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Public Health Assessment Site Tool and Affiliated Applications: A Key Resource for Evaluating the Health Impact of Community Exposure to Hazardous Chemicals

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Editor's Note:

As part of our continued effort to highlight innovative approaches to improve the health and environment of communities, the *Journal* is pleased to publish regular columns from the Agency for Toxic Substances and Disease Registry (ATSDR) at the Centers for Disease Control and Prevention (CDC). ATSDR serves the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances. The purpose of this column is to inform readers of ATSDR's activities and initiatives to better understand the relationship between exposure to hazardous substances in the environment, its impact on human health, and how to protect public health.

Background

The Agency for Toxic Substances and Disease Registry (ATSDR) protects communities from harmful health effects related to exposure to natural and human made hazardous substances. ATSDR works closely with tribal agencies, the ATSDR Partnership to Promote Localized Efforts to Reduce Environmental Exposure (APPLETREE state partners), and other stakeholders to conduct public health assessments (PHAs).

PHAs investigate exposure to environmental contaminants, evaluate potential health effects, and develop public health action plans to prevent and reduce these exposures in communities. During the PHA process, ATSDR and state partners review various types

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of data and information to determine exposure and potential for harmful health effects in communities living near hazardous sites (ATSDR, 2022). The scientific evaluation includes several important steps:

- screening contaminants for further evaluation,
- estimating exposure doses and concentrations, and
- calculating hazard quotients and cancer risk.

Conducting scientific evaluation and assessing public health impacts have become increasingly challenging due to complex sites, multiple exposure routes, multiple chemical exposures, emerging contaminants, and evolving knowledge of chemicals and their toxicities. To improve the scientific quality and consistency of PHA work conducted by health assessors at ATSDR and state health departments, ATSDR has developed a web-based application called the Public Health Assessment Site Tool (PHAST; Figure 1).

Public Health Assessment Site Tool Overview

PHAST helps health assessors evaluate exposure to harmful chemicals at hazardous waste sites by following the approach described in ATSDR's Public Health Assessment Guidance Manual (ATSDR, 2022; Ulirsch & Li, 2022). Figure 2 shows a schematic diagram of PHAST, related applications, and how they work together. Users can enter a variety of data into the tool. PHAST will then generate site-specific doses and exposure concentrations, hazard quotients used to assess noncancer effects, and cancer risk based on built-in default or user-defined site-specific scenarios for drinking water, surface water, soil, sediment, air, and food (Figure 3).

PHAST also maintains a chemical database that contains health guideline information, media-specific screening values, and physical and chemical properties that are used in the three steps of scientific evaluations as described earlier. The chemical database provides a summary of the critical toxicity studies used to derive health guidelines and suggests which toxicity values health assessors should use for making decisions about possible health effects.

PHAST was initially launched in 2017 and has since undergone continuous enhancements. In addition, several auxiliary tools have been developed to further complement this application and enhance its versatility and functionality, including an Exposure Point Concentration (EPC) Tool and a Shower and Household Water-Use Exposure (SHOWER) Model (Figure 2).

Exposure Point Concentration Tool

The EPC Tool is a web-based application built to assist health assessors with estimating EPCs for discrete environmental data, which can then be used in PHAST to calculate exposure doses, hazard quotients, and cancer risk. Discrete data are obtained from individual environmental samples from a given point and time that is independent of other samples. Estimating a reasonable EPC is important as it represents the contaminant concentration at a specific location(s) where people might come into contact with a contaminated medium.

For each environmental data set imported into the tool, the program calculates an EPC that is either the 95th percentile upper confidence limit of the mean of the data or the maximum value of the data for cases where 95th percentile upper confidence limits cannot be reliably calculated.

The EPC Tool automates a series of procedures and calculations so that health assessors can quickly and accurately calculate EPCs for their data in an easy-to-use program in accordance with chemical and media-specific scientific procedures and guidance (ATSDR, 2022). The tool also provides useful supporting tables and figures with summary statistics and other information about the calculated EPCs (e.g., boxplots, other descriptive statistics). Finally, it allows health assessors to export the calculated EPCs and other data (e.g., maximum values for screening) for additional analysis in PHAST.

