Health Consultation

CYPRESS CREEK SUB-AREA III

MEMPHIS, SHELBY COUNTY, TENNESSEE

EPA FACILITY ID: TND981015456

JULY 31, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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MEMPHIS, SHELBY COUNTY, TENNESSEE

EPA FACILITY ID: TND981015456

Prepared by:

Tennessee Department of Health
Under a Cooperative Agreement with the
The Agency for Toxic Substances and Disease Registry

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Foreword

This document summarizes an environmental public health investigation performed by Environmental Epidemiology of the State of Tennessee Department of Health. Our work is conducted under a Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry. In order for the Health Department to answer an environmental public health question, several actions are performed:

Evaluate Exposure: Tennessee health assessors begin by reviewing available information about environmental conditions at a site. We interpret environmental data, review site reports, and talk with environmental officials. Usually, we do not collect our own environmental sampling data. We rely on information provided by the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency, and other government agencies, businesses, or the general public. We work to understand how much contamination may be present, where it is located on a site, and how people might be exposed to it. We look for evidence that people may have been exposed to, are being exposed to, or in the future could be exposed to harmful substances.

Evaluate Health Effects: If people could be exposed to contamination, then health assessors take steps to determine if it could be harmful to human health. We base our health conclusions on exposure pathways, risk assessment, toxicology, cleanup actions, and the scientific literature.

Make Recommendations: Based on our conclusions, we will recommend that any potential health hazard posed by a site be reduced or eliminated. These actions will prevent possible harmful health effects. The role of Environmental Epidemiology in dealing with hazardous waste sites is to be an advisor. Often, our recommendations will be actions items for other agencies. However, if there is an urgent public health hazard, the Tennessee Department of Health can issue a public health advisory warning people of the danger, and will work with other agencies to resolve the problem.

If you have questions or comments about this report, we encourage you to contact us.

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Or call us at: (615) 741-7247 or toll-free during business hours: 1-800-404-3006

Background and Statement of Issues

Site Description and History

In a letter dated March 31, 2005, the Memphis and Shelby County Health Department (MSCHD) and the Tennessee Department of Environment and Conservation (TDEC) jointly requested assistance from the Tennessee Department of Health (TDH). They requested that Environmental Epidemiology (EEP), under our Cooperative Agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR), publish a health consultation for the Cypress Creek area in Memphis, Shelby County. The purposes of this health consultation are: 1) to examine the possible exposure and hazard to residents living adjacent to and near Cypress Creek whose yards have had soil sampled; and 2) to work with TDEC, EPA, MSCHD and Velsicol to jointly identify remedial action levels that are protective of human health.

This health consultation will not look at health outcome data in the Cypress Creek area, but will make a determination about the possibility of health hazards to the people living near the creek. We felt that the best way to ensure the public safety was for all entities to work together to determine what level of cleanup would be required and which areas required cleanup. Past environmental health hazards cannot be determined in this health consultation.

Cypress Creek originates near the center of Memphis and runs north and northwest for eight miles before emptying into the Wolf River. Major channelization and widening was performed prior to 1944. In the 1950s, a levee system and a pumping station were constructed to prevent flooding of Cypress Creek during storm events. A section of the creek upstream of the pumping station was widened to act as a surge basin. Prior to 1963, the creek was used to dispose of sanitary sewage and manufacturing wastewater. Velsicol Chemical Corporation (Velsicol) was among the industries, including Buckeye Chemical and Buckman Laboratory, which discharged industrial wastewater to the creek. In the 1960s, a concrete liner was put in place and some of the creek channel straightened. During the construction of the concrete liner, sediments from the creek bottom and banks were removed and then placed in staging piles. After construction of the channel walls, the staged sediments/soils were used as backfill material to bring the adjacent banks to grade with the new concrete channel walls.

Currently, Velsicol produces various non-pesticide products based on cyclopentadiene. In the past, Velsicol produced pesticides based on cyclopentadiene. In the environment aldrin quickly converts to dieldrin. During the channelization in the 1960s, the city placed sediment from the creek along a City of Memphis construction easement, which included residential back yards. The easement is generally a strip of land of varying width located outside the concrete walls and fence around the creek. There is nothing to demarcate the easement from the other parts of residential yards. Evidence indicates that creek sediment was also used to fill in low elevation areas along the banks of the creek and in other areas near Cypress Creek.

Defining Sub-Areas

In 2001, Velsicol performed a series of soil investigations along Cypress Creek downstream of Velsicol's chemical manufacturing facility, located at 1199 Warford Street, as part of a Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). These off-site RCRA creek investigations were required in response to pesticide exposures to construction workers and Memphis, Light, Gas, and Water utility employees during soil excavations for the Tennessee Department of Transportation Jackson Street Bridge Project over the Illinois Central Gulf Railroad Tracks and Cypress Creek in 1997 and 1998. The soil investigations were performed to understand the distribution of chlorinated pesticides, chemical intermediates, and breakdown products. Cypress Creek was divided into five sub-areas based on the different creek channel conditions and landuse conditions. These sub-areas also reflect different exposure scenarios related to human health risk considerations. The sub-areas are described below and are illustrated in Figure 1:

- Sub-Area I: The industrial areas outside of the channel from Scott Street to 200 feet downstream of Jackson Avenue.
- Sub-Area II: The channel bottom under the concrete liner from Scott Street to Evergreen Street.
- Sub-Area III: The predominantly residential area adjacent to the channel, from 200 feet downstream of Jackson Avenue to Evergreen Street.
- Sub-Area IV: The open space area from Evergreen Street to Chelsea Avenue, including the Upper Surge Basin.
- Sub-Area V: The open space area from Chelsea Avenue to the Wolf River, including the Lower Surge Basin.

Site Investigation and Work

Velsicol, the U.S. Environmental Protection Agency Region 4 (EPA), and the TDEC Division of Solid Waste Management (SWM) have sampled many areas of the creek, the construction easement, residential yards, and other areas. Reports from Velsicol and its contractors were sent to TDEC and EPA in 2001, 2002, 2003, 2004, and 2005 as part of the ongoing RFI and ongoing Interim Measures. This public health investigation will focus on sampling and analysis of soil in Sub-Area III. One hundred twenty-nine (129) properties (76%) of the approximately 170 properties adjacent to or near Cypress Creek in Sub-Area III have analytical data reviewed in this health consultation. Most of the properties are residential, including single family homes, duplexes, or apartments, although some are commercial properties.

Tables 3a and 3b summarize soil sampling and analysis results for chemicals of concern in Sub-Area III residential yards. Addresses with an 'A' designation were taken in the City of Memphis construction easement. Addresses with a 'B' designation were taken closer to the house, or for vacant lots, outside the easement. Figure 2 helps to depict the environmental sampling plan. For this investigation, the chemicals of concern were aldrin, dieldrin, endrin, and endrin-like chemicals. Concentrations for these chemicals ranged from non-detect to 6.34 parts per million

(ppm) for aldrin, 124 ppm for dieldrin, 1,310 ppm for endrin, and 4,153 ppm for endrin-like chemicals. Additional description of the chemicals, sampling procedures, and results is presented later in the Discussion section.

SWM and the EPA Region 4 RCRA program have worked together with Velsicol on options for cleanup of contaminated residential properties. Cleanup involves removal of soil followed by clean fill to create a barrier to exposure and to bring the yard to grade. A bright orange mesh liner will be placed at the bottom of the excavation to delineate new clean soil from unexcavated soil. See the diagram in Figure 2 for clarity. Figure 3 illustrates a yard in the process of being remediated. Remediation has begun on those properties for which the owners have given permission. It is important to note that some home owners, at the advice of their attorneys, have refused to allow access to cleanup their yards. At the time of publication, only a few properties have had cleanup actions performed.

TDEC, EPA, TDH, MSCHD, and Velsicol have actively working together to finalize plans for clean-up of Sub-Area III. For more than a year, these entities have been engaged in detailed discussions of the complex environmental issues at Cypress Creek. Telephone calls, emails, and face-to-face meetings have all been ongoing during this time. All entities have come to agreement on the data set, an understanding of toxicological issues, and the need to move toward cleanup.

Springdale Creek Apartments

Due to past worker exposure in this area of Memphis, the Memphis Light, Gas, and Water utility developed a protocol for working in the Cypress Creek area. Environmental sampling is required before they begin utility work.

Springdale Creek Apartments is a CERCLA site also in Sub-Area III. The south end of the property was previously a former abandoned auto junkyard. The north end of the site was not known to be contaminated, although, Velsicol has actively educated the local community about the soil contamination along the creek and near plant site since 1999. During construction of Springdale Creek Apartments, Memphis Light, Gas, and Water sampled the soil at the apartment complex for pesticides, metals, and polychlorinated biphenyls (PCBs). Their May 2004 sampling and analysis revealed pesticide contamination on the north end of the property which is nearest to the creek channel. An environmental firm further investigated the Springdale site for the property owners. Under oversight by the TDEC Division of Remediation, construction was halted while the site was characterized and then cleaned up.

Table 4 summarizes sampling and analysis for pesticides at the north end of Springdale Creek Apartments. Springdale data for pesticides in soil provides worthwhile comparison to other parts of Sub-Area III. The samples were taken from 0 to 72 inches depth, with most samples taken at 0 to 24 inches. Twelve different pesticides or breakdown products were identified. The concentration of several pesticides in soils near the apartment site led to soil removal as a remedial action. For reference, the maximum dieldrin concentration measured was 119 ppm with an average concentration of 7.5 ppm. Endrin was found up to 3,790 ppm with an average concentration of 105.3 ppm. Soil samples with high pesticide concentrations were sometimes

found at deeper depths. These findings suggests the past use of creek sediment as fill material. Also, the findings suggest that there still may be small areas of elevated levels of contamination yet to be identified along Cypress Creek.

Discussion

Potentially Exposed Population

To determine whether persons have been, are, or are likely to be exposed to contaminants, EEP evaluates the environmental and human components that could lead to human exposure. An exposure pathway contains five elements:

1. a source of contamination,
2. contaminant transport through an environmental medium,
3. a point of exposure,
4. a route of human exposure, and
5. a receptor population.

An exposure pathway is considered complete if there is evidence that all five of these elements have been, are, or will be present.

