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July 14, 2025

Mr. Sanjay Sinha, CPG
Office of Community Relations
Contaminated Site Remediation and Redevelopment
New Jersey Department of Environmental Protection
401 East State Street
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Dear Mr. Sinha:

The New Jersey Department of Health (DOH) has prepared this health consultation per your request to address health concerns from residents living near the Zabriskie-Schedler House (Schedler) property located at 460 Saddle River Road in the Village of Ridgewood, Bergen County, New Jersey. Area residents have expressed concerns about contaminated fill material being brought to the location as part of property redevelopment activities and being dispersed throughout the area during wind and rain events.

This health consultation was prepared in alignment with the risk assessment approach DOH follows under its cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It evaluates the potential public health implications from possible exposures to this historic fill material. Specifically, this evaluation is based on soil sampling data reported in the August 8, 2024, Grid Sampling Letter Report for the Schedler property prepared by Matrix New World Engineering, Land Surveying and Landscape Architecture, P.C. (Matrix).

Background and Statement of Issues

In September 2023, DOH was contacted by a resident of Ridgewood Village concerned about possible soil and potable water well contamination from fill material being brought to the Schedler property. The fill material was being used to construct a berm and for redeveloping the property as a recreational park. DOH contacted the New Jersey Department of Environmental Protection (DEP) regarding these concerns.

In December 2023, DEP's Bureau of Solid Waste Compliance and Enforcement required the Village of Ridgewood to sample the fill material to ensure that the material complies with DEP regulations. Between December 2023 and May 2024, the concerned resident kept DOH

updated on correspondence with DEP and asked how DOH can help address community concerns. DOH informed the resident that environmental sampling data is needed for DOH to evaluate the potential public health implications.

In order to comply with DEP requirements, the Village of Ridgewood retained an environmental consultant (Matrix) to conduct the sampling. Matrix sampled the soil on the property in May and June 2024.

DOH Evaluation Process

An evaluation of site-related environmental contamination and the potential for harmful health effects follows a two-tiered approach:

1. a screening analysis;
2. an in-depth analysis to determine public health implications of exposures.

1. Screening Analysis

A screening analysis involves comparing maximum concentrations of detected substances to media-specific screening levels. These screening levels help us understand what exposure levels of contaminants are safe. These screening levels can be ATSDR comparison values (CVs) or other non-ATSDR values including those established by DEP or the U.S. Environmental Protection Agency (EPA). If concentrations meet or exceed the CV, these substances, referred to as contaminants of potential concern (COPCs), are selected for further evaluation. Concentrations that meet or exceed ATSDR CVs or non-ATSDR screening levels do not necessarily mean that health effects are likely, but they do help health assessors prioritize which contaminants to evaluate further [ATSDR PHAGM 2022].

Comparison Values

Many CVs are available for screening contaminants. CVs help identify potential contaminants of concern. CVs include ATSDR environmental media evaluation guides (EMEGs) and reference media evaluation guides (RMEGs). EMEGs represent estimated contaminant concentrations below which humans exposed during a specific timeframe (acute, intermediate, or chronic) are not expected to experience harmful noncancer health effects. RMEGs are based on USEPA's reference doses. RMEGs represent the concentration in water or soil at which daily human exposure is unlikely to result in harmful noncancer health effects.

If the substance is a known or a probable carcinogen and has cancer toxicity values, health assessors also consider ATSDR's cancer risk evaluation guides (CREGs) for comparison values. CREGs are estimated contaminant concentrations in soil or water that would be expected to cause no more than one excess cancer in a million ($1x10^{-6}$) people exposed during their lifetime.

For some contaminants, EPA or DEP's standards may be used when no other CVs are

available, such as DEP's soil remediation standards.

If contaminant concentrations are above CVs, ATSDR reviews exposure variables (such as duration and frequency) and the toxicologic characteristics of the contaminant to determine likelihood of possible health effects. ATSDR then estimates site-specific exposure doses and compares those to health guideline values. Health guideline values are developed based on data drawn from the epidemiologic and toxicological literature. Many uncertainty factors are applied to ensure that the health guideline values amply protect human health.

Soil Sampling: Soil samples were collected in accordance with DEP's Technical Requirements for Site Remediation (NJDEP 2024). The number of detections, minimum and maximum concentrations and the corresponding CVs are presented in Table 1. The soil sampling data used in this evaluation were collected at a depth interval of 1- to- 1.5-feet below ground surface (bgs). ATSDR considers the top three inches of soil to be accessible for exposures. DOH does not have data for this sample depth and therefore, the next shallowest sample depth was used.

The maximum concentration of benzo[a]pyrene detected in soil exceeded its CV; benzo[a]pyrene is considered a COPC for the site (see Table 1). As benzo[a]pyrene is a polycyclic aromatic hydrocarbon (PAH), the other PAHs (i.e., benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene) detected in the soil were also considered as COPCs (ATSDR 2022). These PAHs will be evaluated further for potential harmful health effects.