Evaluating Exposures From Household Use of Water

PHAST is capable of evaluating residential inhalation and dermal exposure from bathing and showering in contaminated water and from other household water use, such as washing machines and dishwashers. Using results imported from the ATSDR standalone desktop SHOWER model, PHAST can generate hazard quotients and cancer risk estimates for up to eight persons, taking into consideration all household water uses.

The SHOWER model can simulate either inhalation and/or dermal exposure for 830 volatile and semivolatile chemicals. The model can also simulate exposure for 17 per- or polyfluoroalkyl substances (PFAS). Inhalation exposure to PFAS in household water is not usually evaluated quantitatively because most PFAS are nonvolatile. Using the SFIOWER Model, however, improves assessment by accounting for exposures from the more volatile sulfonamide PFAS.

Future Enhancements for the Public Health Assessment Site Tool

Several enhancements are under development for PHAST. For the planned Health Effect Tool, the PHAST team is developing chemical-specific health effects charts that can be generated from site-specific doses and concentrations. Once completed, PHAST will generate a graphic that shows site-specific doses or air concentrations along with a description of the harmful effects that might be expected at those doses or concentrations.

Another enhancement under development is a food calculator that will describe the number of daily, weekly, or monthly meals needed to exceed the ATSDR minimal risk level or a prescribed cancer risk.

PHAST and its affiliated tools have modernized ATSDR’s complex scientific evaluation processes and brought together many cuttingedge resources into a user-friendly platform. They empower public health professionals to conduct assessments of exposure to hazardous chemicals in a consistent and transparent manner. As a result, they have contributed to high scientific quality and trustworthiness in products and services provided by ATSDR and its partners and better protect communities from harmful exposure.

Access to the Public Health Assessment Site Tool

PHAST is available to public health professionals who conduct PHAs to evaluate exposure to harmful chemicals at hazardous waste sites or other sites with known contamination following the PHA process (ATSDR, 2022).

To request access to PHAST, please email phast@cdc.gov. The ATSDR SHOWER Model is a stand-alone application that can be downloaded to your computer. You can request the model by sending an email to showermodel@cdc.gov.

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FIGURE 1.
Home Page of the Public Health Assessment Site Tool

