Health Consultation

PUBLIC COMMENT VERSION

Indoor Dust
Nearby Residential Houses

CABOT CARBON-KOPPERS
SUPERFUND HAZARDOUS WASTE SITE
GAINESVILLE, ALACHUA COUNTY, FLORIDA

EPA FACILITY ID: FLD980709356

Prepared by
Florida Department of Health

MAY 9, 2013

COMMENT PERIOD ENDS: JUNE 24, 2013

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Community Health Investigations
Atlanta, Georgia 30333
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# Table of Contents

Foreword............................................................................................................................ iii
Summary.............................................................................................................................. 1
Background and Statement of Issues .................................................................................. 2
Community Health Concerns............................................................................................. 6
Discussion........................................................................................................................... 6
Health Outcome Data.......................................................................................................... 15
Child Health Considerations............................................................................................. 15
Community Health Concerns Evaluation .......................................................................... 15
Conclusions....................................................................................................................... 16
Recommendations............................................................................................................. 16
Public Health Action Plan................................................................................................. 16
Author and Technical Reviewer ....................................................................................... 18
References......................................................................................................................... 19
Appendices......................................................................................................................... 24
Report Preparation........................................................................................................... 42
Foreword

The Florida Department of Health (DOH) evaluates the public health threat of hazardous waste sites through a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry in Atlanta, Georgia. This health consultation is part of an ongoing effort to evaluate health effects associated with contaminated soil from the Cabot Carbon-Koppers Superfund hazardous waste site. The Florida DOH evaluates site-related public health issues through the following processes:

■ Evaluating exposure: Florida DOH scientists begin by reviewing available information about environmental conditions at the site. The first task is to find out how much contamination is present, where it is, and how human exposures might occur. The US Environmental Protection Agency provided the information for this assessment.

■ Evaluating health effects: If Florida DOH finds evidence that exposures to hazardous substances are occurring or might occur, Florida DOH scientists will determine whether that exposure could be harmful to human health. Florida DOH focuses this report on public health; that is, the health impact on the community as a whole, and base it on existing scientific information.

■ Developing recommendations: In this report, the Florida DOH outlines, in plain language, its conclusions regarding any potential health threat posed by indoor dust, and offers recommendations for reducing or eliminating exposure. The role of the Florida DOH is primarily advisory. For that reason, the evaluation report will typically recommend actions for other agencies, including the US Environmental Protection Agency and the Florida Department of Environmental Protection. If, however, an immediate health threat exists or is imminent, Florida DOH will issue a public health advisory warning people of the danger, and will work to resolve the problem.

■ Soliciting community input: The evaluation process is interactive. The Florida DOH starts by soliciting and evaluating information from various government agencies, individuals or organizations responsible for cleaning up the site, and those living in communities near the site. Florida DOH shares conclusions about the site with the groups and organizations providing the information. Once they prepare a draft report, they seek feedback from the public.

If you have questions or comments about this report, please contact us.
Please write to: Public Health Toxicology Section
Bureau of Epidemiology
Florida Department Health
4052 Bald Cypress Way, Bin # A-08
Tallahassee, FL 32399-1712

Or call us at: 850 245-4299 or toll-free in Florida: 1-877-798-2772
Summary

INTRODUCTION At the Cabot Carbon-Koppers hazardous waste site, the Florida Department of Health (DOH) and the US Agency for Toxic Substances and Disease Registry’s (ATSDR) top priority is to ensure nearby residents have the best information to safeguard their health.

The Koppers portion of this site is at 200 North 23rd Avenue in Gainesville, Florida. Between 1916 and 2009, the Koppers facility made pressure treated wood which contaminated soil with chlorinated dioxins/furans. Nearby residents are concerned dust in their houses is a health threat.

CONCLUSION #1 Dust in Gainesville area background houses and select houses near the Koppers facility is not likely to cause non-cancer illness. In addition, the estimated increased cancer risk in these houses is very low.

BASIS FOR DECISION #1 The highest chlorinated dioxin/furan dose from accidentally ingesting (swallowing) indoor dust in? 13 Gainesville area background houses and 17 houses near the Koppers facility is below health guidelines. The highest estimated increased cancer risk from lifetime exposure is 1 in 100,000 or $1 \times 10^{-5}$. This estimate means that 1 person out of 100,000 people exposed over a lifetime might develop cancer.

CONCLUSION #2 Concentrations of chlorinated dioxins/furans in dust from selected houses near the Koppers facility are higher than concentrations in dust from Gainesville area background houses.

BASIS FOR DECISION #2 Concentrations of chlorinated dioxins/furans in dust from 17 houses near the Koppers facility are statistically higher than 13 Gainesville area background houses.
CONCLUSION #3 The past health risk from chlorinated dioxins/furans in the dust of these houses prior to 2012 is unknown.

BASIS FOR DECISION #3 There was no testing of indoor dust specifically for chlorinated dioxins/furans prior to 2012.

CONCLUSION #4 Health scientists know too little about the toxicity of the brominated dioxins/furans to assess their health risk.

BASIS FOR DECISION #4 Although some studies suggest the toxicities of the brominated dioxins/furans are similar to their chlorinated counterparts, health scientists know too little to quantify the health risk.

NEXT STEPS EPA will consider this report before deciding on any cleanup inside houses near the Koppers facility.

FOR MORE INFORMATION If you have concerns about your health or the health of your children, you should contact your health care provider. You may also call the Florida DOH toll-free at 877 798-2772 and ask for information about the Cabot Carbon-Koppers Superfund hazardous waste site.

Background and Statement of Issues

The purpose of this health consultation report is to assess the public health threat from exposure to dioxin contaminated dust in select houses near the Koppers portion of the Cabot Carbon-Koppers Superfund hazardous waste site in Gainesville. The US Environmental Protection Agency (EPA) requested this assessment.

Many sources contribute to dust inside houses. Sources of dust from inside the house include:
1. The breakdown of plant and animal materials including food debris, animal hairs/dander, feathers, insect parts from cockroaches and dust mites, human skin scales, and molds/mildew;
2. Cotton and wool from the disintegration of clothing, carpets, and furniture as well as stuffing in mattresses, pillows, quilts, and upholstered furniture;
3. Materials deliberately released indoors including tobacco/fireplace smoke, cosmetic/baby powders, powdered laundry detergents, cooking/food particulates, and various sprays and aerosols.

Indoor dust also comes from sources outside the house. Dust from outside the house can enter directly through open windows and doors and/or from tracking in soil from outdoors. Estimates of the contribution of outdoor soil to indoor dust range between 30 and 70% [Trowbridge 1997, EPA 1998, Layton 2009]. Outdoor sources of dioxin contaminated dust include industrial facilities such as pulp/paper mills and wood treating plants, exhaust from automobiles, lawnmowers, and other internal combustion engines and smoke from grills, fireplaces, and debris/trash fires.

Indoor sources of dioxins and dioxin-like contaminants include PCBs found in old fluorescent light capacitors, paints, caulks, and plasticizers, as well as dioxin-contaminated pesticides and home furnishings that incorporate dioxin-like chemicals [O’Conner 2005, UM 2006].

Studies of U.S. houses in background, “unpolluted” areas found average chlorinated dioxin/furan concentrations in indoor dust between 10 and 20 picograms per gram (pg/g) or parts per trillion (ppt) as measured by 2,3,7,8-tetrachlorodibenzo-p-dioxin toxicity equivalence or TCDD-TEQ [UM 2006, O’Conner 2005]. Studies of dust from living spaces in houses near dioxin sources found average chlorinated dioxin/furan (TCDD-TEQ) levels between 50 and 300 pg/g or ppt [ATSDR 2007a, 2007b, 2009b, EPA 2005, 2008, 2010b].

In April 2010, representatives of 12 Stephen Foster neighborhood residents claimed they found dioxin-like compounds in the dust of nine area houses using the Chemical-Activated Luciferase Expression (CALUX®) screening bioassay test [Parsons 2010]. Using this same bioassay, in February 2011 these representatives claimed they found dioxin-like compounds in the dust of another 105 area houses [Calwell 2011]. Residents wanted to know if dust in their houses was a health risk.

