Health Consultation

Anniston PCB Air Sampling

ANNISTON PCB SITE (MONSANTO COMPANY)

ANNISTON, CALHOUN COUNTY, ALABAMA

EPA FACILITY ID: ALD000400123

DECEMBER 18, 2003

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.

You May Contact ATSDR TOLL FREE at
1-888-42ATSDR
or
Visit our Home Page at: http://www.atsdr.cdc.gov

HEALTH CONSULTATION

Anniston PCB Air Sampling

ANNISTON PCB SITE (MONSANTO COMPANY)

ANNISTON, CALHOUN COUNTY, ALABAMA

EPA FACILITY ID: ALD000400123

Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

Background and Statement of Issues

Anniston-area community members have posed questions and voiced concerns regarding polychlorinated biphenyl (PCB) levels in their air. As part of ongoing Agency for Toxic Substances and Disease Registry (ATSDR) activities surrounding polychlorinated biphenyl (PCB) contamination and public health implications in the Anniston, Alabama, area, this health consultation reviews ambient air PCB data collected by Solutia Inc. and the US Environmental Protection Agency (EPA) [1,2]. The data reviewed in this consultation are specific to the PCB air sampling that occurred from January 2000 through January 2001. Solutia Inc. has continued to conduct air sampling since January 2001; these data have been continually provided to ATSDR for review. The more recent sampling results are similar to those reviewed and discussed in this document.

Because the sampling results are expressed in several different ways, three definitions of PCBs are provided here: Aroclor, congener number, and congener class (or homolog). A PCB Aroclor is a name given to formerly commercial PCB products. Aroclors were named according to the different percentages of chlorine, by weight, that the PCB mixture contained. For example, Aroclor 1242 contained approximately 42 percent chlorine by weight. A PCB congener number refers to the specific location(s) of the chlorine(s) on the biphenyl molecule. From one to ten chlorines can be found on a biphenyl structure. For example, PCB congener number 28 is a tri-chlorinated biphenyl, with chlorines attached at the 2, 4, and 4' locations on the biphenyl carbons. There are a total of 209 possible congener numbers. Finally, PCB congener numbers can be grouped into one of ten (mono- through deca-) congener classes by number of chlorines. For example, congener numbers 4 through 15 each have two chlorine atoms; these 12 congener numbers make up the dichlorobiphenyl congener class. It should be noted that individual Aroclors were made up of varying amounts of PCBs by congener class. For example, Aroclor 1242 contained varying amounts of mono- through hexa-PCB congener classes [3]. More in-depth definitions can be found in Appendix B of this report.

Description of Sampling and Analysis

Solutia Inc. collected 24-hour air samples two days per month at five locations on the facility property boundaries from January 2000 through January 2001. The US EPA Region IV collected 24-hour samples for two days in June 2000 at eight locations (Solutia Inc. sampling occurred on the same two days). Six of the EPA sample stations were located approximately 0.25 to 0.5 miles away from the facility property borders; the remaining two sample stations were located approximately 1 mile away. EPA sample stations were located in residential or public access areas. The map in Appendix 1 displays the locations of both Solutia Inc. and the EPA air sampling stations. A description of each location is also provided in this appendix. The heights of both the Solutia Inc. and EPA air sample inlets were reported to be approximately two meters [4]. Residential areas are adjacent to the Solutia Inc. sample stations on the west, northwest, north, and northeast edges of the Solutia Inc. property.

For sample collection, both Solutia Inc. and EPA used the same type of sampling cartridge (PUF/XAD) that collects both vapor phase and particulate-bound PCBs. In addition, both Solutia Inc. and EPA sampled at approximately the same airflow rates for the same period of time (24 hours). However, the method of PCB analysis was different. The EPA used a gas chromatograph (GC) with an electron capture detector (ECD), as described in EPA Method TO-4A [2]. Solutia Inc. used a GC mass spectrometer based on the procedures of EPA Method T0-4 and EPA Method 680 [5].

EPA analyzed for Aroclors 1242, 1254, 1221, 1232, 1248, 1260, 1016, and 1268. EPA also analyzed for PCB congener numbers 28, 52, 60, 66, 74, 77, 81, 99, 101, 105, 118, 126, 138, 153, 156, 163, 169, 170, 180, 183, 187, 194, 195, 196, 201, 203, 206, 208, and 209. Solutia Inc. analyzed for PCBs by mono- through deca-PCB congener classes. Detection limits varied by analytical method and according to the volume of air sampled. EPA detection limits were 2.1 nanograms per cubic meter (ng/m^3) to 3.8 ng/m^3 for PCBs by Aroclor and 0.18 ng/m^3 to 0.52 ng/m^3 for PCBs by congener number. Solutia Inc. detection limits for PCBs by congener class were reported as 0.06 ng/m^3 based on a 350 m^3 air sample volume.

Meteorological Data

EPA provided the meteorological data for its two sampling periods. Winds during the first sampling period (June 27–28) were mainly from the southwest, with hourly average speeds up to 19 miles per hour (mph) for about 73% of the time. Winds were calm (less than 2 mph) for 27% of the time. Calm winds occurred between 8 pm and 7 am. During the second sampling period (June 29–30), winds were also mainly from the southwest. Calm winds occurred from midnight thru 4 am. Heavy rain was recorded from 9 to 10 am on June 29th. Meteorological data were not provided with the Solutia Inc. sample results.

PCB Results by Sample Location

PCBs were detected at all Solutia Inc. sample locations over the 1-year sampling period. Total PCBs were calculated as the sum of levels of each congener class detected. If PCBs were not detected, a value of one-half of the quantitative detection limit was used. Table 1 (Appendix 2) displays a summary of these results by sample station location. Figure 1 (Appendix 3) displays a graphic presentation of these results. Sample location 4 (north) had the highest level of PCBs detected (116 ng/m^3), as well as the highest yearly mean (30.8 ng/m^3) and median (18.9 ng/m^3) concentrations. Sample station location 1 (east) had the lowest annual mean and median concentrations, 5.4 and 4.3 ng/m^3, respectively (maximum concentration: 22.1 ng/m^3).

Figures 2 and 3 (Appendix 3) display the EPA air sampling results by total congeners and by Aroclor 1242. Table 2 (Appendix 2) displays the results of EPA's two-day, off-site PCB sampling. Total PCBs are reported as the sum of congeners detected and as the concentration of Aroclor 1242. If PCBs were not detected, a value of one-half the quantitative detection limit was used. Aroclor 1242 concentrations are higher than the sum of individual congener

concentrations. Aroclor analysis does not measure individual congeners. Because Aroclors are a mix of congeners, analysis is a pattern recognition estimate. These analyses may either over- or underestimate actual PCB concentrations.

Neither PCB congeners nor Aroclor 1242 were found at A and H sample stations that were located approximately one mile west and east-northeast, respectively, from the site. In addition, PCBs were not detected at sample station "B", which was located approximately 0.25 miles southwest of the Solutia Inc. property boundary. PCBs were detected at the remaining five locations. The maximum concentration (4.9 ng/m^3 total congeners and 45 ng/m^3 Aroclor 1242) was detected at the station located approximately 0.25 miles northwest (station "D") of the property boundary. On this same date (June 27, 2000), the maximum PCB concentration found in Solutia Inc.'s data was 96.9 ng/m^3, at its north sample station (station 4).

Sample Results by Sample Date

PCBs were detected on each Solutia Inc. sampling date. Figure 4 and Table 3 display the data arranged by sampling date. The highest maximum (116 ng/m^3) and mean (33.8 ng/m^3) values of total PCBs were detected on June 28, 2000. The data indicate a general trend whereby higher levels of PCBs were generally found in the spring and summer months; the lowest levels were generally detected in the winter months.

PCBs were detected on both days of EPA sampling. When results from the background locations (stations 1 mile from the Solutia Inc. facility) are not included, the average sum of PCB congeners was 0.9 ng/m^3 on June 27th, 2000, and 1.1 ng/m^3 on June 28th. In addition, the Aroclor 1242 concentrations on these two sample dates were 10.3 ng/m^3 and 11.8 ng/m^3, respectively. Table 4 summarizes these results, both with and without background sample results.

Congeners Detected

The mono- through penta-PCB congener classes were commonly detected at all Solutia Inc. sample stations at various times throughout the year. The hexa-chlorinated congener class was commonly detected at the 2-South, 4-North, and 5-Northeast sample stations from the April 28 through September 26, 2000 sampling period. It was less commonly detected at the other locations. The hepta-congener class was detected once at the 2-South station (5/21/00); 3 times at the 4-North station (6/27, 6/28, 7/26); and once at the 5-Northeast location (7/26). Figures 5 and 6 display the number of times that hexa- and hepta-congener PCB classes were detected, both by sample station location and by month sampled.
Results of the two-day sampling by EPA found PCB Aroclor 1242 both days at sample locations C, D, and E; the first day at location F; and the second day at location G. PCB congener numbers 28 (tri-congener class); and 74 (tetra-congener class) were detected. Congener numbers 52, 60, 66, 74, 81 (all in tetra-congener class), 101 (penta-congener class), and 156 (hexa-congener class) were reported as "presumptive evidence of presence of material."

Discussion

In general, airborne PCB levels in the US appear to be decreasing over time, with higher levels being detected in urban areas than in rural locations [3]. For example, in June 1996, atmospheric concentrations of total PCBs measured in urban and rural locations in Baltimore, Maryland, were 0.4–3.4 and 0.02–0.3 ng/m^3, respectively. Table 5 summarizes these data, along with other urban area total PCB air concentrations. The EPA PCB mean values and concentration ranges detected in Anniston are higher than those reported in other urban areas.

The Anniston, Calhoun County area is classified as a "metro county (3)" in the rural-urban continuum code that is used as a classification scheme for all US counties [6]. A "metro county (3)" includes counties in metro areas of fewer than 250,000 in population. In Table 5, the counties that include Baltimore, New Brunswick, and Sturgeon Point are all classified as "metro county (0)," which is defined as central counties of metro areas of 1 million population or more. This classification system, along with the fact that PCBs levels are generally higher in urban areas, indicates that the Anniston area would have been expected to have lower levels of PCBs than the larger and more populated cities displayed in Table 5.

