TEXAS
Health and Human Services

Texas Department of State Health Services

Jennifer A. Shuford, M.D., M.P.H.
Commissioner

January 30, 2023

Loren Hopkins, Ph.D.
Chief Environmental Science Officer
Bureau Chief Community and Children's Environmental Health
Houston Health Department

RE: Health Consultation for the Houston Health Department - Evaluation of soil data collected in the neighborhood adjacent to the former Union Pacific Railroad Houston Wood Preserving Works

Dear Dr. Hopkins:

Per your request, the Texas Department of State Health Services (DSHS) evaluated soil sampling data summarized in the September 20, 2022, Soil Sampling Report prepared for the City of Houston Health Department by Epperson Environmental Group, LLC (Epperson Environmental). We summarize our findings and recommendations in this letter.

If you have any questions, please contact me at (512) 776-3714 or omar.valdez@dshs.texas.gov.

Sincerely,

Omar Valdez
Lead Health Assessor
Health Assessment and Toxicology Program
Texas Department of State Health Services

This publication was made possible by a cooperative agreement [APPLETREE #Ts20-2001] from the Agency for Toxic Substances and Disease Registry. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Agency for Toxic Substances and Disease Registry or the Department of Health and Human Services.

90128999

Background and Statement of Issues

The former Union Pacific Railroad Houston Wood Preserving Works site (UPRR-HWPW) is located at 4910 Liberty Road, Houston, Harris County, Texas. The site was used for various creosoting operations from 1899 until 1984, when all operations stopped. All on-site buildings were dismantled in the early 1990s. The site is currently regulated by the Texas Commission on Environmental Quality as a Resource Conservation and Recovery Act (RCRA) site.

On July 11, 2022, the Houston Health Department and Epperson Environmental collected surface soil samples in the neighborhood adjacent and rights-of-way located around the former UPRR-HWPW site. Sampling was conducted to determine if surface soils were contaminated with chemicals likely to be associated with wood preserving, such as dioxins, polychlorinated biphenyls (PCBs), and hexavalent chromium. The results of the sampling event were summarized in a September 20, 2022, Soil Sampling Report (Report) [Epperson 2022].

The purpose of this health consultation is to determine 1) if residents may be harmed by exposure to chemicals in soil, and 2) if any actions are needed to reduce potentially harmful exposures.

Discussion

Environmental Sampling Data

Available Data

The Report includes laboratory analytical results for 47 surface soil samples collected at depths ranging from 4 to 20 inches (Table 1). Most samples were collected at the 4-to-8-inch depth interval (30 samples), with the remaining 17 samples collected at deeper depths. Discrete soil samples were collected along the perimeter of the former UPPR-HWPW site (outside the fence line) and mostly along the streets of the residential area directly north and west of the site (Figure 1). Soil samples were not collected from the UPRR-HWPW property. The samples were analyzed for dioxins, PCBs, and hexavalent chromium using standard Environmental Protection Agency (EPA) analytical methods [Epperson 2022].

Table 1. Surface Soil Sampling Depth and Contaminants Measured at the UPPR-HWPW site

Soil Sampling Depth (inches below ground surface)	Total Number of Samples	Contaminants Measured
4 to 8	30	Dioxins, PCBs, Hexavalent Chromium
10 to 14	14	Dioxins, PCBs, Hexavalent Chromium
8 to 14	1	Dioxins, PCBs, Hexavalent Chromium
10 to 16	1	Dioxins, PCBs, Hexavalent Chromium
16 to 20	1	Dioxins, PCBs, Hexavalent Chromium

Abbreviations: PCBs = polychlorinated biphenyls

Figure 1. Soil Sampling Locations from the July 11, 2022, Sampling Event [Epperson 2022]

Data Quality

All soil data associated with the Report were reviewed independently by Epperson, and a data usability summary was included in the Report. The independent review concluded 100 percent completeness had been achieved for all samples. Therefore, DSHS assumed adequate quality assurance/quality control procedures were followed with regard to data collection and reporting.

Exposure Evaluation

Chemical contamination in the environment can only harm a person's health if there is exposure to the chemical and if the amount of the chemical the person has exposure to is high enough to cause harm. Whether people have exposure to a chemical depends on several factors, including:

1) Source of contamination (where the chemical comes from);
2) How the chemical moves through the environment (such as surface runoff);
3) Point of exposure where people could contact the contaminated media (such as soil, air, groundwater);
4) Route of human exposure (such as breathing, eating or drinking, or skin contact); and
5) Identifiable exposed population (people living in the area with contaminated soil).

