

Estimated Risks from Short-term Exposures to Benzene in Drinking Water

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California Environmental Protection Agency
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April 2019

In November 2018, the Camp Fire in Butte County destroyed most of the town of Paradise. Water officials believe the heat from the fires caused contamination of the drinking water with benzene and other volatile organic chemicals. OEHHA has been asked by the State Water Resources Control Board to estimate risks from exposure to benzene from regular household uses of tap water, such as drinking, cooking, showering, and bathing to aid residents and water officials in their decision-making.

Benzene levels detected in Paradise from December 2018 to March 2019

Paradise Irrigation District took several hundred water samples from various locations in Paradise from December 2018 to March 2019 and found benzene in 105 samples, at levels ranging from less than 1 part per billion (ppb) to 923 ppb. Benzene concentrations in 80 samples were above the California Maximum Contaminant Level (CA MCL) of 1 ppb, which is based on cancer. Eleven samples were above the Health-Protective Concentration (HPC) of 26 ppb, the level at which noncancer effects are not expected to occur.

Cancer Risk

Assuming a 70-year lifetime exposure, the CA MCL of 1 ppb corresponds to a cancer risk of 7 per million people exposed. OEHHA was asked to estimate cancer risks associated with exposures for one year to the range of benzene levels detected above the MCL. These estimates apply OEHHA methods¹ for taking into account greater childhood sensitivity to carcinogens as well as methods² to account for exposure to benzene during household uses of tap water. In addition to drinking tap water, exposure to benzene can occur from inhalation while cooking, bathing, and showering because benzene volatilizes out of the water.

Table 1 shows cancer risk estimates resulting from one year's exposure to benzene at various concentrations in drinking water, under two scenarios. In the first scenario, the

¹ OEHHA (2009). Technical support document for cancer potency factors: methodologies for derivation, listing of available values, and adjustments to allow for early life stage exposures. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Sacramento, CA.
<https://oehha.ca.gov/air/cnr/technical-support-document-cancer-potency-factors-2009>.

² CalTOX 4.0 multimedia total exposure model developed for the California Department of Toxic Substances Control by the Lawrence Berkeley National Laboratory, available at: <https://www.dtsc.ca.gov/AssessingRisk/caltox.cfm>.

water is used for drinking, cooking, bathing, and showering. In the second scenario, the water is used for bathing and showering, but not for drinking or cooking. These estimates assume showering takes place for 16 minutes at 77 degrees Fahrenheit. By taking a short, cold shower (e.g., 5 minutes at 60 degrees Fahrenheit), the cancer risks may be reduced by up to three- fold compared to the levels provided in Table 1.

Table 1. Estimated cancer risks for 1-year exposure

Benzene Concentration:	1 ppb (CA MCL)	26 ppb	50 ppb	100 ppb	900 ppb
	Estimated cancer risk (per million) from drinking, cooking, and other household uses such as bathing and showering				
- Infant	1	25	48	95	860
- Child	0.3	7.4	14	29	260
- Adult	0.1	2.5	4.8	9.5	86
	Estimated cancer risk (per million) from using water for bathing, showering, and other household uses (excludes drinking and cooking)				
- Infant	0.08	2.0	3.9	7.8	70
- Child	0.17	4.4	8.5	17	150
- Adult	0.04	1.1	2.2	4.3	39

Noncancer effects

In addition to cancer, benzene poses risks for other types of health effects. The main effect is on the blood forming system (hematopoietic system). Benzene interferes with the balanced production of blood cells and leads to a decrease in infection fighting white blood cells (leukocytes and lymphocytes). The concentrations at which these effects become a concern are shown in Table 2.

Table 2. Noncancer risks at different benzene concentrations found in Paradise drinking water

Benzene levels less than 26 ppb	Benzene levels between 26 ppb and 100 ppb	Benzene levels between 100 ppb and 1,000 ppb
Noncancer health effects not expected	Increased risk of hematopoietic toxicity (blood effects) such as a decrease in lymphocytes and leukocytes (white blood cells) in sensitive individuals	Hematopoietic toxicity (blood effects) and neurological effects possible