Table 5. PCB Air Concentrations found in EPA and Solutia Inc. samples vs. other US locations [5]

Sample Location, date	Mean (range) PCB Concentrations, ng/m^{3*}
Anniston, AL, Solutia Inc. samples, Jan 2000–Jan 2001	12.5 (0.03** –116)
Anniston, AL, EPA samples, June 2000	1.0 (0.2** –16.2)
Baltimore, MD, urban area, 1996	(0.4–3.4)
Baltimore, MD, rural area, 1996	(0.02–0.3)
New Brunswick, NJ, urban area, 1997	0.5 (0.1–3.2)
Sturgeon Point, NY, urban area, 1997	0.37

*Solutia Inc. values are the sum of PCBs by congener class; all other values are the sum of PCB congeners; therefore, the Solutia Inc. results may not be directly comparable to the other results in the table.
**half of analytical quantitation limit

Because of the two different methods of sample analysis, a direct quantitative comparison of Solutia Inc. results with EPA's is not possible. Solutia Inc. analyses are reported as PCB congener class; EPA results were reported as Aroclor and as PCB congener number. Solutia Inc. detected mono- through hepta-congener classes. EPA detected Aroclor 1242 and congener numbers 28 and 74. In addition, EPA reported the "presumptive evidence" of the presence of more highly chlorinated congeners (penta and hexa). On the two days when both EPA and Solutia, Inc. sampling occurred, results of the two closest sample stations (Solutia Inc.'s 4- North and EPA's Station D) are roughly comparable. Solutia Inc. data show mono- through hepta-PCB congener classes, with a total PCB concentration detected each day (June 27 and 28) of 96.9 and 116 ng/m^3, respectively. The EPA sampling either detected or found "presumptive evidence" of

tri- through penta-PCB congener classes, with a total PCB concentration of 16.2 ng/m^3 on June 27. The EPA June 28 sample results for the same location detected or found "presumptive evidence for tri- and tetra congener classes, with a total PCB concentration of 2.9 ng/m^3. PCBs were detected by both Solutia Inc. and EPA. EPA found PCBs at lower concentrations than did Solutia Inc. Solutia Inc. sample locations were on the edge of its property line and EPA sample stations were approximately ¼-mile away from the facility property line. If PCB levels are decreasing with distance from the Solutia Inc. sample stations, this trend may indicate that the source of PCBs is on or near the Solutia Inc. property.

The detection of the hexa- and hepta-chlorinated congener PCB classes suggests the presence of Aroclors that are more heavily chlorinated than Aroclor 1242. As an example, hexa-chlorinated congeners make up 0.32 percent of the weight composition of Aroclor 1242, as compared to making up 26.75% of Aroclor 1254 and 43.35% of Aroclor 1260 [3]. The hexa-chlorinated congener class made up approximately 1.6% and 1.4%, respectively, of the composition of the classes detected in the June 27 and 28 samples at Solutia Inc.'s 4-North location. This indicates the presence of more highly chlorinated Aroclors. Further support for the presence of highly chlorinated congeners is the periodic detection of the hepta-chlorinated PCB congeners. This congener class is found only in Aroclors 1248 through 1268 [3].

Community Health Implications

The number of sampling locations in the existing communities surrounding the Solutia Inc. facility is limited. The sample results at stations located near communities suggest that community exposures via inhalation of PCBs could be occurring. More representative sampling in community areas around the facility would assist in better determining residential exposures to PCBs.

Noncancerous health effects

PCBs have been associated with several adverse noncancerous health effects in humans and animals, including liver, thyroid, dermal and ocular changes, immunological alterations, neurodevelopmental changes, reduced birth weight, and reproductive effects. Studies attempting

to show the same health effects in humans that have been observed in animals have generally been inconclusive [3].

In general, some human studies have found associations between PCBs and

1. subtle neurobehavioral effects in children, particularly from pre-natal exposure or exposure during breast-feeding,
2. hepatic (liver) effects in occupationally exposed adults,
3. dermal and ocular effects in occupationally exposed adults and in a population that consumed rice oil that was contaminated with PCBs and dibenzofurans,

4. subtle immunological susceptibility, particularly in infants exposed during gestation or breast-feeding, and
5. reproductive effects, particularly in infants born to mothers who ate contaminated fish [3].

However, one study showed that humans potentially exposed to a dose of 70–140 µg/kg/day of PCBs for months to years showed no evidence of impaired health [7].

Cancer

PCBs are known to cause cancer in animals [3]; however, the evidence that PCBs cause cancer in humans is not as clear. The potential for PCBs to cause cancer has been investigated through human studies that have examined both occupational exposures and environmental exposures. Most of the studies that examined environmental exposures used biological levels of PCBs, rather than environmental levels (i.e., blood samples instead of air samples). Therefore, it is difficult to evaluate the PCB levels discussed in this document for their potential to cause cancer. However, *occupational* exposures to PCBs (usually at much higher levels than what is found in the environment) have been associated with liver, bile tract, intestinal, and skin cancer [8–15].

In contrast to human studies, there is stronger evidence that PCBs cause liver and thyroid cancer in animals [16–19], particularly from exposure to PCBs with 60% chlorine (e.g., Aroclor 1260) [20]. In addition, a more recent study showed that all 4 mixtures of Aroclors (Aroclors 1016, 1242, 1254, and 1260) induced liver tumors [21, 22]. On the basis of sufficient evidence of carcinogenicity in animals, PCBs have been classified as a probable human carcinogen by the US Environmental Protection Agency (EPA) and the International Agency for Research on Cancer (IARC), and they are reasonably anticipated to be a human carcinogen by the National Toxicology Program (NTP).

Average concentrations may represent a more likely scenario for long-term cancer risk exposure, especially when concentrations vary spatially [23], which was the case for the data evaluated in this document. Short-term exposure to carcinogens is an area of considerable debate and research; however, it is generally believed that any exposure factors that are less than what was used for the calculations will significantly decrease the calculated risk (e.g., exposed for a shorter time period; exposed to lower concentrations; exposed less frequently during the time period, etc.).

Child Health Considerations

ATSDR's Child Health Initiative recognizes that the unique vulnerabilities of infants and children demand special emphasis in communities faced with contamination of environmental media. Several studies have reported that low-level PCB exposure during fetal or neonatal development can affect the infant's neurobehavioral development [24, 25]. However, several limitations of these studies have been noted: (1) possible exposure to other neurotoxic chemicals besides PCBs (e.g., dioxins, mercury, lead, or organochlorine pesticides) that may have contributed to the effects; (2) inadequate control for confounding socioeconomic variables such

as maternal smoking, alcohol, and other drug use; and (3) inadequate control for maternal birth weight and nonspontaneous deliveries [26,27]. In addition to these methodological limitations, different studies have measured different neurobehavioral endpoints, thus impeding comparisons between studies.

Therefore, these studies suggest, but do not conclusively prove, an association between prenatal or neonatal exposures to PCBs and neurobehavioral and developmental effects in young children. Furthermore, these effects were reported to occur in populations with background exposures to PCBs, so that a threshold level has not been defined.

Occupational Health Implications

The National Institute for Occupational Safety and Health's (NIOSH's) Recommended Exposure Limit (REL) for airborne PCBs is 1 microgram (µg) per cubic meter of air (1 $\mu g/m^3$ or 1,000 ng/m^3). This exposure limit is based on up to a 10-hour workday for a 40-hour workweek. The highest level of PCBs found in the Solutia Inc. 24-hour air samples (116 ng/m^3) is approximately one-tenth of the NIOSH REL. This 24-hour sampling was conducted at the edges of the facility property in order to determine if off-site migration of PCBs is occurring. Therefore, the data are not likely to be representative of levels present in areas were Solutia Inc. employees work. Depending on the PCB source location(s) in relationship to the air sample station locations, higher PCB levels may be present in the air at other locations on the Solutia Inc. property.

Until the source(s) of PCBs that are resulting in the air concentrations is (are) better defined, it is not known if other occupational exposures are occurring in the community. Occupations involving soil excavation (e.g., power and water line installation) may be resulting in inadvertent employee inhalation or dermal exposures to PCBs.

Source of PCBs

The method of sample collection precludes determining if the airborne PCBs are present in the vapor phase or are bound to airborne particulate matter (or both). Knowing this information would assist in determining whether the airborne PCBs could be readily absorbed via inhalation of the vapor, or could be trapped in the upper respiratory tract (based on particulate size) and possibly cleared or swallowed. This determination could also assist with finding the source of PCBs and the best method of reducing the airborne levels. Surface soil contamination of PCBs would be suspected if the contaminants were particulate bound. Vapor phase PCBs suggest a surface water or a subsurface source. The fact that the less volatile, more highly chlorinated congeners are detected more frequently in the warmer seasons suggests that the PCBs detected may be in the vapor phase (increasing temperature would increase the volatilization rate of PCBs). If the PCB source contains solvents, the presence of the solvents would also increase the likelihood of PCB volatilization. Other information that would assist in determining the source and phase of PCBs includes dates of invasive activities (e.g., excavation) that were/are occurring near air sample stations and meteorological conditions (e.g., precipitation) during sampling periods.

Conclusions

On the basis of the data reviewed, ATSDR concludes that:

1. *Community members* who reside near the Solutia Inc. facility are likely exposed to PCBs via inhalation. Because of the limited air sampling data in residential areas, the magnitude of these exposures cannot be determined; therefore, community member PCB exposures via inhalation pose an indeterminate health hazard. This conclusion category is used by ATSDR when a professional judgment about the level of health hazard cannot be made because information critical to making such a determination is lacking.

2. PCBs are present in the ambient air both on and off the perimeter of the Solutia Inc. property at higher levels than those found in large US urban areas. Air sampling data in areas where current employees of Solutia Inc. are located are not available for review. The existing ambient air PCB data suggest that it is possible that *current Solutia Inc. workers* may be exposed to PCBs while on the Solutia Inc. property. In addition, until the source(s) of PCBs is/are found, potential PCB exposures to *Anniston-area workers involved in soil excavation* activities pose an indeterminate health hazard.

