HEALTH CONSULTATION

FOSTORIA CITY DUMP (PORTAGE PARK)

FOSTORIA, WOOD COUNTY, OHIO

EPA FACILITY ID: OHN000510571

Prepared by the
Ohio Department of Health
Health Assessment Section

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SUMMARY

Introduction The Fostoria City Dump (FCD) site is located in a mixed residential, commercial, and agricultural area within the city of Fostoria, Wood County, Ohio. The FCD site is a former waste disposal area that operated from 1950 to 1970 and is now being used as a community park (Portage Park).

The Ohio Environmental Protection Agency (Ohio EPA) collected soil, sediment, surface water and groundwater samples during an Expanded Site Inspection (ESI) of the Fostoria City Dump site. Analyses of soils, sediment and groundwater included a targeted group of metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) consisting primarily of polycyclic aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs).

The Health Assessment Section (HAS) of the Ohio Department of Health (ODH) prepared this health consultation in response to concerns voiced by the Ohio EPA. This report evaluates the available environmental data, determines whether the public could come into contact with harmful levels of contaminants, and makes recommendations to protect public health.

Conclusions HAS reached two conclusions in this health consultation.

Conclusion 1: **The HAS concludes that frequent contact with PAHs in Portage River sediment just east of the Fostoria City Dump site for more than a year could harm people's health. This is a public health hazard.**

Basis for Decision: People frequently exposed to elevated levels of PAHs at location SE-8, the coal tar spill area in the Portage River, could be at increased risk of developing certain types of skin cancer. However, the likelihood of prolonged exposure to PAHs in this area of the river is low, considering that it is not located on park property where people would be more likely to come into contact with the sediments.

Next Steps: HAS recommends the PAH contamination at SE-8 east of the Fostoria City Dump site be removed or isolated and contained.

Conclusion 2: **The HAS concludes that contact with surface soil at the Fostoria City Dump site overall is not expected to harm people's health. However, a hazard exists for a suspected disposal area located at the south end of the park and an area of exposed waste at the top of the north river bank.**

Basis for Surface soil for sample locations SO-20 and SO-21/22 at the south end of the

Decision:	site is contaminated with arsenic, lead, and cadmium above levels of health concern. In addition, an area of exposed waste on the north bank of the river (sample location SO-15) showed elevated levels of lead according to the previous site investigation. This may pose a hazard to children chronically exposed to these surface soils.
Next Steps:	HAS recommends that surface soil contaminated with lead, arsenic, and cadmium on the south side of the site and the lead-contaminated soil in the exposed waste area along the north river bank be removed or isolated and contained. Limited sampling data and the uncertainties presented in the laboratory results generate some uncertainty with regard to our evaluation of these data and our subsequent conclusions and recommendations. In order to better determine the extent of contamination at the FCD site, additional sampling of surface soils, especially in these "hot spot" areas, is recommended.
For More Information	If you have any concerns about your health, as it relates to exposure to the chemicals of concern at this site, you should contact your health care provider. You can also call the HAS at (614) 466-1390 for answers to health-related questions regarding chemical exposure.

BACKGROUND

Site Description and History

The Fostoria City Dump (FCD) site is located in a mixed residential, commercial, and agricultural area within the city of Fostoria, Wood County, Ohio. The FCD site is a former waste disposal area that operated from 1950 to 1970 and is now being used as a community park (Portage Park). The Portage River flows through the center of the site. The park has two large hills, one on each side of the river, with both consisting primarily of foundry sand. The park features shelter houses, outdoor cooking grills, picnic tables and benches, a walking/biking path, a bridge, and an outdoor amphitheater. The site is surrounded by farmland immediately to the north and west, commercial properties and a mobile home park to the east, and the Fostoria Waste Water Treatment Plant (WWTP) to the south (Ohio EPA 2013).

Demographics and Land Use

Fostoria is located in in northwest Ohio with the city limits extending into Wood, Hancock, and Seneca Counties. It is about 90 miles north of Columbus and 40 miles south of Toledo. Based on the 2010 Census, the city has a population of 13,441. By race, the population of Fostoria is 84.1 percent White, 6.4 percent Black, 0.1 percent Native American, 0.4 percent Asian, 4.3 percent some other race, and 4.7 percent two or more races. About 11.5 percent of the population is Hispanic or Latino (of any race). The city has a total of 5,417 households and 3,432 families.

Fostoria is known for its railroads. The main lines of CSX and N&S remain active today and intersect near the downtown district in an area known as the "Iron Triangle." Fostoria also has a heritage of glass production. At one time, there were at least a dozen glass factories established in Fostoria.

The city of Fostoria is currently using the FCD site as a community park for recreational activities. Activities at the park include hiking, biking, family reunions, school field trips in the summer, and sledding, skiing, and snowboarding in the winter (Ohio EPA 2013).

DISCUSSION

Exposure Pathways

In order for residents to be exposed to chemical contaminants, they must come into direct contact with the contaminants through a completed exposure pathway. A completed exposure pathway consists of five main parts:

1. A **Source** of contamination (a chemical release, landfill, etc.),
2. A method of **Environmental Transport** (air, water, soil, sediment, etc.), which allows the chemicals to move from the source area and bring it into contact with people,
3. A **Point of Exposure** where people come into direct contact with the chemicals,
4. A **Route of Exposure** (ingestion, inhalation, or dermal contact), which is how people come into contact with chemicals, and
5. A **Population at Risk**, i.e., people likely to come into contact with site-related chemicals.

Physical contact with a chemical contaminant does not necessarily result in adverse health effects. A chemical's ability to affect the health of an individual is also controlled by a number of other factors including:

- How much of the chemical a person is exposed to (dose),
- How long a person is exposed to the chemical (duration),
- How often a person is exposed to the chemical (frequency), and
- The toxicity of the chemical (how it affects the body).