Exposure to a chemical will only happen if there is a completed exposure pathway. All five of these factors must be present for an exposure pathway to be completed. DSHS evaluated relevant exposure pathways to determine if any were completed based on the available data.

Pathway Analysis

Exposure to contaminated surface soil in the residential area adjacent to the UPRR-HWPW site represents a completed exposure pathway. Chemicals (including dioxins, PCBs, and hexavalent chromium) were detected in surface soils collected along the facility's fence line and along the residential streets. People might be exposed to contaminants if they get soil on their skin and by swallowing small levels (30 to 200 milligrams) of soil while participating in outdoor activities [Appendix A]. Therefore, DSHS evaluated the soil surface samples.

Screening Analysis

DSHS compared chemicals detected in soil with health comparison values (CVs) published by the Agency for Toxic Substances Disease Registry (ATSDR) [ATSDR 2005]. CVs are contaminant concentrations found in specific environmental media (e.g., soil) and are used to select contaminants for further evaluation. CVs are not intended to be environmental clean-up levels or to indicate that health effects occur at concentrations that exceed these values.

Dioxins

DSHS evaluated a single value, called the dioxin toxic equivalent (TEQ), to determine if there could be risks for health effects. This approach is based on research that shows many dioxins are structurally similar and have similar health effects on humans and animals [PEH 2008]. The TEQ method is used to account for the toxic effects of all dioxin compounds based on the toxicity of 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). TCDD is the most potent of all dioxin compounds [ATSDR 2019]. The TEQ is calculated by assigning each dioxin compound a toxic equivalent concentration based on how toxic it is compared to TCDD. These values are then added together to determine a total TEQ level for the sample [Appendix B]. Additionally, DSHS also evaluated some individual dioxin compounds, including 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin (1,2,3,6,7,8-HCDD), 1,2,3,7,8,9-hexachlorodibenzo-p-dioxin (1,2,3,7,8,9-HCDD), and (2,3,4,7,8-pentachlorodibenzofuran (2,3,4,7,8-PeCDF), separately because they have specific CVs.

The TCDD TEQ was detected above the CV in 44 of the 47 samples. Additionally, 1,2,3,6,7,8-HCDD was detected in 5 samples and 1,2,3,7,8,9-HCDD was detected in 1 sample above CVs. Therefore, TCDD TEQ, 1,2,3,6,7,8-HCDD and 1,2,3,7,8,9-HCDD were further evaluated (Table 3).

Polychlorinated Biphenyls

Polychlorinated biphenyls (PCBs) were manufactured as a mixture of individual PCB compounds. The most common being the Aroclor series [ATSDR 2000]. The Report included both the individual Aroclor results as well as total PCB results. Each of the detected results exhibited only one detected Aroclor (Aroclor 1260). Therefore, DSHS used the total PCB concentration for a given sample. Only 5 of the 47 samples collected detected PCBs.

The concentration of total PCBs in 2 soil samples (samples HHD-11 and HHD-18) exceeded the CV (Table 2; Figure 1). Therefore, PCBs were further evaluated.

Hexavalent Chromium

Hexavalent chromium was detected in 1 soil sample (sample HHD-39). The concentration was above the CV (Table 2). Therefore, hexavalent chromium was further evaluated.

Table 2. Summary of Soil Sampling Results and Comparison Values

Contaminant	Concentration Range (mg/kg)	Comparison Value/ Type (mg/kg)	Total Number of Samples Collected	Number of Samples with Chemicals Detected	Number of Samples Exceeding Comparison Value
TCDD TEQ	2.49E-7 to 9.12E-4	3.0E-06/ ATSDR CREG	47	47	44
1,2,3,6,7,8-HxCDD	3.4E-7 to 1.6E-4	6.3E-05/ ATSDR CREG	47	47	5
1,2,3,7,8,9-HxCDD	1.19E-7 to 8.03E-5	6.3E-05/ ATSDR CREG	47	47	1
2,3,4,7,8-PeCDF	2.94E-7 to 2.63E-5	0.0016/ Int EMEG	47	44	0
Total PCBs	0.037 to 1.9	0.19 / ATSDR CREG	47	6	2
Hexavalent Chromium	3.67	0.22 / ATSDR CREG	47	1	1

Abbreviations: TCDD TCEQ=2,3,7,8-tetrachlorodibenzo-p-dioxin; 1,2,3,6,7,8-HxCDD = 1,2,3,6,7,8-hexachlorodibenzo-p-dioxin; 1,2,3,7,8,9-HxCDD = 1,2,3,7,8,9-hexachlorodibenzo-p-dioxin; 2,3,4,7,8-PeCDF = 2,3,4,7,8-pentachlorodibenzofuran; PCB = polychlorinated biphenyls; mg/kg = milligrams; ASTDR = Agency for Toxic Substances and Disease Registry; Int EMEG = intermediate environmental media evaluation guides; CREG = cancer risk evaluation guides.