Cypress Creek, Sub-Area III is a neighborhood of smaller residential homes, duplexes, apartments, churches, schools, and small commercial businesses. Children live, play, and go to school in the area. The residents of these neighborhoods are the potentially exposed population considered in this report. Figure 4 is a photograph of a typical front and side yard in the area. Notice that the yards are small and that the environmental soil samples most likely indicate representative concentrations of pesticides in the yard and easement areas. The photo shows that the grass cover is incomplete at some properties. Figure 5 shows the concrete channel of the creek and adjacent residential yards on the left side.

Possible completed routes of exposure are incidental ingestion of soil or dust, ingestion of vegetables grown in contaminated soil, inhalation of dusts or vapors (indoors and outdoors), and dermal exposure to soil. EEP considers incidental ingestion of soil by children to be the most significant route of exposure in Sub-Area III. EEP will investigate hazards from this route of exposure in this consultation. Other routes of exposure will, of course, add varying amounts of hazard that will qualitatively be discussed.

The worst case scenario is an assumption that people have had continuous decades-long exposure to contaminated surfaces soils. These soils could have been transported by people, pets, and wind into homes where people were exposed to contaminants as house dust. Everyone may incidentally ingest some amounts of the pesticides in soil, while young children may ingest larger amounts as part of hand-to-mouth activity. For these reasons, it is important to estimate the hazard associated with exposure to pesticide-contaminated soils at properties adjacent to and near Cypress Creek.

Environmental Media Evaluation Guides

Scientists today cannot precisely determine at what level a particular chemical in the environment presents a clear and predictable risk to human health. Sometimes scientists in various government and private agencies disagree on the amount of a chemical necessary to harm a person. At this time, predicting risk from exposure to chemicals in the environment is based on the professional judgments of scientists skilled in toxicology, pharmacology, biochemistry, and other similar disciplines. A collection of studies, opinions, and experiments on chemical exposure makes up what is referred to as the environmental literature.

The Agency for Toxic Substances and Disease Registry (ATSDR), an agency of the U.S. Department of Health and Human Services (HHS), is charged by Congress with providing support in the assessment of any health hazard posed by Superfund or other hazardous waste sites. For non-carcinogenic effects of toxic chemicals, ATSDR derives a minimal risk level (MRL) for each chemical using the environmental literature as the basis for their predictions of a level of that chemical that is without appreciable risk.

MRLs are derived from 'no observed adverse effect levels' (NOAELs) or from less serious 'lowest observed adverse effect levels' (LOAELs). NOAELs are the highest tested dose of a chemical that has been reported to have no harmful health effects on people or animals. A LOAEL is the lowest test dose of a chemical that has been reported to cause harmful health effects in people or animals.

From these MRLs, ATSDR has derived health guidance values, often called EMEGs (environmental media evaluation guides) for soil, air, and water. EMEGs serve as screening guidance to help scientists look more closely at the people who might be exposed to harmful levels of chemicals. To use these screening levels we must know how much of a chemical someone is exposed to, for how long that exposure has been or will be occurring, how frequent the exposure is or will be, and age of the exposed person. If concentrations are below the EMEG for a particular chemical, scientists can be reasonably certain that no adverse health effects will occur in people who are exposed.

EPA is mandated to publish toxicity information that is very similar to ATSDR's MRLs and EMEGs. EPA's reference dose (RfD) and reference concentration (RfC) are analogous to ATSDR's MRL. One difference is that ATSDR must use information that has been published, while EPA may use results of studies that are not published. There are other policy decisions that may result in ATSDR and EPA deriving different MRLs and RfDs and RfCs for the same chemical. In addition, ATSDR derives EMEGs for varying chronic, intermediate, and acute exposure frequencies. Chronic exposure is defined as one year or more. Intermediate exposure is defined as 15 – 364 days. Acute exposure is defined as fourteen days or less. EPA-derived RfDs and RfCs are for chronic or lifetime exposure.

If ATSDR does not have a published EMEG for a particular chemical, EEP used EPA's health guidance values or reached an agreement with EPA, TDEC, and ATSDR about which health guidance values to use. In the context of exposure at Cypress Creek, RfDs are used to evaluate

ingestion exposures which include outdoor surface soil and household dust, while RfCs are used for inhalation exposures.

If a chemical is a probable or known human carcinogen, EPA derives a cancer risk value for that chemical. EPA uses data from animal studies (and human epidemiology studies, if they are available) to extrapolate from high doses with known carcinogenic end points to very low doses using complex models. Often EPA assumes there is no threshold; that is, any exposure will result in some risk of cancer. This is an assumption that is valid is some cases and not in others, but for most chemicals we lack sufficient data to know the validity of the assumption. EPA then uses one of several models to determine the slope of the 95% upper confidence level of the extrapolated response at low concentrations. This derived slope factor is the number that represents the theoretical risk of excess cancer from exposure to the chemical in question per unit dose (EPA 1992). It is important to note that the cancer risk value is a statistically-derived number representing an upper 95% confidence level of a theoretical straight line predicting one extra cancer case in one million people, when the background lifetime risk of cancer is about one in two for men and one in three for women (ACS 2005). ATSDR may publish a guidance value called a Cancer Risk Evaluation Guide (CREG) that equates to a theoretical risk of one excess cancer in a million people [1].

As can be seen in Table 1 below, EPA and ATSDR are in agreement about toxicity guidelines for the pesticides of concern at Cypress Creek. The toxicity of the pesticides is discussed in the section, Toxicity of Chemicals of Concern.

Table 1. Comparison of ATSDR and EPA derived environmental media evaluation guides for aldrin, dieldrin, and endrin (ATSDR 1996, 2002, EPA IRIS)

Chemical	ATSDR			EPA	
	NOAEL/LOAEL mg/kg·day	MRL mg/kg·day	Child Chronic EMEG ppm	NOAEL/LOAEL mg/kg·day	RfD mg/kg·day
Aldrin	0.025 (LOAEL)	0.00003	2	0.025 (LOAEL)	0.00003
Dieldrin	0.005 (NOAEL)	0.00005	3	0.005 (NOAEL)	0.00005
Endrin	0.025 (NOAEL)	0.00003	20	0.025 (NOAEL)	0.00003

MRLs and slope factors will change periodically as scientists discover more about how a particular chemical does or does not cause harm to people. The MRLs and slope factors can get higher or lower. ATSDR Health Assessments and Consultations are based on the best information available at the time of the assessment. A summary of the "do's and don'ts" of using health guidance values follows (DeRosa 2002).

[1] One extra cancer case in a million people can be written two other ways: 1 x 10^{-6} or 1E-6 risk.

Health guidance values may be properly used as:

1. Screening values to identify substances/chemicals of concern at hazardous waste sites that need further investigation into the toxicology of the substances
2. Substance-specific trigger levels to identify possible need for further investigation of potential exposure scenarios
3. Identification of populations at potential risk
4. Computation of other health guidance values (for example, use of oral MRLs in calculating soil ingestion screening levels).

Health guidance values should not be used as:

1. Threshold levels for a toxic effect
2. Predictors of toxicity at any given level above the health guidance value
3. Absolute values (since there is an inherent area of uncertainty surrounding them)
4. Screening values for all effects and populations (without first evaluating the relevance of the critical effect upon which the health guidance value is based).

Toxicology of Chemicals of Concern

Aldrin/Dieldrin

Aldrin and dieldrin are two closely related organochlorine insecticides. They were used in agriculture and to control mosquitoes from the early 1950s until 1989, when their manufacture in the United States was discontinued. Aldrin and dieldrin are not very water soluble, but readily bind to sediment and rarely leach into deeper soil layers and groundwater. Evaporation from moist soil surfaces can occur. They take decades to break down in the environment, particularly in oxygen deprived deeper soil, resulting in persistent soil residues and varying degrees of uptake in a wide range of crops. Aldrin converts rapidly to dieldrin in biological systems of soils, plants, and animals. Dieldrin accumulates in fatty tissues, uterine tissues, breast milk, and can cross the placental barrier (ATSDR 2002, Liu et al. 1997).

In chronic-duration animal studies the liver was the most sensitive target organ for aldrin and dieldrin toxicity, although the central nervous system is also an important target of toxicity. Other effects in animals that may be associated with exposure to aldrin or dieldrin include kidney toxicity, immune effects, fetal toxicity, subtle neurological effects, and decreased reproductive function. However, these effects have not been observed in all studies and they have occurred at higher doses (ATSDR 2002).

Longer-term exposure to aldrin and dieldrin in occupational settings, where levels were typically were much higher, has been associated with central nervous system effects. A few case reports have attributed liver and kidney toxicity and hemolytic anemia to oral exposure to aldrin or dieldrin, but these effects were not observed in larger occupational studies, suggesting that they are likely to be rare.

Cyclodiene pesticides inhibit gamma-aminobutyric acid (GABAergic) neurotransmission by blocking the chloride ion channel of the GABA A receptor ($GABA_A$)[2]. The central nervous system effects of cyclodiene pesticides are caused by this inhibition of the neurotransmission. It also has implications for developing fetuses and infants (Devlin 2002).

Fetuses may be affected through transplacental exposure. Fetuses may bioconcentrate aldrin and dieldrin, and infants may absorb the pesticides in mothers' milk (ATSDR 2002).

Aldrin and dieldrin are associated with liver cancer in mice, but not in other animals. The International Agency for Research on Cancer (IARC) has categorized aldrin and dieldrin as Group 3 (unclassifiable as to human carcinogenic potential) chemicals. That means that the IARC does not consider the evidence strong enough to consider aldrin and dieldrin carcinogens. Based on the finding of liver tumors in mice, EPA classified both aldrin and dieldrin as B2 probable human carcinogens. However, the mouse carcinogenicity data may not be relevant to humans.

Endrin

Endrin is a solid, white, almost odorless substance that was used as a pesticide to control insects, rodents, and birds. Endrin has not been produced or sold for general use in the United States since 1986.