Other factors affecting a chemical's likelihood of causing adverse health effects upon exposure include the individual's:

- Personal habits,
- Diet,
- Age and sex,
- Current health status, and
- Past exposures to toxic chemicals (occupation, hobbies, etc.).

Pathways Likely at the FCD Site (Portage Park)

The exposure pathways likely at this site include intermittent, incidental contact with contaminated surface soil at the park and surface water and sediment from the Portage River. Contamination of groundwater-based drinking water resources is not expected to be occurring from contaminants at this site, as: 1) There are no private wells or public water supply wells within 2,000 feet of the center of the FCD site, and 2) Groundwater flow is reported to be to the north—the city's water supply wells are located south of the site (Ohio EPA 2013).

Environmental Data

Data Evaluation

Ohio EPA collected soil, sediment, surface water and groundwater samples as part of a Site Inspection (SI) of the Fostoria City Dump in September 2011 and an Expanded Site Inspection (ESI) in August of 2012. Analyses of soils, sediment and groundwater included a targeted group of metals, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs) consisting primarily of polycyclic aromatic hydrocarbons (PAHs), pesticides, and polychlorinated biphenyls (PCBs).

The tables in the Tables section of this report were created using selective data highlighting significant or elevated contaminant detections in the samples listed in the ESI report. The results were summarized and compared to health-based guidelines or comparison values. Comparison values (CVs) are chemical and media-specific concentrations in air, soil, and drinking water that are used by the Agency for Toxic Substances and Disease Registry (ATSDR) health assessors and others to identify environmental contaminants at hazardous waste sites that require further evaluation. It should be noted that contaminants detected at concentrations that exceed their respective CVs do not necessarily represent a health threat. Instead, the results of the CV screening identify those contaminants that warrant a more detailed, site-specific evaluation to determine whether health effects may occur.

Data Quality

It was noted that many of the laboratory results for the selected chemicals of concern were qualified. For example, all sediment sample results for lead and zinc and five out of seven results for cadmium were flagged as "estimated quantities" (J) (Table 1 of the ESI report). Most of the laboratory results for VOCs were flagged "not detected above the reported sample quantitation limit" (U). In this evaluation, the numerical values designated with a U were regarded as non-detections. Results for chromium were not speciated, i.e., chromium VI, the most toxic form of chromium, was not analyzed separately, making it difficult to apply the proper comparison value. All values for the PCB Aroclor 1254 were estimated quantities (J), as were the undiluted sample results for the pesticide DDT. About half of the sediment results for the seven carcinogenic PAHs (cPAHs) were estimated values. Likewise, most of the surface soil results for the cPAHs (Table 2 of the ESI report) were estimates. Due to the uncertainties presented by the data, the public health implications derived from them may not be as reliable as the HAS program would prefer.

Public Health Implications

Sediment

In general, sample results for targeted metals, VOCs, PCBs, and pesticides in sediment were below health-based screening levels and were not evaluated further (Table 1). Results for PAHs tended to be above their respective comparison values and were selected for further evaluation. The PAH levels in one background sediment sample (SE-8) were orders of magnitude higher than the levels found in the second background sample or any of the sediment samples collected on the FCD site.

While not all PAHs are considered carcinogenic (e.g., pyrene), the U.S. EPA has determined that seven PAHs are probable human carcinogens (ATSDR 1995). Benzo(a)pyrene (B(a)P) was used as a surrogate to assess the relative toxicity of the PAH mixture. Exposure doses and estimated cancer risks were calculated for skin contact (dermal exposure) and for inadvertent (incidental) ingestion of sediment in Appendix A. Excess cancer risk is expressed as a portion of the population that may be affected by a carcinogen during a lifetime of exposure. An estimated risk of 1×10^{-6} predicts the probability of one additional cancer, over background, in an exposed population of one million.

The estimated cancer risk from exposure to PAHs in sediment within the FCD (Portage Park) site was calculated to be very low and within the U.S. EPA cancer risk range of 1×10^{-4} to 1×10^{-6}. However, sediment sample SE-8, one of the two background samples, was highly contaminated with PAHs, with a total B(a)P equivalent concentration of 382 ppm and a calculated cancer risk exceeding 1×10^{-4} or 1 in 10,000 for both incidental ingestion and dermal exposure to sediment (See Appendix A). High concentrations of PAHs in sediment background sample SE-8 just east of the site boundary (Figure 2) are suspected to be from a documented spill of a coal tar substance into the sanitary sewer system from an unknown source.

People frequently exposed to elevated levels of PAHs could have an increased risk of developing certain types of skin cancer. It is not known if this area of the Portage River is accessible to the public or if prolonged exposure to PAH-contaminated sediment in this area is likely.

Surface Soil

Some individual sample results for heavy metals; including arsenic, cadmium, and lead were above health-based screening levels (Table 2). Two out of five samples were above the 400 ppm soil screening level for lead, while the overall average was below the soil screening level. For arsenic, two out of five sample locations were above ATSDR's chronic environmental media evaluation guide (EMEG) of 15 ppm, while the overall average was below this guideline. For cadmium, one sample was above ATSDR's 5 ppm EMEG for cadmium, while the overall average was below this comparison value. Chromium would not be above levels of health concern unless all of the chromium was present in its most toxic form (hexavalent chromium), which was not known as the chromium was not speciated as to its form. The highest heavy metal concentrations were detected in sample location SO-21/22 (soil samples SO-21 and SO-22 were duplicate samples). Several heavy metals were also detected at concentrations above comparison

values at sample location SO-20. These two sample locations were in the area suspected to be a former petroleum disposal pit. They are also located next to the former waste water treatment plant sludge lagoons.