Bold values indicate the concentrations exceeded the comparison value.

Health Evaluation

Contaminants that exceeded their CV were further evaluated to determine if exposure to these chemicals could harm people's health. Site-specific exposure doses were calculated and compared with health guidelines. An exposure dose is an estimated amount of a contaminant that gets into a person's body over a specific time. If health guidelines were exceeded, site-specific exposure doses were compared with levels at which adverse health effects have been observed in animal or human studies. The health evaluation considers the potential noncancer and cancer health effects to the general public, including sensitive groups such as children.

DSHS calculated a 95 percent upper confidence limit (UCL) of the arithmetic mean as the exposure point concentration (the concentration of a chemical a person would be exposed to in soil) if more than 8 samples were collected, and the contaminant was detected in at least 4 samples. The maximum concentration was used as the exposure point concentration if fewer than 8 samples were collected, or the contaminant was detected in fewer than 4 samples (Table 3).

Table 3. Concentration of Contaminants of Potential Concern and Exposure Point Concentration

Contaminant of Potential Concern	Concentration Range	Exposure Point Concentration
2,3,7,8-TCDD TEQ	0.249 to 912(ng/kg)	91.5 (ng/kg)*
1,2,3,6,7,8-HxCDD	0.34 to 160 (ng/kg)	31.3 (ng/kg)*
1,2,3,7,8,9-HxCDD	0.119 to 80.3 (ng/kg)	17.3 (ng/kg)*
Total PCBs	0.037 to 1.9 (mg/kg)	1.9 (mg/kg)†
Hexavalent Chromium	3.67 (mg/kg)	3.67 (mg/kg)†

Abbreviations: 2,3,7,8-TCDD TEQ = tetrachlorodibenzo-p-dioxin toxic equivalent; 1,2,3,6,7,8-HxCDD = hexachlorodibenzo-p-dioxin; HxCDD =1,2,3,7,8,9-hexachlorodibenzo-p-dioxin; PCB = polychlorinated biphenyls; ng/kg = nanogram per kilogram; mg/kg = milligram per kilogram.

***** 95 percent upper confidence level of the arithmetic mean.

† Maximum concentration detected.

DSHS calculated potential exposures for residents, including adults (21 years and older) and children (6 to less than 21 years), living or visiting the area. DSHS assumed adults and children (6 years and older) would potentially be exposed to soils 4 days per week for 52 weeks each year, for 15 years for children and 33 years for adults. DSHS considered two exposure scenarios: an average, or central tendency exposure (CTE), scenario and a higher-

than-average, or reasonable maximum exposure (RME), scenario. CTE refers to individuals who have average or typical exposure to a contaminant. While RME refers to people who are at the high end of the exposure distribution (approximately the 95th percentile), the RME scenario is intended to assess exposures that are higher than average but still within a realistic exposure range.

Standard body weight, exposure duration, and EPA's default bioavailability factors were used to calculate the daily exposure doses (Appendix A).

Noncancer Health Effects

To evaluate possible noncancer health effects, the estimated combined ingestion and dermal exposure dose was compared to an appropriate health guideline, such as ATSDR's minimal risk level (MRL) or EPA's reference dose (RfD). A health guideline is an estimate of daily exposure to a substance over a specified duration that is unlikely to cause harmful, noncancer health effects in humans. If an estimated exposure dose is lower than the health guideline, adverse noncancer health effects are not expected to occur. If an estimated dose is higher, it does not necessarily mean it will harm people's health; it means that DSHS must conduct an in-depth evaluation to determine if adverse health effects are possible and if the exposure poses a health hazard. This is done by comparing the dose to known noncancer health effect levels reported in the scientific literature.

DSHS calculated hazard quotients (HQs) to compare estimated exposure doses to health guidelines, which are safe doses at which adverse health effects are not expected. The HQs were calculated by dividing the estimated exposure dose by the health guideline, such as the MRL. If the HQ is less than one, then adverse health effects are not likely. If the HQ is greater than one, further evaluation is warranted.