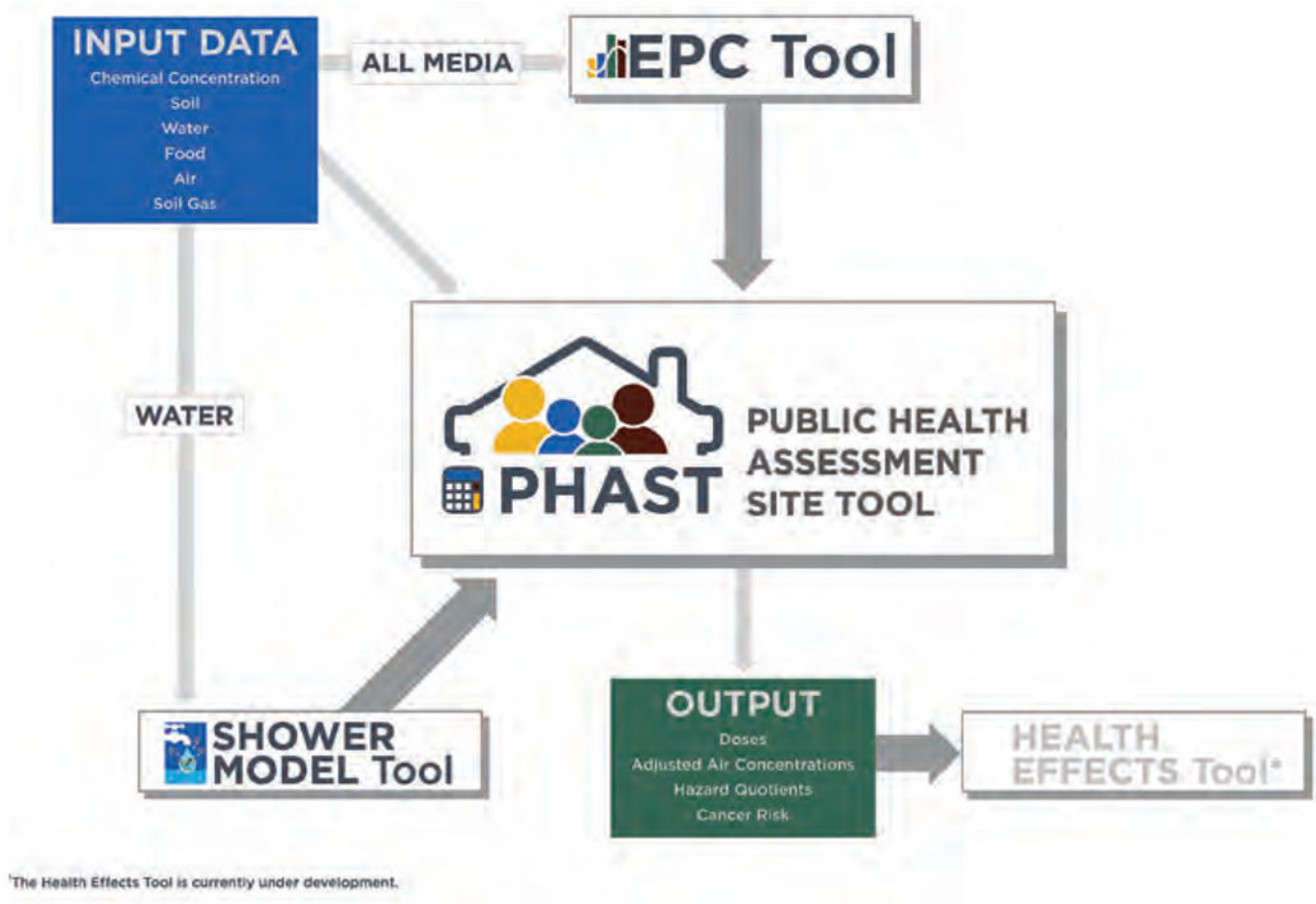

FIGURE 2. Conceptual Diagram of the Public Health Assessment Site Tool, Related Applications, and Types of Input and Output Data

Note. EPC = Exposure Point Concentration; SHOWER = Shower and Household Water-Use Exposure.

Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	CTE Cancer Risk	CTE Exposure Duration (years)	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	RME Cancer Risk	RME Exposure Duration (years)
Birth to <1 year	0.0065	13 †	-	1	0.014	29 †	-	1
1 to <2 years	0.0027	5.4 †	-	1	0.0078	16 †	-	1
2 to <6 years	0.0022	4.3 †	-	4	0.0056	11 †	-	4
6 to <11 years	0.0016	3.2 †	-	5	0.0044	8.8 †	-	5
11 to <16 years	0.0011	2.2 †	-	1	0.0035	7.0 †	-	5
16 to <21 years	0.0011	2.2 †	-	0	0.0034	6.8 †	-	5
Total child	-	-	1.9E-5 ‡	12	-	-	7.1E-5 ‡	21
Adult	0.0015	3.1 †	1.3E-5 ‡	12	0.0039	7.7 †	9.0E-5 ‡	33
Pregnant individual	0.0012	2.4 †	-	-	0.0035	7.1 †	-	-
Breastfeeding individual	0.0023	4.6 †	-	-	0.0049	9.8 †	-	-
Birth to <21 years plus 12 years during adulthood §	-	-	-	-	-	-	1.0E-4 ‡	33

FIGURE 3. Example of an Output Table Generated by the Public Health Assessment Site Tool for Drinking Water

Note. The example table shows calculated ingestion doses, hazard quotients, and cancer risks for benzene at 100 ppb in household water. The calculations were generated using PHAST v2.1.1.0 from ATSDR. The noncancer hazard quotients were calculated using the chronic (>1 year) minimal risk level of 0.0005 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 0.055 $(mg/kg/day)^{-1}$. ATSDR = Agency for Toxic Substances and Disease Registry; CTE = central tendency exposure (typical); RME = reasonable maximum exposure (higher).

† A shaded cell indicates the hazard quotient is >1, which ATSDR evaluates further.

‡ A shaded cell indicates that the cancer risk exceeds one extra case in a million people similarly exposed, which ATSDR evaluates further.

§ This cancer risk represents a scenario where children are likely to continue to live in their childhood homes as adults.