Endrin is well absorbed through ingestion, inhalation, and dermal routes of exposure. The central nervous system is the primary target site for endrin toxicity. Acute ingestion of endrin in amounts much greater than what is present along Cypress Creek have led to convulsions and death. Less severe symptoms include headache, convulsions, dizziness, nausea, vomiting, nervousness, and confusion. No long-term health effects have been noted in occupationally exposed workers. Birth defects, especially abnormal bone formation, have been seen in some laboratory animal studies (ATSDR 1996).

In studies using rats, mice, and dogs, endrin did not produce cancer. The EPA has determined that endrin is not classifiable as to its human carcinogenicity (Group D), because the available information is inadequate (ATSDR 1996).

Endrin-like chemicals: Heptachlorobicycloheptene / Hexachloronorbornadiene / Isodrin

All agencies involved have agreed to group heptachlorobicycloheptene, hexachloronorborna-diene, and isodrin with endrin for toxicity purposes.

[2] GABA is one of two major inhibitory neurotransmitters in the central nervous system acting through the GABA receptor on all parts of the brain except the spinal cord and brainstem. There are 2 main forms of the GABA receptor. $GABA_A$ subunits combine to form a chloride ion channel, while $GABA_B$ subunits act with a protein to increase conductance in a potassium ion channel. The GABA receptor is composed of two or more subunits. The alpha-$GABA_A$ unit binds with a variety of pharmaceutical agents, while the beta-$GABA_A$ subunit binds with GABA (Devlin 2002).

Heptachlorobicycloheptene (Hex VCL) and hexachloronorbornadiene are intermediates in the synthesis of cyclopentadiene pesticides. No information was found regarding their toxicity. Structurally they are similar to the chlorinated bicycloheptene portion of aldrin, dieldrin, isodrin, endrin, but lack the epoxide portion of dieldrin and endrin (Figure 6). Heptachlorobicyclo-heptene and hexachloronorbornadiene were grouped with endrin for toxicity purposes, but they could have been grouped with any of the other pesticides given the current lack of knowledge about their toxicity. The concentrations of these two intermediates are large enough to influence the margin of safety for any pesticide with which they are grouped.

No health comparison values were found for isodrin. Structurally, it is a stereoisomer of aldrin. According to Velsicol, isodrin does not show insecticidal activity (personal communication, Chuck Hanson, Velsicol, July, 27, 2005). However, we do not know if it might be toxic to humans at a sufficient dose.

Other Pesticide Characteristics

Reports have indicated that many of the identified pesticides are volatile and can infiltrate buildings from soil. An assessment of the environmental contamination of a residential community built on a thick layer of harbor sludge in the Netherlands found that the maximal combined daily intake of aldrin, dieldrin, isodrin, and telodrin (not found in the Cypress Creek area) by soil ingestion, inhalation of contaminated indoor air, and diet exceeded the allowable daily intake by a factor of three. In the referenced study, the total indoor air concentrations of the compounds in the living rooms of homes built on contaminated soil were 10 times higher than outdoor air levels (ATSDR 2002). Most of the houses in Sub-Area III were built before the creek was lined with concrete, so it is unlikely that any dredged sediment from the creek is under the houses. This does not rule out flooding of the creek adding smaller amounts of contaminated sediment to the yards or under the house in the crawl space.

Contamination in the indoor environment could be caused by people and pets tracking in contaminated soil and dust from outside. Pets dig in the soil and accumulate soil and dust in their fur. Persistent contaminants can be stored in carpets, upholstered furniture, and plush toys (Butte 2002).

In addition, a few people in the community have vegetable gardens and may ingest very small amounts with their home grown produce. A single garden plot was sampled, both vegetables and soil. Little of the pesticides in soil were taken up by the vegetables. These results are encouraging, but cannot necessarily be extrapolated to all properties or lifestyles (GeoSyntec 2005). Mustard, kale, turnip and rape greens, tomatoes, and sweet potatoes were sampled and analyzed for chemicals of concern. Most samples showed no detectable levels of chemicals of concern. Kale and turnip greens and sweet potatoes showed levels of some pesticides as shown in Table 2 below.

Table 2. Detectable pesticide concentrations, in parts per billion (ppb), in kale greens, turnip greens, and sweet potatoes grown in one residential yard in Cypress Creek, Sub-Area 3, Memphis, Shelby County, Tennessee (GeoSyntec 2005).

Pesticide	Kale Greens	Turnip Greens	Sweet Potatoes
Dieldrin	3.42	8.53	4.65
Endrin	ND	3.83	12.2
Endrin ketone	ND	ND	17.3
Hex VCL	ND	ND	36.9

Child Health Considerations

The many physical differences between children and adults demand special emphasis. Infants and children are influenced by their physical location. Newborns are generally near their mothers, so exposures will be similar to those experienced by the mother. Babies and toddlers are often placed on the floor or outside on the lawn. These effects of location are important in the Cypress Creek area. Portions of many yards have bare dirt. A young child placed on the ground may be exposed to any pesticides in the soil through dermal absorption, ingestion, and inhalation of particles. Soil from unvegetated parts of the yard likely enter a house as dust particles which may become trapped in carpet, upholstered furniture, and plush toys. Because young children are often on the floor and play with plush toys, their exposures to pesticide contaminated dust would, again, be through the routes of dermal exposure, ingestion, and inhalation of the larger respirable particles that settle out (Bearer 1995). The skin of infants and young children is more permeable to lipophilic compounds than adult skin, resulting in a greater absorption of the pesticides investigated in this consultation.

As children get older, they play within walking distance of their homes. In the Cypress Creek area, there are vacant lots and fields with known pesticide contamination and other vacant lots and fields that have not been tested. Some of these areas are covered with weeds and others are bare, leading to potential exposure to unknown amounts of pesticides and pesticide-related chemicals during play activities.

Because of their larger surface-to-volume ratio, children have a higher metabolic rate and respiration rate. Therefore, their exposure to contaminants in the air is greater than that of an adult. Children's caloric requirement is also a function of their larger surface-to-volume ratio. Their consumption of food, on a kilogram of food per body weight basis, is higher than that of an adult (Bearer 1995, Landrigan 1999, NRC 1993).

The Toxicology of Chemicals of Concern section above suggests that children might be more at risk from exposure to aldrin and dieldrin than are adults. In addition, fetuses may bioconcentrate aldrin and dieldrin. Birth defects, especially abnormal bone formation, have been seen in some laboratory animals during studies of endrin toxicity (ATSDR 2002).

It has been hypothesized that prenatal exposure to cyclopentadiene pesticides could alter expression of $GABA_A$ receptors and have long-term consequences. These pesticides act as

potent $GABA_A$ receptor antagonists in both insects and mammalians. $GABA_A$ receptors develop in spatio-temporal synchrony with GABAergic pathways in the rat embryo; therefore, GABA may regulate development of $GABA_A$ receptors. Liu et al. (1997) presented evidence that dieldrin selectively alters expression of $GABA_A$ subunit transcripts in rat embryonic brainstem cultures, supporting the hypothesis that functional activity of $GABA_A$ receptors influences developmental expression of the subunits.

In the Cypress Creek area, children may live in a home with pesticide contamination, attend school or a child care facility, and play in areas with pesticide contamination. Many families in the Cypress Creek area have owned the same property for forty years, with three generations of one family staying in the Cypress Creek area, leading to lifetime exposure, potentially from conception onwards.

Environmental Soil Sampling

One hundred twenty-nine (129) properties (76%) of the approximately 170 properties adjacent to or near Cypress Creek in Sub-Area III are addressed in this health consultation. Tables 3a and 3b summarize soil sampling and analysis results for chemicals of concern in Sub-Area III residential yards. Addresses with an 'A' designation were taken in the City of Memphis construction easement. Addresses with a 'B' designation were taken nearer the residence, or for vacant lots or businesses, outside the easement. All samples were collected as 5-point, 0 to 9 inch deep, horizontal composites. The aliquots for these composite samples were generally taken within 25 feet of a common center where there was adequate space in the yard. Figure 2 helps to illustrate the environmental soil sampling plan. The 2003-2004 dry weight soil sample analyses detected the following pesticides, intermediates, and metabolic products: aldrin, alpha-chlordane, gamma-chlordane, chlordene, dieldrin, endosulfan I, endosulfan II, endosulfan sulfate, endrin, endrin ketone, heptachlor, heptachlorepoxide, heptachlorobicycloheptene (hex VCL), hexachloronorbornadiene, and isodrin. Identified chemicals of concern are aldrin, dieldrin, endrin, and endrin-like chemicals. The other pesticides and pesticide-like chemicals had concentrations too low to have any meaningful contribution to any health hazard.

Margin of Safety

In order to determine if ingestion of any soils in Sub-Area III could possibly result in adverse health effects, margins of safety (MOS) were calculated for aldrin, dieldrin, and total endrin. A margin of safety compares the dose resulting from ingestion of the pesticide in soil to NOAEL or LOAEL for that pesticide. Generic assumptions of a 10 kg child, ingesting 200 mg/day of contaminated soil were made in order to calculate the predicted dose of each pesticide. The NOAEL was divided by the dose to predict the margin of safety between the ingested dose and the level at which harmful effects not are observed in long-term animal studies.

A risk assessment done to determine clean-up levels would not use only generic assumptions, but would use more refined values for the equation variables, such as body weight, amount of soil ingested, exposure frequency, and exposure duration.

For example, to predict the Margin of Safety from endrin at Residence 19 as listed in Table 3a & 3b, the concentrations of endrin, isodrin, hexachloronorbornadiene, and heptachloro-bicycloheptadiene were summed. Then, the sum of these endrin and endrin-like chemicals was used to calculate dose:

$$Dose = \frac{Concentration\,\frac{mg}{kg} \times IngestionRate\,\frac{mg}{day} \times ConversionFactor\,\frac{1kg}{10^6 mg}}{BodyWeight(kg)}$$

$$Dose = \frac{0.04\,\frac{mg}{kg} \times 200\,\frac{mg}{day} \times \frac{1kg}{10^6 mg}}{10kg}$$

$$Dose = 0.0000008\,\frac{mg}{kg \times day} \quad \text{OR} \quad Dose = 8.0x10^{-7}\,\frac{mg}{kg \times day}$$

Standard assumptions for childhood exposure were used for ingestion rate and body weight. Ingestible fraction was assumed to be 1; and no unique value for a bioavailability factor was found for use amongst the scientific literature. The Margin of Safety (MOS) can then be calculated as follows:

$$MOS = \frac{NOAEL\,\frac{mg}{kg \times day}}{Dose\,\frac{mg}{kg \times day}}$$

$$MOS = \frac{0.025\,\frac{mg}{kg \times day}}{0.0000008\,\frac{mg}{kg \times day}}$$

Margin of Safety for endrin at Residence 19 = 31,250

NOAELs and the LOAEL for aldrin were derived from animal studies, because of a lack of epidemiologic data using human subjects. Caution is needed in interpretation of MOS derivations because recent reports indicate that cyclodiene pesticides may have in-utero neurological implications and because children may be more susceptible to adverse effects from these pesticides. ATSDR generally believes that a margin of safety less than ten (<10) may result in harm, a Margin of Safety between 10 and 1,000 needs more evaluation, and a margin of safety greater than 1,000 should result in no harm (Mellard).