Exposures to PAHs from contaminated soil were estimated based on five surface soil samples collected within and outside the fill area of the FCD site and the two background samples highlighted in the Ohio EPA ESI report. Cancer risk was calculated using the carcinogenic PAHs (Appendix A, Table A-5). Based on the onsite sample results, there is a negligible lifetime cancer risk from exposure to PAHs in surface soil. For the highest sample (SO-21/22), the risk for a child was calculated to be 5×10^{-6}, about twice the estimate for the background samples. Overall, incidental contact with surface soils at the Fostoria City Dump site is not expected to harm people's health. However, the area of the suspected disposal area (sample locations SO-20 and SO-21/22) on the south end of the site (Figure 3) has concentrations of arsenic, lead, and cadmium above levels of health concern for a child chronically exposed to surface soil.

Previous Site Investigations

In September 2011, the Ohio EPA collected water, sediment, soil, and leachate samples during a Site Investigation of the FCD site. Heavy metals were found at concentrations several times above background concentrations in the surface soil primarily at sample location SO-15 (Figure 4). This sample was a composite of 30 individual grab samples collected over an area of exposed waste at the top of the north river bank (Ohio EPA 2012). Lead, detected at 682 ppm, was the only metal of health concern exceeding a health-based comparison value, in this case the 400 ppm screening level for lead in soil. This would be a hazard for a child who regularly played in bare surface soil in this northern area of the site.

Surface soil sample SO-16, also a composite sample, was taken from the walking path around the north hill (Figure 4). This sample contained a component of dark colored (black to grey) foundry sand. PAHs were found to be the major contaminants detected at concentrations above screening levels; however, the levels of PAHs were lower than those detected in background sample SO-4. The cancer risk from incidental exposure to the surface soil SO-16 was calculated using the seven cPAHs (Appendix Tables A-6 and A-7). This estimate did not exceed the target risk range (1 in 10,000 to 1 in 1,000,000) used by the U.S.EPA. The HAS concludes that incidental contact with surface soils along the walking trail at this site is not expected to harm people's health.

Child Health Considerations

In communities faced with air, water, or food contamination, the many physical differences between children and adults demand special emphasis. Children could be at greater risk than are adults from certain kinds of exposure to hazardous substances. Children play outdoors and sometimes engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than are adults; this means they breathe dust, soil, and vapors close to the ground. A child's lower body weight and higher intake rate results in a greater dose of hazardous substance per unit of body weight. If toxic exposure levels are high enough during critical growth stages, the developing body systems of children can sustain permanent damage. Finally, children are

dependent on adults for access to housing, for access to medical care, and for risk identification. Thus adults need as much information as possible to make informed decisions regarding their children's health.

Children are more sensitive to the effects of lead exposure than are adults. Even at low levels, lead can affect a child's mental and physical development, in part because their brains and nervous systems are still developing. The effects of lead are the same whether it enters the body through breathing or swallowing. The major adverse health effect from exposures to excessive amounts of lead is damage to the nervous system potentially resulting in lower intelligence and behavioral effects that persist into adulthood (ATSDR 2007).

CONCLUSIONS

1. The HAS concludes that frequent contact with PAHs in sediment in the Portage River at location SE-8, the coal tar spill area upstream and just east of the Fostoria City Dump site (Portage Park), for more than a year could harm people's health. This is a public health hazard. People frequently exposed to elevated levels of PAHs could have an increased risk of developing certain types of skin cancer. However, the likelihood of prolonged exposure to PAHs in this area of the Portage River is likely low due to a lack of easy access, as it is not located on park property.

2. The HAS concludes that contact with surface soil at the Fostoria City Dump site overall is not expected to harm people's health. However, a suspected disposal area located on the south end of the park (sample locations SO-20 and SO-21/22) is contaminated with arsenic, lead, and cadmium above levels of health concern. In addition, an area of exposed waste on the north bank of the river (sample location SO-15) showed elevated levels of lead, according to the previous site investigation. This would be a hazard for a child chronically exposed to surface soils in this specific area.

RECOMMENDATIONS

1. The HAS recommends that the off-site PAH contamination of the river sediment at SE-8 just east of the Fostoria City Dump site be removed or otherwise mitigated. Public access to this area of the river is likely limited, which may reduce the potential for contact with PAHs.
2. The HAS recommends that surface soil contaminated with lead, arsenic, and cadmium on the south side of the site (SO-20, SO-21/22) and the lead-contaminated soil in the exposed waste area along the north river bank (SO-15) be removed or isolated and contained.

3. Limited sampling data and the uncertainties presented in the laboratory results generate some uncertainty with regard to our evaluation of these data and our subsequent conclusions and recommendations. In order to better determine the areas of contamination, additional sampling of surface soils at the FCD site is recommended.

REFERENCES

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REPORT PREPARATION

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TABLES

Table 1. Selected Chemicals Detected in Sediment – Fostoria City Dump

Chemical	*Range of Detections (ppm)*	*Average (ppm)*	*Frequency of Detections*	*Frequency Above Comparison Value*	*Comparison Value (ppm)*	Type
Metals[1]						
Cadmium	0.21–2	0.65	7/7	0/7	5	C-EMEG (child)
Chromium	18.8–68.8	33.3	7/7	1/7 0/7	45 75,000	C-EMEG (child); VI form RMEG (child); III form
Lead	28.9–317	142	7/7	0/7	400	RSL
Mercury	0.13–0.95	0.46	7/7	0/7	15	RMEG (child); salts
Zinc	117–657	272	7/7	0/7	15,000	C-EMEG (child)
Volatile Organic Compounds (VOCs)						
2-Butanone	0.044	0.044	1/7	0/7	30,000	RMEG (child)
Methylene chloride	ND	ND	0/7	0/7	300	RMEG (child)
Trichloroethylene	0.0034	0.0034	1/7	0/7	25	RMEG (child)
Toluene	0.12–0.45	0.285	2/7	0/7	4,000	RMEG (child)

Source: Ohio EPA 2013

[1] All sample results for lead and zinc and five out of seven results for cadmium were flagged as "estimated quantities" (J). Chromium VI, the most toxic form of chromium, was not analyzed separately.