Florida DOH/ATSDR cannot assess the health risk based on the results of the CALUX® screening bioassay. Studies show that concentrations of dioxin-like compounds measured by the CALUX® screening bioassay tend to exceed those concentrations of chlorinated dioxins/furans measured by standard GC/MS methods. In addition to chlorinated dioxins/furans, the CALUX® bioassay responds to a variety of polyhalogenated diaromatic hydrocarbon compounds including brominated dioxins/furans, polychlorinated and polybrominated biphenyls, chlorinated and brominated naphthalenes, and others.
Representatives of the 12 Stephen Foster neighborhood residents analyzed 10 indoor dust samples they collected in 2010 using both the CALUX® and standard GC/MS methods [Calwell 2012]. In these 10 samples, the concentration of dioxin-like compounds measured by the CALUX® screening bioassay over-estimated the concentration of dioxins measured by the standard GC/MS anywhere from 13% to 1,771%. This range of differences between the two tests is too large to use an average difference to reliably estimate dioxin concentrations in other dust samples based on the CALUX® results.

In July 2011, a workgroup of county/state/federal health & environmental agencies, University of Florida toxicologists, community leaders, and the responsible party determined the documentation supporting the CALUX® screening bioassay test results was inadequate to assess the public health threat. This workgroup recommended EPA investigate the levels of chlorinated dioxins/furans in indoor dust using a standard gas chromatograph/mass spectrometer (gc/ms) test [DOH 2011c].

In May 2012, EPA collected dust samples from 17 houses near the Koppers facility and 13 Gainesville area background houses distant from the Koppers facility. EPA analyzed these dust samples using the standard gc/ms test for chlorinated dioxins/furans (EPA method 1613). They also analyzed the dust samples for brominated dioxins/furans. Lastly, they analyzed the dust samples for dioxin-like compounds using the CALUX® screening bioassay [EPA 2012]. The concentrations of chlorinated dioxins/furans in the dust of these houses prior to 2012 is unknown.

This health consultation report compares the contaminant concentrations found by EPA in select houses near the Koppers facility to Gainesville area background houses. It assesses the public health threat based on EPA’s standard gc/ms test (EPA method 1613) for chlorinated dioxins/furans. It addresses incidental dust ingestion (swallowing) but not dust inhalation or skin contact. This assessment calculates a traditional exposure dose based on a fixed dust ingestion rate. It also calculates an alternative exposure dose based on the amount of dust present (loading) but does not rely on this dose to estimate the health risk. Finally this assessment compares the chlorinated and brominated dioxin concentrations to the concentration of dioxin-like compounds using the CALUX® bioassay.

This assessment requires the use of assumptions, judgments, and incomplete data. These factors contribute to uncertainty in evaluating the health threat. Assumptions and judgments in this assessment err on the side of protecting public health and may overestimate the risk.

This assessment estimates the health risk for individuals exposed to the highest measured level of dioxins. This assessment, however, does not apply equally to all nearby residents. Not all nearby residents were exposed to the highest measured level of contamination. The health risk for most nearby residents is less than the health risk estimated in this report.
Site Description

The Cabot Carbon-Koppers Superfund hazardous waste site is near the intersection of North 23rd Avenue and North Main Street in Gainesville, Alachua County, Florida, 32601 (Figure 1). In September 1984, EPA listed this site on their Superfund National Priorities List.

Chemical treatment of wood to prevent rot and decay occurred on the Koppers portion of the site between 1916 and 2009. Soil on the 90-acre Koppers portion of the site is contaminated with dioxins and other chemicals. Ground water is also contaminated. In 2009, the highest concentration of dioxins (expressed as 2,3,7,8-tetrachlorodibenzo dioxin toxicity equivalents or TCDD-TEQ) was 170,635 picogram per gram (pg/g) or parts per trillion (ppt) in surface soil in the northeastern portion of the site. The highest TCDD-TEQ concentration on the site along the western boundary near the Stephen Foster neighborhood was 907 pg/g (ppt). In the past, winds likely carried dioxin-contaminated soil (dust) offsite.

Since 2009, consultants for the party responsible for the Koppers facility have tested over 90 surface soil samples (0-6 inches deep) in the adjacent neighborhood. They found TCDD-TEQ concentrations in nearby neighborhood soil from a high of 1,302 pg/g (ppt) in the easement next to the western Koppers facility boundary to a low of 1 pg/g (ppt) northwest of the facility. The pattern of decreasing dioxin concentration with distance from the Koppers facility suggests that wind-blown dust deposition from Koppers facility was a major source of dioxins in adjacent neighborhood surface soil.

Ground water cleanup under the Koppers facility has been on-going for many years. Nearby residents use municipal water. The responsible party is testing more soil in the adjacent neighborhood to determine the extent of dioxin contamination. The EPA record of decision requires the responsible party to remove dioxin contaminated soil in the adjacent neighborhood and to consolidate/contain on-site soil contamination.

Previous Health Assessments

In 1989, the Florida Department of Health (DOH) found the Cabot Carbon-Koppers site a potential health risk, recommended warning signs, and recommended additional environmental testing [ATSDR 1989]. In 1993, Florida DOH recommended a more comprehensive public health assessment [ATSDR 1993].

In 1995, Florida DOH found arsenic levels in Springstead Creek sediments at the Koppers facility drainage ditch outfall could cause illness and recommended additional testing. Florida DOH also recommended posting warning signs and restricting site access [ATSDR 1995].

In a series of three health consultation reports, Florida DOH reviewed soil test results from the adjacent neighborhood [ATSDR 2009b, 2010, 2011b]. They found dioxin contamination in the 30-foot wide easement just west of Koppers facility could possibly harm children’s health. Florida DOH recommended parents keep children from playing...
in this easement. The responsible party erected a permanent fence and posted permanent
warning signs along this easement. Florida DOH concluded incidental ingestion
(swallowing very small amounts) of dioxin-contaminated surface soil in the adjacent
neighborhood was not expected to harm children or adults. Accidentally swallowing
very small amounts of this soil over a lifetime may however result in an estimated “very
low” increased risk of cancer. Florida DOH recommended additional soil testing.

Florida DOH reviewed sediment test results from Springstead and Hogtown Creeks that
drain the site and concluded that current contaminant levels were not a public health
threat. Due to the lack of testing, Florida DOH could not conclude the risk from
exposures between 1979 and 2006 [ATSDR 2011a]. Florida DOH tested eggs from
nearby home grown chickens and found dioxin levels were not harmful [DOH 2011a].

Demographics

Approximately 7,170 people live within one mile of the Cabot Carbon-Koppers site.
Sixty-three percent (63%) are white, 31% are African-American, 4% are Hispanic origin,
and 2% are of other descent. Twenty-two percent (22%) are less than 18 years old.
Forty-four percent (44%) have a high school diploma or less and 56% have at least two
years of college. Ninety-one percent (91%) speak only English and 82% make less than
$50,000 a year [EPA 2010a].

Land Use

Land use immediately west of the Koppers facility is residential. Further to the west,
land use is mixed residential/commercial. Land use immediately to the north and south
of the Koppers facility is mixed residential/commercial/industrial. Land use east of the
Koppers facility (on the former Cabot Carbon portion of the site) is commercial.

Community Health Concerns

For many years nearby residents, especially those in the neighborhood west of Koppers
facility, have been concerned about their health. After discovery of dioxin contaminated
soil in some yards just west of Koppers facility, they were concerned that contaminated
dust in their houses may be affecting their health.

Discussion

Pathway Analyses

Chemical contamination in the environment can harm your health but only if you have
contact with those contaminants (exposure). Without contact or exposure, there is no
harm to health. If there is contact or exposure, how much of the contaminants you
contact (concentration), how often you contact them (frequency), for how long you
contact them (duration), and the danger of the contaminant (toxicity) all determine the
risk of harm.