Results of these calculations indicate that two-thirds of the properties sampled in Sub-Area III had margins of safety above 1000, indicating no public health hazard from exposure to pesticides at those properties. Nine properties showed margins of safety less than 10, indicating the possibility of a public health hazard at those properties and the need for remediation. Several properties showed margins of safety between 10 and 1000, indicating the need for a site-specific risk assessment and discussion between agencies to determine which properties need remediation.

The methodology used in this Health Consultation is not the only valid way to predict hazards. Because toxicology and risk and hazard assessment methodology seldom have clear cut data or assumptions, the toxicologists, engineers, scientists, and risk managers at TDEC, EPA, TDH,

MSCHD, and Velsicol are working together to arrive at the appropriate way to determine those properties requiring remediation to protect public health.

Conclusions

1. For the majority of residential properties, contaminants were not found at levels of concern.

2. A past, current, and future public health hazard exists from exposure to soil contaminated with pesticides and associated chemicals on some residential properties in Sub-Area III adjacent to or near Cypress Creek in Memphis, Shelby County, Tennessee.

Recommendations

1. It is recommended that the Tennessee Department of Environment and Conservation, U.S. Environmental Protection Agency Region IV, Memphis and Shelby County Health Department, Tennessee Department of Health, and other appropriate parties continue to work collaboratively to see that cleanup of those properties needing remediation takes place as quickly as possible.

2. All involved entities should continue to work together and share findings to ensure that all areas that might have been filled with Cypress Creek sediment are identified and evaluated.

Public Health Action Plan

1. The Tennessee Department of Health (TDH), the Tennessee Department of Environment and Conservation (TDEC), the U.S. Environmental Protection Agency (EPA), and the Memphis and Shelby County Health Department (MSCHD) are currently working together to finalize cleanup levels and remedial methodology.

2. TDH, TDEC, and MSCHD will work together to make and distribute fact sheets that explain what will happen next with respect to remediation and when it will happen. Telephone numbers for important contacts will be included on all correspondence, flyers, fact sheets, and public displays.

3. TDH along with MSCHD and TDEC will hold a public meeting to present information included in this Health Consultation and plans for mitigating exposure to pesticide contamination. TDH will present its findings and will explain what they mean, with all the uncertainties.

4. Additional education and communication will be provided as the need arises.

5. TDH will work with other agencies to determine if any types of epidemiological studies are feasible. If studies are feasible then TDH will work with other agencies to develop protocols and plans for implementing the studies.

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Figures

Figure 1. Map of Cypress Creek Sub-Areas III, IV, and V, Memphis, Shelby County, Tennessee. Notice Sub-Area III is predominantly urban residential. Sub-Area II is under the concrete liner of the creek in Sub-Area III. Sub-Area I is the industrial area to the southeast upstream of the creek channel.

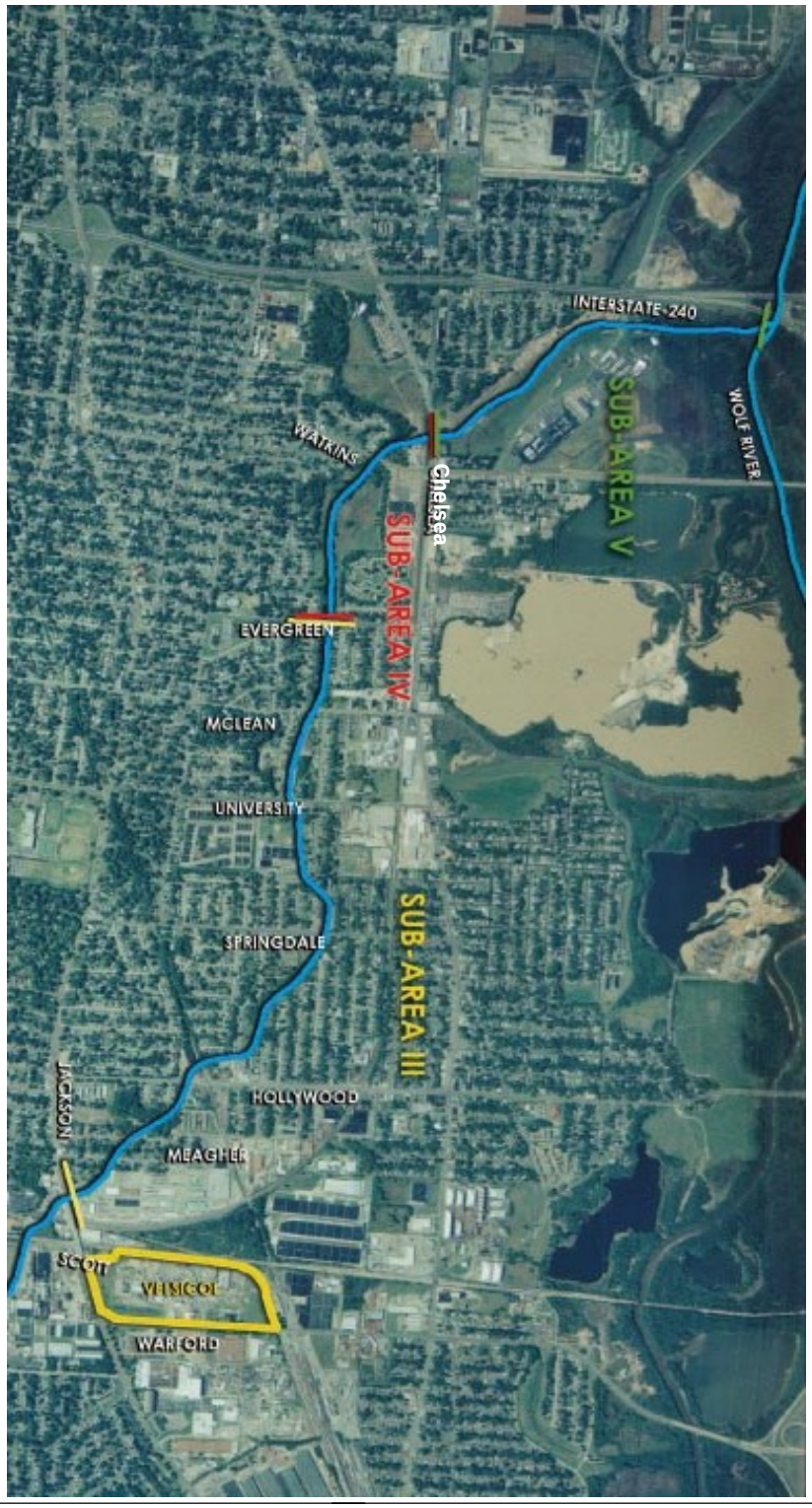


Figure 2. Phase 1 Cleanup of Residential Property. Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee.

● Discrete sample.

The 5 discrete samples in each area were composited and analyzed. The resulting composite result for Area "B" and Easement "A" were averaged to obtain a "representative" concentration for the entire yard.

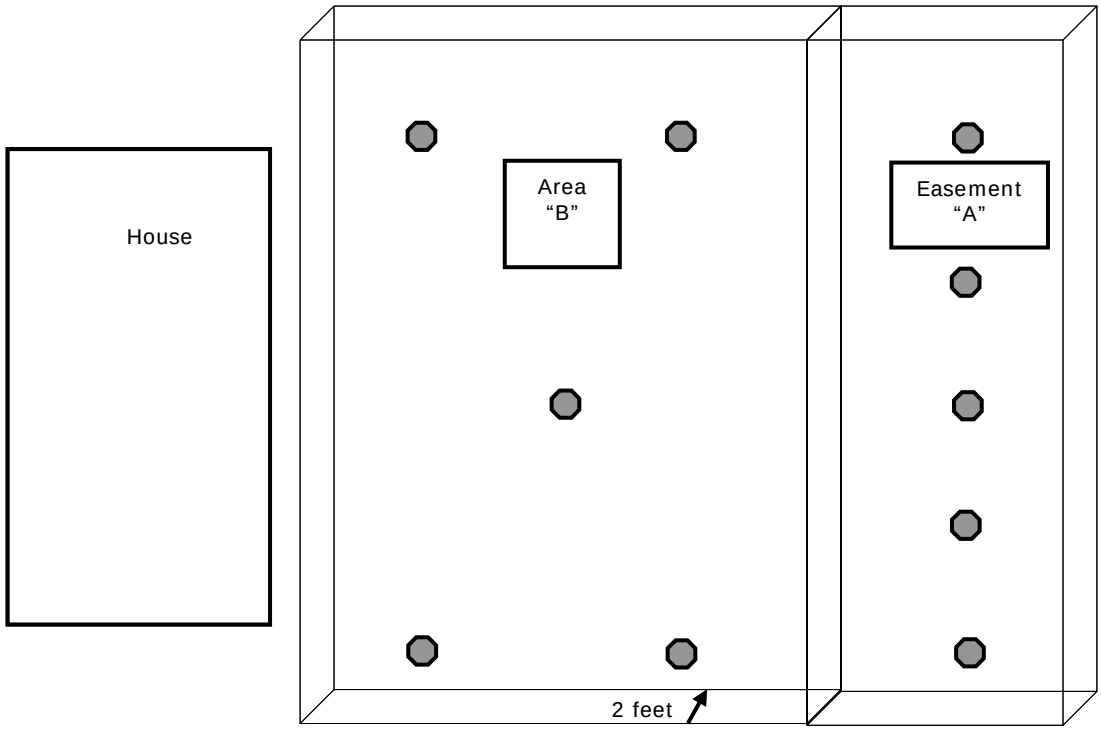


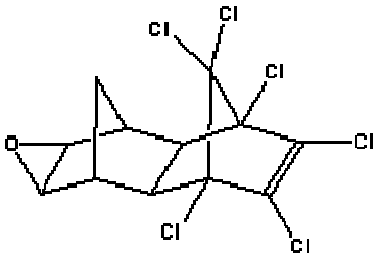
Figure 3. On-going remediation of a residential property. Two feet of soil was extracted. Orange mesh was installed before clean soil was filled and the yard's vegetative cover repaired. (photo – David M. Borowski, Oct. 26, 2005)

Figure 4. View of a typical residential lot adjacent to Cypress Creek. Note minimal landscaping, broken ground cover, and small lot size (photo – David M. Borowski, Jan. 2005).