C-EMEG – chronic environmental media evaluation guide (ATSDR)

ND – not detected

ppm – parts per million

RMEG – reference dose media evaluation guide (ATSDR)

RSL – regional screening level (U.S. EPA)

Table 1. Selected Chemicals Detected in Sediment (continued) – Fostoria City Dump

Chemical	*Range of Detections (ppm)*	*Average (ppm)*	*Frequency of Detections*	*Frequency Above Comparison Value*	*Comparison Value (ppm)*	Type
Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)[2]						
Benzo(a)pyrene	0.17–4.7	2.2	7/7	7/7	0.096	CREG
Benz(a)anthracene	0.37–13	4.4	7/7	7/7	0.15	RSL
Benzo(b)fluoranthene	0.57–15	5.3	7/7	7/7	0.15	RSL
Benzo(k)fluoranthene	0.42–9	3.3	7/7	5/7	1.5	RSL
Chrysene	0.51–11	4.2	7/7	0/7	15	RSL
Dibenz(a,h)anthracene	0.091–2.5	0.8	7/7	7/7	0.015	RSL
Indeno(1,2,3-cd)pyrene	0.36–2.8	1.6	7/7	7/7	0.15	RSL
Polychlorinated Biphenyls (PCBs)[3]						
Aroclor 1254	0.048–0.5	0.2	7/7	0/7	1	C-EMEG (child)
Pesticides[4]						
4,4'-DDT	0.0026–0.025	0.008	4/7	0/7	2.1	CREG

Source: Ohio EPA 2013

[2]About half of the cPAH results were flagged as "estimated quantities" (J).

[3]All sample results for Aroclor 1254 were estimated quantities (J).

[4] Four sample results for DDT were estimated quantities (J); three were flagged as "not detected above the reported sample quantitation limit" (U).

C-EMEG – chronic environmental media evaluation guide (ATSDR)

CREG – cancer risk evaluation guide (ATSDR)

ppm – parts per million

RSL – regional screening level (U.S. EPA)

Note: Results for duplicates were averaged in deriving this table.

Table 2. Selected Chemicals Detected in Surface Soil – Fostoria City Dump

Chemical	*Range of Detections (ppm)*	*Average (ppm)*	*Frequency of Detections*	*Frequency Above Comparison Value*	*Comparison Value (ppm)*	Type
Metals						
Arsenic	4.9–32	14.1	5/5	2/5	15	C-EMEG (child)
Cadmium	0.32–13	4.0	5/5	1/5	5	C-EMEG (child)
Chromium	21.8–890	285	5/5	2/5 0/5	45 75,000	C-EMEG (child); VI form RMEG (child); III form
Lead	37.6–780	317	5/5	2/5	400	RSL
Mercury	0.047–4	1.3	5/5	0/5	15	RMEG (child); salts
Zinc	97.5–1,550	694	5/5	0/5	15,000	C-EMEG (child)
Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs)						
Benzo(a)pyrene	0.06–1.6	0.51	5/5	3/5	0.096	CREG
Benz(a)anthracene	0.04–2.1	0.70	5/5	2/5	0.15	RSL
Benzo(b)fluoranthene	0.07–1.7	0.68	5/5	2/5	0.15	RSL
Benzo(k)fluoranthene	0.05–1.4	0.56	5/5	0/5	1.5	RSL
Chrysene	0.07–3.1	1.0	5/5	0/5	15	RSL
Dibenz(a,h)anthracene	0.1–0.19	0.16	5/5	5/5	0.015	RSL
Indeno(1,2,3-cd)pyrene	0.04–0.30	0.16	5/5	3/5	0.15	RSL

Source: Ohio EPA 2013

C-EMEG – chronic environmental media evaluation guide (ATSDR)

ppm – parts per million

RMEG – reference dose media evaluation guide (ATSDR)

RSL – regional screening level (U.S. EPA)