Cancer Health Effects

To estimate cancer risk for cancer-causing contaminants, the estimated exposure dose was multiplied by the contaminant's cancer slope factor. The calculated cancer risk is called an excess lifetime cancer risk, which estimates the proportion of a population that may be affected by a carcinogen during a lifetime exposure. An excess lifetime cancer risk represents the additional risk above the existing background cancer risk. It should be noted that cancer risk estimates are not a measure of the actual cancer cases in a community; rather they are a tool used by DSHS for making public health recommendations.

DSHS evaluated the potential noncancer and cancer adverse health effects from current and future exposure to contaminants, including dioxins, total PCBs, and hexavalent chromium, in soil.

Dioxins

Noncancer Health Effects

The health guideline used to determine the noncancer health effects from dioxin (including TCDD TEQ, 1,2,3,6,7,8-HxCDD and 1,2,3,7,8,9-HxCDD) exposure was EPA's RfD of 7E-10 mg/kg/day. The RfD is based on decreased sperm count and motility in men exposed to 2,3,7,8-TCDD as boys [EPA 2012].

DSHS calculated combined ingestion and dermal chronic exposure doses for children (6 years and older) and adults using the 2,3,7,8-TCDD TEQ concentration detected in soil (91.5 ng/kg). The estimated exposure doses for children (4.9E-11 to 6.5E-10 mg/kg/day) and adults (2.8E-11 to 7.4E-11 mg/kg/day) were less than the RfD (HQs less than 1) (Table 4). DSHS also determined the noncancer health effects from exposure to individual dioxin compounds detected in soil, including 1,2,3,6,7,8-HxCDD and 1,2,3,7,8,9-HxCDD. The estimated exposure doses for children and adults for both 1,2,3,6,7,8-HxCDD and 1,2,3,7,8,9-HxCDD were less than the RfD (HQs less than 1) (Table 5 and Table 6). Therefore, noncancer harmful health effects from present and future exposures to the dioxin concentrations in soil are unlikely to occur in children and adults (Table 4).

Cancer Health Effects

Human studies have shown an association between 2,3,7,8-TCDD and soft-tissue sarcomas, lymphomas, and stomach carcinomas [ATSDR 1998; ATSDR 2012]. EPA has classified 2,3,7,8-TCDD as a probable human carcinogen [EPA 2012]. Similarly, the National Toxicology Program considers dioxin as a known human carcinogen [NTP 1982]. ATSDR uses an oral cancer slope factor of 130,000 $(mg/kg/day)^{-1}$. This oral cancer slope factor was developed by California EPA based on the occurrence of hepatocellular adenomas and carcinomas in male mice [COEHHA 2011a; NTP 1982].

Using a cancer slope factor of 130,000 $(mg/kg/day)^{-1}$, DSHS estimated excess cancer risk due to long-term exposure to 2,3,7,8-TCDD TEQ (91.5 ng/kg) to be 4 to 5 in 1,000,000 people exposed (4E-6 to 5E-6) for children and 2 to 4 in 1,000,000 people exposed (2E-6 to 4E-6) for adults (Table 4). The estimated cancer risks are not a health concern.

DSHS also calculated cancer risk from exposure to individual dioxin compounds detected in soil, including 1,2,3,6,7,8-HxCDD and 1,2,3,7,8,9-HxCDD. The cancer risk for both children and adults was determined to be less than 1 in 1,000,000 people exposed (1E-6) (Table 5 and Table 6). The cancer risk is not a health concern.

Table 4. Chronic Exposure Dose, Noncancer Hazard Quotient, and Cancer Risk Estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for TCDD TEQ (9.1E-5 mg/kg) in Off-site Soil*

Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	CTE Cancer Risk	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	RME Cancer Risk
6 to <11 years	1.4E-10	<1	2E-6	3.7E-10	<1	5E-6
11 to < 16 years	5.8E-11	<1	2E-6	1.2E-10	<1	5E-6
16 to < 21 years	4.9E-11	<1	2E-6	1.0E-10	<1	5E-6
Adult	2.8E-11	<1	2E-6	7.4E-11	<1	4E-6

Abbreviations: mg/kg/day = milligram per kilogram per day; TCCD TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalent.

*The calculations in this table were generated using ATSDR's PHAST v2.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) reference dose of 7E-10 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 130,000 $(mg/kg/day)^{-1}$.