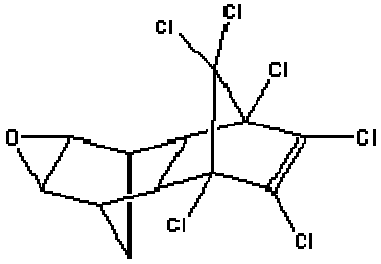
Figure 5. View of concrete channel. Observe the residential homes and back yards on the left just beyond the retention wall (photo – David M. Borowski, Jan. 2005).

Figure 6. Chemical structures of chemicals of concern

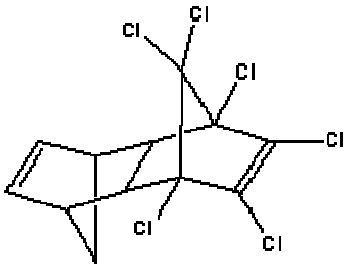
Endrin



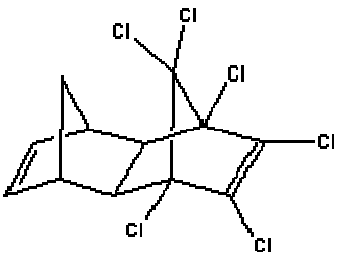
Dieldrin



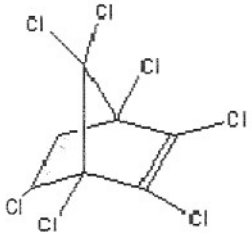
Aldrin



Isodrin



Heptachlorobicycloheptene



1,2,3,4,7,7-Hexachloronorbornadiene

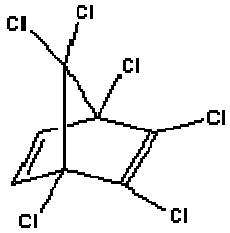


Table 3a. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Aldrin	Aldrin Property Average	Dieldrin	Dieldrin Property Average	Endrin [1]	Endrin [1] Property Average
1	A	0.012	0.02	0.10	0.15	0.09	0.27
	B	0.00767		0.20		0.45	
2	A	0.00614	0.01	0.13	0.13	0.38	0.24
	B	0.00629		0.12		0.10	
3	A	0.627	0.63	11		70.5	
4	A	0.0063	0.01	0.26	0.26	0.26	0.25
	B	0.00976		0.26		0.24	
5	A	0.00588	0.01	0.08	0.16	0.15	
	B	0.00608		0.24		0.09	
6	A-1	16.5	2.36	118	47.9	1240	516.57
	A	10.9		39.10		370	
	B	0.00605		0.48		1.78	
	A-2	35		124		1310	
	A-3	8.66		40.80		553	
	A-4	0.638		7.13		79.4	
	B-2	0.589		5.78		61.8	
7	A	0.0024	0.00	0.49	0.39	0.58	
	B	0.0022		0.29		0.46	
8	B	0.00546	0.01	0.92	0.53	0.80	0.58
	C	0.00585		0.13		0.36	
9	A	0.00582	0.01	0.36	0.64	0.01	
	B	0.00613		0.93		0.01	
10	C	0.0156	0.02	0.46	0.46	0.90	0.90
11	B	0.00556	0.01	0.62	0.62	3.72	3.72
12	A	0.00556	0.01	0.67	0.67	2.20	2.20
13	B	0.00643	0.01	0.56	0.56	1.52	1.52
14	B	0.0682	0.07	1.06	1.06	7.83	7.83
15	B	0.00605	0.01	0.73	0.73	1.60	1.60
16	B	0.0753	0.08	0.17	0.17	0.39	0.39
17	A	0.0063	0.01	0.61	0.60	3.93	3.50
	B	0.00638		0.59		3.06	
18	A	0.00615	0.75	0.27	3.48	0.56	38.88
	B	1.5		6.69		77.2	
19	C	0.00595	0.01	0.06	0.06	0.02	0.02

[1] Concentrations are included in endrin total and endrin total property average in Table 3b.

Table 3a. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Aldrin	Aldrin Property Average	Dieldrin	Dieldrin Property Average	Endrin [1]	Endrin [1] Property Average
20	C	0.00573	0.01	0.91	0.91	1.84	1.84
21	A	0.605	0.61	11.20	11.2	69.1	69.1
22	B	0.024	0.04	3.00	3.75	12	16
	A	0.061		4.50		20	
23	A	0.535	0.41	8.49	9.30	39.1	40.3
	D	0.28		10.10		41.5	
24	A	0.0293	0.06	1.51	2.64	4.87	13.14
	B	0.081		3.76		21.4	
25	A	0.0672	0.04	1.79	1.02	3.95	2.01
	B	0.00561		0.26		0.07	
26	B	0.00583	0.01	0.16	0.16	0.28	0.28
27	C	0.0747	0.07	3.53	3.53	20.2	20.2
28	C	0.00989	0.01	0.52	0.52	1.47	
29	A	0.019	0.08	1.30	1.15	4.30	4.25
	B	0.14		0.99		4.20	
30	A	0.293	0.38	4.71	6.26	33.60	44.70
	B	0.463		7.81		55.80	
31	A	0.0316	0.02	1.05	0.89	3.23	2.27
	B	0.00615		0.74		1.30	
32	A	1.18	0.59	9.69	4.86	75.80	37.95
	B	0.00604		0.03		0.10	
33	A	6.34	3.29	29.00	15.05	252.00	126.57
	B	0.249		1.10		1.14	
34	A	0.249	0.13	5.96	2.99	41.60	20.81
	B	0.0063		0.01		0.03	
35	A	0.287	0.15	4.86	2.56	22.40	11.41
	B	0.00612		0.27		0.41	
36	A	0.00544	0.01	0.02	0.17	0.09	1.04
	B	0.0153		0.33		1.99	
37	A	0.0675	0.04	0.68	0.41	2.41	1.29
	B	0.00571		0.15		0.17	
38	A	0.00579	0.04	0.87	1.34	2.56	14.13
	B	0.0832		1.80		25.70	
39	A	0.0672	0.07	0.31	0.33	0.91	1.40
	B	0.0708		0.35		1.90	
40	A	0.00592	0.01	0.61	0.31	2.42	1.21
	B	0.00619		0.01		0.01	

[1] Concentrations are included in endrin total and endrin total property average in Table 3b.

Table 3a. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Aldrin	Aldrin Property Average	Dieldrin	Dieldrin Property Average	Endrin [1]	Endrin [1] Property Average
41	A	0.00637	0.01	0.22	0.18	0.54	0.38
	B	0.0061		0.13		0.22	
42	A	0.0757	0.07	0.30	0.83	0.98	7.59
	B	0.0698		1.36		14.20	
43	A	0.0555	0.03	3.94	1.97	21.20	10.61
	B	0.00625		0.01		0.01	
44	B	0.0059	0.01	0.17	0.17	0.28	0.28
45	A	0.00561	0.01	0.39	0.39	0.91	0.91
46	A	0.00615	0.01	0.04	0.09	0.08	0.26
	B	0.00594		0.13		0.43	
47	A	0.0151	0.01	1.50	1.02	5.25	3.48
	B	0.00653		0.54		1.70	
48	A	0.0189	0.02	1.83	1.77	7.11	8.71
	B	0.0275		1.71		10.30	
49	A	0.00564	0.05	0.79	1.27	1.76	3.30
	B	0.0955		1.75		4.84	
50	A	0.0309	0.15	1.97	2.02	5.40	11.48
	B	0.0589		2.19		7.26	
	B-2	0.524		3.88		33.20	
	C	0.00556		0.05		0.07	
51	B	0.0145	0.01	1.25	1.25	1.47	1.47
52	C	0.0704	0.07	0.47	0.47	2.09	2.09
53	C	0.0765	0.08	0.72	0.82	3.05	3.46
	D	0.0771		0.92		3.86	
54	A	0.112	0.18	2.74	3.23	5.30	8.75
	B	0.241		3.72		12.20	
55	C	0.452	0.45	1.67	1.67	6.95	6.95
56	A	0.102	0.05	1.75	0.89	8.89	4.46
	B	0.00553		0.03		0.02	
57	B	0.0728	0.07	0.33	0.33	0.47	0.47
58	C	0.0686	0.07	0.22	0.22	0.66	0.66
59	A	0.0306	0.04	1.47	1.98	3.46	6.64
	B	0.054		2.48		9.82	
60	C	1	1.00	9.53	9.53	69.50	69.50
61	A	0.0701	0.07	1.67	1.62	5.53	5.17
	D	0.0701		1.57		4.81	
62	A	0.0209	0.02	0.80	0.80	2.80	2.80

[1] Concentrations are included in endrin total and endrin total property average in Table 3b.

