ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

29 Hazen Drive, Concord, New Hampshire 03301 • (603) 271-3503 • www.des.nh.gov

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1,4-Dioxane: Health Information Summary

INTRODUCTION

1,4-Dioxane is a clear liquid with a faint pleasant odor. Historically, it was added to chlorinated solvents like 1,1,1-trichloroethane (TCA) to function as a stabilizer to prevent the breakdown of the solvent and increase its functional life. It is currently used as a solvent in paints, varnishes, adhesives, detergent and cleaning preparations, cosmetics, and pesticides. 1,4-dioxane may be present as an unintentional contaminant or byproduct in hydraulic fracturing fluids, some automotive fluids like antifreeze, some pharmaceuticals and consumer products like cosmetics, soaps, shampoo and bubble bath, and in some fire suppression foams that include surfactants. 1,4-dioxane can enter the environment through a variety of industrial uses, accidental spills and leaching from landfills and contaminated waste sites. 1,4-dioxane may also be present near hospital laundries, drycleaners, or car washes where there is high detergent usage.

1,4-dioxane has been detected in ambient air but is typically degraded within a few days. 1,4-dioxane is resistant to degradation in soil and does not stick to soil, therefore it is more likely to move to groundwater where it is expected to persist due to its solubility in water. Showering is not expected to be a significant source of exposure as 1,4-dioxane is not expected to volatilize at typical shower water temperatures. 1,4-dioxane does not accumulate in plants or animals. Therefore, consuming home-produced vegetables, fruit or meat is not likely to be a significant source of exposure.

1,4-dioxane is considered an “emerging contaminant,” meaning that it has recently been recognized as a potential or actual threat to the environment and human health. Until recently, it was not possible to detect it at the low concentrations usually present in the environment. Because of the improved ability to detect 1,4-dioxane at lower concentrations, environmental officials have increased sampling efforts to determine how widespread its presence is in soil and groundwater. 1,4-dioxane has been detected in some private wells in NH above the ambient groundwater quality standard (AGQS) and can be challenging to remove from drinking water and wastewater via conventional treatment methods.

HEALTH EFFECTS

Exposure and Metabolism

The primary route of exposure to 1,4-dioxane is through the ingestion of water from contaminated municipal drinking water sources or contaminated private wells. Other routes of exposure can include inhalation of contaminated air and absorption of 1,4-dioxane through the skin via the use of consumer products (e.g. cosmetics, detergents, and shampoos). Other minor sources of exposure could include trace amounts of 1,4-dioxane found in food-related applications (e.g. as a solvent or an inert ingredient in pesticides, residues from packaging adhesives, and/or the presence of 1,4-dioxane in some food supplements).

Human and animal studies show that 1,4-dioxane that is inhaled or ingested is readily absorbed into the body, while much less absorption occurs through the skin (dermal route). Both human and animal studies indicate that 1,4-dioxane and its metabolites are rapidly excreted in the urine, with much of it eliminated within one

day after exposure ceases. Since metabolism is rapid and some chemicals produce the same metabolites, interpreting biomonitoring results can be challenging.

Short-Term (acute) Effects
There are a few studies related to human exposure that provide information about the health effects of short-term exposure to high levels of 1,4-dioxane. Several of these studies indicated eye and respiratory irritation resulting from the inhalation of high airborne levels of 1,4-dioxane. Exposure to very high levels (e.g. in occupational settings) may cause severe kidney and liver effects and possibly death. Animal studies have shown that short-term, high-level exposures to 1,4-dioxane can affect the liver and kidneys. It should be noted that levels of 1,4-dioxane that are normally found in the environment, or in consumer products, are generally much lower than levels found in workplace settings or used in animal studies.

Long-Term (chronic) Effects
Animal studies have shown that long-term exposure to 1,4-dioxane can cause toxic effects to the liver and kidney such as swelling, degenerative changes, cell death and lesions.

Carcinogenic (cancer-causing) Effects
Animal studies and a limited number of studies of human exposure (which had limitations) to 1,4-dioxane in the workplace have suggested that 1,4-dioxane is a likely carcinogen. Several types of animals exposed to 1,4-dioxane in their drinking water showed an increase in liver cancer, while other animal studies observed tumors at a variety of other sites, including the lung, kidney, mammary gland and nasal tissue. The United States (U.S.) Department of Health and Human Services - National Toxicology Program (NTP) considers 1,4-dioxane to be *reasonably anticipated to be a human carcinogen*. The International Agency for Research on Cancer (IARC) categorizes 1,4-dioxane in Group 2B, *possibly carcinogenic to humans.*

Developmental/Reproductive Effects
No studies related to human exposure that have evaluated reproductive or developmental effects are known. The only known study specifically conducted to assess the reproductive and developmental effects of 1,4-dioxane exposed pregnant rats to very large amounts of 1,4-dioxane via feeding tube directly into their stomachs, which resulted in some offspring with reduced body weight and minor bone malformations.

HEALTH STANDARDS AND CRITERIA

The New Hampshire Ambient Groundwater Quality Standard (AGQS) for 1,4-dioxane is 0.32 µg/L. The AGQS concentration is based on a chance that one additional individual out of one million equally exposed individuals would develop cancer, if consuming water at or above this concentration. This assumes individuals with a body weight of 80 kg who drink 2.5 liters of water a day for 70 years.

The U.S. Occupational Safety and Health Administration (OSHA) has developed a permissible exposure limit or PEL for 1,4-dioxane in workplace air of 100 parts per million by volume (ppmv) averaged over eight hours.

The U.S. Food and Drug Administration (FDA) allows up to 10 ppm of 1,4-dioxane in the food supply for specific purposes where exposure is likely to be minimal, such as in some components of dietary supplement tablets. The FDA also allows use of 1,4-dioxane as an indirect food additive as a component of adhesives used in food packaging.

FOR MORE INFORMATION

For information on the drinking water regulations and testing, please contact the NHDES Drinking Water and Groundwater Bureau at (603) 271-2513 or dwgbinfo@des.nh.gov. For information on health effects please contact the NHDES Environmental Health Program (EHP) at (603) 271-6802.

For a list of references, please contact the EHP at (603) 271-6802.

Note: This fact sheet information is accurate as of August 2023. The availability of additional information after this date may render this information inaccurate or incomplete.