Table 5. Chronic Exposure Dose, Non-cancer Hazard Quotient, and Cancer Risk Estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for 1,2,3,6,7,8-HxCDD (3.1E-5 mg/kg) in Off-site Soil*

Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	CTE Cancer Risk	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	RME Cancer Risk
6 to <11 years	4.6E-11	<1	3E-8	1.2E-10	<1	8E-8
11 to < 16 years	2.0E-11	<1	3E-8	4.2E-11	<1	8E-8
16 to < 21 years	1.7E-11	<1	3E-8	3.4E-11	<1	8E-8
Adult	9.5E-12	<1	3E-8	2.5E-11	<1	7E-8

Abbreviations: mg/kg/day = milligram per kilogram per day; 1,2,3,6,7,8-HxCDD = hexachlorodibenzo-p-dioxin.

*The calculations in this table were generated using ATSDR's PHAST v2.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) reference dose of 7E-10 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 6,200 $(mg/kg/day)^{-1}$.

Table 6. Chronic Exposure Dose, Non-cancer Hazard Quotient, and Cancer Risk Estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for 1,2,3,7,8,9-HxCDD (1.7E-5 mg/kg) in Off-site Soil*

Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	CTE Cancer Risk	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	RME Cancer Risk
6 to <11 years	2.6E-11	<1	2E-8	6.9E-11	<1	4E-8
11 to < 16 years	1.1E-11	<1	2E-8	2.3E-11	<1	4E-8
16 to < 21 years	9.2E-12	<1	2E-8	1.9E-11	<1	4E-8
Adult	5.3E-12	<1	1E-8	1.4E-11	<1	4E-8

Abbreviations: mg/kg/day = milligram per kilogram per day; 1,2,3,7,8,9-HxCDD = hexachlorodibenzo-p-dioxin.

*The calculations in this table were generated using ATSDR's PHAST v2.2.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) reference dose of 7E-10 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 6,200 $(mg/kg/day)^{-1}$.

Polychlorinated Biphenyls (PCBs)

Noncancer Health Effects

The health guideline used to determine the noncancer health effects from total PCB exposure was ATSDR MRL of 0.00002 mg/kg/day. The MRL is

based on a lowest observed adverse effect level of 0.005 mg/kg/day for immunological effects in adult monkeys that were evaluated after 23 and 55 months of exposure to Aroclor 1254 [ATSDR 2000].

DSHS calculated combined ingestion and dermal chronic exposure doses for children (6 years and older) and adults using the highest concentration of total PCBs (1.9 mg/kg). The estimated exposure doses for children (3.0E-6 to 1.0E-5 mg/kg/day) and adults (1.2E-6 to 2.2E-6 mg/kg/day) were less than the MRL (HQs less than 1) (Table 8). Therefore, noncancer harmful health effects from present and future exposures to the PCBs are unlikely to occur in children and adults.

Cancer Health Effects

The EPA has classified PCBs as probable human carcinogens and the National Toxicology Program has classified PCBs as reasonably anticipated to be a carcinogen [EPA 1996, NTP 2021]. EPA derived a cancer slope factor of 2 $(mg/kg/day)^{-1}$ from a study that found liver tumors in female rats exposed to Aroclors 1260, 1254, 1242, and 1016, and in male rats exposed to 1260 [EPA 1996].

Using a cancer slope factor of 2 $(mg/kg/day)^{-1}$, DSHS estimated cancer risks were 2 in 1,000,000 to 3 in 100,000 exposed people (2E-6 to 3E-5) for children and 1 to 2 in 1,000,000 exposed people (1E-6 to 2E-6) for adults (Table 7). These cancer risks are not a health concern.

Table 7. Chronic Exposure Dose, Non-cancer Hazard Quotient, and Cancer Risk Estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for Total PCBs (1.9 mg/kg) in Off-site Soil*

Exposure Group	CTE Dose (mg/kg/day)	CTE Non-cancer Hazard Quotient	CTE Cancer Risk	RME Dose (mg/kg/day)	RME Non-cancer Hazard Quotient	RME Cancer Risk
6 to <11 years	5.7E-06	<1	2E-6	1.0E-05	<1	3E-5
11 to < 16 years	3.5E-06	<1	2E-6	4.8E-06	<1	3E-5
16 to < 21 years	3.0E-06	<1	2E-6	4.1E-06	<1	3E-5
Adult	1.2E-06	<1	1E-6	2.2E-06	<1	2E-6

Abbreviations: mg/kg/day = milligram per kilogram per day; PCB = polychlorinated biphenyls.