To provide perspective on the levels of PAHs present in the soil on the Schedler property, DOH reviewed a DEP report from 2020 where PAHs were sampled in various New Jersey counties to estimate background concentrations of PAHs in soil. This investigation found that the highest levels of PAHs were found in Bergen, Hudson, Mercer, and Somerset counties. The investigation also determined that establishing a single background concentration for PAHs in developed areas of New Jersey was not feasible; however, the DEP investigation included average levels of surface and sub-surface soil PAH levels obtained during sampling activities. Table 3 summarizes the average levels of the PAHs from DEP's investigation, which ranged from 0.05 to 0.32 milligrams per kilogram (mg/kg). The calculated average levels for the PAHs detected in soil on the Schedler property ranged from 0.1 to 0.77 mg/kg (see Table 2), which is slightly higher but largely within the background levels.

Mercury was detected in only one soil sample and was below the DEP residential soil remediation standard and therefore is not a contaminant of potential concern for the purposes of this evaluation.

2. **In-Depth Analysis - Public Health Implications of Exposures**

People are exposed to an environmental contaminant through incidental ingestion of soil and water, breathing air, and skin contact with a substance containing the contaminant. Exposure pathways are used to evaluate specific ways in which people were, are, or will be exposed to

environmental contamination. An exposure pathway is a series of steps starting with the release of a contaminant in environmental media and ending at the interface with the human body. A completed exposure pathway consists of the following five elements:

1. Source of contamination (historic fill);
2. Environmental media and transport mechanisms (soil);
3. Point of exposure (residential properties);
4. Route of exposure (ingestion); and
5. Exposed population (residents)

Generally, ATSDR considers three exposure categories as follows:

a. completed exposure pathways — all five elements of a pathway are present;
b. potential exposure pathways — one or more of the elements might not be present, but information is insufficient to eliminate or exclude the element; and
c. eliminated exposure pathways —one or more of the elements is absent.

Completed Exposure Pathways

Based on the information available to DOH, one completed exposure pathway has been identified and are described below:

Incidental Ingestion and dermal (skin) contact with contaminated soil: Residents living in the area of the Schedler property may ingest contaminated soil on their properties as a result of wind and rain events causing soil on the Schedler property to move off-site. There may also have been trespassing on the Schedler property itself prior to the start of redevelopment activities. However, the worst-case scenario of residents ingesting contaminated soil would also address this trespassing scenario.

Exposure Point Concentration

When assessing the public health implications of exposure to a contaminant of potential concern, ATSDR recommends using the 95% upper confidence limit (UCL) of the arithmetic mean to determine the exposure point concentration (EPC) [ATSDR 2023a]. The 95% UCL is considered a conservative estimate of average contaminant concentrations in an environmental medium. EPCs were calculated for PAHs (see Table 2) using ATSDR's EPC tool (ATSDR 2023a).

Evaluating the Potential for Non-Cancer Health Effects

ATSDR's exposure dose guidance was used to calculate exposure doses [ATSDR 2018], which can be calculated for soil ingestion scenarios using the ATSDR Public Health Assessment Site Tool (PHAST). Exposure doses were calculated for residents living in the area surrounding the Schedler property. For people with typical (average) soil ingestion rates, a central tendency exposure (CTE) scenario can be used. For people with above average ingestion rates, a reasonable maximum exposure (RME) scenario is used. The RME refers to people with above

average exposures but still within a realistic exposure range. The RME scenario is the most conservative scenario and will be used to evaluate the potential for harmful health effects.

To determine the risk for harmful noncancer health effects for PAHs, DOH compared the calculated exposure doses to a health guideline value. As mentioned previously, health guideline values are developed based on data drawn from the epidemiologic and toxicological literature. Many uncertainty factors are applied to ensure that the health guideline values amply protect human health.

ATSDR's health guideline value is called a Minimal Risk Levels (MRL). MRLs identify exposures that could be potentially hazardous to human health. MRLs can be set for the following three different time periods depending on the length of time people are exposed to the substance:

- acute (up to 14 days),
- intermediate (from 15-364 days), and
- chronic (exposure for more than 365 days)

Exposures to contaminants above the MRL (for the relevant time period) do not necessarily mean that health problems will occur. An MRL is an estimate of the amount of a chemical a person can breathe, eat, or drink each day without a detectable noncancer risk to health.

MRLs are based on toxicological studies in animals and on reports of human occupational (workplace) exposures. MRLs are usually extrapolated doses from observed effect levels in animal toxicological studies or occupational studies. They are adjusted by a series of uncertainty factors or through the use of statistical models. In toxicological literature, observations might be reported as follows:

- **No-observed-adverse-effect level (NOAEL)**: A NOAEL is the ***highest*** tested dose of a substance that has been reported to have ***no*** harmful health effects on people or animals.
- **Lowest-observed-adverse-effect level (LOAEL)**: A LOAEL is the ***lowest*** tested dose of a substance that has been reported to ***cause*** harmful health effects in people or animals.

