



The **Hazard Evaluation and Emergency Response (HEER) Office** is part of the Hawai'i Department of Health Environmental Health Administration whose mission is to protect human health and the environment. The HEER Office provides leadership, support, and partnership in preventing, planning for, responding to, and enforcing environmental laws relating to releases or threats of releases of hazardous substances.

Arsenic in Hawaiian Soils: Questions and Answers on Health Concerns

This fact sheet provides landowners, private citizens, farmers, developers, construction contractors, realtors, and others with an overview of the potential human health concerns associated with arsenic-contaminated soils in Hawai'i. Additionally, this fact sheet discusses methods for reducing exposure to soil arsenic and provides resources for further information.

What is arsenic and where is it found in Hawai'i?

Arsenic is a naturally occurring element in the earth's crust. In Hawai'i, low levels of arsenic are found naturally in native soils. However, significantly elevated levels of arsenic have been identified in soils at former sugar cane fields, former pesticide storage or mixing areas, former sugar plantation camps, a former canec production plant, wood-treatment plants, and at least one former golf course. The presence of elevated levels of soil arsenic at some historic sugar plantation areas is believed to be related to the widespread use of sodium arsenite (an inorganic arsenic compound) or other arsenic-based herbicides/pesticides in and around the cane fields in the 1920s through 1940s. Because inorganic arsenic is stable in the environment, it remains in the soil many years after use. Another possible source of arsenic exposure is past use of inorganic arsenic as an insecticide in "canec" board. Canec board was made out of waste sugar cane fiber and widely used for ceilings or walls in home or commercial construction in Hawai'i during the 1930s through the 1950s (see Arsenic in Canec Ceilings and Wallboard in Hawai'i fact sheet). Arsenic was also a common ingredient in wood preservatives for many years (e.g. copper-chromium-arsenic ["CCA"] pressure-treated lumber). Certain types of fertilizers that contained arsenic may be a source of contamination as well.



This map estimates extent of former lands in sugar cane cultivation in Hawai'i, 1920-1937 (orange areas). Elevated levels of arsenic may be found in soils within some of these areas, related to the use of arsenic-based herbicides in and around cane fields in the 1920s through 1940s.

How are people exposed to arsenic?

- **Unintentional ingestion of soil** - If arsenic is in the soil, ingesting the soil is the primary source of exposure. The main concern is that on a regular or periodic basis some people may unintentionally swallow very small amounts of contaminated soil - especially young children who are unaware of the hazards and may be exposed to contaminated soil through normal play activities. Most children put their hands, toys, or other objects in their mouths, and these often have small amounts of soil and dust on them that the child swallows. Residual dirt on produce grown in arsenic-contaminated soil and on hands after gardening or outside work may also contribute to arsenic exposure through accidental ingestion of soil particles. In most cases the amount of inorganic arsenic that a person could be exposed to from contaminated soils is estimated to be less than inorganic arsenic in their diet. It is important to minimize additional exposure to inorganic arsenic from non-food sources, however, in order to minimize potential health risks. Inhalation of arsenic in dust is possible, but in most circumstances this is a very minor source of exposure compared to unintentional soil ingestion. Arsenic in soil is not believed to be absorbed through bare skin in significant amounts.



TOP: Children are at risk of arsenic exposure from unintentional ingestion of soil through normal play activities.



BOTTOM: Local produce grown in soil with elevated arsenic is considered safe to eat provided it is washed to remove soil and dust. Low but significant levels of inorganic arsenic are found in foods such as rice, fish, chicken and seaweed that are common in diets of Hawai'i, but adverse health effects from arsenic in these foods has not been reported.

- **Food** - Arsenic is found in shellfish and fish from many areas of the world. Arsenic in seafood is primarily organic arsenic, a different chemical form than inorganic arsenic used in the past on sugar plantations, in canec board products, and for wood treatment. Organic arsenic compounds are generally not considered toxic or harmful. Common island diets contain trace amounts of inorganic arsenic in foods such as rice, fish, chicken, and seaweed although no adverse health effects have been reported from arsenic in these foods. HDOH tested produce from community gardens with elevated soil arsenic and found arsenic levels were similar to levels in produce from grocery stores across the mainland U.S. Produce grown in soil with elevated arsenic is considered safe to eat provided it is washed to remove soil and dust.
- **Water** - In some parts of the world, arsenic in drinking water is a concern. In Hawai'i, this is not the case. HDOH has implemented a water quality-testing program for all public water systems in the state, including testing for arsenic and other chemicals. Results of these tests have not detected arsenic in any of the State's public drinking water.
- **Factors limiting exposure to arsenic in soil** - Arsenic binds to other chemicals like iron and aluminum oxides that are abundant in many of the soils in Hawai'i. This characteristic significantly reduces the arsenic soil hazard for humans. Also, arsenic bound very tightly in soils is typically not taken up by plants.

What are the human health concerns of arsenic exposure?

People who have been exposed to high levels of arsenic over long periods of time have had health symptoms that include changes in skin pigmentation (dark spots), thickening or warts on the palms of the hands and soles of the feet, damage to heart and blood vessels, and inflammation of the liver. In addition, long-term exposure to high levels of arsenic has been associated with an increased risk of cancer.