Knowing or estimating the frequency with which people could have contact with
hazardous substances is essential to assessing the public health importance of these
contaminants. To decide if people can contact contaminants at or near a site, Florida
DOH looks at human exposure pathways. Exposure pathways have five parts. They are:

1. a source of contamination like a hazardous waste site,
2. an environmental medium like air, water, or soil that can hold or move the
contamination,
3. a point where people come into contact with a contaminated medium like water at the
tap or soil in the yard,
4. an exposure route like ingesting (contaminated soil or water) or breathing
(contaminated air),
5. a population who could be exposed to contamination like nearby residents.

Florida DOH eliminates an exposure pathway if at least one of the five parts referenced
above is missing and will not occur in the future. Exposure pathways not eliminated are
either completed or potential. For completed pathways, all five pathway parts exist and
exposure to a contaminant has occurred, is occurring, or will occur. For potential
pathways, at least one of the five parts is missing, but could exist. Also for potential
pathways, exposure to a contaminant could have occurred, could be occurring, or could
occur in the future.

For this assessment Florida DOH evaluates the long-term health threat from incidental
ingestion (swallowing) very small amounts of indoor dust. For this completed pathway,
dust from the Koppers facility is the source. Dust, blown by the wind from the site into
the nearby neighborhood, is the environmental medium. The exposure point is dust
inside approximately 200 nearby neighborhood houses. Incidental ingestion (accidentally
swallowing very small amounts of dust) is the exposure route. Ingestion of very small
amounts of dust is common in children younger than 6 years old who put fingers or toys
in their mouths. Ingestion of very small amount of dust also occurs in adults who do not
wash their hands before cooking or eating. The exposed population is approximately 500
nearby neighborhood residents (Table 1).

This report does not address inhalation of indoor dust. Because of the large day to day
variation in indoor air quality, the 2011 dioxin dust workgroup (made up of county/state/
federal health & environmental agencies, University of Florida toxicologists, community
leaders, and the responsible party) did not recommend indoor air testing. This report
also does not address skin contact with dioxins in indoor dust. Health scientists know too
little about the toxicity of dioxins from skin contact to assess the health risk.
Environmental Data

In March 2012, EPA collected composite indoor dust samples from 17 houses near the Koppers facility. These houses were in an area bonded on the east by the Koppers facility, on the south by NW 23rd Avenue, on the west by NW 6th Street, and on the north by NW 33rd Avenue (Figure 1). EPA also collected composite indoor dust samples from 13 unaffected background houses two miles northwest and two miles southwest of the Koppers facility.

EPA collected composite dust samples from rugs, carpets, and hard surface floors in high traffic areas (main entrance, main living area, and bedroom). They collected these samples as prescribed by EPA Standard Operating Procedure 2040 using a Nilfisk GS-80 vacuum equipped with a high efficiency particulate air (HEPA) filter [EPA 2002]. To estimate dust loading, EPA also measured the dimensions of the dust collection surface area [EPA 2012].

In some houses, EPA also collected a dust sample from the owner’s vacuum cleaner bag. Florida DOH did not consider these samples, because the source of this dust is unverifiable.

Testing of dust from inside 17 houses near the Koppers facility and 13 Gainesville area background houses is adequate for an initial assessment. EPA tested the number of houses suggested in the 2011 dust investigation/interpretation plan. Since EPA did not report the street addresses of the houses tested, it is not possible to determine whether these houses are representative of the neighborhood. Additionally, it is not possible to evaluate the relationship between indoor dust contamination and either distance from the Koppers facility or contaminant concentrations in outdoor soil.

EPA analyzed the dust samples for chlorinated dioxins/furans using standard EPA gc/ms method 1613. Along with EPA method 8920, EPA method 1613 is the standard for detection and quantitative measurement of polychlorinated dibenzo-p-dioxins (tetra- through octachlorinated homologues; PCDDs), and polychlorinated dibenzofurans (tetra- through octachlorinated homologues; PCDFs) in a variety of environmental matrices at part-per-trillion (ppt) to part-per-quadrillion (ppq) concentrations. This long-established method is the definitive standard for determining dioxin concentrations in soil, sediment, fly ash, water, sludge (including paper pulp), still bottom, fuel oil, chemical reactor residue, fish tissue, and human adipose tissue. For this investigation, the TCDD-TEQ concentration includes only those congeners with a concentration above the detection limit.

EPA also analyzed the dust samples for brominated dioxins/furans using a method similar to EPA methods 8290 and 1613. Brominated dioxins/furans are low level (part per billion) contaminants in polybrominated diphenyl ethers. A variety of consumer products contain polybrominated diphenyl ethers to make them slow to burn. These flame retardant containing products include furniture, upholstery, electrical equipment (television cabinets), textiles, carpet padding, and other household products. Break down or physical abrasion of these household products creates dust containing polybrominated
diphenyl ethers as well as low levels of brominated dioxins/furans [ATSDR 2004, Butte and Heinzow 2002].

In addition to the chlorinated and brominated dioxins/furans, EPA had a laboratory analyze the dust samples using the Chemical-Activated Luciferase Expression (CALUX®) screening bioassay test, EPA Method 4435 [EPA 2012]. CALUX® is a relatively new bio-analytical screening procedure for dioxin-like compounds in soils/sediments. EPA has not validated this method for dust samples. EPA bases this method on the ability of dioxin and related chemicals to activate the aryl hydrocarbon receptor (AhR), a chemical-responsive DNA binding protein that mediates the toxic and biological effects of these chemicals. The CALUX® method compares the bioluminescence response from dioxin-like chemicals in a sample extract to a standard response from different concentrations of 2,3,7,8-TCDD to report a CALUX® TCDD Bio-TEQ concentration in a sample.

For soil tests, there is some correlation between the CALUX® method and EPA methods 1613 and 8290. The TCDD Bio-TEQ concentrations reported by the CALUX® method, however, tend to be higher than the TCDD-TEQ concentrations reported using EPA methods 1613 and 8290. To varying degrees, the CALUX® method responds to other compounds including brominated and fluorinated dioxins/furans, biphenyls, and naphthalenes. These compounds contribute to the CALUX® TCDD Bio-TEQ method results but not standard EPA method results.

Specifically, the CALUX® test is responsive to polybrominated diphenyl ethers (PBDEs) which are used as flame retardant in fabrics, electronic plastics (TVs and PCs), and other household products. The CALUX® test is also sensitive to polybrominated dibenzo dioxins (PBDDs), polybrominated dibenzofurans (PBDFs), and polybrominated biphenyls (PBBs) which are all breakdown products of PBDEs. All of these chemicals are likely found in indoor dust. Thus CALUX® responds to many brominated compounds found in house dust potentially leading to higher estimates of dioxin concentrations than identified by standard EPA methods 8290 and 1613.

Tables 2 through 5 summarize the chlorinated dioxins/furans and brominated dioxins/furans using EPA analytical methods and the CALUX® test results for dust from Gainesville area background houses and select houses near the Koppers facility.

Compared to Gainesville area background houses, houses near the Koppers facility on average have higher concentrations of TCDD-TEQ in indoor dust. Using the non-parametric Wilcoxon Rank Sum Test [DEP 2012], there is a 95% chance that the mean/median concentrations of TCDD-TEQ in dust from the 17 houses near the Koppers facility are higher than the mean/median concentrations of TCDD-TEQ in the dust from the 13 Gainesville area background houses.

In general, the concentrations of dioxin-like compounds in indoor dust measured by the CALUX® test were greater than the standard EPA test for just TCDD-TEQ. As expected, in most (9/10) background houses, the concentrations of TCDD-TEQ in indoor dust was less than the concentration of all the dioxin-like compounds measured with the
CALUX® screening bioassay. In more than half (10/17) of the houses near the Koppers facility, the concentrations of TCDD-TEQ in indoor dust was less than the concentration of all the dioxin-like compounds measured with the CALUX® screening bioassay. The presence of the brominated dioxins/furans partially explains why the CALUX® concentrations were higher than the TCDD-TEQ concentrations.