Recommendations

1. Conduct periodic air sampling for PCBs in residential areas surrounding the Solutia Inc. facility to better determine community exposures.

2. Ensure that current Solutia Inc. employees at this facility are not exposed to PCBs above occupational guidelines. Conducting personal and/or area air sampling at various locations on the facility property during various activities (e.g., indoor office work, outdoor excavation) would assist in determining if occupational exposures to PCBs are occurring.

3. Until the sources of contamination are better characterized, consider environmental testing (e.g., of soil, air) for PCBs prior to soil excavation activities in the Anniston area to ensure that occupational exposures do not occur above recommended guidelines.

Public Health Action Plan

Completed Actions

ATSDR has provided input to EPA regarding the types and general locations of air sampling needed in communities near the Solutia facility that will allow a public health determination.

Ongoing Actions

ATSDR continues review of PCB air sampling results to ensure that the trends observed in the 2000–2001 data set do not increase. If ambient air levels of PCBs increase, ATSDR will prepare additional health consultations as necessary.

Future Actions

ATSDR will assist in reviewing community based air sampling plans and provide input on residential air sampling station locations. When residential air data are available, ATSDR will review and provide a public health determination for the community.

Prepared by:

Lynn C. Wilder, M.S., CIH
Environmental Health Scientist
Exposure Investigations and Consultations Branch
Division of Health Assessment and Consultation

Reviewed by:

Susan Moore, MS
Chief, Health Consultation Section
Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation

Susan Metcalf, MD, MPH
Chief, Exposure Investigation Section
Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation

Clement Welsh, PhD
Environmental Health Scientist
Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation

John E. Abraham, PhD
Chief, Exposure Investigations and Consultations Branch
Division of Health Assessment and Consultation

References

1. Solutia Inc. 2000. Ambient PCBs Measurements Program–Anniston, Alabama. Ambient PCB concentrations, January 2000 through January 2001.

2. US Environmental Protection Agency, Region IV, Science and Ecosystem Support Division. Polychlorinated biphenyl ambient air study, Anniston, Alabama. 2000 Jun.

3. Agency for Toxic Substances and Disease Registry. Toxicological profile for polychlorinated biphenyls (PCBs). Atlanta: US Department of Health and Human Services; 2000 Nov. Available online at http://www.atsdr.cdc.gov/toxprofiles/tp17.html.

4. Personal Communication T. Slagle, US Environmental Protection Agency, Region IV, Science and Ecosystem Support Division. 2001 Jan.

5. ENSR Corporation. Work plan for estimating ambient PCB levels in the vicinity of Solutia's Anniston, AL facility. Document Number 6105-006-150. 2000 Apr.

6. US Department of Agriculture, Web site available at www.ers.usda.gov/friefing/rurality/ruralurbcon/.

7. Kimbrough RD. Polychlorinated biphenyls (PCBs) and human health: an update. Crit Rev Toxicol 1995; 25: 133-166.

8. Brown DP. Mortality of workers exposed to polychlorinated biphenyls—an update. Arch Environ Health 1987; 42(6):333-339.

9. Brown DP, Jones M. Mortality and industrial hygiene study of workers exposed to polychlorinated biphenyls. Arch Environ Health 1981; 36:120-129.

10. Gustavsson P et al. A cohort study of Swedish capacitor manufacturing workers exposed to polychlorinated biphenyls (PCBs). Am J Ind Med 1997; 32(3):234-239.

11. Gustavsson P et al. Short-term mortality and cancer incidence in capacitor manufacturing workers exposed to polychlorinated biphenyls. Am J Ind Med 1986; 10:341-344.

12. Bertazzi PA et al. Cancer mortality of capacitor manufacturing workers. Am J Ind Med 1987; 11:165-176.

13. National Institute for Occupational Safety and Health (NIOSH). Health hazard evaluation report: Westinghouse Electric Corporation, Bloomington, Indiana. HETA 89-116-2094; 1991.

14. Kimbrough RD et al. Mortality in male and female capacitor workers exposed to polychlorinated biphenyls. J Occup Environ Med 1999; 41(3):161-171.

15. Sinks T et al. Mortality among workers exposed to polychlorinated biphenyls. Am J Epidemiol 1992; 136(4):389-398.

16. Kimbrough RD et al. Induction of liver tumors in Sherman strain female rats by polychlorinated biphenyl 1260. J Nat Cancer Inst 1975; 55:1453-1459.

17. Norback DH, Weltman RH. Polychlorinated biphenyls induction of hepatocellular carcinoma in the Sprague-Dawley rat. Environ Health Perspect 1985; 60:97-105.

18. Schaeffer E et al. Pathology of chronic polychlorinated biphenyl (PCB) feeding rats. Toxicol Appl Pharmacol 1984; 75:278-288.

19. National Cancer Institute. Bioassay of Aroclor 1254 for possible carcinogenicity. NCI-GC-TR-38. Bethesda, MD: National Cancer Institute; 1978. NTIS PB279624.

20. Moore JA et al. A comparison of liver tumor diagnoses from seven PCB studies in rats. Regul Toxicol Pharmacol.1994; 20:362-370.

21. Mayes BA et al. Comparative carcinogenicity in Sprague-Dawley rats of the polychlorinated mixtures Aroclors 1016, 1242, 1254, and 1260. Toxicol Sci 1998; 41(1):62-76.

22. General Electric Company. An assessment of the chronic toxicity and oncogenicity of Aroclor 1016, Aroclor 1242, Aroclor 1254, and Aroclor 1260 administered in diet to rats. Volume I and II. Final neurotoxicity and neuropathology report. Environmental Research Center, General Electric Company; 1997. Battelle Study No. SC920192.

23. Agency for Toxic Substances and Disease Registry. Public health assessment guidance manual. Atlanta: US Department of Health and Human Services; 1990 Dec. Rep. No.TP-90-04.

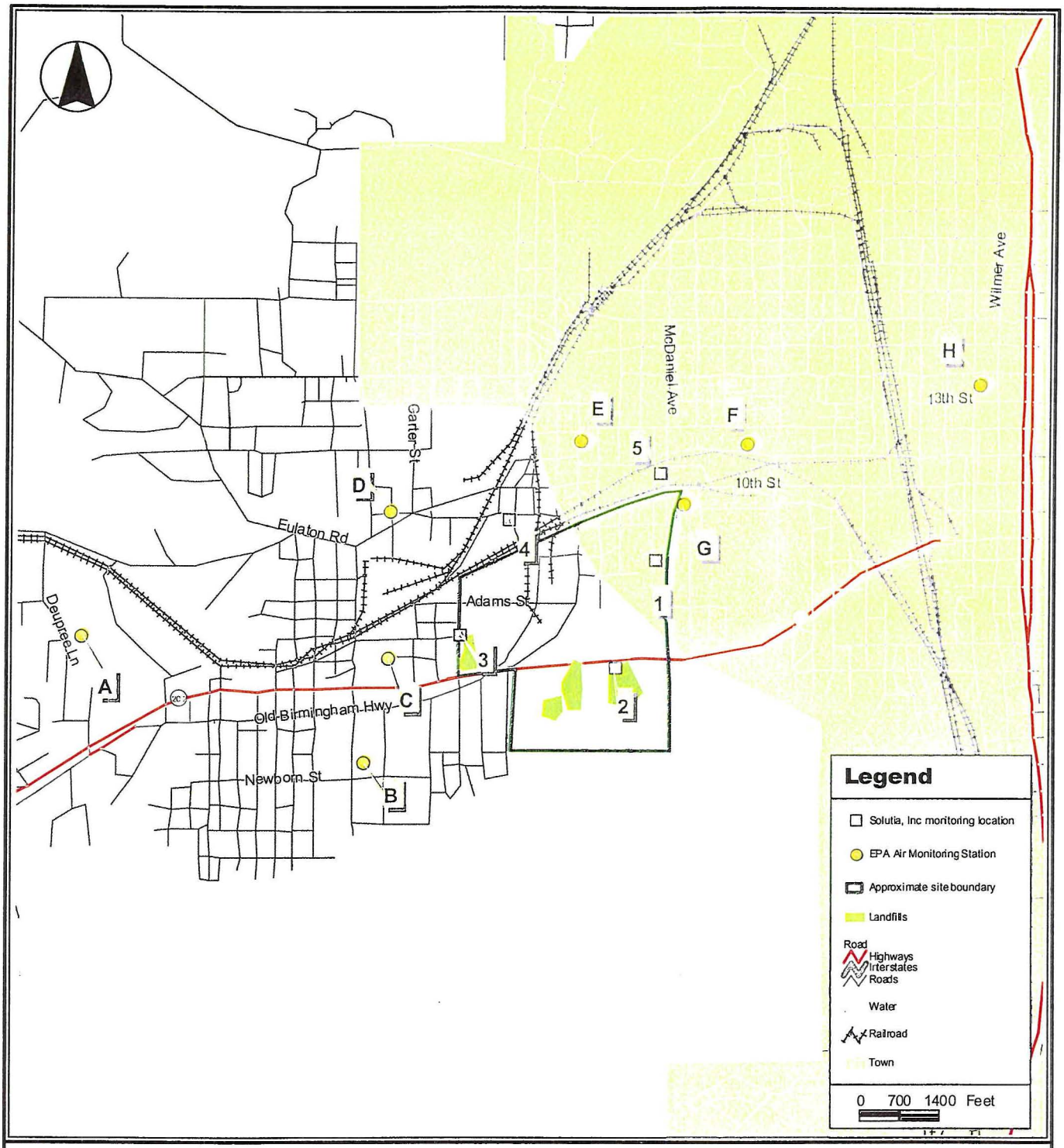
24. Jacobson JL et al. Effects of in utero exposure to polychlorinated biphenyls and related contaminants on cognitive function in young children. J Pediatr 1990; 116:38-45.

25. Rogan WJ, Gladen BC. Study of human lactation for effects of environmental contaminants: the North Carolina breast milk and formula project and some other ideas. Environ Health Perspect 1996; 60: 215-221.