To provide perspective on the potential for health effects, a calculated exposure dose is compared to the MRL and the applicable NOAEL or LOAEL. As the exposure dose increases beyond the MRL and approaches the level of the NOAEL and/or LOAEL, the likelihood of adverse health effects increases.

When MRLs are unavailable, the EPA Reference Dose (RfD) is used. A reference dose is an estimate of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The EPA's RfD will be used to evaluate noncancer health effects for PAHs in this evaluation because there is no MRL available for PAHs.

Incidental Ingestion and dermal (skin) contact with contaminated soil: Exposures are based on incidental ingestion (i.e., representing inadvertent soil/dust ingestion) of contaminated soil; noncancer residential exposure doses were calculated using the following formula in the ATSDR's PHAST:

$$\text{Exposure Dose (mg/kg/day)} = \frac{C * IR * EF * CF}{BW}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor representing a residential exposure scenario;
CF = conversion factor (10^{-6} kg/mg) and,
BW = body weight (kg)

Dermal (skin) exposures to contaminated soil: Dermal exposure is the contact between a contaminant and exposed population as well as absorption of the contaminant into the body through the skin (ATSDR 2023b). Dermal exposure doses were also calculated using PHAST and added to the ingestion doses to create a combined dose. Dermal exposure doses were calculated using the following formula:

$$\text{Dermal Exposure Dose (mg/kg/day)} = \frac{C * AF * EF * CF * ABS_d * SA}{BW * ABS_{GI}}$$

where, mg/kg/day = milligrams of contaminant per kilogram of body weight per day;
C = concentration of contaminant in surface soil (mg/kg);
AF = adherence factor to skin (mg/cm^2-event);
EF = exposure factor representing the site-specific exposure scenario;
CF = conversion factor (10^{-6} kg/mg);
ABS_d = dermal absorption fraction to skin;
SA = skin surface area available for contact (cm^2);
BW = body weight (kg); and,
ABS_{GI} = gastrointestinal absorption factor.

Noncancer health effects are assessed by comparing the exposure dose to a health guideline to calculate a ratio known as a hazard quotient (HQ). For PAHs, EPA's RfD was used as the health guideline to calculate the hazard quotient. The hazard quotient is defined as follows.

$$\textit{Hazard Quotient (HQ)} = \frac{\textit{Exposure Dose}}{\textit{RfD}}$$

If the HQ is less than one, noncancer harmful effects are unlikely. If the HQ is greater than one, then a more in-depth toxicological evaluation is needed to determine possible harmful effects. ATSDR's exposure dose guidance for soil ingestion and EPA's Exposure Factor Handbook were used to calculate exposure doses (ATSDR 2018, USEPA 2011).

For the PAHs that exceeded CVs, exposure doses were calculated only for benzo(a)pyrene as this is the only PAH which has a health guideline (i.e. RfD) to calculate the HQ. However, the other PAHs will be considered in the cancer evaluation (ATSDR 2022).

Exposure doses for benzo(a)pyrene were calculated for soil ingestion and dermal contact assuming default residential exposure factors and using the ATSDR's PHAST tool. As described earlier, for people with average soil ingestion rates, DOH used a central tendency exposure (CTE) scenario. For people with higher-than-average ingestion rates, a reasonable maximum exposure (RME) scenario was used. The RME refers to people with higher-than-average exposures but still within a realistic exposure range.

Benzo[a]pyrene: Benzo[a]pyrene belongs to a class of over 100 different compounds (known as polycyclic aromatic hydrocarbons or PAHs) that are found and formed during incomplete combustion of coal, oil, wood, or other organic substances (ATSDR 1995). More commonly they are found in petroleum-based products such as coal tar, asphalt, creosote, and roofing tar. In the environment, benzo[a]pyrene is found in complex mixtures of other PAH compounds; many of which have similar toxicological effects and environmental fate.

Noncancer adverse health effects associated with benzo[a]pyrene exposures have been observed in animals but generally not in humans (ATSDR 1995). Noncancer effects are usually seen following exposure to much higher levels than found in the environment. The main concern for PAH exposures is potential cancer effects.

Assuming default residential exposure factors (see Table 4a), exposure doses were calculated for soil ingestion and dermal contact. This is the most conservative scenario assuming that the soil from the Schedler property has migrated off-site onto residential yards and accidentally ingested by area residents.

The combined (i.e., ingestion and dermal) HQ (Hazard Index) for the CTE and RME scenarios associated with benzo[a]pyrene was calculated and found to be two to three orders of magnitude lower than 1 (see Table 4b). **Therefore, noncancer health effects from exposure to benzo[a]pyrene are unlikely**.