**Identifying Contaminants of Concern**

There are no Agency for Toxic Substance and Disease Registry (ATSDR), EPA, or Florida Department of Environmental Protection (DEP) comparison values for indoor dust. Florida DOH evaluated the health risk from exposure to the levels of chlorinated dioxins/furans that were measured using standard EPA method 1613.

Although some studies suggest the toxicities of the brominated dioxins/furans are similar to their chlorinated counterparts [Mennear and Lee 1994, Birnbaum, et al 2003], health scientists know too little about the toxicity of the brominated dioxins/furans to quantify the health risk. Therefore in this document, Florida DOH includes the brominated dioxins/furans concentrations but cannot assess the health risk.

Florida DOH also reports the CALUX® screening bioassay test results. Florida DOH cannot, however, assess the health risk based on the results of the CALUX® screening bioassay. Studies show that concentrations of dioxin-like compounds measured by the CALUX® screening bioassay tend to exceed those concentrations of chlorinated dioxins/furans measured by standard methods. In addition to chlorinated dioxins/furans, the CALUX® bioassay responds to a variety of poly-halogenated diaromatic hydrocarbon compounds including brominated dioxins/furans, polychlorinated and polybrominated biphenyls, chlorinated and brominated naphthalenes, and others.

**Public Health Implications**

Florida DOH provides site-specific public health recommendations on the basis of toxicological literature, levels of environmental contaminants, evaluation of potential exposure pathways, duration of exposure, and characteristics of the exposed population. Whether a person will be harmed depends on the type/amount of contaminant, how they are exposed, how long they are exposed, how much contaminant is absorbed, genetics, and individual lifestyles.

After identifying contaminants of concern, Florida DOH evaluates exposures by estimating daily doses for children and adults. Karmin [1988] explains the concept of dose as follows:

“…all chemicals, no matter what their characteristics, are toxic in large enough quantities. Thus, the amount of a chemical a person is exposed to is crucial in deciding the extent of toxicity that will occur. In attempting to place an exact number on the amount of a particular compound that is harmful, scientists recognize they must consider the size of an organism. It is unlikely, for example,
that the same amount of a particular chemical that will cause toxic effects in a 1-pound rat will also cause toxicity in a 1-ton elephant.

Thus instead of using the amount that is administered or to which an organism is exposed, it is more realistic to use the amount per weight of the organism. Thus, 1 ounce administered to a 1-pound rat is equivalent to 2,000 ounces to a 2,000-pound (1-ton) elephant. In each case, the amount per weight is the same; 1 ounce for each pound of animal.”

This amount per weight is the dose. Toxicology uses dose to compare toxicity of different chemicals in different animals. Florida DOH uses the units of milligrams (mg) of contaminant per kilogram (kg) of body weight per day (mg/kg/day) to express doses in this assessment. A milligram is 1/1,000 of a gram; a kilogram is approximately 2 pounds.

For this report, Florida DOH estimated an incidental indoor dust ingestion dose using two different methods. First, they estimated a traditional dose based on a fixed incidental dust ingestion (swallowing) rate. This traditional method is independent of the amount of dust present. Second, they estimated an alternate dose based on the dioxin loading (weight of dioxin per surface area). This alternate method assumes the amount of dust ingested per day varies with the amount dust present. The more dust blows in or is tracked in, the higher the amount of dust ingested and the higher the dose.

**Traditional Indoor Dust Ingestion Dose**

To calculate a traditional dust ingestion dose, Florida DOH uses standard exposure factors [ATSDR 2005; EPA 1997]. Florida DOH assumes people are exposed daily to the maximum dioxin concentration measured. Florida DOH also makes the health protective assumption that 100% of the ingested dioxins are absorbed into the body. The percent actually absorbed into the body, however, is likely less.

The general formula for estimating a dose is:

$$ D = \frac{(C \times IR \times EF)}{BW} $$

- **D** = exposure dose (milligrams per kilogram per day or mg/kg/day)
- **C** = contaminant concentration (picograms per gram or pg/g)
- **IR** = intake rate for indoor dust (milligrams per day or mg/day)
- **EF** = exposure factor (unitless)
- **BW** = body weight (kilograms or kg)

$$ EF = \frac{F \times ED}{AT} $$

- **EF** = exposure factor (unitless)
- **F** = frequency of exposure (days/year)
- **ED** = exposure duration (years)
- **AT** = averaging time (days) (ED x 365 days/year for non-carcinogens; 78 years x 365 days/year for carcinogens)
To estimate a traditional dose, Florida DOH assumes an indoor dust ingestion rate of 60 milligrams per day for children and young adults (0.5 to 21 years) and 11 milligrams per day for adults (21+ years) (Dr. Leah Stuchal, University of Florida, personal communication 2011).

For Gainesville area background houses, Table 6 lists the traditional doses by age groups for people exposed to the maximum TCDD-TEQ concentration in indoor dust. For houses near the Koppers facility, Table 7 lists the traditional doses by age groups for people exposed to the maximum TCDD-TEQ concentration in indoor dust.

**Alternative Indoor Dust Ingestion Dose**

In addition to the traditional fixed ingestion rate dose, this assessment considers the weight of dust per surface area. Because the rate of dust generation and frequency of cleaning varies from one house to another, the amount of dust in each house varies. To estimate an alternative incidental ingestion (swallowing) dose based on dioxin dust concentrations and the amount of dust present (dust loading), Florida DOH used the following equation (Dr. Leah Stuchal, University of Florida, personal communication 2012).

\[
D = \frac{C \times SA \times FE \times ET \times FI \times DTF \times CF}{BW}
\]

- **D** = Dose from dust ingestion (mg/kg/day)
- **C** = Dust loading concentration (µg/cm²)
- **SA** = Surface area, 125 cm²/event (adult), 29.7 cm²/event (child)
- **FE** = Frequency, 10 events/hr (adult), 35.4 events/hr (child)
- **ET** = Exposure time, 8 hr/day (adult), 9.83 hr/day (child daycare)
- **FI** = Fraction ingested, 0.5 unitless
- **DTF** = Dermal transfer factor, 0.485 (µg on hand/cm² dermal contact area)/(µg on surface/cm² of contact surface)
- **CF** = Conversion factor, 10⁻³ mg/µg
- **BW** = Body weight, 76 kg (adult) and 17.4 kg (2 to 6 year old child)

The mean hand surface area for an adult male is 168 cm² per hand [EPA 1992]. It is assumed that 37.2% ± 9.4% of the whole hand area contacted the surface with 12 pounds of applied pressure [Rodes 2001]. This resulted in a contact hand surface area for an adult of 125 cm² for both hands (168 cm² × 37.2% × 2 hands). From the Rio Bravo Healthy Children Study, the surface area for a child (25-36 months-old) for two hands combined is 99 cm² [Black 2005; Freeman 2005a; Freeman 2005b; Shalat 2003]. Leckie
provided data on the number of fingers mouthed during a mouthing event for the December 2003 meeting of EPA’s Science Advisory Panel. From these data and hand proportions obtained from children’s hand drawings (Children’s Dietary Lead Study), the maximum portion of the hand that is mouthed appears to be about 33%; e.g., one palm without fingers or five partial fingers. Four partial fingers or two full fingers accounted for about 28% of the hand surface area. Based upon these data, 30% is a rough estimate of the maximum fraction of the mouthed hand surface area. Combined with the estimate of hand surface area, this results in a hand surface area contributing to incidental ingestion of 29.7 cm$^2$ (99 cm$^2$ x 30% x 2 hands).

One study reported dermal transfer factors for selected contact surface types and skin wetness conditions using <80 µm fluorescein-tagged Arizona Test Dust on adult hand surfaces [Rodes 2001]. Based on information provided in this study, this model uses a dermal transfer factor of 0.485 for damp hands on vinyl linoleum. Vinyl linoleum is the surface with the most conservative (worst case) dermal transfer factor that is likely to be present at a residence. Damp conditions most accurately represent the hand-to-mouth transfer scenario. This model bases the fraction ingested (FI) on the mean to upper percentile removal efficiency of residues from fingers for a child [EPA 2000]. This fraction also accounts for the damp conditions represented in a hand-to-mouth transfer scenario.