Note: Results for duplicates were averaged in deriving this table

FIGURES

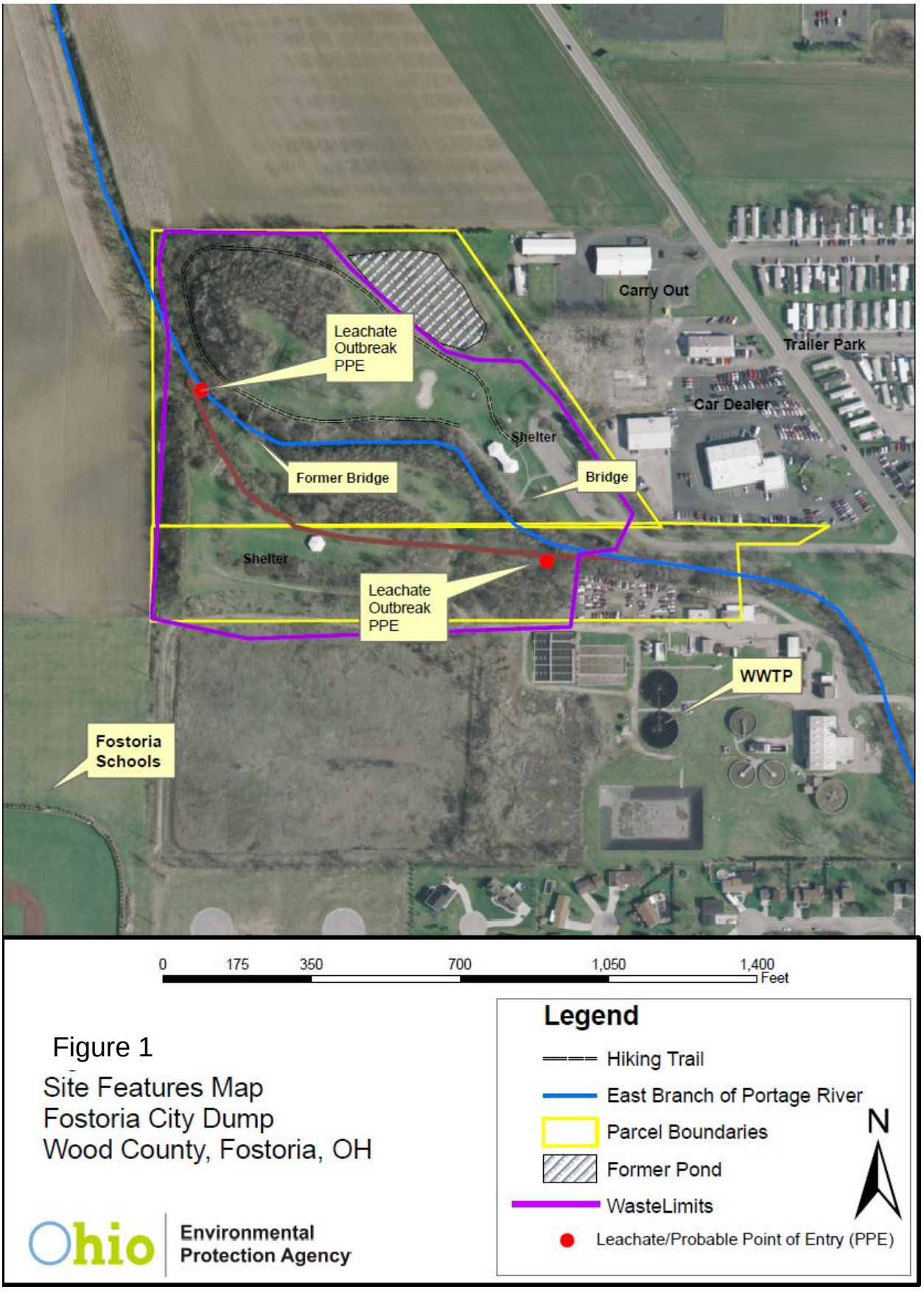

Figure 1

Site Features Map
Fostoria City Dump
Wood County, Fostoria, OH

Ohio Environmental Protection Agency

Figure 2

Sediment and Surface Water Upstream Sample Locations Map
Fostoria City Dump
Wood County, Fostoria, OH

0 87.5 175 350 525 700 Feet

Figure 3

Surface Soil Sample Location Map
Fostoria City Dump
Wood County, Fostoria, OH

Ohio Environmental Protection Agency

Legend

Surface Soil Locations

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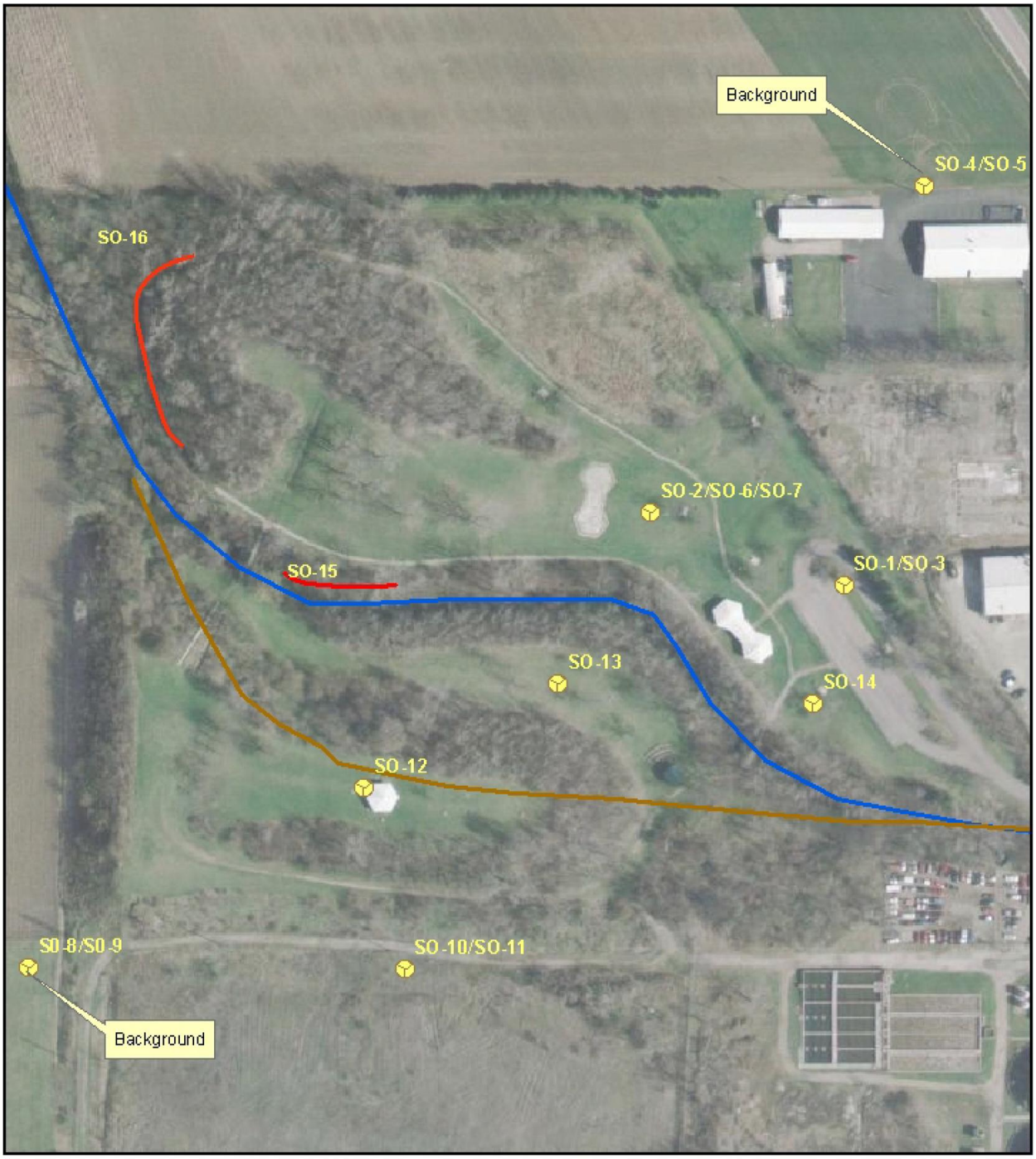