26. Schantz SL. Developmental neurotoxicity of PCBs in humans: What do we know and where do we go from here? Neurotoxicol Teratol 1997; 18: 339-362.

27. Segal RF. Epidemiological and laboratory evidence of PCB-induced neurotoxicity 1996; 26: 709-737.

Appendix 1
Air Sample Station Locations



Anniston, Alabama PCB Site

Anniston, Alabama

CERCLIS No. ALD004019048

AIR MONITORING LOCATIONS

PAC032102

SAIC GIS

Description of Air Sample Station Locations

Sample Location	Station ID	Location Description
East	1	adjacent to the Retention Pond situated just north of Highway 202 and just east of the Solutia Inc. facility.
South	2	near the point of lowest elevation of the South Landfill, approximately 50 feet from eastbound Highway 202
West	3	atop the West End Landfill, approximately 100 feet from westbound Highway 202
North	4	north portion of Solutia Inc. property
northeast	5	Miller property, located on northeast portion of Solutia Inc. property

EPA Region IV Sample Station Locations, June 2000 [2]			
Sample Location	Station ID	Distance[+]	Location Description
west	A	1.0	Wellborn High School (background site)
southwest	B	0.25	South Hunter Street
west	C	0.25	Vacant lot between Hunter and 3rd Streets
northwest	D	0.25	Intersection of Ware Street and 9th Street
north	E	0.25	Intersection of Clydesdale Avenue and 12th Street
northeast	F	0.50	Head Start School, 1000 West 12th Street
northeast	G	0.25	Intersection of Lincoln and Zinn Parkways
northeast	H	1.0	Intersection of Nobel and 13th Streets (downtown Anniston)
[+] estimated distance (miles) from border Solutia Inc. property boundary			

Appendix 2
Tables

Table 1. Sum of PCB Congener Class Concentrations by Sample Location.
Solutia Inc. on-property air 24-hr sampling (January 2000 through January 2001)

Sample Location[+]	Map Key/Station Number (appendix 1)	# Samples	PCB Concentration by Congener Class Concentrations (ng/m^3)		
			Range	Mean	Median
east	1	25	0.03*–22.1	5.4	4.3
east (co-located)	1	13	0.03*–20.3	5.6	3.2
south	2	24	0.03*–20.1	6.2	4.9
west	3	26	0.2– 43.4	10.5	7.8
North	4	24	0.1–116	30.8	18.9
north (co-located)	4	14	0.03*–44.2	18.9	16.8
northeast	5	25	0.03*–34.7	10.3	9.2

[+] refer to legend in attachment for description of sample location
* half of the minimum quantitation limit

Table 2. PCB Concentrations: by Sum of Congeners and by Aroclor 1242. EPA Off-Site 24-hour Air Sampling, June 27 & 28, 2000				
Sample Location[+] (approximate distance from Solutia property)	Map Key/ Station Number (attachment)	# Samples	PCB Congeners (Aroclor 1242) ng/m^{3*}	
			Range	Mean
west (1.0)	A	2	0.2–0.2** (1–1**)	0.2** (1**)
southwest (0.25)	B	2	0.2–0.2** (1–1**)	0.2** (1**)
west (0.25)	C	2	0.2** –0.7 (4.6–8.8)	0.5 (6.7)
northwest (0.25)	D	2	2.5–4.9 (25–45)	3.7 (35)
north (0.25)	E	2	0.7–2.2 (7.3–25)	1.5 (16.2)
northeast (0.5)	F	2	0.2** –0.8 (3.3^{++} & <5.5)	0.5 (4.4^{++})
northeast (0.25)	G	2	0.2** –0.4 (1** –5.7^{++})	0.3 (3.4^{++})
northeast co-located (0.25)	G	2	0.2* –0.6 (1** –8.6)	0.4 (4.8)
northeast (1.0)	H	2	0.2–0.2** (1–1**)	0.2** (1**)

[+]refer to legend in attachment for description of sample location

[*] levels shown are the sum of PCB congeners and, in parentheses, levels of PCBs reported as Aroclor 1242

** half of the minimum quantitation limit

[++]estimated value

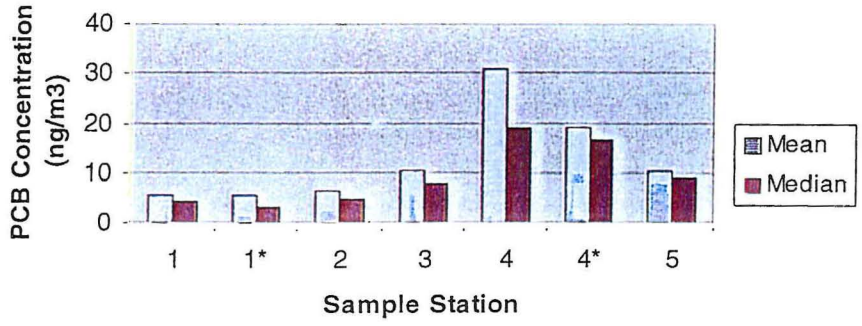
Table 3. Sum of PCB Congener Class Concentrations by Sample Date. Solutia Inc. on-property air 24-hr sampling (January 2000 through January 2001)				
Sample Date[+]	# Samples	Total PCB Concentration in air (ng/m^3)–from all sample stations		
		range	mean	median
1/ 25	6	0.03[*] –17.4	3.4	0.4
1/ 26	5	0.6–9.7	2.9	1.2
2/ 24	5	0.03[*] –16.1	5.6	0.4
2/ 28	5	1–23.2	7.7	2.8
3/ 27	6	6.6–43.5	22.1	21.2
3/ 28	5	6.4–37.4	14.2	9.9
4/ 28	5	8.6–68.8	29.3	15.6
4/ 29	6	7.5–63.5	20	9.6
5/ 20	4	9.8–34.7	20.4	18.5
5/ 21	5	16.2–27.4	19.9	19.0
6/ 27	7	2.6–96.9	22.8	4.6
6/ 28	5	8.8–116	33.8	14.9
7/ 25	7	0.5–11.5	3.6	2.7
7/ 26	5	2.1–77.4	22.3	12.6
8/22	4	0.2–6.8	3.2	2.8
8/ 23	6	5.7–36.9	15.2	9.2
9/ 27	6	2.8–21	9.6	6.4
9/ 28	7	3.8–52.3	19.1	10.4
10/25	6	4.3–16.5	8.2	5.5
10/26	7	8.8–44.2	19.1	13.2
11/27	6	4.0–27.0	12.4	11.2
11/28	7	1.9–27.3	9.9	6.8
12/19	7	0.2–7.5	2.4	2.1
12/20	6	0.1–5.4	2.1	2.0
1/16 (2001)	7	0.4–8.0	2.8	1.4
1/17 (2001)	6	0.03*–2.2	1.0	0.9

Table 3. Sum of PCB Congener Class Concentrations by Sample Date. Solutia Inc. on-property air 24-hr sampling (January 2000 through January 2001)				
Sample Date[+]	# Samples	Total PCB Concentration in air (ng/m^3)–from all sample stations		
		range	mean	median
[+]= year 2000, unless noted [*] = half of the minimum quantitation limit				

Table 4. EPA Off-Site Air Sampling Sum of PCB Congeners and Aroclor 1242 (ng/m^3)				
All Locations				
Sample Date (2000)	# Samples	PCB Congeners (Aroclor 1242)[+]		
		range	mean	median
6 /27	9	0.2[*]–4.9 (1[*] –45)	0.8 (7.2)	0.2 (1[*])
6/ 28	9	0.2[*] –2.5 (1[*] –25)	0.9 (9.1)	0.6 (5.6)
All Locations--*without background samples*				
6 /27	7	0.2[*] –4.9 (1[*] –45)	0.9 (10.3)	0.2 (4.0)
6/ 28	7	0.2[*] –2.5 (1[*] –25)	1.1 (11.8)	0.7 (7.3)
[+] levels shown are the sum of PCB congeners and, in parentheses, levels of PCBs reported as Aroclor 1242 [*] half of the minimum quantitation limit				

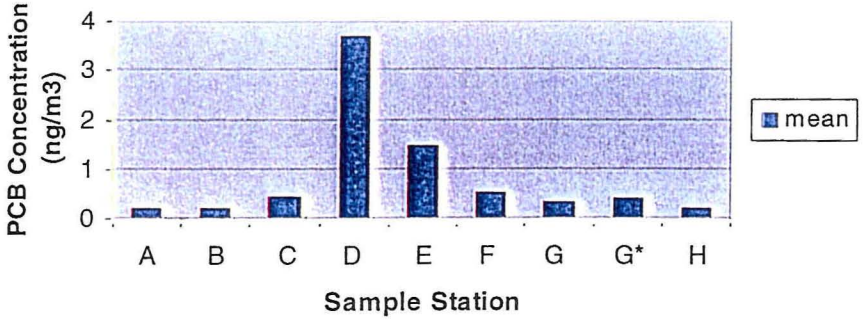
Appendix 3
Figures

Figure 1. PCB Concentrations (as sum of all PCB congener classes), Solutia Inc. data