* The calculations in this table were generated using ATSDR's PHAST v2.2.0.0. The noncancer hazard quotients were calculated using the chronic (greater than 1 year) minimal

risk level of 0.00002 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 2 $(mg/kg/day)^{-1}$.

Hexavalent Chromium

Noncancer Health Effects

The health guideline used for hexavalent chromium was ATSDR's MRL of 0.0009 mg/kg/day. The MRL is based on a benchmark dose of 0.09 mg/kg/day for diffuse epithelial hyperplasia of the duodenum in mice [ATSDR 2012].

DSHS calculated combined ingestion and dermal chronic exposure doses for children (6 years and older) and adults using the only concentration of hexavalent chromium detected (3.67 mg/kg). The estimated exposure doses for children (1.5E-6 to 3.4E-5 mg/kg/day) and adults (1.1E-6 to 1.5E-5 mg/kg/day) were less than the MRL (HQs less than 1) (Table 8). Therefore, it is unlikely that the children or adults would experience noncancer health effects from hexavalent chromium in soil exposure.

Cancer Health Effects

The EPA has classified hexavalent chromium as a known human carcinogen through inhalation [EPA 1998]. Similarly, the National Toxicology Program has classified hexavalent chromium as a known human carcinogen based on occupational studies where workers exposed by inhalation developed lung cancer [NTP 2008]. The California Environmental Protection Agency derived a cancer slope factor of 0.5 $(mg/kg/day)^{-1}$ based on National Toxicology Program's animal study [COEHHA 2011b].

DSHS calculated the total cancer risk using the cancer slope factor of 0.5 $(mg/kg/day)^{-1}$ and the detected hexavalent chromium concentration. The estimated cancer risks were 5 to 6 in 1,000,000 exposed people (5E-6 to 6E-6) for children (ages 6 years to <21 years) and 1 to 2 in 1,000,000 exposed people (1E-6 to 2E-6) for adults (Table 8). The estimated cancer risks from hexavalent chromium in soil are not a health concern.

Table 8. Chronic Exposure Dose, Non-cancer Hazard Quotient, and Cancer Risk Estimations for Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME) for Hexavalent Chromium (3.7 mg/kg) in Soil*

Exposure Group	CTE Dose (mg/kg/day)	CTE Noncancer Hazard Quotient	CTE Cancer Risk	RME Dose (mg/kg/day)	RME Noncancer Hazard Quotient	RME Cancer Risk
6 to <11 years	2.4E-05	<1	5E-6	3.4E-05	<1	6E-6
11 to < 16 years	1.7E-05	<1	5E-6	2.0E-05	<1	6E-6
16 to < 21 years	1.5E-05	<1	5E-6	1.7E-05	<1	6E-6
Adult	5.3E-06	<1	1E-6	7.1E-06	<1	2E-6

Abbreviations: mg/kg/day = milligram per kilogram per day

* The calculations in this table were generated using ATSDR's PHAST v2.2.0.0. The non-cancer hazard quotients were calculated using the chronic (greater than 1 year) minimal risk level of 0.0009 mg/kg/day and the cancer risks were calculated using the cancer slope factor of 0.5 $(mg/kg/day)^{-1}$ and age-dependent adjustment factors.

Limitations

There are several limitations regarding this health consultation:

- The health risk estimates assume long-term exposure (4 days per week for 52 weeks per year, for 15 years for children and 33 years for adults) to areas not likely to be continuously occupied. They were based on the results of one sampling event and in some cases based on the maximum result of chemicals (PCBs and hexavalent chromium) only detected in one location.
- All samples were collected offsite from UPRR-HPWP. Conclusion are limited to the sample locations.
- The data set from the Report may not adequately represent residential exposure due to the irregular distribution and spacing of soil sample locations.
- Estimating an exposure dose requires determining how much, how often, and how long a person may be exposed to contaminants. Although DSHS' assumptions were health protective, each person's exposure could be higher or lower and risks may vary based on factors such as genetics and lifestyle (e.g., diet, physical activity, smoking).
- The conclusions are based on soil samples at a point in time.

Conclusions

Based on the data provided in the Report, DSHS concludes that incidental swallowing or coming into contact with soil contaminants (dioxins, PCBs, and hexavalent chromium) in the area sampled is not expected to harm people's health.

Basis for Conclusion

To evaluate the potential for noncancer and cancer effects, DSHS used site-specific exposure assumptions and a higher-than-average (reasonable maximum) exposure scenario. Exposure doses for the adults (21 years and greater) and children (six to less than 21 years) were less than the health guidelines. Long-term (more than one year) exposures to dioxins, PCBs, and hexavalent chromium are not expected to cause noncancer health effects.