Evaluating the Potential for Cancer Health Effects

DOH evaluates the potential for cancer health effects by assessing the excess cancer risk relating to exposure over the background cancer risk. In New Jersey, approximately 45% of women and 47% of men (about 46% overall), will be diagnosed with cancer in their lifetime (NJDOH 2023). This is referred to as the "background cancer risk."

The term "excess cancer risk" represents the risk on top of the background cancer risk and is referred to as the Lifetime Excess Cancer Risk, or LECR. An LECR of "one-in-a-million" (1/1,000,000 or 10^{-6} cancer risk) means that if one million people are exposed to a cancer-causing substance at a certain level for a period, then one cancer above the background number of cancers may develop in those one million people over the course of their lifetime (considered 78 years).

To put the LECR of $1x10^{-6}$ in context of New Jersey's background cancer risk, the number of cancers expected in one million people over their lifetime is 460,000 (46%) in New Jersey. If these one million people are all exposed to a cancer-causing substance for a specific duration, then 460,001 people may develop cancer instead of the expected 460,000 over the course of their lifetime (78 years).

DOH follows ATSDR's guidelines to evaluate theoretical cancer risks from environmental exposures (ATSDR 2022). A concern for an increased risk is categorized as an excess of one or more additional cancer cases per 10,000 people (expressed as risk in "the $1x10^{-4}$ range" or higher). When cancer risk estimates are less than 1×10^{-4}, a determination is needed as to whether a concern exists or does not exist for an increased risk of cancer.

Several factors are considered in determining whether cancer risks less than 1×10^{-4} are a health concern. Site specific factors may be considered in addition to the default factors used in the risk assessment model (which include the length of exposure, sensitive populations who may already have an elevated risk due to exposure to other carcinogens, and exposure to mutagenic carcinogens at a young age). Additionally, if maximum contaminant concentrations are used in the risk assessment model due to limited environmental data, the data may not represent actual exposures.

It should be noted that the estimated cancer risks are a theoretical estimate of risk that DOH use as a tool for deciding whether public health actions are needed to protect health. It is not an actual estimate of cancer cases in a community and is not a prediction that cancer will occur. It is also important to note that while cancer rates are readily available at an aggregate level, individual exposures cannot be captured in these analyses, and other risk factors associated with cancer are not taken into account.

According to the United States Department of Health and Human Services (DHHS), the cancer class of contaminants detected are categorized as follows:

1 = Known human carcinogen
2 = Reasonably anticipated to be a carcinogen
3 = Not classified

The ATSDR CREGs developed for carcinogens presented earlier are based on one excess cancer case per one million individuals exposed for a lifetime. The DOH considers estimated cancer risks of less than or equal to one additional cancer case among one million persons exposed an unlikely increased cancer risk (expressed exponentially as $1x10^{-6}$).

The exposure assumptions and recommended exposure factors used to calculate the LECR are the same as those used to assess noncancer health effects. The LECRs were calculated using the following formula (ATSDR 2022):

$$\text{LECR} = \text{Cancer Exposure Dose} \times \text{CSF}$$

Exposure dose for carcinogenic chemicals were calculated using the following formula:

$$\textit{Cancer Exposure Dose (mg/kg/day)} = \frac{C*IR*EF*CF}{BW} * \frac{ED}{AT}$$

where, C = concentration of contaminant in soil (mg/kg);
IR = soil ingestion rate (kg/day);
EF = exposure factor representing the site-specific exposure scenario;
CF = conversion factor (10^{-6} kg/mg)
ED = exposure duration[1] (year);
BW = body weight (kg); and,
AT = averaging time (year)[2]

Using residential default exposure assumptions (i.e., residential exposure duration of 21 years for children and 33 years for adults over a 78-year lifetime), the LECRs were calculated by multiplying the exposure dose by the cancer slope factor. The cancer slope factor is defined as the slope of the dose-response curve obtained from animal and/or human cancer studies and is expressed as the inverse of the daily exposure dose, i.e., $(mg/kg/day)^{-1}$.

The LECR for chemicals that act with a mutagenic mode of action (MOA) for carcinogenesis can be quantified using age-dependent adjustment factors (ADAFs) (USEPA 2005). The ADAFs are factors by which cancer risk is multiplied to account for increased susceptibility to mutagenic compounds when exposure takes place early in life – standard ADAFs are 10 (for ages below 2 years old), 3 (for ages 2 up to 16 years old), and 1 (for ages greater than 16). The ADAF was applied to benzo(a)pyrene because this contaminant is a mutagen.