0 87.5 175 350 525 700 Feet

Figure 4
Soil Sample Location Map
Fostoria City Dump
Wood County, Fostoria, OH

Ohio Environmental Protection Agency

Legend

- Soil Sample Locations
- Historic River Channel
- Soil Sample Composite Area
- East Branch Portage River

N

Appendix A. Estimates of Exposure and Cancer Risk

The Health Assessment Section (HAS) of the Ohio Department of Health (ODH) evaluated exposures to contaminants at the Fostoria City Dump (FCD) site, now known as Portage Park, in Fostoria, Ohio. This section focuses on polycyclic aromatic hydrocarbons (PAHs), selected for further evaluation and an estimation of cancer risk.

Carcinogenicity of PAHs

While not all PAHs are considered carcinogenic (e.g., pyrene), the U.S. EPA has determined that benz(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, and indeno(1,2,3-c,d)pyrene are probable human carcinogens (ATSDR 1995). The National Toxicology Program (NTP) at the U.S. Public Health Service considers 15 individual PAHs to be "reasonably anticipated to be human carcinogens" (NTP 2011). The International Agency for Research on Cancer (IARC) upgraded its overall evaluation of benzo(a)pyrene to Group 1 (carcinogenic to humans) in 2010 [IARC 2010].

Benzo(a)pyrene (B(a)P) was used as a surrogate to assess the relative toxicity of the seven carcinogenic PAHs (cPAHs) classified by the U.S. EPA as probable human carcinogens. To determine the toxicity of the mixture of PAHs, the concentration of each individual cPAH was multiplied by a toxic equivalency factor (TEF) which relates its toxicity to that of B(a)P. The highest PAH concentrations were found in the background sediment sample SE-8, which was collected in the Portage River directly east of the site (Ohio EPA 2013). The benzo(a)pyrene toxicity equivalent concentration (TEQ) was calculated for sediment (Table A-1) and surface soil (Table A-2). Exposure doses and cancer risks were calculated for incidental ingestion of PAH-contaminated sediment (Table A-3) and dermal exposure to sediment (Table A-4).

Estimating Cancer Risk

The estimated cancer risk from exposure to contaminants associated with this site was calculated by multiplying the estimated exposure dose by the cancer slope factor (CSF) for benzo(a)pyrene. This calculation estimates the excess cancer risk expressed as a portion of the population that may be affected by a carcinogen during a lifetime of exposure. An estimated risk of 1×10^{-6} predicts the probability of one additional cancer, over background, in an exposed population of one million. Because of conservative safety factors used to calculate the CSFs, using these values provides only an estimate of risk; the true or actual risk is unknown and could be close to zero.

Sediment

The estimated cancer risk from exposure to PAHs in sediment within the FCD site was calculated to be very low and within the U.S. EPA cancer risk range of 1×10^{-4} to 1×10^{-6}. However, sediment sample (SE-8), one of the two background samples, was highly contaminated with PAHs, with a B(a)P equivalent concentration of 382 ppm and a calculated cancer risk exceeding 1×10^{-4} or 1 in 10,000 for both incidental ingestion and dermal exposure to sediment. This estimated risk represents a low to moderate increase in cancer risk and falls outside the

target range of cancer risks (1 in 10,000 to 1 in 1,000,000) considered acceptable by the U.S. EPA.

Surface Soil

Exposure doses to PAHs from contaminated surface soil were estimated based on locations within and outside the fill area of the FCD site as highlighted in the Ohio EPA ESI report. Cancer risk was calculated using the carcinogenic PAHs (Table A-5). Based on the onsite sample results, there is a negligible lifetime cancer risk from exposure to PAHs in surface soil. For the highest sample (SO-21/22), the risk for a child was calculated to be 5×10^{-6}, about twice the estimate for the background samples.

Table A-1. Toxicity Equivalent Benzo(a)pyrene Concentration in Sediment

		Samples																	
cPAH	***TEF***	***SE-8***	*C x TEF*	***SE-9***	*C x TEF*	***SE-10***	*C x TEF*	***SE-11***	*C x TEF*	***SE-12/13***	*C x TEF*	***SE-14***	*C x TEF*	***SE-15***	*C x TEF*	***SE-16***	*C x TEF*	***SE-17***	*C x TEF*
Benzo(a)pyrene	1.00	150.00	150.00	0.11	0.110	0.17	0.170	2.70	2.700	4.65	4.650	3.30	3.300	2.90	2.900	0.98	0.980	0.45	0.450
Benz(a)anthracene	0.10	270.00	27.00	0.14	0.014	13.00	1.300	3.70	0.370	6.25	0.625	3.80	0.380	2.90	0.290	0.81	0.081	0.37	0.037
Benzo(b)fluoranthene	0.10	220.00	22.00	0.14	0.014	15.00	1.500	4.70	0.470	6.85	0.685	4.90	0.490	3.50	0.350	1.30	0.130	0.57	0.057
Benzo(k)fluoranthene	0.10	180.00	18.00	0.11	0.011	9.00	0.900	3.00	0.300	4.2	0.420	2.40	0.240	2.90	0.290	1.00	0.100	0.42	0.042
Chrysene	0.01	260.00	2.60	0.16	0.002	11.00	0.110	3.70	0.037	6	0.060	3.90	0.039	3.30	0.033	1.00	0.010	0.51	0.005
Dibenzo(a,h)anthracene	5.00	31.00	155.00	0.20	1.000	2.50	12.500	0.65	3.250	1	5.000	0.57	2.850	0.59	2.950	0.22	1.100	0.09	0.455
Indeno (1,2,3-cd) pyrene	0.10	75.00	7.50	0.06	0.006	1.20	0.120	2.20	0.220	2.75	0.275	2.10	0.210	1.90	0.190	0.70	0.070	0.36	0.036
Total B(a)P TEQ			382		1.2		16.6		7.3		11.7		7.5		7.0		2.5		1.1

Source: Ohio EPA 2013

Results reported in parts per million (ppm)
Samples SE-8 and SE-9 are background samples; however SE-8 was not used for PAH background purposes due to the sample being taken from a coal tar source area.