DSHS also concluded there is no cancer concern from exposure to chemicals detected in soil. This is because the cancer risk values are not distinguishable from the range of variability of cancer cases occurring without exposure to these chemicals of potential concern.

References

[ATSDR 1998] Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Atlanta: ATSDR, December 1998. Available from: https://www.atsdr.cdc.gov/toxprofiles/tp104.pdf.

[ATSDR 2000] Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polychlorinated Biphenyls (PCBs). Atlanta: ATSDR, November 2000. Available from: https://www.atsdr.cdc.gov/ToxProfiles/tp17.pdf.

[ATSDR 2005] Agency for Toxic Substances and Disease Registry. January 2005. Public Health Assessment Guidance Manual. Atlanta: ATSDR 2005 Available from: https://www.hhs.gov/guidance/document/atsdr-public-health-assessment-guidance-manual.

[ATSDR 2012] Agency for Toxic Substances and Disease Registry. Addendum to the Toxicological Profile for Chlorinated Dibenzo-p-Dioxins. Atlanta: ATSDR, November 2012. Available from: https://www.atsdr.cdc.gov/toxprofiles/cdds_addendum.pdf.

[ATSDR 2019] Agency for Toxic Substances and Disease Registry (ATSDR). ATSDR Office of Community Health Hazard Assessment Toxic Equivalents Guidance for Dioxin and Dioxin-like Compounds: Atlanta: ATSDR, 2019; Available from: https://www.atsdr.cdc.gov/pha-guidance/resources/ATSDR-TEQ-Guidance-Dioxin-and-Dioxin-like-Compounds-508.pdf.

[COEHHA 2011a] California Office of Environmental Health Hazard Assessment. 2,3,7,8-Tetrachlorodibenzo-p-dioxin and related compounds Potency Information. 2011. Available from: https://oehha.ca.gov/chemicals/2378-tetrachlorodibenzo-p-dioxin-and-related-compounds.

[COEHHA 2011b] California Office of Environmental Health Hazard Assessment. Chromium-Hexavalent Cancer Potency Information. 2011. Available from: https://oehha.ca.gov/chemicals/chromium-hexavalent.

[EPA 1996] U.S. Environmental Protection Agency. Integrated Risk Information System. Chemical Assessment Summary. Polychlorinated Biphenyls (PCBs). 1996, Available from: https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0294_summary.pdf#nameddest=woe.

[EPA 1998] U.S. Environmental Protection Agency. Toxicological Review of Hexavalent Chromium. 1998, Available from: https://iris.epa.gov/static/pdfs/0144tr.pdf.

[EPA 2012] U.S. Environmental Protection Agency. Integrated Risk Information System. Chemical Assessment Summary. 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD). 2012. Available from: https://iris.epa.gov/static/pdfs/1024_summary.pdf.

[Epperson 2022] Soil Sampling Report: Neighborhood Around Former Union Pacific Railroad Houston Wood Preserving Works 4910 Liberty Road Houston, TX 77026. Epperson Environmental Group LLC. September 20, 2022.

[NTP 1982] National Toxicology Program. Technical Report on the Carcinogenesis Bioassay of 2,3,7,8- Tetrachlorodibenzo-p-dioxin in Osborne-Mendel Rs and B6C3F-1 Mice. Technical Report Series National Toxicology Program. U.S Department of Health and Human Services. February 1982. Available from: https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr201.pdf?utm_source=direct&utm_medium=prod&utm_campaign=ntpgolinks&utm_term=tr201.

[NTP 2008] National Toxicology Program. Technical Report on the Toxicology and Carcinogenesis Studies of Sodium Dichromate Dihydrate in F344/N Rats and B6C3F1 Mice. 2008. Available from: https://ntp.niehs.nih.gov/ntp/htdocs/lt_rpts/tr546.pdf.

[NTP 2021] National Toxicology Program. U.S. Department of Health and Human Services. 15th Report on Carcinogens. Profile: Polychlorinated Biphenyls. 2021, Available from: https://ntp.niehs.nih.gov/ntp/roc/content/profiles/polychlorinatedbiphenyls.pdf.

[PEH 2008] Public England Health. Dioxins Toxicological Overview. Centre for Radiation, Chemical and Environmental Hazards, 2008.