Table 3a. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.							
Residence	Sample Location	Aldrin	Aldrin Property Average	Dieldrin	Dieldrin Property Average	Endrin [1]	Endrin [1] Property Average
63	A	0.0063	0.03	0.33	0.20	1.47	0.77
	B	0.0608		0.06		0.06	
64	B	0.0065	0.01	0.02	0.02	0.06	0.06
65	C	0.00568	0.01	0.01	0.01	0.01	0.01
66	A	0.0221	0.02	0.38	0.38	1.04	1.04
67	A	0.00545	0.01	0.27	0.33	0.20	0.33
	B	0.00567		0.38		0.45	
68	A	0.0188	0.02	0.87	0.51	3.74	1.91
	B	0.0148		0.16		0.07	
69	A	0.0284	0.02	0.98	0.58	3.04	1.81
	B	0.00573		0.19		0.58	
70	A	0.0148	0.01	0.62	0.34	2.38	1.22
	B	0.00592		0.06		0.06	
71	A	0.00624	0.01	0.42	0.25	0.94	0.53
	B	0.00622		0.07		0.12	
72	A	0.067	0.07	0.30	0.53	0.70	2.15
	B	0.0682		0.60		2.93	
	D	0.0681		0.68		2.83	
73	A	0.0682	0.07	1.30	0.83	6.14	3.45
	B	0.0696		0.37		0.77	
74	A	0.00595	0.01	0.61	0.60	1.81	1.81
	B	0.00635		0.60		1.80	
75	A	0.0422	0.01	3.31	0.99	14.30	4.42
	B	0.00613		0.64		3.33	
	C	0.00562		0.01		0.01	
	B-2	0.00537		0.03		0.03	
76	A	0.00652	0.01	0.52	0.30	2.96	1.54
	B	0.00593		0.07		0.11	
77	A	0.0106	0.01	0.64	0.37	0.87	0.47
	B	0.00636		0.10		0.08	
78	A	0.0163	0.01	0.18	0.12	0.86	0.44
	B	0.00633		0.05		0.01	
79	B	0.0042	0.01	0.00	0.10	0.02	0.24
	A	0.0084		0.19		0.46	
80	A	0.00581	0.01	0.26	0.26	0.58	0.44
	B	0.00597	0.01	0.27		0.29	

[1] Concentrations are included in endrin total and endrin total property average in Table 3b.

Table 3a. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Aldrin	Aldrin Property Average	Dieldrin	Dieldrin Property Average	Endrin [1]	Endrin [1] Property Average
81	A	0.006	0.01	0.01	0.01	0.01	0.01
	B	0.00623		0.01		0.02	
82	A	0.006	0.01	0.38	0.20	0.58	0.29
	B	0.00635		0.02		0.01	
83	A	0.00585	0.01	0.01	0.06	0.01	0.05
	B	0.00612		0.11		0.10	
84	A	0.039	0.02	0.64	0.32	1.80	0.90
	B	0.0017		0.01		0.01	
85	A	0.018	0.01	0.27	0.14	0.39	0.20
	B	0.008		0.00		0.00	
86	A	0.014	0.01	0.41	0.21	0.58	0.29
	B	0.0018		0.00		0.00	
87	A	0.0115	0.01	0.48	0.25	0.99	0.50
	B	0.00631		0.01		0.01	
88	A	0.0084	0.04	0.29	0.18	0.96	0.97
	B	0.0693		0.07		0.98	
89	A	0.0212	0.01	0.92	0.47	5.79	2.90
	B	0.00592		0.01		0.01	
90	A	0.0638	0.06	0.63	0.51	2.60	2.07
	B	0.0625		0.40		1.53	
91	A	1.12	0.70	21.70	12.30	163	89.60
	B	0.285		2.90		16.20	
92	A	0.0246	0.02	1.45	0.74	5.95	2.98
	B	0.00597		0.03		0.01	
93	A	0.0062	0.02	0.52	1.56	1.40	3.40
	B	0.041		2.60		5.40	
94	EA	0.0065	0.01	0.22	0.37	0.40	0.60
	CA	0.019		0.51		0.79	
	WA	0.015	0.01	0.19	0.10	0.32	0.18
	WB	0.0043		0.02		0.04	
95	A	0.0082	0.02	0.55	1.53	1.60	5.45
	B	0.034		2.50		9.30	
96	A	0.0244	0.03	1.12	0.93	5.60	3.85
	B	0.0262		0.74		2.10	
97	A	0.012	0.01	0.36	0.18	0.75	0.38
	B	0.0021		0.00		0.00	

[1] Concentrations are included in endrin total and endrin total property average in Table 3b.

Table 3a. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Aldrin	Aldrin Property Average	Dieldrin	Dieldrin Property Average	Endrin [1]	Endrin [1] Property Average
98	A-2	0.00675	0.01	0.17	0.13	0.17	0.18
	A	0.00629		0.20		0.38	
	B	0.00611		0.01		0.01	
99	C	0.0025	0.00	0.07	0.06	0.25	0.24
	S	0.0012		0.05		0.22	
100	C	0.0017	0.00	0.00	0.00	0.00	0.00
	S	0.0017		0.00		0.00	
101	C	0.00654	0.01	0.01	0.01	0.01	0.01
102	A	0.0019	0.01	0.00	0.09	0.01	0.19
	B	0.015		0.18		0.37	
103	A	0.00635	0.01	0.08	0.04	0.10	0.05
	B	0.00626		0.01		0.01	
104	A	0.0017	0.00	0.17	0.11	0.36	0.18
	B	0.00065		0.05		0.00	
105	A	0.0013	0.00	0.16	0.08	0.34	0.18
	B	0.0027		0.01		0.02	
106	A	0.00561	0.01	0.12	0.09	0.31	0.29
	B	0.0059		0.07		0.28	
107	B	0.00627	0.01	0.13	0.13	0.24	0.24
108	A	0.00651	0.01	0.09	0.06	0.18	0.09
	B	0.00661		0.02		0.01	
109	C	0.00566	0.01	0.01	0.01	0.01	0.01
110	A	0.0104	0.03	0.42	0.64	1.51	1.89
	B	0.0407		0.85		2.26	
111	A	0.137	0.07	2.03	1.02	15.50	7.80
	B	0.00566		0.01		0.10	
112	B	0.00675	0.04	0.01	0.85	0.01	2.39
	A	0.0654		1.69		4.77	
113	A	0.00954	0.01	1.29	1.19	4.13	3.64
	B	0.0102		1.08		3.14	
114	A	0.064	0.06	1.29	5.44	4.42	2.24
	B	0.062		9.58		0.06	
115	A	0.0132	0.02	0.37	0.54	0.27	0.41
	B	0.0207		0.71		0.56	
116	A	0.133	0.09	1.33	2.74	6.61	3.32
	B	0.0371		4.14		0.02	

[1] Concentrations are included in endrin total and endrin total property average in Table 3b.

Table 3a. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Aldrin	Aldrin Property Average	Dieldrin	Dieldrin Property Average	Endrin [1]	Endrin [1] Property Average
117	A	0.011	0.01	0.54	0.27	1.45	0.73
	B	0.00613		0.01		0.01	
118	A	0.07	0.04	1.00	0.50	3.70	1.86
	B	0.0018		0.00		0.01	
119	A	0.0433	0.02	1.30	0.65	4.61	2.31
	B	0.00629		0.01		0.01	
120	C	0.00577	0.07	0.01	1.61	0.01	5.61
	A	0.0598		1.94		5.71	
	B	0.152		2.87		11.10	
121	A	0.00545	0.01	0.32	0.16	0.52	0.26
	B	0.00564		0.01		0.01	
122	A	0.03	0.02	0.60	0.30	1.40	0.70
	B	0.0024		0.00		0.01	
123	A	0.0633	0.05	2.80	1.65	7.38	4.35
	B	0.0662		2.12		5.56	
	C	0.00571		0.04		0.12	
124	A	0.0325	0.02	0.26	0.17	1.12	0.61
	B	0.00613		0.08		0.11	
125	A	0.0021	0.01	0.32	0.60	0.46	1.38
	B	0.014		0.88		2.30	
126	A	0.0896	0.05	0.96	0.50	5.24	2.63
	B	0.00551		0.04		0.03	
127	A	0.0259	0.02	0.63	0.32	2.88	1.44
	B	0.00647		0.01		0.01	
128	A	0.00981	0.02	0.50	0.53	0.81	0.88
	B	0.0372		0.57		0.95	
129	A	0.0065	0.01	0.16	0.14	0.43	0.37
	B	0.00649		0.12		0.31	

[1] Concentrations are included in endrin total and endrin total property average in Table 3b.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
1	A	0.16	0.59	5.20	2.62	2.25	1.13	0.02	0.14	7.72	4.75
	B	1.03		0.04		0.01		0.26		1.79	
2	A	1.08	0.58	4.75	2.41	2.01	1.01	0.03	0.02	8.25	4.26
	B	0.08		0.07		0.01		0.01		0.27	
3	A	144	144	28.60	0.03	20	20	26.90	26.90	290	290
4	A	1.07	0.99	0.59	0.63	0.32	0.34	0.03	0.02	2.26	2.24
	B	0.92		0.68		0.37		0.02		2.22	
5	A	0.22	0.13	5.45	2.73	1.93	0.97	0.02	0.01	7.77	3.84
	B	0.04		0.01		0.01		0.01		0.15	
6	A-1	1190	478.13	776	344.48	1420	554.30	837	353.90	5463	2247
	A	410		318		515		294		1907	
	B	0.98		0.09		0.03		0.07		2.95	
	A-2	1060		937		1540		1030		5877	
	A-3	561		319		367		270		2070	
	A-4	70		29.1		15.20		26.70		220.40	
	B-2	54.90		32.2		22.90		19.50		191.30	
7	A	2.40	1.29					0.09	0.05	3.07	1.34
	B	0.18						0.01		0.65	
8	B	1.33	0.73	0.07	0.07	0.06	0.06	0.03	0.04	2.29	1.48
	C	0.14		0.06		0.07		0.05		0.68	
9	A	0.25	0.33	0.05	0.03	0.01	0.01	0.03	0.02	0.34	0.39