Equation 1. Total Toxicity Equivalency Factor Concentration

$$TEQ = \sum [C_i] \times TEF_i$$

TEQ = toxicity equivalent of a mixture
C_i = concentration of individual compound
TEF_i = toxic equivalency factor, i.e., relative potency (as based on carcinogenicity) to benzo(a)pyrene

Example:

$$TEQ = (1 \times 0.17\ ppm) + (0.1 \times 13\ ppm) + (0.1 \times 15\ ppm) + (0.1 \times 9\ ppm) + (0.01 \times 11\ ppm) + (5 \times 2.5\ ppm) + (0.1\ \times 1.2\ ppm)$$
$$= 16.6\ ppm$$

Table A-2. Toxicity Equivalent Benzo(a)pyrene Concentration in Surface Soil

cPAH	*TEF*	*Samples*													
		SO-17	*C x TEF*	***SO-18***	*C x TEF*	***SO-19***	*C x TEF*	***SO-20***	*C x TEF*	***SO-21/22***	*C x TEF*	***SO-23***	*C x TEF*	***SO-24***	*C x TEF*
Benzo(a)pyrene	1.00	0.19	0.190	0.19	0.19	0.17	0.170	0.68	0.680	1.55	1.550	0.06	0.064	0.08	0.076
Benz(a)anthracene	0.10	0.19	0.019	0.19	0.02	0.04	0.004	1.2	0.120	2.10	0.210	0.07	0.007	0.10	0.010
Benzo(b)fluoranthene	0.10	0.04	0.004	0.05	0.00	0.07	0.007	1.4	0.140	1.70	0.170	0.10	0.010	0.12	0.012
Benzo(k)fluoranthene	0.10	0.19	0.019	0.19	0.02	0.17	0.017	1.1	0.110	1.40	0.140	0.07	0.007	0.05	0.005
Chrysene	0.01	0.05	0.000	0.04	0.00	0.07	0.001	1.9	0.019	3.10	0.031	0.08	0.001	0.10	0.001
Dibenzo(a,h)anthracene	5.00	0.19	0.950	0.19	0.95	0.17	0.850	0.15	0.750	0.10	0.495	0.02	0.095	0.02	0.095
Indeno (1,2,3-cd) pyrene	0.10	0.19	0.019	0.19	0.02	0.17	0.017	0.3	0.030	0.23	0.023	0.04	0.004	0.04	0.004
Total B(a)P TEQ			1.20		1.20		1.06		1.85		2.62		0.19		0.20

Source: Ohio EPA 2013

Results reported in parts per million (ppm)
Samples SO-17 and SO-18 are background samples
TEQ = toxicity equivalent of a mixture
C = concentration of individual compound
TEF = toxic equivalency factor, i.e., relative potency (as based on carcinogenicity) to benzo(a)pyrene

Table A-3. Exposure Doses and Estimated Cancer Risk from Incidental Ingestion of Sediment

Age (years)	*Body Weight (kg)*	*Maximum Concentration (ppm)*	*Sample Location*	*Intake Rate (mg/day)*	*Exposure Dose (mg/kg/day)*	*Exposure Duration (years)*	*Estimated Cancer Risk*
Onsite							
1–6 child	16	16.6	SE-10	200	5.2×10^{-5}	6	3.2×10^{-5}
18–70 adult	70	16.6	SE-10	100	5.9×10^{-6}	30	1.8×10^{-5}
Off-site (Background)							
1–6 child	16	382	SE-8	200	1.2×10^{-3}	6	7.5×10^{-4}
18–70 adult	70	382	SE-8	100	1.4×10^{-4}	30	4.3×10^{-4}

kg = kilogram
ppm = parts per million
mg = milligram

Equation 2. Incidental Ingestion Exposure Dose*

$$dose = \frac{concentration\ x\ intake\ rate\ x\ exposure\ factor\ x\ conversion\ factor}{body\ weight}$$

dose = estimated exposure dose (mg/kg/day)
concentration = contaminant concentration (mg/kg)
intake rate = intake rate of sediment (mg/day)
exposure factor = exposure factor (unitless)
conversion factor = conversion factor (10^{-6} kg/mg)
body weight = body weight (kg)

Example:

$$dose = \frac{\frac{382mg}{kg} x \frac{200\ mg}{day} x \left(\frac{90}{365}\right) x\ (10^{-6}\ kg/mg)}{16\ kg} = 1.2\ x\ 10^{-3} \frac{mg}{kg}/day$$

*Equations from ATSDR Public Health Assessment Guidance Manual 2005. Contaminant concentration was derived from the maximum PAH concentrations (Ohio EPA 2013), converted to a benzo(a)pyrene toxicity equivalent concentration.