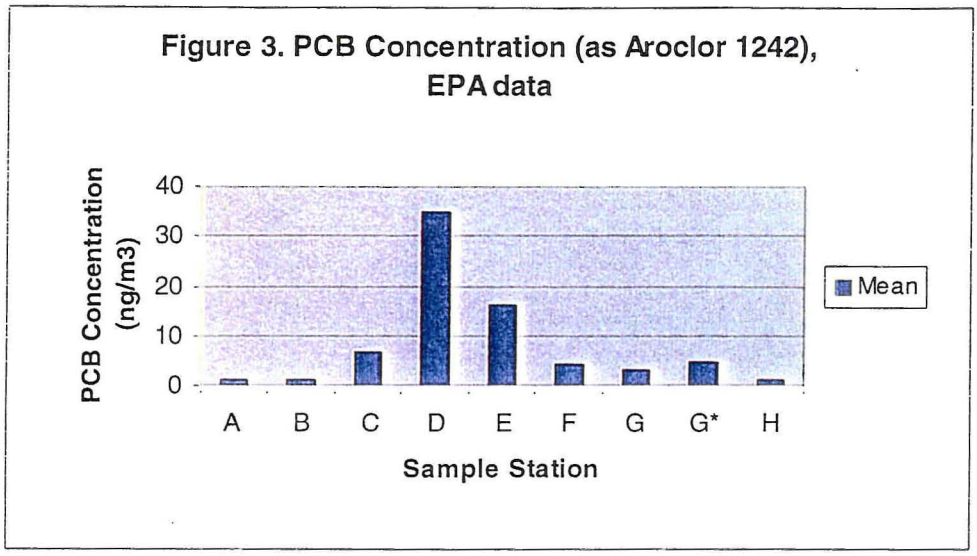


*co-located sample location

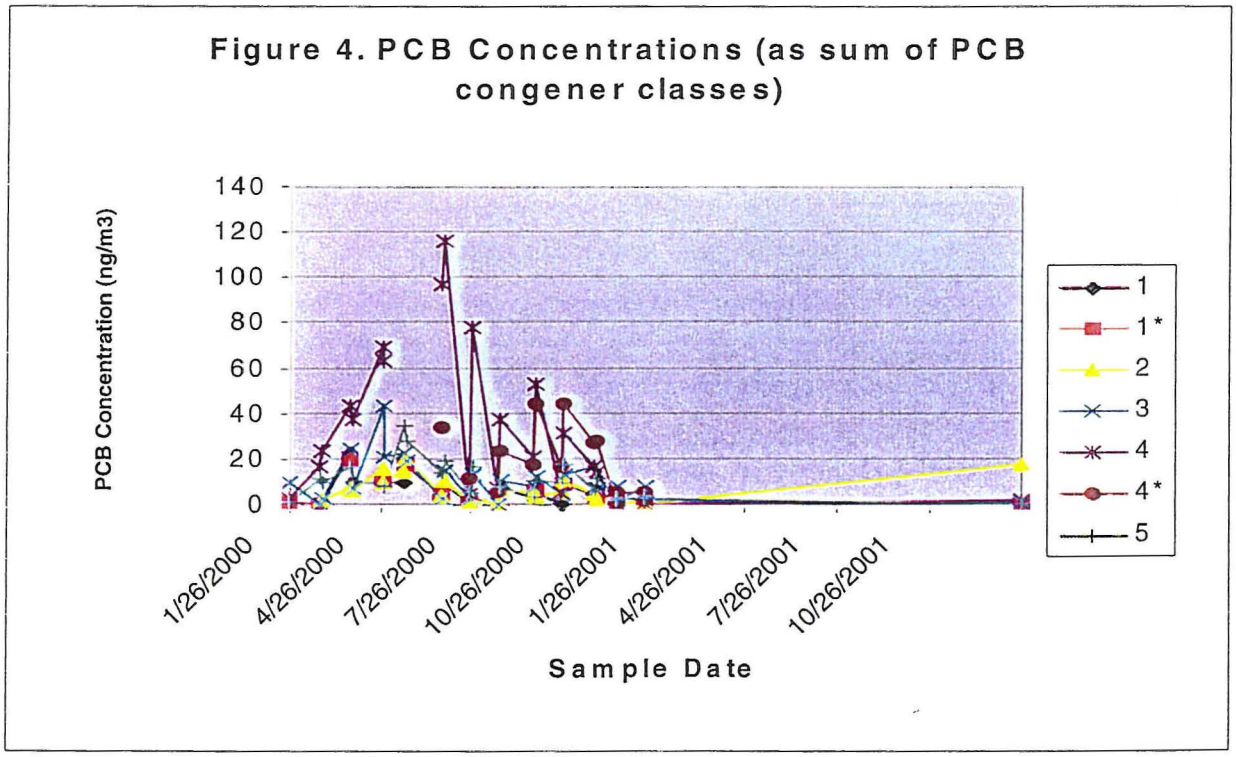
Figure 2. PCB Concentrations (as sum of all congener numbers), EPA data



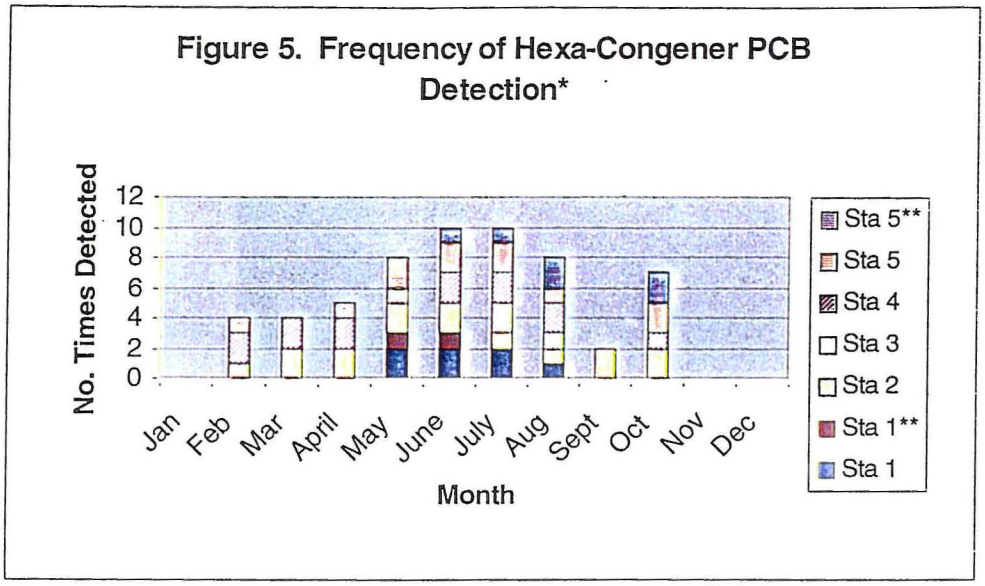
*co-located sample location



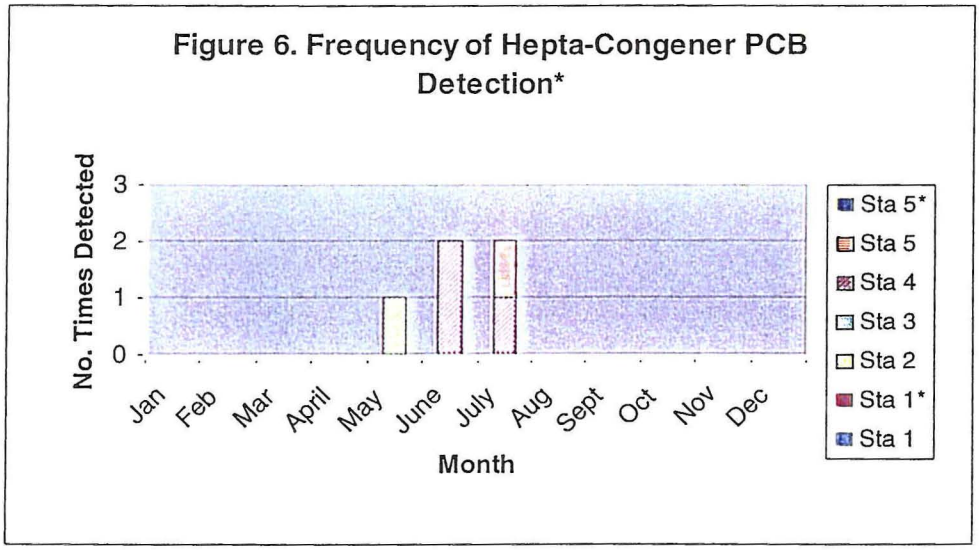
*co-located sample location



*co-located sample location



*maximum possible frequency per sample station is two times per month
**co-located sample location



*maximum possible frequency per sample station is two times per month
**co-located sample location

Appendix 4
Response to Public Comments

Comments from the Community

Comment:

1) Background and Statement of issues:
   a) Can you do a comparison of the three different ways the samples are referred to and explain how one relates to the other?

Response: Please see the "Helpful Definitions for PCBs" that has been added as Appendix 5 to this report.

Comment:

   b) Would you briefly describe the toxicity and how it relates to health issues?

Response: This description is provided in the *Community Health Implications* section (page 6) of this report.

Comment:

2) Description of Sampling and Analysis:
   a) If two different methods of sampling were used, how could an accurate comparison be made?

Response: An accurate comparison cannot be made. As discussed later in the document (page 5), the results of these two sampling methods cannot be directly compared.

Comment:

   b) Please explain how and why the EPA used different detection limits/levels.

Response: The detection limit for air samples varies with the amount (or volume) of air that is sampled. Results with the lowest detection levels are from samples in which the most air was collected. Results with the highest detection levels are from the samples in which the least amount of air was collected.

Comment:

   c) Did Monsanto/Solutia use different ones as well?

Response: Solutia's detection limit was based on a single known or predicted amount of air that should be sampled every time. This detection limit was, therefore, different from the detection limits that EPA calculated.

Comment:

d) How many sampling stations were there and [what was the] reason for them?

Response: Solutia had 5 sampling stations and EPA had 8 sampling stations. Solutia sampling station locations were selected to provide information about concentrations of PCBs in air at the north, south, east, and west fence-line of the Solutia property. The 5th location (to the northeast) was placed where EPA had done air sampling. The Alabama Department of Environmental Management and the US EPA required this sampling and agreed to these locations.

The EPA sampling station locations were selected to assess PCBs in ambient air around the Solutia facility. Five monitoring locations were located within ¼ mile of the Solutia property, one was located between ¼–½-mile of the northeast property line, and two background locations were located about 1 mile away from the facility.

Comment:

e) Could you explain Aroclors and congener numbers and the significance as to whether they could be from recent exposure or previous exposure?

Response: In general, Aroclors and congeners with less chlorine (lower Aroclor numbers and lower congener numbers) tend to degrade faster in both the environment and in people than those with more chlorine. Therefore, finding the presence of both the lower chlorinated and the more highly chlorinated congeners in outdoor air indicates that community exposures to both are ongoing.

Comment:

3) Meteorological Data:
   a) How would the weather affect the sampling process?
   b) What could you learn from the data?
   c) Should Monsanto/Solutia not have provided this to you to help in your analyses?