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
	B	0.41		0.02		0.01		0.01		0.46	
10	C	1.90	1.90	0.01	0.01	0.01	0.01	0.16	0.16	2.96	2.96
11	B	1.61	1.61	1.05	1.05	0.13	0.13	0.07	0.07	6.57	6.57
12	A	1.32	1.32	0.17	0.17	0.01	0.01	0.06	0.06	3.76	3.76
13	B	4.86	4.86	0.01	0.01	0.01	0.01	0.08	0.08	6.48	6.48
14	B	9.43	9.43	0.51	0.51	0.13	0.13	0.29	0.29	18.19	18.19
15	B	2.25	2.25	0.28	0.28	0.03	0.03	0.10	0.10	4.26	4.26
16	B	0.12	0.12	0.08	0.28	0.08	0.08	0.08	0.08	0.73	0.93
17	A	4.61	3.14	1.45	0.89	0.06	0.10	0.26	0.14	10.31	7.75
	B	1.66		0.32		0.14		0.02		5.20	
18	A	1.32	34.96	1.89	26	0.39	15.90	0.13	31.07	4.30	146.80
	B	68.60		50.1		31.40		62		289.30	
19	C	0.01	0.01	0.01	0.01	0.01		0.01	0.01	0.05	0.04
20	C	1.56	1.56	0.85	0.85	0.13	0.13	0.21	0.21	4.59	4.59
21	A	120	120	41.70		22.40		18.90	18.90	272.10	208
22	B	21	36					0.98	2.04	33.98	54.04
	A	51						3.10		74.10	
23	A	61.80	65.30	33.90	33.10	5.53	4.74	13.50	10.44	153.83	153.88
	D	68.80		32.30		3.95		7.37		153.92	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
24	A	20.30	10.94	2.06	6.38	0.13	0.42	2.02	3.23	29.38	34.10
	B	1.58		10.70		0.71		4.44		38.83	
25	A	18.40	9.23	4.43	2.22	0.26	0.13	0.63	0.32	27.67	13.91
	B	0.06		0.01		0.01		0.01		0.15	
26	B	0.41	0.41	0.03	0.03	0.02	0.02	0.03	0.03	0.76	0.76
27	C	52.20	52.20	10.20	10.20	0.68	0.68	3.73		87.01	83.28
28	C	2.51	2.51	0.34		0.08	0.08	0.26	0.26	4.65	2.85
29	A	11	13					0.78	5.89	16.08	23.14
	B	15						11.00		30.20	
30	A	83.60	102.80	4.89	26.00	0.31	2.60	16.90	18.10	139.30	194.19
	B	122		47.10		4.88		19.30		249.08	
31	A	21.90	13.63	2.68	1.49	0.06	0.03	2.29	1.22	30.16	18.63
	B	5.36		0.29		0.01		0.15		7.11	
32	A	119	59.69	23.00	11.52	12.90	6.45	60.80	30.42	291.50	146.03
	B	0.39		0.04		0.01		0.04		0.57	
33	A	302	151.77	165.00	82.91	220	110.54	149	78.10	1088	549.87
	B	1.53		0.81		1.07		7.19		11.74	
34	A	73.10	36.59	23.40	11.71	3.44	1.73	7.26	3.64	148.80	74.47
	B	0.07		0.02		0.01		0.01		0.14	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
35	A	58.10	29.62	5.07	2.57	0.35	0.19	17.50	8.79	103.42	52.57
	B	1.13		0.06		0.03		0.08		1.72	
36	A	0.12	0.57	0.02	0.32	0.01	0.13	0.01	0.18	0.25	2.24
	B	1.02		0.62		0.25		0.35		4.23	
37	A	5.33	2.81	1.19	0.60	0.12	0.09	0.39	0.20	9.44	5.00
	B	0.30		0.01		0.06		0.02		0.55	
38	A	5.87	15.84	1.82	2.05	0.10	0.18	0.24	3.89	10.59	36.09
	B	25.80		2.28		0.27		7.54		61.59	
39	A	0.95	1.75	1.21	1.00	0.07	0.07	0.42	0.27	3.55	4.49
	B	2.55		0.79		0.07		0.11		5.43	
40	A	1.10	0.59	2.63	1.32	0.09	0.05	0.14	0.07	6.38	3.25
	B	0.08		0.01		0.01		0.01		0.12	
41	A	0.40	0.26	0.74	0.37	0.01	0.01	0.02	0.01	1.71	1.04
	B	0.13		0.01		0.01		0.01		0.37	
42	A	1.22	7.81	0.93	3.04	0.08	0.12	0.09	0.40	3.29	18.96
	B	14.40		5.15		0.17		0.72		34.64	
43	A	36.20	18.11	20.80	10.40	2.47	1.24	2.98	1.49	83.65	41.85
	B	0.01		0.01		0.01		0.01		0.04	
44	B	0.09	0.09	0.02	0.02	0.01	0.01	0.03	0.03	0.43	0.43
45	A	0.30	0.30	1.18		0.06	0.06	0.06	0.06	2.51	1.33
46	A	0.13	0.26	0.39	0.27	0.01	0.01	0.01	0.01	0.62	0.80
	B	0.38		0.16		0.01		0.02		0.99	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
47	A	19.90	12.30	3.58	2.16	0.34	0.19	1.05	0.62	30.12	18.73
	B	4.70		0.73		0.04		0.19		7.35	
48	A	30.30	25.00	4.91	3.13	0.47	0.40	1.11	1.36	43.90	38.59
	B	19.70		1.35		0.33		1.60		33.28	
49	A	7.40	17.50	3.08	2.71	0.25	0.24	0.29	3.34	12.78	27.09
	B	27.60		2.34		0.23		6.39		41.40	
50	A	37.00	26.90	4.40	8.31	0.30	3.36	1.73	6.40	48.83	56.44
	B	34.00		7.58		0.62		2.33		51.79	
	B-2	36.40		21.20		12.50		21.50		124.80	
	C	0.19		0.07		0.01		0.02		0.36	
51	B	10.20	10.20	3.08	3.08	0.17	0.17	0.69	0.69	15.61	15.61
52	C	5.33		0.68	0.68	0.07	0.07	1.02	1.02	9.19	3.86
53	C	6.16	6.45	0.36	0.41	0.08	0.08	0.71	0.68	10.36	11.06
	D	6.73		0.45		0.08		0.64		11.76	
54	A	53.40	62.85	10.30	12.90	1.01	3.73	4.47	6.97	74.48	95.19
	B	72.30		15.50		6.44		9.46		115.90	
55	C	15.20	15.20	7.83	7.83	1.49	1.49	18.10	18.10	49.57	49.57
56	A	13.70	6.88	6.32	3.17	1.42	0.72	4.15	2.08	34.48	17.30
	B	0.06		0.01		0.01		0.01		0.11	
57	B	3.49	3.49	0.72	0.72	0.07	0.07	0.37	0.37	5.12	5.12
58	C	0.51	0.51	0.54		0.07	0.07	0.07	0.07	1.84	1.31