Data on adult hand-to-mouth activity are not available. This model uses a reasonable estimate of 10 events/hr as a high-end occurrence for hand-to-mouth activity of 10-12 year-olds [Freeman 2001]. This model also uses child hand-to-mouth activity from the Rio Bravo Healthy Children Study [Black 2005; Freeman 2005a; Freeman 2005b; Shalat 2003]. A frequency of 35.4 events/hr represents the 90th percentile for children ages 36-60 months. This model uses an exposure time of 9.83 hr/day from the National Human Activity Pattern Survey. This figure represents the 90th percentile for time spent at school or in a public building by children ages 1-4 years-old [NHAPS 1996].

Table 8 lists alternative dust loading dose estimates. Estimated doses using the alternative dust loading model are similar (same order of magnitude) to estimated doses using the traditional fixed ingestion rate method (Tables 6 and 7). For this alternative dust loading model, a high degree of uncertainty exists in estimates of surface area contacted per day (SA) and frequency of hand-to-mouth events (FE). Because of these large uncertainties, Florida DOH does not rely on the alternative dose estimates from this model to judge the health risk from incidental dust ingestion.

2,3,7,8-Tetrachlorodibenzo-p-dioxins - Toxicity Equivalence (TCDD-TEQ)

Dioxins and furans are a family of chlorinated compounds with similar structures but varying toxicities. They have very low solubility in water and tend to stick to ash, soil, plants or any surface with a high organic content. Forest fires, manufacture of pentachlorophenol wood preservative, manufacture of bleached paper, and burning municipal garbage containing plastic all produce small amounts of dioxins [ATSDR 1998].
Non-Cancer Illness – Incidental ingestion (swallowing) of TCDD-TEQ in indoor dust of Gainesville area background houses and select houses near the Koppers facility is not likely to cause any non-cancer illness in adults or children. The highest estimated doses of dioxins found in both groups of houses are below the ATSDR chronic oral minimal risk level (MRL) for 2,3,7,8-TCDD of $1 \times 10^{-9}$ mg/kg/day (Tables 6 and 7). An MRL is an estimate of the daily human exposure to a hazardous substance that is likely to be without an appreciable risk of adverse non-cancer health effect over a specified route and duration of exposure. ATSDR’s MRL for 2,3,7,8-TCDD is similar to the EPA chronic oral reference dose (RfD) of $0.7 \times 10^{-9}$ mg/kg/day. An RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of the daily exposure of the human population to a potential hazard that is likely to be without risk of deleterious effects during a lifetime.

Cancer Risk – The estimated increased cancer risk from incidental ingestion (swallowing) of TCDD-TEQ in indoor dust of Gainesville area background houses and select houses near the Koppers facility is very low ($1 \times 10^{-5}$) (Tables 6 and 7). This estimate means that 1 person out of 100,000 people exposed over a lifetime might develop cancer. The American Cancer Society estimates the background cancer rate in the US is 1 in 3. That is, for every 100,000 people, on average about 33,333 will get some form of cancer during their lifetime. Exposure to this dust would, at most, increase the lifetime cancer risk from 33,333 cases in 100,000 people to 33,342 cases in 100,000 people.

This is a conservative (worst case) estimate of the increased cancer risk. The actual risk is likely lower.

The US Department of Health and Human Services (DHHS) has determined that it is reasonable to expect that 2,3,7,8-TCDD may cause cancer. EPA has determined that 2,3,7,8-TCDD is a probable human carcinogen. For this assessment, Florida DOH used an oral cancer slope factor $1.5 \times 10^5$ per mg/kg/day. This is the same value used by EPA in their 2011 Record of Decision for this site [EPA 2011].

For cancer, Florida DOH quantifies the increased risk by using the general formula:

$$Risk = D \times SF$$

Risk = Cancer risk
D = Dose (mg/kg/day)  
SF = Slope factor (mg/kg-day)$^{-1}$

To put the cancer risk into perspective, Florida DOH uses the following descriptors for the different numeric cancer risks:

- 1 in 10 ($10^{-1}$)  “very high” increased risk
- 1 in 100 ($10^{-2}$)  “high” increased risk
- 1 in 1,000 ($10^{-3}$)  “moderate” increased risk
- 1 in 10,000 ($10^{-4}$)  “low” increased risk
- 1 in 100,000 ($10^{-5}$)  “very low” increased risk
- 1 in 1,000,000 ($10^{-6}$)  “extremely low” increased risk
**Multiple Chemical Exposure**

Health scientists know too little to estimate the health risk from simultaneous exposure to chlorinated dioxins/furans and brominated dioxins/furans.

**Health Outcome Data**

In two previous reports, Florida DOH epidemiologists analyzed cancer disease rates for the area around the Koppers facility using data from the Florida Cancer Data System. They were unable to identify an increase in overall area cancer rates between 1981 and 2010 [DOH 2011b, 2012].

**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 sometime engage in hand-to-mouth behaviors that increase their exposure potential. Children are shorter than 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 system 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.

This assessment takes into account the special vulnerabilities of children. It specifically calculates a dose for children and young adults exposed to indoor dust by assuming a higher dust ingestion rate and age-specific body weights.

**Community Health Concerns Evaluation**

For many years nearby residents, especially those in the neighborhood west of the Koppers facility, have been concerned about their health. After discovery of dioxin contaminated soil in some yards just west of the Koppers facility, they were concerned that contaminated dust in their houses may be affecting their health.
Based on the data evaluated for this report, levels of chlorinated dioxins/furans in the dust of select houses near the Koppers facility are not likely to cause illness. Health scientists, however, know too little about the toxicity of brominated dioxins/furans to quantify the health risk.

**Conclusions**

1. Incidental ingestion (swallowing) of chlorinated dioxins/furans in indoor dust of 13 Gainesville area background houses and 17 houses near the Koppers facility is not likely to cause non-cancer illness in adults or children. The estimated increased cancer risk from incidental ingestion (swallowing) of chlorinated dioxins/furans in indoor dust of these houses is very low (1 in 100,000 or 1 x 10^{-5}). This estimate means that 1 person out of 100,000 people exposed over a lifetime might develop cancer.

2. Concentrations of chlorinated dioxins/furans in dust from selected houses near the Koppers facility are higher than concentrations in the dust from Gainesville area background houses.

3. The health risk from chlorinated dioxins/furans in the dust of these houses prior to 2012 is unknown.

4. Health scientists know too little about the toxicity of the brominated dioxins/furans to quantify their health risk.

**Recommendations**

Florida DOH/ATSDR have no recommendations.

**Public Health Action Plan**

**Actions Completed**

1. In May 2009, the Alachua County Health Department (CHD) hand delivered letters to 20 nearby residences advising them to keep their children from playing in the City of Gainesville easement just west of the Koppers facility. Contractors for the responsible party erected a temporary fence to discourage trespassing on this easement and posted temporary “keep out” and “no trespassing” signs.

2. In June 2009, the Florida DOH, Alachua CHD, EPA, and Florida DEP held an open house meeting attended by about 120 nearby residents.
3. In July 2009, the Florida DOH distributed a health consultation report and summary fact sheet on off-site surface soil.

4. In June 2010, the Florida DOH and the Alachua CHD distributed two community updates: one soliciting public comment on a draft creek sediment report and another alerting the community to a second off-site surface soil report.

5. In October 2010, the Florida DOH, Alachua CHD, EPA, and Florida DEP held an open house meeting attended by over 100 nearby residents.

6. In November/December 2010, the responsible party erected a permanent fence along the City easement just west of the Koppers facility and posted permanent warning signs.

7. In January 2011, the Florida DOH and the Alachua CHD distributed a community update informing nearby residents about a preliminary review of the soil sampling data.

8. In early 2011, the Cabot Carbon Corporation removed tarry waste from sediment in the ditches that drain the Cabot Carbon portion of the site as well as from sediments in Springstead and Hogtown creeks.