These types of health effects have been identified in some countries where drinking water is contaminated with high amounts of arsenic. These health effects have not been documented from soil arsenic exposure in Hawai'i. However, very small increases in the risk of cancer are also extremely hard to associate with past chemical exposures and to examine in relatively small population sizes that occur in many regions of the Hawaiian Islands. Consequently, limiting exposure to elevated levels of arsenic wherever possible is generally recommended. Arsenic does not accumulate in the body (bioaccumulate). Stopping exposure will reduce arsenic levels in the body.



This picture shows soil sample collection from a small garden located on the island of Hawai'i. The garden is on former sugar cane land and therefore has the potential for elevated soil arsenic concentrations. Soil testing for arsenic will confirm if arsenic levels are elevated.

When should testing for soil arsenic be conducted?

The potential to encounter elevated soil arsenic exists for farmers, residents, construction contractors, or others that live or work on former sugar cane lands (see map, page 1), and on lands known to have had facilities associated with arsenic use. Many of the former sugar cane lands have not yet been tested, and testing has been limited in those areas where studies have been conducted (e.g. the former Ola'a/Puna Sugar Mill plantation area). Soil arsenic levels can also vary considerably from site to site, even for sites in close proximity. Consequently, soil testing is the only option to know for certain if levels are elevated, and to what extent. If initial testing shows arsenic above natural background levels (up to 20 milligrams per kilogram [mg/kg]), additional soil arsenic bioaccessibility testing is generally recommended by HDOH. For new residential or commercial developments, testing may be conducted by environmental consultants as

part of the environmental site assessment process required by the owner, buyer, or lending institution. A guide to assist homeowners in how to test for soil arsenic is available from the HEER Office. Once land is tested, HDOH has guidance to help interpret the soil arsenic levels, and determine what action, if any, may be warranted to reduce exposure to the arsenic. In some specific areas, HDOH may have limited information about other land tested in the same general vicinity.

How can I test to see if I have been exposed to arsenic?

Any arsenic exposure testing should be recommended and conducted by a doctor or trained medical professional. Tests are available to measure arsenic in your urine, blood, or hair and fingernails. HDOH has not generally recommended human exposure testing in former sugar cane plantation areas. The urine arsenic test is considered the most reliable, but is expensive, and determines exposure only within the last few days. The testing can determine if the level of arsenic in the body is higher or lower than the average person. The testing cannot determine the origin of the arsenic (e.g. soil or food) or whether the arsenic levels in the body will affect the individual's health. Limited urine arsenic testing (by HDOH and the federal Agency for Toxic Substances Disease Registry [ATSDR]) of people living by two Hawai'i Island garden areas with elevated soil arsenic found



normal arsenic levels in most individuals tested. The tests could not determine if higher inorganic arsenic exposures measured in some older individuals was from soil ingestion or the rice and seafood diets they ate.

What can I do to prevent exposure to contaminated soil?

If testing reveals elevated levels of soil arsenic on your land, or you have not tested but live or work in an area that may have elevated soil arsenic levels, the potential for exposure can be minimized through a variety of means. Some options for limiting exposure to contaminated soil include:

- If you work with contaminated soil, old arsenic-treated wood, or canec, you should use common protective gear to reduce exposure. This may include use of gloves, long-sleeve clothing, safety glasses, or a dust mask. Additionally, working with these materials may result in arsenic-containing dirt or dust on your clothing. Be sure to change clothes and shower right after working with these materials, and avoid spreading dirt from clothes or shoes into your vehicle or house.
- If you have bare soil on your property, maintain grass, other vegetative cover, or some kind of surface material over the soil. This acts as a barrier to prevent soil exposure. Cover dog runs with old rugs or other materials to eliminate bare dirt areas.
- Keep children from playing in bare dirt and keep toys, pacifiers, and other items that go into children's mouths clean.
- Wash hands and face thoroughly after working or playing in the soil, especially before meals and snacks.
- Wash fruits and vegetables from the garden with water before bringing them in the house, then wash again inside with a brush to remove any remaining soil particles. Pare root and tuber vegetables before eating.
- Bring in clean sand for sandboxes and add soil known to be free of contamination to food garden areas. You could also make raised garden beds with clean soils.
- Avoid tracking soil into the home and clean up right away if soil is tracked in. Remove work and play shoes before entering the house. Keep pets from tracking soil into your home.

Further Information

For questions about this fact sheet or further information on HEER Office guidance related to soil arsenic, contact:

Hawai'i Department of Health,
Hazard Evaluation and Emergency Response Office
2385 Waimano Home Rd., Uluakupu Building 4
Pearl City, HI 96782, Telephone: (808) 586-4249

To access more detailed information regarding soil arsenic, including detailed reports of studies conducted in Hawai'i and elsewhere, please visit the HEER Office website: <http://eha-web.doh.hawaii.gov/eha-cma/Leaders/HEER/soil-arsenic-guidance-and-information>

Additional references located on HEER Office website:

HDOH, 2008. *Homeowner's Guide to Soil Testing for Arsenic*
HDOH, 2010. *Arsenic in Canec Ceilings and Wallboard in Hawai'i* (Fact Sheet)

Federal Government

To learn about recommendations from the Federal Government regarding arsenic, you can also contact the Agency for Toxic Substances and Disease Registry, Toxic Substances Portal website: <https://www.atsdr.cdc.gov/substances/index.asp>

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