Response: Weather should not impact or affect the sampling results. However, bad weather can result in power outages or instrument malfunction that would make the sample being collected invalid.

Reviewing wind direction, wind speed, and barometric pressure for the 24-hour period when each sample is collected can assist the enforcement agencies in determining which direction the source(s) of PCBs is/are in relationship to the sample station. This assists in source identification. For health purposes, meteorological information is sometimes useful in identifying weather conditions that result in "worst case" contaminant levels in air. For example, gas emissions from municipal waste landfills are usually higher after a low pressure system moves into an area.

Comment:

4) PCB Results by Sample Location:
   a) This is probably expected that [the farther you are away from the source of contamination] the less the [community] exposure should be.

Response: Comment noted.

Comment:

5) What is significant about higher levels in the spring and summer months than in the fall or winter?

Response: If people are outdoors more in the spring and summer and the air PCB levels tend to be higher, this means that people's exposures are higher in the warmer months. It can also indicate that the PCBs may be in vapor form, not particulate. This might also provide information that could assist in source identification efforts.

Comment:

6) Congeners Detected:
   a) What do the congeners that were detected represent as far as exposure is concerned?

Response: People are exposed to PCBs that are eliminated from the body (in general, PCBs with low chlorine content) over time and to PCBs that accumulate in the body (in general, PCBs that are highly chlorinated) over time. In general, commercial PCB mixtures with high chlorine content are thought to be more toxic than mixtures with low chlorine content. [Agency for Toxic Substances and Disease Registry Toxicological Profile for Polychlorinated Biphenyls (PCBs)].

Comment:

7) Discussion:

The fact that there are higher levels in Anniston than in those larger, more populated areas is a sure indication to us that we are continuing to be exposed to higher than normal levels of PCBs on a daily basis. This alone should suggest that some measures need to be immediately implemented to reduce this exposure. There are residents living adjacent to the Monsanto/Solutia fence line.

Response: ATSDR does not disagree with this comment.

Comment:

a) Here again we are using data that is not compatible and what is the sense of it?

Response: Although ATSDR cannot use the fence line air sampling results to estimate community exposures to PCBs, we can use the results to justify our recommendation to put samplers in the communities surrounding the Solutia facility. The results of future community air sampling can be used by ATSDR and other health agencies to estimate exposures.

Comment:

8) Community Health Implications:
   a) Given the fact that the community is exposed to these levels 24 hours a day, seven days a week, there should be some health assessment or some type of characterization of the present community health status implemented as soon as possible. We may not know the exact relationship between PCBs and everything that they are supposed to cause, but we do know enough to say that continued low level exposure is a threat to human health, especially to the health of children.

Response: Results of the recommended community air sampling can be used by ATSDR and other health agencies to estimate exposures.

Comment:

9) Occupational Health Implications:
   b) This is good that NIOSH has been requested to assess worker exposures, because if the levels are higher on the site than in the community, the workers are being exposed and they need to know this.

Response: ATSDR is discussing this possibility with NIOSH. If Solutia does not want NIOSH to perform a health hazard evaluation (HHE) for its employees, NIOSH does not have "right of entry" based on a request from ATSDR. If three or more Solutia workers request an HHE from NIOSH (this request is confidential—the workers can remain anonymous), then NIOSH does have the right to enter the facility and perform worker exposure assessments. More information on NIOSH, its HHE program, and how to make a request for an HHE can be found on their Web site www.cdc.gov/niosh/. In some cases, the state health department can also make the request for assistance to enable NIOSH to enter the facility.

Comment:

c) Please mention the type of excavation workers who may be exposed.

Response: Until the areas where PCB soil contamination are all identified, workers who are frequently involved in excavating or digging up soil, such as workers laying pipelines, digging drainage ditches, or installing power poles, should be aware of the possibility of PCB contamination.

Comment:

10) Conclusion:
    a) Please define *indeterminate health hazard*

Response: An indeterminate health hazard is the category used in ATSDR's public health assessment documents when a determination of the level of health hazard cannot be made because information critical to such a decision is lacking. In this case, the critical information that is lacking is PCB air sampling results in residential areas.

Comment:

b) With levels this high and on a daily basis, *may* is a word that does not seem to be appropriate to use here in describing whether or not we are being exposed

Response: This comment has been incorporated into the health consultation conclusion.

Comment:

11) Recommendations:
    a) It would have more meaning if these recommendations were directed toward the appropriate agency for actions.

Response: Recommendations for air sampling in the community are currently being negotiated by the US EPA and Solutia. ATSDR has requested an HHE from NIOSH. Again, if Solutia does not want NIOSH to perform a health hazard evaluation (HHE) for its employees, NIOSH does not have "right of entry" based on a request from ATSDR. If three or more Solutia workers request an HHE from NIOSH (this request is confidential—the workers can remain anonymous), then NIOSH does have the right to enter the facility and perform worker exposure assessments. More information on NIOSH, its HHE program, and how to make a request for an HHE can be found on NIOSH's Web site: www.cdc.gov/niosh/. In some cases, the state health department can also make the request for assistance to enable NIOSH to enter the facility.

Comment:

How much time and how many more sample results will be required for ATSDR to implement some other action?

Response: Preferably, ATSDR would like to see air sampling data collected over a 1-year period (with the same frequency that Solutia is currently collecting samples) in communities around the facility.

Comment:

Community recommendations:

1. ATSDR to do its own air sampling and monitoring in a way that would help determine where the source of the exposure is.

2. Set up monitoring stations out in the community at different sites and distances to determine if the exposure is in the community and at what levels
3. We would like for DHAC to compose a list of upcoming consultations, along with time lines
4. We would like to know what has happened with the recommendations for the Air Consultation thus far
5. We would also like to know what happened to the recommendations that the ADPH provided in its PHA

Response: Recommendations noted. DHAC will provide the community with a list of upcoming consultations, along with timelines. On the basis of the recommendations from this health consultation, EPA is working with Solutia to establish air sampling in the community. ATSDR has forwarded the information request regarding ADPH's PHA recommendations to ADPH for follow-up.

Comments from a university

I collected air samples for PCB analysis in residential neighborhoods in Anniston, Alabama from May 1997 to June 1998. Samples were collected from a residential back yard in the 1200 block of Carter Street and from the Mars Hill Missionary Baptist Church (located in what had been a residential neighborhood), and from a residential yard on 6th Street near Montrose Avenue (see attached map). The Mars Hill site was located about 1600 feet east-northeast from the Monsanto plant site and abut 1300 feet north from the South Landfill where 10 million pounds of PCBs are known to be buried. The Montrose site was located abut 1300 feet to the NE from the Mars Hill site. The Carter Street site was located about 1 mile NW from the Mars Hill site.

These samples were collected in support of the plaintiffs in *Bowie et al. v. Monsanto Co., et al.* I testified about these results on January 16, 2002. A synopsis of my testimony was published in the *Birmingham News* (Birmingham, AL) on January 17, 2002.

My sampling operationally separated particle-associated PCBs from gas phase PCBs. Normally, 90% or more of total atmospheric PCBs are found in the gas phase. Anniston samples were consistent with this trend. Samples were analyzed for 109 different PCB congeners. The total PCB is the sum of those congeners.

The results of my sampling show an arithmetic average total PCB concentration of 28.2 ng m^{-3} at Carter (n=19). These results show that Mars Hill has about 28% higher average total PCB than Montrose, and nearly 3 times more than Carter, about one mile away.

US EPA Region 3 has determined that a risk-based total PCB concentration in ambient air (for an average adult) is 3.1 ng/m^3. Each of these sites exceeds that value by a least 3 times, showing that residential properties up to one mile away receive an amount of PCBs that could place people living and working in the area at risk.

The minimum average value observed in this data set (9.7 ng/m^{-3}) is more than 3 times greater than the maximum average observed in Chicago since 1993 (Bueheler and Hites, 2002). The Mars Hill site exceeds this amount by a factor of 9.

ATSDR states that the sources of atmospheric PCBs are not known and cannot be determined from Solutia or EPA data sets. However, my research provides an opportunity to investigate a likely source. My results show that the annual trend of atmospheric PCBs at the Mars Hill site does not show a strong change with air temperature, which would be expected. Normally, atmospheric PCB concentrations are relatively low in winter and higher in summer because of the effects of air temperature on evaporation of PCBs into the air from ground surfaces. Our data from Carter follow this trend. Mars Hill data do not follow this trend because the source of PCBs is not in equilibrium with air temperature. This means that the PCBs in the source are not immediately exposed to air, suggesting that they are buried in the ground or otherwise stored anywhere in Anniston in the 10, 000,000 pounds of PCB buried in the Monsanto/Solutia South Landfill (US EPA, 2001). This is the expected source of atmospheric PCBs at Mars Hill and Montrose. The South Landfill is known by US EPA to be covered with unspecified vegetation growing on soil of unknown depth. Neither of these is known to be a barrier to evaporation of PCBs into the atmospheric gas phase.

Trees absorb PCBs from air into the lipid tissues in bark, so they act as passive air samplers during their lifetimes. PCB data from tree bark that I collected in July 1998 show that trees at the Mars Hill site have 30 times as much PCBs in bark than trees about 5 miles distant. This shows that Mars Hill is close to an atmospheric source of PCB.

The much higher concentrations of atmospheric PCBs at Mars Hill and Montrose—in contrast with Carter—suggest that some of the atmospheric PCBs in the Mars Hill/Montrose area may be condensing onto surfaces over the distance to Carter, about one mile. These surfaces would include soils, vegetation, streets, automobiles, homes (indoors and outdoors), and animals (including people) in the area. Some of my congener-specific air data verify this trend. My tree bark data confirm this pattern.

Air PCB data from samples collected by Solutia since 1998 and by USEPA in 2000 have a number of disadvantages when used to address the issue of exposure of residential areas to atmospheric PCBs. Although Solutia has collected air samples for over five years, its sampling sites have changed many times, making a long-term site study impossible.

PCB air data from Solutia are not congener-specific and cannot be used to identify the types of trends observed in my data. Data from Solutia show some significant quality control issues, particularly with espect to collocated samples, lack of reporting of blank values, and analytical recoveries.