9. In a May 2011 report, Florida DOH evaluated the public health risk from exposure to sediments in Springstead and Hogtown Creek sediments.

10. In June 2011 and March 2012 reports, Florida DOH evaluated area cancer rates.

11. On August 29, 2011, Florida DOH and Alachua CHD held an open house meeting to answer questions about the cancer data review report and to solicit comments on the draft soil health consultation report.

12. On June 7, 2012, the Alachua CHD distributed a community update informing nearby residents of an update to the cancer statistics review and of EPA’s indoor dust collection.

13. On October 5, 2012, the Alachua CHD distributed a community update soliciting public comment on a draft assessment of surface soil in the neighborhood adjacent to the Koppers facility.

**Actions Underway**

1. The Alachua CHD continues to recommend people living near the site practice good general hygiene. This includes hand washing with soap and water after contacting bare soil in area between NW 26 Avenue and NW 32 Avenue, east of NW 6th Street, and west of the Koppers facility.

**Actions Planned**

1. Florida DOH will evaluate additional soil test results.
2. Florida DOH will continue to keep nearby residents informed of their findings.
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ATSDR Reviewer
Alan Parham
Technical Project Officer
Division of Community Health Investigations
References


## Appendices

### Tables and Figures

**Table 1. Completed Human Exposure Pathway**

<table>
<thead>
<tr>
<th>COMPLETED PATHWAY NAME</th>
<th>SOURCE</th>
<th>ENVIRONMENTAL MEDIA</th>
<th>POINT OF EXPOSURE</th>
<th>ROUTE OF EXPOSURE</th>
<th>EXPOSED POPULATION</th>
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<td>Contaminated soil on the Koppers site</td>
<td>Dust</td>
<td>Inside about 200 nearby houses</td>
<td>Ingestion</td>
<td>About 500 residents of the adjacent neighborhood</td>
<td>Past, Present, and Future</td>
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Table 2. Gainesville Area Background Houses: Contaminant Concentrations in Indoor Dust

<table>
<thead>
<tr>
<th>Background House</th>
<th>TCDD-TEQ Concentration (pg/g)</th>
<th>Brominated Dioxin &amp; Furan-TEQ* Concentration (pg/g)</th>
<th>CALUX® Screening Bioassay Concentration (pg/g)</th>
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TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents  
CALUX® = Chemical-Activated Luciferase Expression bioassay  
pg/g = picograms per gram (parts per trillion, ppt)  
Source of data: EPA 2012
Table 3. Select Houses Near the Kopper Facility: Contaminant Concentrations in Indoor Dust

<table>
<thead>
<tr>
<th>House</th>
<th>TCDD-TEQ Concentration (pg/g)</th>
<th>Brominated Dioxin &amp; Furan-TEQ* Concentration (pg/g)</th>
<th>CALUX® Screening Bioassay Concentration (pg/g)</th>
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TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents  
CALUX® = Chemical-Activated Luciferase Expression bioassay  
pg/g = picograms per gram (parts per trillion, ppt)  
Source of data: EPA 2012
Table 4. Gainesville Area Background Houses: Contaminant Loading in Indoor Dust

<table>
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<tr>
<th>Background House</th>
<th>Dust Load (mg/m²)</th>
<th>TCDD-TEQ Load (pg/m²)</th>
<th>Brominated Dioxin &amp; Furan-TEQ* Load (pg/m²)</th>
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TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents
CALUX® = Chemical-Activated Luciferase Expression bioassay
mg/m² = milligrams per square meter
pg/m² = picograms per square meter
Source of data: EPA 2012
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<th>House</th>
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</tbody>
</table>

TCDD – TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents  
CALUX® = Chemical-Activated Luciferase Expression bioassay  
mg/m² = milligrams per square meter  
pg/m² = picograms per square meter  
Source of data: EPA 2012
Table 6. Gainesville Area Background Houses: Maximum TCDD-TEQ Dust Concentration and Mean Traditional Dose/Cancer Risk by Age Group

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Body Weight (kg)</th>
<th>Maximum TCDD-TEQ Dust Concentration (mg/kg)</th>
<th>Dust Ingestion Rate (mg/day)</th>
<th>Exposure Factor (unit less)</th>
<th>Mean Dose (mg/kg/day)</th>
<th>ATSDR Chronic Oral MRL (mg/kg/day)</th>
<th>Cancer Slope Factor (per mg/kg/day)</th>
<th>Mean Cancer Risk (unit less)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child 0.5 - 1</td>
<td>9.2</td>
<td>7.73 x 10^{-3}</td>
<td>60</td>
<td>0.96</td>
<td>4.84 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^5</td>
<td>4.65 x 10^{-7}</td>
</tr>
<tr>
<td>Child 1 - 2</td>
<td>11.4</td>
<td>7.73 x 10^{-3}</td>
<td>60</td>
<td>0.96</td>
<td>3.91 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^5</td>
<td>7.51 x 10^{-7}</td>
</tr>
<tr>
<td>Child 2 - 6</td>
<td>17.4</td>
<td>7.73 x 10^{-3}</td>
<td>60</td>
<td>0.96</td>
<td>2.56 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^5</td>
<td>1.97 x 10^{-6}</td>
</tr>
<tr>
<td>Child 6 - 11</td>
<td>31.8</td>
<td>7.73 x 10^{-3}</td>
<td>60</td>
<td>0.96</td>
<td>1.40 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^5</td>
<td>1.35 x 10^{-6}</td>
</tr>
<tr>
<td>Child 11 - 21</td>
<td>64.2</td>
<td>7.73 x 10^{-3}</td>
<td>60</td>
<td>0.96</td>
<td>6.94 x 10^{-11}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^5</td>
<td>1.33 x 10^{-6}</td>
</tr>
<tr>
<td>Adult 21 - 65</td>
<td>80</td>
<td>7.73 x 10^{-3}</td>
<td>11</td>
<td>0.96</td>
<td>1.02 x 10^{-11}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^5</td>
<td>8.63 x 10^{-7}</td>
</tr>
<tr>
<td>Adult 65+</td>
<td>76</td>
<td>7.73 x 10^{-3}</td>
<td>11</td>
<td>0.96</td>
<td>1.07 x 10^{-11}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^5</td>
<td>3.10 x 10^{-6}</td>
</tr>
<tr>
<td>Child 0.5 - 21</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>5.86 x 10^{-6}</td>
</tr>
<tr>
<td>Adult 21 - 78</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>1.17 x 10^{-6}</td>
</tr>
<tr>
<td>Lifetime (child+adult)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>7.04 x 10^{-6}</td>
</tr>
</tbody>
</table>

kg = kilograms  mg/kg = milligrams per kilogram  mg/day = milligrams per day  mg/kg/day = milligrams per kilogram per day  
TCDD-TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents  ATSDR = Agency for Toxic Substances and Disease Registry
Table 7. Select Houses Near the Koppers Facility: Maximum TCDD-TEQ Dust Concentration and Mean Traditional Dose/Cancer Risk by Age Group