Incidental Ingestion and dermal (skin) contact with contaminated soil

As indicated earlier, benzo[a]pyrene and other PAHs were the carcinogens found in the soil. The LECRs associated with incidental ingestion and dermal contact with contaminated soil were evaluated as follows:

Benzo[a]pyrene and other PAHs: Benzo[*a*]pyrene and other PAHs are widespread in the environment and are formed during incomplete combustion or pyrolysis of organic material. The DHHS has determined that PAHs may reasonably be expected to be carcinogens. Chronic exposure to PAHs has been found to cause cancer. In laboratory animal tests, some PAHs have caused cancer via inhalation (lung cancer), ingestion (stomach cancer), or dermal contact (skin cancer).

The USEPA has developed guidelines (USEPA 1993) to assess cancer risk associated with PAH exposures using a relative potency estimate approach. Using this approach, the cancer potency of carcinogenic PAHs can be estimated based on their relative potency with reference to benzo[a]pyrene. For each of the carcinogenic PAHs, the benzo[a]pyrene equivalence was calculated by multiplying the EPC concentration with the cancer potency factor. The total

[1]The exposure duration for residents using the more conservative RME scenario is 21 years for children and 33 years for adults.
[2]The averaging time represents an average lifetime of 78 years.

benzo[a]pyrene equivalence was then obtained by summing each of the individual benzo[a]pyrene equivalences (see Table 2).

Assuming default residential exposure factors (see PHAST Table 5a), LECRs were calculated for soil ingestion and dermal contact. Benzo[a]pyrene and other PAHs were considered as the potential COPCs for the site. Using the benzo[a]pyrene equivalent of all PAHs (i.e., 1.14 mg/kg) the calculated LECR for a child is approximately two extra cancer cases for every 100,000 similarly exposed individuals using the more conservative RME scenario. For adults, the LECR for the RME scenario is approximately two extra cancer cases for 1,000,000 similarly exposed (see PHAST Table 5b). **These LECRs represent no concern for an increased theoretical cancer risk.**

Conclusions

Based on the available data, NJDOH concludes that past and current exposures to PAHs through incidental ingestion and dermal contact are unlikely to have harmed people's health. The calculated hazard index was two to three orders of magnitude lower than 1, indicating that noncancer harmful effects are unlikely. Additionally, there is no concern for an increased theoretical cancer risk from exposures to PAHs in the soil from the site.

Recommendations

- DOH recommends that the DEP and the Village of Ridgewood continue to take measures to ensure that the fill material brought to the Schedler site complies with DEP regulations.

- DOH recommends that DEP consider collecting surface soil samples at the site and on adjacent residential properties to characterize community exposures.

Please feel free to contact me at 609-826-4984 or by email at Christa.Fontecchio@doh.nj.gov with any questions or concerns. You may also refer any concerned residents to me as well.

Sincerely,

Christa Fontecchio, M.P.H.
Environmental and Occupational Health Surveillance Program
New Jersey Department of Health

c: Leah Graziano, R.S. Regional Director, ATSDR Region 2

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Non-Certified

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Table 1: Soil sampling results of the fill area and Berm

Contaminant	Number of Detections	Concentration (mg/kg)[a]		CV[b] (mg/kg)	COPC[c]
		Minimum	Maximum		
2-Chlorophenol	1	0.073	0.073	260 (RMEG)	No
4-Chloro-3-methyl phenol	1	0.18	0.18	NA	-
2,4-Dichlorophenol	1	0.18	0.18	160 (RMEG)	No
2,4-Dimethylphenol	1	0.18	0.18	1000 (RMEG)	No
2,4-Dinitrophenol	1	0.18	0.18	100 (RMEG)	No
4,6-Dinitro-o-cresol	1	0.18	0.18	NA	-
2-Methylphenol	1	0.073	0.073	320 (NJDEP SRS)	No
3&4-Methylphenol	1	0.073	0.073	630 (NJDEP SRS)	No
2-Nitrophenol	1	0.18	0.18	NA	-
4-Nitrophenol	1	0.37	0.37	NA	-
Pentachlorophenol	1	0.15	0.15	260 (EMEG)	No
Phenol	1	0.073	0.073	16000 (RMEG)	No
2,3,4,6-Tetrachlorophenol	1	0.18	0.18	1600 (RMEG)	No
2,4,5-Trichlorophenol	1	0.18	0.18	5200 (RMEG)	No
2,4,6-Trichlorophenol	1	0.18	0.18	35 (CREG)	No
Acenaphthene	15	0.0127	1.15	3100 (RMEG)	No
Acenaphthylene	17	0.0245	0.289	NA	-
Acetophenone	3	0.0088	0.18	5200 (RMEG)	No
Anthracene	17	0.0283	2.49	16000 (RMEG)	No
Atrazine	2	0.073	0.073	1800 (RMEG)	No
Benzo[a]anthracene	23	0.0136	3.37	ATSDR*	**Yes**
Benzo[a]pyrene	20	0.0451	3.35	0.065 (CREG)	**Yes**
Benzo[b]fluoranthene	23	0.0167	3.41	ATSDR*	**Yes**
Benzo[g,h,i]perylene	20	0.0397	2.31	ATSDR*	**Yes**
Benzo[k]fluoranthene	19	0.0209	1.3	ATSDR*	**Yes**
Butyl benzyl phthalate	7	0.0158	0.113	10000 (RMEG)	No
1,1'-Biphenyl	8	0.0054	0.12	87 (NJDEP SRS)	No
Benzaldehyde	9	0.0106	0.174	5200 (RMEG)	No
Carbazole	18	0.0058	0.699	NA	-
Chrysene	23	0.0119	2.96	510 (NJDEP SRS)	No
Dibenzo[a,h]anthracene	16	0.0202	0.455	ATSDR*	**Yes**
Dibenzofuran	6	0.0176	0.0452	NA	-
Di-n-butyl phthalate	6	0.0055	0.0129	5200 (RMEG)	No
bis(2-Ethylhexyl)phthalate	21	0.0092	0.144	320 (CREG)	No
Fluoranthene	24	0.0232	11.5	2100 (RMEG)	No
Fluorene	12	0.0264	1.36	3100 (RMEG)	No
Indeno[1,2,3-cd]pyrene	21	0.035	1.84	ATSDR*	**Yes**
2-Methylnaphthalene	10	0.0096	0.439	240 (NJDEP SRS)	No
Naphthalene	10	0.0182	0.996	1000 (RMEG)	No
Phenanthrene	24	0.0218	9.84	NA	-
Pyrene	23	0.038	9.48	1600 (RMEG)	No