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
59	A	17.50	23.95	3.11	6.49	0.15	0.55	1.03	1.22	25.25	38.85
	B	30.40		9.87	9.87	0.96		1.40		52.45	
60	C	65.20	65.20	41.80	41.80	22.90	22.90	42.00	42.00	241.40	241.40
61	A	14.20	20.05	6.96	6.71	0.80	0.76	1.35	1.52	28.84	34.20
	D	25.90		6.45		0.73		1.68		39.57	
62	A	5.09	5.09	3.04	3.04	0.22	0.22	0.63	0.63	11.78	11.78
63	A	3.68	1.88	0.53	0.29	0.05	0.05	0.21	0.13	5.93	3.13
	B	0.08		0.06		0.06		0.06		0.32	
64	B	0.03	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.12	0.12
65	C	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
66	A	2.55		1.35	1.35	0.16	0.16	0.74	0.74	5.85	3.30
67	A	1.07	1.69	0.63	0.48	0.02	0.03	0.13	0.12	2.06	2.64
	B	2.30		0.33		0.04		0.11		3.22	
68	A	8.22	4.16	2.00	1.01	0.16	0.08	0.29	0.15	14.41	7.30
	B	0.09		0.01		0.01		0.01		0.19	
69	A	10.30	5.70	1.69	1.09	0.14	0.09	1.17	0.64	16.34	9.33
	B	1.10		0.48		0.05		0.11		2.32	
70	A	3.69	1.88	2.11	1.06	0.33	0.17	0.20	0.10	8.71	4.43
	B	0.06		0.01		0.01		0.01		0.14	
71	A	1.57	0.82	0.56	0.29	0.04	0.02	0.20	0.11	3.32	1.78
	B	0.08		0.02		0.01		0.02		0.24	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
72	A	0.56	2.31	1.03	0.98	0.07	0.07	0.11	0.25	2.47	5.76
	B	3.00		0.91		0.07		0.26		7.17	
	D	3.37		1.00		0.08		0.37		7.66	
73	A	6.77	4.23	4.00	2.22	0.35	0.21	0.89	0.54	18.15	10.65
	B	1.69		0.43		0.07		0.19		3.14	
74	A	4.19	4.18	0.83	0.47	0.04	0.03	0.32	0.22	7.18	6.69
	B	4.16		0.10		0.01		0.12		6.19	
75	A	40.50	10.92	8.98	2.42	0.69	0.19	2.71	0.74	67.18	18.68
	B	3.13		0.68		0.06		0.24		7.45	
	C	0.01		0.01		0.01		0.01		0.03	
	B-2	0.03		0.01		0.01		0.01		0.08	
76	A	5.93	3.02	1.20	0.60	0.04	0.02	0.30	0.15	10.43	5.34
	B	0.11		0.01		0.01		0.01		0.24	
77	A	4.03	2.15	1.52	0.79	0.13	0.07	0.19	0.11	6.73	3.59
	B	0.27		0.07		0.01		0.03		0.46	
78	A	0.20	0.11	0.28	0.14	0.21	0.11	0.43	0.22	1.97	1.01
	B	0.03		0.01		0.01		0.01		0.06	
79	B	0.01	0.71					0.01	0.07	0.03	1.02
	A	1.40						0.14		2.00	
80	A	1.24	0.95	0.57	0.31	0.04	0.02	0.08	0.07	2.51	1.79
	B	0.67		0.04		0.01		0.06		1.07	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
81	A	0.10	0.06	0.06	0.04	0.01	0.01	0.01	0.01	0.19	0.13
	B	0.02		0.01		0.01		0.01		0.06	
82	A	1.12	0.56	0.61	0.31	0.06	0.03	0.16	0.08	2.52	1.27
	B	0.01		0.01		0.01		0.01		0.03	
83	A	0.54	0.37	0.88	0.47	0.05	0.03	0.09	0.07	1.56	0.98
	B	0.20		0.05		0.02		0.05		0.40	
84	A	5.20	2.61					0.50	0.25	7.50	3.76
	B	0.02						0.00		0.03	
85	A	0.52	0.26					0.08	0.04	0.99	0.50
	B	0.01						0.00		0.01	
86	A	0.69	0.35					0.12	0.06	1.39	0.70
	B	0.00						0.00		0.01	
87	A	2.09	1.06	0.91	0.46	0.09	0.05	0.15	0.08	4.23	2.14
	B	0.03		0.01		0.01		0.01		0.06	
88	A	0.76	0.85	0.69	0.44	0.05	0.06	0.19	0.23	2.65	2.56
	B	0.94		0.20		0.07		0.27		2.47	
89	A	14.70	7.36	3.88	1.95	0.12	0.06	0.72	0.36	25.20	12.63
	B	0.02		0.01		0.01		0.01		0.06	
90	A	5.61	5.45	1.91	1.24	0.11	0.09	0.36	0.58	10.59	9.42
	B	5.28		0.57		0.08		0.79		8.25	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
91	A	205	115.50	99.30	56.85	42.40	23.94	38.50	21.13	548.20	307.02
	B	26		14.40		5.47		3.76		65.83	
92	A	14	7.01	4.27	2.14	0.23	0.12	0.75	0.38	25.20	12.63
	B	0.03		0.01		0.01		0.01		0.05	
93	A	6.20	19.60					0.19	1.05	7.79	24.05
	B	33						1.90		40.30	
94	EA	0.81	2.21					0.08	0.13	1.29	2.93
	CA	3.60						0.17		4.56	
	WA	0.46	0.25					0.07	0.04	0.85	0.47
	WB	0.04						0.01		0.09	
95	A	7.00	17.50					0.25	0.83	8.85	23.78
	B	28						1.40		38.70	
96	A	13.30	9.49	4.01	2.55	0.16	0.15	0.48	0.51	23.55	16.53
	B	5.67		1.08		0.14		0.53		9.51	
97	A	1	0.50					0.08	0.04	1.83	0.92
	B	0.00						0.00		0.01	
98	A-2	0.13	0.15	0.08	0.09	0.01	0.01	0.02	0.03	0.41	0.47
	A	0.31		0.20		0.02		0.06		0.96	
	B	0.01		0.01		0.01		0.01		0.03	
99	C	0.19	0.17					0.05	0.03	0.49	0.43
	S	0.14						0.02		0.38	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
100	C	0.00	0.00					0.00	0.00	0.01	0.01
	S	0.00						0.00		0.01	
101	C	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.05	0.05
102	A	0.00	0.19	NA	NA			0.00	0.02	0.01	0.40
	B	0.38		NA				0.04		0.79	
103	A	0.08	0.05	0.05	0.03	0.01	0.01	0.01	0.01	0.25	0.14
	B	0.01		0.01		0.01		0.01		0.03	
104	A	0.36	0.18					0.03	0.02	0.75	0.38
	B	0.01						0.00		0.01	
105	A	0.40	0.21					0.05	0.03	0.79	0.42
	B	0.02						0.00		0.04	
106	A	0.28	0.20	0.23	0.13	0.01	0.01	0.02	0.02	0.85	0.65
	B	0.12		0.04		0.01		0.01		0.45	
107	B	0.26	0.26	0.16	0.16	0.02		0.04	0.04	0.72	0.70
108	A	0.13	0.07	0.07	0.04	0.01		0.06	0.03	0.45	0.23
	B	0.01		0.01		0.01	0.01	0.01		0.03	
109	C	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.03	0.03
110	A	1.30	2.92	1.07	0.92	0.02	0.06	0.17	0.41	4.07	6.19
	B	4.54		0.77		0.09		0.65		8.32	
111	A	16.60	8.33	9.90	4.95	1.33	0.67	4.13	2.07	47.46	23.82
	B	0.06		0.01		0.01		0.01		0.17	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
112	B	0.02	5.76	0.01	3.82	0.01	0.12	0.01	0.46	0.05	12.55
	A	11.50		7.63		0.24		0.92		25.06	
113	A	7.51	7.74	3.51	3.07	0.19	0.16	0.38	0.55	15.73	15.15
	B	7.96		2.62		0.13		0.72		14.57	
114	A	7.95	12.23	3.11	6.19	0.16	0.50	1.01	1.73	16.65	22.88
	B	16.50		9.26		0.84		2.44		29.11	
115	A	0.26	0.66	0.17	0.11	0.03	0.03	0.06	0.05	0.79	1.26
	B	1.06		0.05		0.03		0.04		1.73	
116	A	10.30	11.85	1.78	1.91	0.28	0.17	3.22	1.93	22.19	19.18
	B	13.40		2.04		0.06		0.65		16.17	
117	A	5.49	2.75	1.09	0.55	0.12	0.06	0.40	0.20	8.55	4.29
	B	0.01		0.01		0.01		0.01		0.03	
118	A	14.00	7.01					0.54	0.27	18.24	9.14
	B	0.02						0.01		0.03	
119	A	12.00	6.00	3.01	1.51	0.16	0.08	0.88	0.44	20.66	10.35
	B	0.01		0.01		0.01		0.01		0.03	
120	C	0.01	20.07	0.01	6.19	0.01	0.54	0.01	2.05	0.03	34.45
	A	26.30		6.77		0.63		1.58		40.99	
	B	33.90		11.80		0.99		4.55		62.34	
121	A	0.50	0.25	0.88	0.44	0.09	0.05	0.29	0.15	2.28	1.15
	B	0.01		0.01		0.01		0.01		0.03	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 3b. Concentration of pesticides (in parts per million). Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee, for 129 residences.

Residence	Sample Location	Endrin Ketone	Endrin ketone Property Average	Hex VCL	Hex VCL Property Average	Hexachloro-norbornadiene	Hexachloro-norbornadiene	Isodrin	Isodrin Property Average	Total Endrin [1, 2]	Total Endrin Property Average[1, 2]
122	A	4.40	2.20	NA	NA			0.16	0.08	5.96	2.99
	B	0.01		NA				0.00		0.02	
123	A	28.70	13.55	11.30	5.95	0.54	0.37	1.80	0.97	49.72	25.19
	B	11.70		6.52		0.57		1.08		25.43	
	C	0.25		0.02		0.01		0.03		0.44	
124	A	0.48	0.27	1.64	0.83	0.28	0.14	0.97	0.50	4.49	2.36
	B	0.06		0.02		0.01		0.03		0.22	
125	A	1.30	10.65		NA			0.07	0.52	1.83	12.55
	B	20						0.97		23.27	
126	A	9.95	5.07	3.26	1.67	0.71	0.36	1.25	0.63	20.41	10.36
	B	0.20		0.07		0.01		0.01		0.32	
127	A	7.07	3.54	1.74	0.87	0.09	0.05	0.48	0.24	12.26	6.15
	B	0.01		0.01		0.01		0.01		0.03	
128	A	0.98	1.48	0.75	0.98	0.06	0.06	0.15	1.12	2.73	4.52
	B	1.98		1.21		0.05	0.03	2.10		6.30	
129	A	0.44	0.44	0.19	0.16	0.01	0.01	0.06	0.05	1.13	1.04
	B			0.14		0.01		0.05		0.51	

[1] Includes concentration of endrin and endrin property average from Table 3a.

[2] Total endrin property average is the sum of the average concentrations for each chemical considered with endrin for toxicity purposes – endrin, endrin ketone, heptachlorobicycloheptene (Hex VCL), hexachloronorbornadiene, and isodrin.

Table 4. Concentration of pesticides (parts per million), Springdale Creek Apartments, North-Side pesticide summary, Memphis, Shelby County (EnSafe 2004).

Pesticide	Minimum	Maximum	Average [1]
Dieldrin	0.049	119	7.465
Heptachlor epoxide	1.940	1.940	1.940
Heptachlor	0.350	207	27.345
Endrin ketone	0.031	2,550	92.292
Aldrin	0.034	523	26.072
4,4'-DDD	0.028	2,000	63.175
Endrin aldehyde	0.440	438	42.373
Endrin	0.028	3,790	105.268
Endosulfan sulfate	0.401	0.401	0.401
Endosulfan II	0.037	1.770	0.903
4,4'-DDT	0.242	0.400	0.321
4,4'-DDE	0.061	0.110	0.086

[1] The average is based on 159 sample locations.

Table 5. Chemical groupings and child chronic Environmental Media Evaluation Guides (EMEGs) or child chronic Reference Dose Media Evaluation Guides (RMEG) for chemicals of concern. Cypress Creek, Sub-Area III, Memphis, Shelby County, Tennessee.

Chemical	Chemical Grouping	Child Chronic EMEG	NOAEL or LOAEL	CREG
Aldrin	Aldrin	2 ppm	0.025 mg/kg·day (LOAEL)	0.04 ppm
Dieldrin	Dieldrin	3 ppm	0.005 mg/kg·day (NOAEL)	0.04 ppm
Endrin	Endrin	20 ppm	0.025 mg/kg·day (NOAEL)	NA
Endrin ketone				
Heptachlorobicycloheptene (Hex VCL)				
Hexachloronorbornadiene				
Isodrin				

EMEG: ATSDR Environmental Media Evaluation Guide
RMEG: ATSDR Reference Dose Media Evaluation Guide, taken from EPA's reference dose
NOAEL: No observed adverse effect level
LOAEL: Lowest observed adverse effect level
CREG: Cancer risk evaluation guide for 1/1,000,000 excess cancer risk
NA: Not available, Class D carcinogen, not classifiable as to human carcinogenicity

Certification

This Health Consultation: Cypress Creek, Sub-Area III was prepared by the Tennessee Department of Health, Environmental Epidemiology under a Cooperative Agreement with the Agency for Toxic Substances and Disease Registry (ATSDR). It was prepared in accordance with the approved methodology and procedures that existed at the time the health consultation was begun. Editorial review of this document was performed by the Cooperative Agreement partner.

Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation, ATSDR has reviewed this public health consultation and concurs with the findings.

Team Leader, CAT, CAPEB, DHAC, ATSDR