<table>
<thead>
<tr>
<th>Age Group (years)</th>
<th>Body Weight (kg)</th>
<th>Maximum TCDD-TEQ Dust Concentration (mg/kg)</th>
<th>Dust Ingestion Rate (mg/day)</th>
<th>Exposure Factor (unit less)</th>
<th>Mean Dose (mg/kg/day)</th>
<th>ATSDR Chronic Oral MRL (mg/kg/day)</th>
<th>Cancer Slope Factor (per mg/kg/day)</th>
<th>Mean Cancer Risk (unit less)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child 0.5 - 1</td>
<td>9.2</td>
<td>9.09 x 10^{-5}</td>
<td>60</td>
<td>0.96</td>
<td>5.69 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^{-9}</td>
<td>5.47 x 10^{-6}</td>
</tr>
<tr>
<td>Child 1 - 2</td>
<td>11.4</td>
<td>9.09 x 10^{-5}</td>
<td>60</td>
<td>0.96</td>
<td>4.59 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^{-5}</td>
<td>8.83 x 10^{-7}</td>
</tr>
<tr>
<td>Child 2 - 6</td>
<td>17.4</td>
<td>9.09 x 10^{-5}</td>
<td>60</td>
<td>0.96</td>
<td>3.01 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^{-5}</td>
<td>2.31 x 10^{-6}</td>
</tr>
<tr>
<td>Child 6 - 11</td>
<td>31.8</td>
<td>9.09 x 10^{-5}</td>
<td>60</td>
<td>0.96</td>
<td>1.65 x 10^{-10}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^{-5}</td>
<td>1.58 x 10^{-6}</td>
</tr>
<tr>
<td>Child 11 - 21</td>
<td>64.2</td>
<td>9.09 x 10^{-5}</td>
<td>60</td>
<td>0.96</td>
<td>8.16 x 10^{-11}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^{-5}</td>
<td>1.57 x 10^{-6}</td>
</tr>
<tr>
<td>Adult 21 - 65</td>
<td>80</td>
<td>9.09 x 10^{-5}</td>
<td>11</td>
<td>0.96</td>
<td>1.20 x 10^{-11}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^{-5}</td>
<td>1.02 x 10^{-6}</td>
</tr>
<tr>
<td>Adult 65+</td>
<td>76</td>
<td>9.09 x 10^{-5}</td>
<td>11</td>
<td>0.96</td>
<td>1.26 x 10^{-11}</td>
<td>1 x 10^{-9}</td>
<td>1.5 x 10^{-5}</td>
<td>3.64 x 10^{-7}</td>
</tr>
<tr>
<td>Child 0.5 - 21</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>6.90 x 10^{-6}</td>
</tr>
<tr>
<td>Adult 21 - 78</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>1.38 x 10^{-5}</td>
</tr>
<tr>
<td>Lifetime (child+adult)</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>8.28 x 10^{-6}</td>
</tr>
</tbody>
</table>

kg = kilograms  mg/kg = milligrams per kilogram  mg/day = milligrams per day  mg/kg/day = milligrams per kilogram per day  
TCDD-TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents  ATSDR = Agency for Toxic Substances and Disease Registry  MRL = minimal risk level
Table 8. Maximum TCDD-TEQ Dust Loading and Maximum Alternative Dose Estimates for Gainesville Area Background Houses and Houses Near the Koppers Facility

<table>
<thead>
<tr>
<th>Area</th>
<th>Maximum TCDD-TEQ Dust Loading ($\mu$g/cm$^2$)</th>
<th>Hand Surface Area per Event (cm$^2$/event)</th>
<th>Frequency (events/hour)</th>
<th>Exposure Time (hours/day)</th>
<th>Fraction Ingested (unit less)</th>
<th>Dermal Transfer Factor (unit less)</th>
<th>Body Weight (kg)</th>
<th>Maximum Alternative Dose (mg/kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background Child</td>
<td>$8.95 \times 10^{-10}$</td>
<td>29.7</td>
<td>35.4</td>
<td>9.83</td>
<td>0.5</td>
<td>0.485</td>
<td>17.4</td>
<td>$1.3 \times 10^{-10}$</td>
</tr>
<tr>
<td>Background Adult</td>
<td>$8.95 \times 10^{-10}$</td>
<td>125</td>
<td>10</td>
<td>8</td>
<td>0.5</td>
<td>0.485</td>
<td>76</td>
<td>$2.9 \times 10^{-11}$</td>
</tr>
<tr>
<td>Child Near Koppers Facility</td>
<td>$56.06 \times 10^{-10}$</td>
<td>29.7</td>
<td>35.4</td>
<td>9.83</td>
<td>0.5</td>
<td>0.485</td>
<td>17.4</td>
<td>$8.1 \times 10^{-10}$</td>
</tr>
<tr>
<td>Adult Near Koppers Facility</td>
<td>$56.06 \times 10^{-10}$</td>
<td>125</td>
<td>10</td>
<td>8</td>
<td>0.5</td>
<td>0.485</td>
<td>76</td>
<td>$1.8 \times 10^{-10}$</td>
</tr>
</tbody>
</table>

$\mu$g/cm$^2$ = micrograms per square centimeter $cm^2$ = square centimeter $kg$ = kilogram mg/kg/day = milligrams per kilogram per day

TCDD-TEQ = 2,3,7,8-tetrachlorodibenzo-p-dioxin toxic equivalents
**Glossary**

**Absorption**
The process of taking in. For a person or animal, absorption is the process of a substance getting into the body through the eyes, skin, stomach, intestines, or lungs.

**Acute**
Occurring over a short time [compare with *chronic*].

**Acute exposure**
Contact with a substance that occurs once or for only a short time (up to 14 days) [compare with *intermediate duration exposure* and *chronic exposure*].

**Additive effect**
A biologic response to exposure to multiple substances that equals the sum of responses of all the individual substances added together [compare with *antagonistic effect* and *synergistic effect*].

**Adverse health effect**
A change in body function or cell structure that might lead to disease or health problems.

**Ambient**
Surrounding (for example, *ambient air*).

**Analyte**
A substance measured in the laboratory. A chemical for which a sample (such as water, air, or blood) is tested in a laboratory. For example, if the analyte is mercury, the laboratory test will determine the amount of mercury in the sample.

**Background level**
An average or expected amount of a substance or radioactive material in a specific environment, or typical amounts of substances that occur naturally in an environment.

**Cancer**
Any one of a group of diseases that occurs when cells in the body become abnormal and grow or multiply out of control.

**Cancer risk**
A theoretical risk of for getting cancer if exposed to a substance every day for 70 years (a lifetime exposure). The true risk might be lower.

**Carcinogen**
A substance that causes cancer.
Chronic
Occurring over a long time (more than 1 year) [compare with acute].

Chronic exposure
Contact with a substance that occurs over a long time (more than 1 year) [compare with acute exposure and intermediate duration exposure].

Comparison value (CV)
Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. The CV is used as a screening level during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

Completed exposure pathway [see exposure pathway].

Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
CERCLA, also known as Superfund, is the federal law that concerns the removal or cleanup of hazardous substances in the environment and at hazardous waste sites. ATSDR, which was created by CERCLA, is responsible for assessing health issues and supporting public health activities related to hazardous waste sites or other environmental releases of hazardous substances.

Concentration
The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, breath, or any other media.

Contaminant
A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful (adverse) health effects.

Dermal
Referring to the skin. For example, dermal absorption means passing through the skin.

Dermal contact
Contact with (touching) the skin [see route of exposure].

Detection limit
The lowest concentration of a chemical that can reliably be distinguished from a zero concentration.

Dose (for chemicals that are not radioactive)
The amount of a substance to which a person is exposed over some time period. Dose is a measurement of exposure. Dose is often expressed as milligram (amount) per kilogram (a measure of body weight) per day (a measure of time) when people eat or drink
contaminated water, food, or soil. In general, the greater the dose, the greater the likelihood of an effect. An “exposure dose” is how much of a substance is encountered in the environment. An “absorbed dose” is the amount of a substance that actually got into the body through the eyes, skin, stomach, intestines, or lungs.

**Dose-response relationship**
The relationship between the amount of exposure [dose] to a substance and the resulting changes in body function or health (response).

**Environmental media**
Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

**Environmental media and transport mechanism**
Environmental media include water, air, soil, and biota (plants and animals). Transport mechanisms move contaminants from the source to points where human exposure can occur. The environmental media and transport mechanism is the second part of an exposure pathway.

**EPA**
United States Environmental Protection Agency.

**Exposure**
Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term [acute exposure], of intermediate duration, or long-term [chronic exposure].

**Exposure assessment**
The process of finding out how people come into contact with a hazardous substance, how often and for how long they are in contact with the substance, and how much of the substance they are in contact with.

**Exposure pathway**
The route a substance takes from its source (where it began) to its end point (where it ends), and how people can come into contact with (or get exposed to) it. An exposure pathway has five parts: a source of contamination (such as an abandoned business); an environmental media and transport mechanism (such as movement through groundwater); a point of exposure (such as a private well); a route of exposure (eating, drinking, breathing, or touching), and a receptor population (people potentially or actually exposed). When all five parts are present, the exposure pathway is termed a completed exposure pathway.