Definitions: RMEG = ATSDR Reference Media Evaluation Guide for chronic exposure for a child; EMEG = ATSDR Environmental Media Evaluation Guide for chronic exposure for a child; CREG = ATSDR Cancer Risk Evaluation Guide for chronic exposure; NA = Not available; NJDEP SRC = NJDEP Residential Direct Contact Soil Remediation Standard; [a] milligrams of contaminant per kilogram of soil [b] Comparison Value; [c] Contaminant of Potential Concern; *Selected as a COPC based on ATSDR's PAH guidance [ATSDR 2022a].

Table 2: EPC[1] and BaP[2] equivalent of PAHs

PAH Congener	EPC Statistic	EPC Value (mg/kg)	PF[3]	BaP Equivalent (mg/kg)
Benzo[a]anthracene	95UCL	0.65	0.1	0.065
Benzo[a]pyrene	95UCL	0.69	1	0.69
Benzo[b]fluoranthene	95UCL	0.77	0.1	0.077
Benzo[g,h,i]perylene	95UCL	0.51	NA	-
Benzo[k]fluoranthene	95UCL	0.27	0.1	0.027
Dibenzo[a,h]anthracene	95UCL	0.1	2.4	0.24
Indeno[1,2,3-cd]pyrene	95UCL	0.4	0.1	0.04
			Total BaP =	**1.14**

[1] Exposure Point Concentration; [2] Benzo[a]pyrene equivalent; [3] Potency Factor;[4] 95% Upper Confidence Limit

Table 3: Average PAH levels in New Jersey Soils *

Contaminant	Average Background Soil Concentration (mg/kg)
Benzo[a]anthracene	0.23
Benzo[a]pyrene	0.23
Benzo[b]fluoranthene	0.32
Benzo[g,h,i]perylene	0.14
Benzo[k]fluoranthene	0.18
Dibenzo[a,h]anthracene	0.053
Indeno[1,2,3-cd] pyrene	0.12

Definitions: mg/kg = milligrams of contaminant per kilogram of soil;
*The levels in this table represent both surface and sub-surface samples.
Source: Concentrations of Polycyclic Aromatic Hydrocarbons

Table 4a: Site-specific Parameters for PHAST Input

Site-specific Parameters Table – PAHs Noncancer Risk

Equations

Soil/Sediment Ingestion Exposure Dose Equation

$$\mathbf{D_{noncancer} = (C \times IR \times EF_{noncancer} \times CF) \div BW}$$ **Equation 1**

$D_{noncancer}$ = dose (mg/kg/day), C = contaminant concentration (mg/kg), IR = intake rate (mg/day), $EF_{noncancer}$ = exposure factor (unitless), CF = conversion factor (10^{-6} kg/mg), BW = body weight (kg)

Administered Dermal Dose Equation

$$\mathbf{ADD_{noncancer} = (C \times EF_{noncancer} \times CF \times AF \times ABS_d \times SA) \div (BW \times ABS_{GI})}$$ **Equation 2**