US EPA collected a very small number of samples in 2000, not enough to reach any major conclusions. US EPA results have only 10 specific congeners. Most of those congeners are not found in high concentrations in air. US EPA results report PCBs in terms of Aroclors. It is well known that because of the variable vapor pressures of PCB congeners, once in air, they do not resemble an Aroclor. Therefore, US EPA data can only be used as an approximation of actual PCBs in air.

An adequate air sampling program in Anniston will require a minimum of 10 samplers located in various industrial and residential communities at distances up to 3 miles from the Solutia/Monsanto plant site and landfills. Samplers also need to be placed on all known Solutia/Monsanto landfills. Samples need to be collected every 6 days over a minimum of 5 years, with full collection of meteorological data at each site. A disinterested third party must conduct sample collection and analytical work. A high level of quality control in the field and laboratory must be part of the protocol. PCB analysis must be congener-specific, with a minimum of 100 congeners.

References

Uehler SS, Hites RA. The Great Lakes Integrated Atmospheric Deposition Network. In: Environmental Science and Technology 2002; 36(17), 355A-359A.

United States Environmental Protection Agency. Final summary report of technical review and evaluation of potential PCB releases: Anniston PCB Site, Anniston, Alabama. Washington DC: Office of Emergency and Remedial Response; 2001 May.

Response: ATSDR is interested in reviewing the environmental sampling data collected by this commenter.

Comments from industry

Background and Statement of Issues

Comment: The document notes that the data reviewed for the draft Health Consultation were only those collected from January 2000 through January 2001. While the document notes that additional data have continued to be collected by Solutia, it is unclear why the additional data have not been considered, since these results have been and continue to be reported to ATSDR, EPA, and ADEM every other month. In most cases, the more recent data show declining trends

in PCB air levels at the monitoring stations. It should be noted that EPA also had done air sampling in 1999, in addition to the 2000 sampling event.

Response: ATSDR did not include additional data because the time period for the issuance of the public comment version of this document would have been postponed. Regardless, until air sampling is conducted in the communities, the health conclusion is not likely to change. As stated in the health consultation, the PCB air data are continuing to undergo review by ATSDR. According to the Table A (provided by commenter), annual mean and median concentrations vary over time but show no obvious trends. The following tables summarize this fact.

Sum of Mean PCB Congener Class Concentrations by Sample Location and Year. Solutia Inc. on-property 24-hour sampling			
Sample Location--ID	2000 Mean, ng/m^3	2001 Mean, ng/m^3	2002 Mean, ng/m^3
East—1	5.4	5.2	4.6
East—1 Dup	5.6	2.4	4.4
South—2	6.2	6.5	5.4
West—3	10.5	9.0	7.7
North—4	30.8	12.3	14.1
North—4 Dup	18.9	n/a[+]	n/a[+]
Northeast--5	10.3	11.1	13.5
[+]n/a, not analyzed			

Sum of Median PCB Congener Class Concentrations by Sample Location and Year. Solutia Inc. on-property 24-hour sampling			
Sample Location--ID	2000 Median, ng/m^3	2001 Median, ng/m^3	2002 Median, ng/m^3
East—1	4.3	2.3	4.3
East—1 Dup	3.2	0.4	4.6
South—2	4.9	1.7	4.0
West—3	7.8	5.7	7.7
North—4	18.9	10.8	12.6
North—4 Dup	16.8	n/a[+]	n/a[+]
Northeast--5	9.2	9.0	9.3
[+]n/a, not analyzed			

Comment: Page 2, second paragraph: In the third-to-last sentence, congeners 4 through 15 each have two chlorine "atoms", not "molecules". In the next line, dichlorophenyl: should read "dichlorobiphenyl".

Response: Changes have been made in the text.

Comment: *PCB Results by Sample Location* As noted above, Solutia has continued to collect air samples at the five locations discussed in this report. In general, the levels have declined. For example, for Station 4, the current mean for all samples collected from January of 2000 through December of 2002 is 20.3 ng/m^3, nearly half the value reported by ATSDR. The mean for calendar year 2002 was 14.1 ng/m^3. While the values for Station 4 are still at or above background ranges for air concentrations in other urban areas, the levels are declining. The same trend is observed at the other sampling stations. (See Table A.)

Response: As stated in the health consultation, the PCB air data are continuing to undergo review by ATSDR. According to the Table A (provided by commenter), annual mean and median concentrations vary over time but show no obvious trends. The following tables summarize this fact.

Sum of Mean PCB Congener Class Concentrations by Sample Location and Year. Solutia Inc. on-property 24-hour sampling			
Sample Location--ID	2000 Mean, ng/m^3	2001 Mean, ng/m^3	2002 Mean, ng/m^3
East—1	5.4	5.2	4.6
East—1 Dup	5.6	2.4	4.4
South—2	6.2	6.5	5.4
West—3	10.5	9.0	7.7
North—4	30.8	12.3	14.1
North—4 Dup	18.9	n/a$^+$	n/a$^+$
Northeast--5	10.3	11.1	13.5
$^+$n/a, not analyzed			

Sum of Median PCB Congener Class Concentrations by Sample Location and Year. Solutia Inc. on-property 24-hour sampling			
Sample Location--ID	2000 Median, ng/m^3	2001 Median, ng/m^3	2002 Median, ng/m^3
East—1	4.3	2.3	4.3
East—1 Dup	3.2	0.4	4.6
South—2	4.9	1.7	4.0
West—3	7.8	5.7	7.7
North—4	18.9	10.8	12.6
North—4 Dup	16.8	n/a$^+$	n/a$^+$
Northeast--5	9.2	9.0	9.3
$^+$n/a, not analyzed			

Discussion Section

Comment: While Solutia has no specific comments with regard to the information presented in the discussion of background levels of PCBs in the United States, the discussion focuses on comparisons to limited data available FOR 1996 AND 1997. A more complete table of atmospheric concentrations of PCBs can be found in ATSDR's *Toxicological Profile for Polychlorinated Biphenyls (Update, November 2000)* at pages 522–524. Results as recently as 1994 and 1995 from Chicago and New Bedford, MA, show background levels ranging up to 14 ng/m^3. The levels measured by Solutia and the EPA are generally within these ranges. And, certainly, most, if not all, of the levels measured in residential areas *per se* are well within the background ranges. It is important to keep in mind that the levels measured by Solutia are fence line levels on our industrial site.

Response: ATSDR used the 1996 and 1997 study data because they are the most recent.

Comment: It should be noted that EPA has established a screening level for PCBs in air, most recently for air levels of PCBs measured subsequent to the September 11, 2001 terrorist activity in New York City. The EPA screening level, a level "set well below exposure levels shown to cause cancer in animals, as well as those associated with any other health effects", is 730 ng/m^3, based on continuous exposure for a year to levels averaging that concentration. The dose received from such a continuous exposure for one year would be equivalent to a lifetime (i.e.,70 years, per EPA guidance) exposure of 10 ng/m^3, which is essentially the same as the upper range of background air concentrations for urban areas in the United States. The average air levels of PCBs in the air at the Solutia fence line and in the residential areas are generally below this screening level. Based on these results, one would not expect increased risks of health problems associated with potential exposure to these air levels, according to the EPA.

Response: As stated in this comment, the air PCB screening level is based on a one-year exposure period. Exposures in the Anniston community have been occurring longer than one year; therefore, using the latter guideline is not appropriate.

Comment: ATSDR correctly notes in this section that, because of differences in the analytical methods used by the EPA and Solutia, a direct quantitative comparison of Solutia's results with either the EPA's reported results or with results from studies of background levels in urban areas is not possible. It should be noted, however, that Solutia's methodology, which uses a gas chromatograph for separation and a mass spectrometer for identification and quantitation of congener classes (GC/MS), would be expected to give the highest results of the various methods employed. Both the congener-specific analysis and the analysis for Aroclor mixtures, while generally of acceptable accuracy and precision, have the potential to "miss" gas chromatographic peaks that are not "targets" for the particular analytical scheme. However, the GC/MS method detects and measures all PCB congeners present above the detection limit in a given sample.

Because the analytical methodology used by Solutia's contract laboratory would provide the highest results for concentrations of PCBs in air, those results provide a "worst-case scenario" for comparison with either EPA's reported levels or with levels reported as background levels in other urban areas. Further, the Health Consultation correctly notes that PCB levels are lower in residential areas in Anniston, even those as close as one quarter of a mile from the plant. ATSDR speculates that these results may indicate a source of PCBs on or near the Solutia property. While this speculation has some degree of plausibility, another plausible explanation is the difference in analytical methodology. The differences in methodology would be expected to show the greatest effect (i.e., Solutia's results being higher) at the lower concentrations measured in the residential areas.

Response: Comment noted.

Comment: Finally, Solutia finds the discussion of the presence of higher chlorinated congeners in some Solutia results to be speculative and not helpful. Higher chlorinated congeners were only found sporadically, usually on those rare occasions when PCB air levels were elevated above normal background concentrations. It is not clear what the point of ATSDR's discussion of these sporadic reports is. If it is to suggest that Aroclor mixtures with greater than 42% average chlorination are present and may be contributing to measurements of total PCBs in air, that seems to be a given. However, a more general point needs to be made. The discussion of which Aroclor mixtures may or may not be represented by various congeners or congener classes in the reported air levels is not a fruitful discussion. The presence or absence of particular congeners in air is determined by the individual properties of the congeners, not by the Aroclor mixture or mixtures that may have originally been present at a given site. That fact is precisely the reason Solutia chose to analyze the air samples for congener classes, rather than for Aroclor mixtures. The congener class analysis provides a much sounder basis for discussion of the particular PCBs present in air at a given site and assures that all PCBs present are detected and measured, not just those associated with a particular Aroclor mixture.

Response: Occupational exposure guidelines are based on Aroclor mixture; therefore, a discussion of Aroclor is needed. Discussions regarding the degree of chlorination of congeners is also intended to highlight the fact that the more highly chlorinated compounds are more persistent in the environment (degrade more slowly) and may contribute to a higher health risk. Finally, some co-planar PCBs—identified by congener number, not congener class—are of great health interest because they are thought to have dioxin-like activity.