**Hazard**
A source of potential harm from past, current, or future exposures.
**Hazardous waste**
Potentially harmful substances that have been released or discarded into the environment.

**Health consultation**
A review of available information or collection of new data to respond to a specific health question or request for information about a potential environmental hazard. Health consultations are focused on a specific exposure issue. Health consultations are therefore more limited than a public health assessment, which reviews the exposure potential of each pathway and chemical [compare with public health assessment].

**Indeterminate public health hazard**
The category used in ATSDR’s public health assessment documents when a professional judgment about the level of health hazard cannot be made because information critical to such a decision is lacking.

**Ingestion**
The act of swallowing something through eating, drinking, or mouthing objects. A hazardous substance can enter the body this way [see route of exposure].

**Inhalation**
The act of breathing. A hazardous substance can enter the body this way [see route of exposure].

**Intermediate duration exposure**
Contact with a substance that occurs for more than 14 days and less than a year [compare with acute exposure and chronic exposure].

**mg/kg**
Milligram per kilogram.

**mg/cm2**
Milligram per square centimeter (of a surface).

**mg/m3**
Milligram per cubic meter; a measure of the concentration of a chemical in a known volume (a cubic meter) of air, soil, or water.

**Migration**
Moving from one location to another.

**Minimal risk level (MRL)**
An ATSDR estimate of daily human exposure to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful (adverse), noncancerous effects. MRLs are calculated for a route of exposure (inhalation or oral) over a specified time period (acute, intermediate, or chronic). MRLs should not be used as predictors of harmful (adverse) health effects [see reference dose].
National Priorities List for Uncontrolled Hazardous Waste Sites (National Priorities List or NPL)
EPA’s list of the most serious uncontrolled or abandoned hazardous waste sites in the United States. The NPL is updated on a regular basis.

No apparent public health hazard
A category used in ATSDR’s public health assessments for sites where human exposure to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the exposure is not expected to cause any harmful health effects.

No public health hazard
A category used in ATSDR’s public health assessment documents for sites where people have never and will never come into contact with harmful amounts of site-related substances.

NPL [see National Priorities List for Uncontrolled Hazardous Waste Sites]

Point of exposure
The place where someone can come into contact with a substance present in the environment [see exposure pathway].

Population
A group or number of people living within a specified area or sharing similar characteristics (such as occupation or age).

Potentially responsible party (PRP)
A company, government, or person legally responsible for cleaning up the pollution at a hazardous waste site under Superfund. There may be more than one PRP for a particular site.

ppb
Parts per billion.

ppm
Parts per million.

Public comment period
An opportunity for the public to comment on agency findings or proposed activities contained in draft reports or documents. The public comment period is a limited time period during which comments will be accepted.

Public availability session
An informal, drop-by meeting at which community members can meet one-on-one with ATSDR staff members to discuss health and site-related concerns.
Public health action
A list of steps to protect public health.

Public health advisory
A statement made by ATSDR to EPA or a state regulatory agency that a release of hazardous substances poses an immediate threat to human health. The advisory includes recommended measures to reduce exposure and reduce the threat to human health.

Public health assessment (PHA)
An ATSDR document that examines hazardous substances, health outcomes, and community concerns at a hazardous waste site to determine whether people could be harmed from coming into contact with those substances. The PHA also lists actions that need to be taken to protect public health [compare with health consultation].

Public health hazard
A category used in ATSDR’s public health assessments for sites that pose a public health hazard because of long-term exposures (greater than 1 year) to sufficiently high levels of hazardous substances or radionuclides that could result in harmful health effects.

Public health hazard categories
Public health hazard categories are statements about whether people could be harmed by conditions present at the site in the past, present, or future. One or more hazard categories might be appropriate for each site. The five public health hazard categories are no public health hazard, no apparent public health hazard, indeterminate public health hazard, public health hazard, and urgent public health hazard.

Public health statement
The first chapter of an ATSDR toxicological profile. The public health statement is a summary written in words that are easy to understand. The public health statement explains how people might be exposed to a specific substance and describes the known health effects of that substance.

Public meeting
A public forum with community members for communication about a site.

Receptor population
People who could come into contact with hazardous substances [see exposure pathway].

Reference dose (RfD)
An EPA estimate, with uncertainty or safety factors built in, of the daily lifetime dose of a substance that is unlikely to cause harm in humans.

RfD
See reference dose.
Risk
The probability that something will cause injury or harm.

Risk reduction
Actions that can decrease the likelihood that individuals, groups, or communities will experience disease or other health conditions.

Risk communication
The exchange of information to increase understanding of health risks.

Route of exposure
The way people come into contact with a hazardous substance. Three routes of exposure are breathing [inhalation], eating or drinking [ingestion], or contact with the skin [dermal contact].

Safety factor [see uncertainty factor]

SARA [see Superfund Amendments and Reauthorization Act]

Sample
A portion or piece of a whole. A selected subset of a population or subset of whatever is being studied. For example, in a study of people the sample is a number of people chosen from a larger population [see population]. An environmental sample (for example, a small amount of soil or water) might be collected to measure contamination in the environment at a specific location.

Sample size
The number of units chosen from a population or environment.

Source of contamination
The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum. A source of contamination is the first part of an exposure pathway.

Special populations
People who might be more sensitive or susceptible to exposure to hazardous substances because of factors such as age, occupation, sex, or behaviors (for example, cigarette smoking). Children, pregnant women, and older people are often considered special populations.

Stakeholder
A person, group, or community who has an interest in activities at a hazardous waste site.

Statistics
A branch of mathematics that deals with collecting, reviewing, summarizing, and interpreting data or information. Statistics are used to determine whether differences between study groups are meaningful.
Substance
A chemical.

Superfund Amendments and Reauthorization Act (SARA)
In 1986, SARA amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects from substance exposures at hazardous waste sites and to perform activities including health education, health studies, surveillance, health consultations, and toxicological profiles.

Surface water
Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs [compare with groundwater].

Survey
A systematic collection of information or data. A survey can be conducted to collect information from a group of people or from the environment. Surveys of a group of people can be conducted by telephone, by mail, or in person. Some surveys are done by interviewing a group of people [see prevalence survey].

Toxic agent
Chemical or physical (for example, radiation, heat, cold, microwaves) agents which, under certain circumstances of exposure, can cause harmful effects to living organisms.

Toxicological profile
An ATSDR document that examines, summarizes, and interprets information about a hazardous substance to determine harmful levels of exposure and associated health effects. A toxicological profile also identifies significant gaps in knowledge on the substance and describes areas where further research is needed.

Toxicology
The study of the harmful effects of substances on humans or animals.

Tumor
An abnormal mass of tissue that results from excessive cell division that is uncontrolled and progressive. Tumors perform no useful body function. Tumors can be either benign (not cancer) or malignant (cancer).

Uncertainty factor
Mathematical adjustments for reasons of safety when knowledge is incomplete. For example, factors used in the calculation of doses that are not harmful (adverse) to people. These factors are applied to the lowest-observed-adverse-effect-level (LOAEL) or the no-observed-adverse-effect-level (NOAEL) to derive a minimal risk level (MRL). Uncertainty factors are used to account for variations in people’s sensitivity, for differences between animals and humans, and for differences between a LOAEL and a NOAEL. Scientists use uncertainty factors when they have some, but not all, the
information from animal or human studies to decide whether an exposure will cause harm to people [also sometimes called a safety factor].

**Urgent public health hazard**
A category used in ATSDR’s public health assessments for sites where short-term exposures (less than 1 year) to hazardous substances or conditions could result in harmful health effects that require rapid intervention.
Report Preparation

The Florida Department of Health, Public Health Toxicology section prepared this health consultation report under a cooperative agreement with the US Agency for Toxic Substances and Disease Registry. Florida DOH followed approved methodologies and procedures existing at the time it began its assessment. Florida DOH completed an editorial review of this document.

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