$ADD_{noncancer}$ = administered dermal dose (mg/kg/day), C = contaminant concentration (mg/kg), $EF_{noncancer}$ = exposure factor (unitless), CF = conversion factor (10^{-6} kg/mg), AF = adherence factor (mg/cm^2-event), ABS_d = dermal absorption fraction (unitless), SA = skin surface area available for contact (cm^2), BW = body weight (kg), ABS_{GI} = gastrointestinal absorption factor (unitless)

Hazard Quotient

$$\mathbf{HQ = D_{noncancer} \div HG}$$ **Equation 3**

HQ = hazard quotient, $D_{noncancer}$ = dose (mg/kg/day), HG = health guideline (e.g., oral MRL, RfD)

Site-specific Exposure Factors

Duration Category	Days per Week	Weeks per Year	Years	Exposure Group Specific $EF_{noncancer}$	Exposure Group Specific* EF_{cancer}
Chronic	7	52.14	33	1	-

Abbreviations: EF = exposure factor; NC = not calculated

Note: The dermal absorbed dose equation includes 1 event/day EF parameter.

Site-specific Exposure Parameters

Exposure Group	Body Weight (kg)	Exposure Duration (years)	CTE Intake Rate (mg/day)	RME Intake Rate (mg/day)	Adherence Factor to Skin (mg/cm^2/event)	Combined Skin Surface Area (cm^2)	Notes
Birth to < 1 year	7.8	1	55	150	0.2	1,772	-
1 to < 2 years	11.4	1	90	200	0.2	2,299	-
2 to < 6 years	17.4	4	60	200	0.2	2,592	-
6 to < 11 years	31.8	5	60	200	0.2	3,824	-
11 to < 16 years	56.8	5	30	100	0.2	5,454	-
16 to < 21 years	71.6	5	30	100	0.2	6,083	-
Total Child (all age groups)	-	21	-	-	-	-	-
Adult	80	33	30	100	0.07	6,030	-

Abbreviations: cm^2 = centimeters square skin; CTE = central tendency exposure (typical); kg = kilograms; mg/cm^2/event = milligram chemical per centimeter square of skin per event; mg/day = milligram soil per day; RME = reasonable maximum exposure (higher)

Contaminant Information

Contaminant Name	Entered Concentration	EPC Type	Converted Concentration*	Dermal Absorption Fraction	ABS_{GI}	Bioavailability Factor
Benzo(a)pyrene	0.69 mg/kg	95% UCL of the mean	0.69 mg/kg	0.13	1	1

Abbreviations: ABS_{GI} = gastrointestinal absorption factor; EPC = exposure point concentration; mg/kg = milligram chemical per kilogram soil; mg/kg = milligrams per kilogram; UCL = upper confidence limit

* Contaminant concentration converted to standard unit for calculating exposure.

Table 4b: Residential: Site-specific combined ingestion and dermal exposure doses for chronic exposure to benzo(a)pyrene in soil at 0.69 mg/kg along with noncancer hazard quotients *

Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient
Birth to < 1 year	8.9E-06	0.030	1.7E-05	0.058
1 to < 2 years	9.1E-06	0.030	1.6E-05	0.052
2 to < 6 years	5.1E-06	0.017	1.1E-05	0.035
6 to < 11 years	3.5E-06	0.012	6.5E-06	0.022
11 to < 16 years	2.1E-06	0.0070	2.9E-06	0.0098
16 to < 21 years	1.8E-06	0.0060	2.5E-06	0.0083
Total Child	-	-	-	-
Adult	7.3E-07	0.0024	1.3E-06	0.0045

Abbreviations: CTE = central tendency exposure (typical); mg/kg/day = milligram chemical per kilogram body weight per day; mg/kg = milligram chemical per kilogram soil; RME = reasonable maximum exposure (higher); yrs = years

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The noncancer hazard quotients were calculated using the chronic (lifetime) reference dose of 0.0003 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 1.7 $(mg/kg/day)^{-1}$ and age-dependent adjustment factors.

Table 5a: Site-specific Parameters – PAHs – Cancer Risk

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Equations

Soil/Sediment Ingestion Exposure Dose Equation

$$\mathbf{D_{noncancer} = (C \times IR \times EF_{noncancer} \times CF) \div BW}$$ **Equation 1**

$D_{noncancer}$ = dose (mg/kg/day), C = contaminant concentration (mg/kg), IR = intake rate (mg/day), $EF_{noncancer}$ = exposure factor (unitless), CF = conversion factor (10^{-6} kg/mg), BW = body weight (kg)

Administered Dermal Dose Equation

$$\mathbf{ADD_{noncancer} = (C \times EF_{noncancer} \times CF \times AF \times ABS_d \times SA) \div (BW \times ABS_{GI})}$$ **Equation 2**