Appendix A: Site-specific Exposure Factors and Contaminant Information

Site-specific Exposure Factors

Duration Category	Days per Week	Weeks per Year	Years	Exposure Group Specific $EF_{noncancer}$	Exposure Group Specific* EF_{cancer}
Chronic	4	52.14	15 (child) 33 (adult)	0.57	= $EF_{noncancer}$ x Exposure Duration for Cancer $_{Exposure\ Group}$ (years) ÷ 78 years

Abbreviations: EF = exposure factor
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)
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)	-	15	-	-	-	-
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	Concentration (ng/kg)	EPC Type	Converted Concentration* (mg/kg)	Dermal Absorption Fraction	ABS_{GI}	Bioavailability Factor
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	31.1	95% UCL of the mean	3.1E-5	0.03	1	1

Contaminant Name	Concentration (ng/kg)	EPC Type	Converted Concentration* (mg/kg)	Dermal Absorption Fraction	ABS_{GI}	Bioavailability Factor
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	17.3	95% UCL of the mean	1.7E-5	0.03	1	1
2,3,7,8-TCDD TEQ	91.5	95% UCL of the mean	9.2E-5	0.03	1	1
Polychlorinated biphenyls	1.9	Maximum	1.9	0.14	1	1
Hexavalent Chromium	3.7	Maximum	3.7	0.01	0.025	1

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

* Contaminant concentration converted to standard unit for calculating exposure.

Appendix B:

Example TEQ Calculation with Detected Dioxin Results from Sample HHD-01 4-8"

Dioxin Compound	Analytical Result (ng/kg)	TEF*	TEC†
1,2,3,7,8-PeCDD	1.08	1.0	1.08
1,2,3,4,7,8-HxCDD	3.26	0.1	0.326
1,2,3,6,7,8-HxCDD	8.80	0.1	0.880
1,2,3,7,8,9-HxCDD	5.30	0.1	0.530
1,2,3,4,6,7,8-HpCDD	635	0.01	6.35
OCDD	8650	0.0003	2.60
2,3,7,8-TCDF	0.341	0.1	0.0341
1,2,3,7,8-PeCDF	0.462	0.03	0.0139
2,3,4,7,8-PeCDF	1.83	0.3	0.549
1,2,3,4,7,8-HxCDF	2.42	0.1	0.242
1,2,3,6,7,8-HxCDF	1.45	0.1	0.145
1,2,3,7,8,9-HxCDF	0.363	0.1	0.0363
2,3,4,6,7,8-HxCDF	2.38	0.1	0.238
1,2,3,4,6,7,8-HpCDF	59.2	0.01	0.592
1,2,3,4,7,8,9-HpCDF	1.87	0.01	0.0187
OCDF	251	0.003	0.0753
		2,3,7,8-TCDD TEQ††	13.71

Abbreviations: 1,2,3,7,8-PeCDD = pentachlorodibenzo; 1,2,3,4,7,8-HxCDD = 1,2,3,4,7,8-hexachlorodibenzo-p-dioxin; 1,2,3,6,7,8-HxCDD = hexachlorodibezo-p-dioxin; 1,2,3,7,8,9-HxCDD = hexachlorodibenzo-p-dioxin; 1,2,3,4,6,7,8-HpCDD = heptachlorodibenzo-p-dioxin; OCDD = octachlorodibenzodioxin; 2,3,7,8-TCDF = tetrachlorodibenzofuran; 1,2,3,7,8-PeCDF = pentachlorodibenzofuran; 1,2,3,7,8-PeCDF = pentachlorodibenzofuran; 2,3,4,7,8-PeCDF = pentachlorodibenzofuran; 1,2,3,4,7,8-HxCDF = hexachlorodibenzofuran; 1,2,3,6,7,8-hexachlorodibenzofuran; 1,2,3,7,8,9-HXCDF = hexachlordibenzofuran; 2,3,4,6,7,8-HxCDF = hexachlorodibenzofuran; 1,2,3,4,6,7,8-HpCDF = heptachlorodibenzofuran; 1,2,3,4,7,8,9-HpCDF = heptachlorobenzofuran; OCDF = octachlorodibenzo-p-dioxin;
2,3,7,8 TCDD TEQ = tetrachlorodibenzo-p-dioxin toxic equivalent; ng/kg = nanogram per kilogram.

*World Health Organization 2005 Toxic Equivalent Factors (TEF) for Dioxins and Dioxin-like Compounds
†Toxic Equivalent Concentration (TEC) for each compound = Analytical Result x TEF
††2,3,7,8-TCDD TEQ for a sample = Sum of TECs for detected compounds