Table A-4. Exposure Doses and Estimated Cancer Risk from Dermal Exposure to Sediment

Age (years)	*Body Weight (kg)*	*Maximum Concentration (ppm)*	*Exposed Skin Area* (cm^2)*	*Sediment Adhered (mg/cm^2)*	*Total Sediment Adhered (mg)*	*Exposure Dose (mg/kg/day)*	*Exposure Duration (years)*	*Estimated Cancer Risk*
Onsite								
1-11	30	16.6	3478	0.2	696	9.5×10^{-6}	12	1.2×10^{-5}
12-17	50	16.6	6930	0.2	1386	1.1×10^{-5}	6	7.1×10^{-6}
18-70	70	16.6	8415	0.07	589	3.4×10^{-6}	30	1.1×10^{-5}
Off-Site (Background)								
1-11	30	382	3478	0.2	696	2.2×10^{-4}	12	2.7×10^{-4}
12-17	50	382	6930	0.2	1386	2.6×10^{-4}	6	1.6×10^{-4}
18-70	70	382	8415	0.07	589	7.9×10^{-5}	30	2.5×10^{-4}

kg = kilogram
ppm = parts per million
cm^2 = square centimeter
mg = milligram

*Exposed skin area includes feet legs, and hands.

Equation 3. Dermal Contact Exposure Dose from Sediment

$$dose = \frac{concentration\ x\ sediment\ adhered\ x\ bioavailability\ x\ exposure\ factor\ x\ conversion\ factor}{body\ weight}$$

dose = estimated exposure dose (mg/kg/day)
concentration = contaminant concentration (mg/kg)
sediment adhered = total sediment adhered (mg)
bioavailability = bioavailability factor (unitless)
exposure factor = exposure factor (unitless)
conversion factor = conversion factor (10^{-6} kg/mg)
body weight = body weight (kg)

Example:

$$dose = \frac{\frac{382\ mg}{kg}\ x\ 696\ mg\ x\ 0.1\ x\ (\frac{90}{365})\ x\ 10^{-6}\ \frac{kg}{mg}}{30\ kg} = 2.2\ x\ 10^{-4}\ mg/kg/day$$

Equation 4. Cancer Risk*

Cancer Risk = Exposure Dose x Cancer Slope Factor

Cancer Risk = estimated theoretical cancer risk (unitless)
Exposure Dose = estimated exposure dose (mg/kg/day)
Cancer Slope Factor = cancer slope factor $(mg/kg/day)^{-1}$; 7.3 $(mg/kg/day)^{-1}$ for B(a)P

Example:

Cancer Risk = 2.2×10^{-4} mg/kg/day x 7.3 $(mg/kg/day)^{-1}$ x 12 years/70 years = 2.7×10^{-4}

*Cancer risk can be defined as the number of additional cases of cancer in a population due to exposure to a toxic substance, usually written as a negative power of 10. For example, one additional case of cancer per 10,000 individuals is written as 1×10^{-4}. The estimated cancer risks are compared to guidelines for cancer risk as suggested by the U.S. EPA which range from 1×10^{-4} to 1×10^{-6} (1 in 10,000 to 1 in 1,000,000).

The estimated cancer risk in the example above is derived from the dermal exposure dose estimated for a child spending three months per year at the east off-site (background) location SE-8, found to have the highest levels of PAHs in sediment. The estimated cancer risk is low to moderate and falls outside the target range of cancer risks (1 in 10,000 to 1 in 1,000,000) considered acceptable by the U.S. EPA.

Table A-5. Exposure Doses and Estimated Cancer Risk from Incidental Ingestion of Surface Soil

Age (years)	*Body Weight (kg)*	*Maximum Concentration (ppm)*	*Sample Location*	*Intake Rate (mg/day)*	*Exposure Dose (mg/kg/day)*	*Exposure Duration (years)*	*Estimated Cancer Risk*
Onsite							
1–6 child	16	2.62	SO-21	200	8.2×10^{-6}	6	5.1×10^{-6}
18–70 adult	70	2.62	SO-21	100	9.4×10^{-7}	30	2.9×10^{-6}
Off-site (Background)							
1–6 child	16	1.2	SO-17	200	3.8×10^{-6}	6	2.4×10^{-6}
18–70 adult	70	1.2	SO-17	100	4.3×10^{-7}	30	1.3×10^{-6}

kg = kilogram
ppm = parts per million
mg = milligram

Equation 5. Incidental Ingestion Exposure Dose

$$dose = \frac{concentration\ x\ intake\ rate\ x\ exposure\ factor\ x\ conversion\ factor}{body\ weight}$$

dose = estimated exposure dose (mg/kg/day)
concentration = contaminant concentration (mg/kg)
intake rate = intake rate of sediment (mg/day)
exposure factor = exposure factor (unitless): 90 days/365 days = 0.25
conversion factor = conversion factor (10^{-6} kg/mg)
body weight = body weight (kg)

Table A-6. Toxicity Equivalent Benzo(a)pyrene Concentration in Surface Soil SO-16

cPAH	*TEF*	*SO-16 C (ppm)*	*C x TEF*
Benzo(a)pyrene	1.00	1.9	1.9
Benz(a)anthracene	0.10	2.1	0.21
Benzo(b)fluoranthene	0.10	3.6	0.36
Benzo(k)fluoranthene	0.10	1.4	0.14
Chrysene	0.01	2.1	0.021
Dibenzo(a,h)anthracene	5.00	0.48	2.4
Indeno (1,2,3-cd) pyrene	0.10	1.9	0.19
Total B(a)P TEQ			**5.22**

Source: Ohio EPA 2012 (Site Investigation)

TEQ = toxicity equivalent of a mixture
C = concentration of individual compound
TEF = toxic equivalency factor, i.e., relative potency (as based on carcinogenicity) to benzo(a)pyrene

Table A-7. Exposure Doses and Estimated Cancer Risk from Incidental Ingestion of Soil at SO-16

Age (years)	*Body Weight (kg)*	*Maximum Concentration (ppm)*	*Sample Location*	*Intake Rate (mg/day)*	*Exposure Dose (mg/kg/day)*	*Exposure Duration (years)*	*Estimated Cancer Risk*
Onsite							
1–6 child	16	5.22	SO-16	200	1.6×10^{-5}	6	1.0×10^{-5}
18–70 adult	70	5.22	SO-16	100	1.9×10^{-6}	30	5.8×10^{-6}

kg = kilogram
ppm = parts per million
mg = milligram