$ADD_{noncancer}$ = administered dermal dose (mg/kg/day), C = contaminant concentration (mg/kg), $EF_{noncancer}$ = exposure factor (unitless), CF = conversion factor (10^{-6} kg/mg), AF = adherence factor (mg/cm^2-event), ABS_d = dermal absorption fraction (unitless), SA = skin surface area available for contact (cm^2), BW = body weight (kg), ABS_{GI} = gastrointestinal absorption factor (unitless)

Cancer Risk Equations

$CR = D_{noncancer} \times CSF \times (ED \div LY)$ **Equation 3**

$ADAF\text{-}adjusted\ CR = (D_{noncancer} \times CSF) \times (ED \div LY) \times ADAF$ **Equation 4**

Total CR = Sum of the CR for all exposure groups **Equation 5**

CR = cancer risk (unitless), $D_{noncancer}$ = dose, CSF = oral cancer slope factor [$(mg/kg/day)^{-1}$], EF (cancer) = exposure factor (cancer) calculated as follows: EF (noncancer; unitless) x exposure group specific exposure duration (years) ÷ lifetime of 78 years, ADAF = age-dependent adjustment factor (unitless), ED = exposure duration (years), LY = lifetime years (78 years)

Site-specific Exposure Factors

Duration Category	Days per Week	Weeks per Year	Years	Exposure Group Specific $EF_{noncancer}$	Exposure Group Specific* EF_{cancer}
					-
					-
Chronic	7	52.14	33	1	= $EF_{noncancer}$ x Exposure Duration for $Cancer_{Exposure\ Group}$ (years) ÷ 78 years
					-

Abbreviations: EF = exposure factor; NC = not calculated

Note: The dermal absorbed dose equation includes 1 event/day EF parameter.

* Cancer risk is averaged over a lifetime of exposure (78 years).

Site-specific Exposure Parameters

Exposure Group	Body Weight (kg)	Exposure Duration (years)	CTE Intake Rate (mg/day)	RME Intake Rate (mg/day)	Adherence Factor to Skin (mg/cm^2/event)	Combined Skin Surface Area (cm^2)	Notes
Birth to < 1 year	7.8	1	55	150	0.2	1,772	-
1 to < 2 years	11.4	1	90	200	0.2	2,299	-
2 to < 6 years	17.4	4	60	200	0.2	2,592	-
6 to < 11 years	31.8	5	60	200	0.2	3,824	-
11 to < 16 years	56.8	5	30	100	0.2	5,454	-
16 to < 21 years	71.6	5	30	100	0.2	6,083	-
Total Child (all age groups)	-	21	-	-	-	-	-
Adult	80	33	30	100	0.07	6,030	-

Abbreviations: cm^2 = centimeters square skin; CTE = central tendency exposure (typical); kg = kilograms; mg/cm^2/event = milligram chemical per centimeter square of skin per event; mg/day = milligram soil per day; RME = reasonable maximum exposure (higher)

Contaminant Information

Contaminant Name	Entered Concentration	EPC Type	Converted Concentration*	Dermal Absorption Fraction	ABS_{GI}	Bioavailability Factor
BaP Equivalent	1.14 mg/kg	95% UCL of the mean	1.14 mg/kg	0.13	1	1

Abbreviations: ABS_{GI} = gastrointestinal absorption factor; EPC = exposure point concentration; mg/kg = milligram chemical per kilogram soil; mg/kg = milligrams per kilogram; UCL = upper confidence limit

* Contaminant concentration converted to standard unit for calculating exposure.

Table 5b: Residential: Site-specific combined ingestion and dermal exposure doses for chronic exposure to BaP Equivalent in soil at 1.14 mg/kg along with cancer risk estimates*

Exposure Group	CTE Dose (mg/kg/day)	CTE Cancer Risk	RME Dose (mg/kg/day)	RME Cancer Risk	Exposure Duration (yrs)
Birth to < 1 year	1.5E-05	-	2.9E-05	-	1
1 to < 2 years	1.5E-05	-	2.6E-05	-	1
2 to < 6 years	8.3E-06	-	1.8E-05	-	4
6 to < 11 years	5.7E-06	-	1.1E-05	-	5
11 to < 16 years	3.4E-06	-	4.9E-06	-	5
16 to < 21 years	3.0E-06	-	4.1E-06	-	5
Total Child	-	1.2E-5 ‡	-	2.2E-5 ‡	21
Adult	1.2E-06	8.7E-7	2.2E-06	1.6E-6 ‡	33

Abbreviations: CTE = central tendency exposure (typical); mg/kg/day = milligram chemical per kilogram body weight per day; mg/kg = milligram chemical per kilogram soil; RME = reasonable maximum exposure (higher); yrs = years

* The calculations in this table were generated using ATSDR's PHAST v2.4.2.0. The EPC: 1.1 mg/kg and cancer risks were calculated using the cancer slope factor of 1.7 $(mg/kg/day)^{-1}$ and age-dependent adjustment factors.

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