</b> <b>• Oral</b>	<p>Kidney and bone effects have also been observed in laboratory animals ingesting cadmium.</p> <p>Anemia, liver disease, and nerve or brain damage have been observed in animals eating or drinking cadmium. We have no good information on people to indicate what cadmium levels people would need to eat or drink to result in these diseases, or if they would occur at all.</p>
<b>Cancer</b>	<p>Lung cancer has been found in some studies of workers exposed to cadmium in the air and studies of rats that breathed in cadmium.</p> <p>The U.S. Department of Health and Human Services (DHHS) has determined that cadmium and cadmium compounds are known human carcinogens. The International Agency for Research on Cancer (IARC) has determined that cadmium is carcinogenic to humans. The EPA has determined that cadmium is a probable human carcinogen.</p>

More information on how cadmium can affect your health is found in Chapters 2 and 3.

## 1.6 HOW CAN CADMIUM AFFECT CHILDREN?

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

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<p><b>Effects in children</b></p>	<p>The health effects seen in children from exposure to toxic levels of cadmium are expected to be similar to the effects seen in adults (kidney and lung damage).</p> <p>Harmful effects on child development or behavior have not generally been seen in populations exposed to cadmium, but more research is needed.</p> <p>A few studies in animals indicate that younger animals absorb more cadmium than adults. Animal studies also indicate that the young are more susceptible than adults to a loss of bone and decreased bone strength from exposure to cadmium.</p> <p>Cadmium is found in breast milk and a small amount will enter the infant's body through breastfeeding. The amount of cadmium that can pass to the infant depends on how much exposure the mother may have had.</p>
<p><b>Birth defects</b></p>	<p>We do not know whether cadmium can cause birth defects in people.</p> <p>Studies in animals exposed to high enough levels of cadmium during pregnancy have resulted in harmful effects in the young. The nervous system appears to be the most sensitive target. Young animals exposed to cadmium before birth have shown effects on behavior and learning. There is also some information from animal studies that high enough exposures to cadmium before birth can reduce body weights and affect the skeleton in the developing young.</p>

**1.7 HOW CAN FAMILIES REDUCE THE RISK OF EXPOSURE TO CADMIUM?**

<p><b>Do not smoke tobacco products</b></p>	<p>Cadmium accumulates in tobacco leaves. The national geometric mean blood cadmium level for adults is 0.376 µg/L. Mean blood cadmium levels for heavy smokers have been reported as high as 1.58 µg/L.</p>
<p><b>Good occupational hygiene</b></p>	<p>Occupational exposure can be controlled through personal protective equipment, good industrial hygiene practices, and control and reduction of cadmium emissions.</p> <p>Children can be exposed to cadmium through parents who work in cadmium-emitting industries. Therefore, good hygiene practices such as bathing and changing clothes before returning home may help reduce the cadmium transported from the job to the home.</p>
<p><b>Avoid cadmium contaminated areas and food</b></p>	<p>Check and obey local fishing advisories before consuming fish or shellfish from local waterways.</p> <p>Avoid hazardous waste sites.</p>

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<p><b>Proper disposal of cadmium-containing products</b></p>	<p>Dispose of nickel-cadmium batteries properly. Many states have laws in effect that ban the disposal of batteries as municipal waste. Recycle old batteries whenever possible.</p> <p>Contact your local waste and recycling authority on how to properly dispose of paints and coatings.</p>
<p><b>Handle properly</b></p>	<p>Do not allow children to play with batteries. If mishandled, batteries could rupture.</p> <p>Children may also swallow small nickel-cadmium batteries.</p>

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

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

<p><b>Detecting exposure</b></p>	<p>Cadmium can be measured in blood, urine, hair, or nails. Urinary cadmium has been shown to accurately reflect the amount of cadmium in the body.</p>
<p><b>Measuring exposure</b></p>	<p>The amount of cadmium in your blood shows your recent exposure to cadmium. The amount of cadmium in your urine shows both your recent and your past exposure.</p> <p>Cadmium levels in hair or nails are not as useful as an indication of when or how much cadmium you may have taken in, partly because cadmium from outside of your body may attach to the hair or nails.</p> <p>Tests are also available to measure the amount of cadmium inside your liver and kidneys.</p>

More information on how cadmium can be measured in exposed humans is presented in Chapters 3 and 7.

**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

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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. These are levels of a toxic substance in air, water, soil, or food that do not exceed a critical value. This critical value 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.

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 cadmium include the following:

<b>Drinking water</b>	The EPA has determined that exposure to cadmium in drinking water at a concentration of 0.04 mg/L for up to 10 days is not expected to cause any adverse effects in a child.  The EPA has determined that lifetime exposure to 0.005 mg/L cadmium in drinking water is not expected to cause any adverse effects.
<b>Consumer products</b>	The FDA has determined that cadmium levels in bottled water should not exceed 0.005 mg/L.
<b>Workplace air</b>	OSHA set a legal limit of 5 $\mu\text{g}/\text{m}^3$ cadmium in air averaged over an 8-hour work day.

More information on governmental rules regarding cadmium can be found in 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 contact ATSDR at the address and phone number below.



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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](http://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 1-800-CDCINFO (1-800-232-4636), by e-mail at [cdcinfo@cdc.gov](mailto:cdcinfo@cdc.gov), or by writing to:

Agency for Toxic Substances and Disease Registry  
Division of Toxicology and Human Health Sciences (proposed)  
1600 Clifton Road NE  
Mailstop F-62  
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/>