Comment: *Community Health Implications.* While Solutia agrees that the number of air samples taken in residential areas, rather than on Solutia property, is limited, it should be noted that the available information does not suggest that significant exposures to PCBs via an air pathway are occurring in the community. Even the average levels measured at the Solutia fence line are within or only slightly above background ranges for other urban areas in the United States. Those levels are also generally below the health-based screening level for PCBs recently

established by the EPA, as discussed above. Based on that screening level, as adjusted for lifetime exposure, one would not expect increased risks of health problems associated with potential exposure to these air levels, according to the EPA.

Response: The health-based screening level was developed by EPA for residents of New York City after the 2001 collapse of the World Trade Center. A screening level developed for an emergency event based on no more than one year of exposure is not applicable to multiple (chronic) year exposures.

Comment: *Noncancerous health effects* While Solutia agrees that the studies of health effects in humans have generally been inconclusive, some of the effects noted in the numbered list require comment.

1. The reports of subtle neurodevelopmental effects in children are more fully discussed in the *Child Health Considerations* section of the health consultation. However, it should be noted that almost all the studies that have reported these subtle effects associate them with prenatal exposure. Only one or two studies suggest that exposures from breastfeeding may be associated with subtle effects; the weight of the evidence is that exposures from breast feeding are not associated with adverse effects. ATSDR should provide assurance that the benefits of breastfeeding clearly outweigh any potential risk from exposures to PCBs by that route.
2. The hepatic effects in occupationally exposed adults are limited to transient elevations in some liver enzymes, which are inconsistently reported in some of the cross-sectional health studies. (Reports of more serious liver effects from the 1930s and 1940s were associated with concurrent exposures to polychlorinated naphthalenes (PCNs), not with the low levels of PCBs mixed with the PCNs in some industrial products.)
3. The health effects noted in the two populations that consumed rice oil contaminated with thermally-degraded heat transfer fluids are now known to be associated with polychlorinated dibenzofurans (PCDSs), not with the PCBs in those fluids. The scientific and medical literature is clear on that point.
4. The immunological effects reported in infants have only been reported in one population and are of questionable clinical significance.
5. It is not clear what the agency means by "reproductive effects, particularly in infants". If ATSDR is referring to the slight decreases in head circumference that have been inconsistently reported in the literature, it should be noted that these effects, if they are real, are slight, are of no clinical significance, and are more appropriately characterized as developmental effects.

Response: Despite the scientific controversy and the "inconclusive" interpretations derived from some reports (see reviews by Dr. Susan Shantz [Schantz SL, *Neurotox Teratol* 1996;18(3):217-27] and Dr. Richard Seegal [Seegal RF, *Crit Rev Toxicol* 1996; 26(6):709-

37], numerous, more recent reports of laboratory and epidemiological investigations have added to the weight of evidence indicating that concerns over environmental exposures to PCBs are warranted (for general reviews see: Giesy JP and Kannan K *Critical Rev Toxicol* 1998;28:511–69; Fischer L J, Seegal R, Ganey IP, Pessah I, and Kodavanti P. *Toxicol Sci* 1998;41:49–61). An example of the uncertainties is provided in the reports of some investigators who conclude that research studies have described subtle effects of questionable consequence, while other investigators consider the same results adverse responses.

While it is unreasonable to predict that all health effects observed in PCB-treated laboratory animals will occur in humans, it is notable that numerous investigators conclude that the evidence from animal experiments leads to strong suspicions that similar health effects may or could occur in humans. Included in these documented and suspected responses to PCBs are neurodevelopmental effects (Brouwer AM, Longnecker ML, Birnbaum LJ, Cogliano JP, Kostyaiak PS, Schantz S, and G. Winneke, *Environ Health Perspect* 1999;107:639–49) and altered thyroid homeostasis (Osius NW, Karmaus WH, Kruse HJ, Witten J. *Environ Health Perspect* 1999;107:843–49; Porterfield S. *Environ Health Perspect* 2000;108:4:433–38). Of importance are reports suggesting that perinatal exposures to PCBs could be of particular concern (Brouwer AM, Longnecker ML, Birnbaum LJ, Cogliano JP, Kostyaiak PS, Schantz SL et al. *Environ Health Perspect* 1999;107:639–49; ATSDR. Toxicological profile for polychlorinated biphenyls (update) 2000). Relevant to the response to this comment, as well as other comments noted below, is the recent release of ATSDR's Toxicological Profile for Polychlorinated Biphenyls as a "Final" document. This updated version of the Toxicological Profile contains numerous references to the newest literature relevant to health effects of PCBs.

On the basis of conclusions stated in the most recent literature, ATSDR believes that it is reasonable to suspect that exposures to PCBs can induce a variety of responses in both animals and humans, and that some of those responses could occur as a result of exposures to environmental PCBs.

Comment: *Cancer* The associations of specific types of cancer noted in the first paragraph of this section with occupational (emphasis in the original) exposures to PCBs have not been consistently reported in the various studies. Nor have the strengths of association been remarkable in general. While there have been sporadic reports of increased SMRs for specific cancer types in a few studies, the weight of the evidence is strong that PCBs are not associated with cancer in humans, based on the occupational studies. In fact, the most recent update of a study of heavily exposed capacitor workers did not find any increases in cancer-related mortality. (Kimbrough, RD, et al., *Journal of Occupational and Environmental Medicine,* **2003**, 45(30, 271-282.)

Response: See response to previous comment.

Occupational Health Implications

Comment: The discussion in this section improperly relies solely on the National Institute for Occupational Safety and Health (NIOSH) Recommended Exposure Limit (REL) for PCBs. This REL was recommended by NIOSH over 25 years ago, and it has never been adopted by the Occupational Safety and Health Administration (OSHA). The REL is not a risk-based value; it was based on analytical considerations. Further, as is clear in the health consultation, the REL and OSHA's Permissible Exposure Limit (PEL), which will be discussed below, are based on average exposures over a normal workweek. ATSDR improperly compares the NISOH REL with single highest value reported in over 5 years of air sampling by Solutia and the EPA. Comparisons, if any are to be made at all, should be with average values, not a single maximum value. The average values at the Solutia monitoring stations are 50 to 100 times lower than the NIOSH REL.

The proper standard with which to compare potential occupational exposures to PCBs is the OSHA PEL (as articulated in recent EPA guidance), which is 1 mg/m^3 for Aroclor 1242 and 0.5 mg/m^3 for Aroclor 1254. These values are equivalent to 1,000,000 ng/m^3 and 500,000 ng/m^3, respectively. The average values of the air sampling results reported by Solutia and the EPA are generally hundred of thousands of times lower than the OSHA PEL. Even if one accepts ATSDR's speculative concerns that fence line levels may not represent air levels in areas where employees work, it is inconceivable that air levels anywhere on or off the site even approach the standard established by OSHA.

Response: Without worker personal air sampling results, ATSDR errs on the side of protecting health. If worker monitoring data exist, ATSDR would be happy to provide this information to NIOSH for review.

The NIOSH REL is based on the risk of skin, liver, and reproductive effects, and on the potential for cancer. It is also based on tumors of the liver and pituitary gland and leukemias noted in animals [NIOSH 1992]. The American Conference of Governmental Industrial Hygienists (ACGIH) guidelines for Aroclors 1242 and 1254 are 1 mg/m^3 and 0.5 mg/m^3, respectively. These guidelines are based on the risk of systemic toxicity [ACGIH 1991]. It should be noted that OSHA, NIOSH, and ACGIH recommend that exposures to PCBs through skin contact should be avoided/minimized.

Comment: With regard to ATSDR's additional speculations that occupations involving soil excavations may be resulting in potential exposure to airborne PCBs, several points need to be made. In the first place, Solutia has been working with and will continue to work with excavation contractors in the Anniston area, including employees of utilities, to assure that workers have neither dermal nor inhalational exposures to PCBs in impacted soils. In a number of cases, Solutia has sampled soils prior to excavation activity and removed or isolated impacted soils. Secondly, as discussed above, the OSHA PEL, which is protective for an occupational

lifetime for exposure to PCBs, is hundreds of thousands of times higher than average levels of PCBs measured anywhere in Anniston. Finally, Solutia's contractors implement strict dust control measures for any excavation activities to prevent generation of dust, and they monitor dust levels during the activities to assure that dust levels are not generated in excess of background levels.

Response: ATSDR commends Solutia for working with area excavation contractors. We will refer questions regarding this issue to Solutia for soil sampling prior to area excavation activities. It should be noted that OSHA, NIOSH, and ACGIH recommend that exposures to PCBs through skin contact should be avoided/minimized.

Source of PCBs

Comment: Solutia agrees that there are a number of uncertainties associated with the air sampling information that has been gathered by both Solutia and the EPA. Solutia and the Alabama Department of Environmental Management, under the oversight of the EPA, have agreed to an air-sampling plan that will attempt to address these uncertainties. This plan has also been submitted to ATSDR. Implementation of the plan will begin in the near future. Solutia will continue to provide results of air monitoring to ADEM, EPA and ATSDR, as we have been doing for years. This section suggests that the presence of solvents in any potential source area for PCBs could increase the likelihood of PCB volatilization (i.e., facilitated volatilization). This effect, if it occurs at all, is unlikely to be of any practical significance. In the first place, there are no known solvents present at significant levels in any of the extensively sampled areas at or near our facility. In the second place, based on the low vapor pressures of PCBs, especially as contrasted to the vapor pressures of commonly encountered solvents, significant facilitated volatilization would not be expected.

Response: ATSDR is aware of groundwater solvent contamination that is currently undergoing remediation on the Solutia property. ATSDR is unaware of subsurface sampling for solvents beyond the Solutia property.

Comment: Conclusion 1. Solutia is confident that the available air sampling results on our site and the more limited information available in the residential areas provide sufficient information to assure that potential exposures do not pose a health hazard to community members. The average levels at the fence line and in the residential areas are generally below the screening level for PCBs established by the EPA in New York City. Further, as discussed previously, the levels are orders of magnitude below the OSHA PEL for Aroclor 1242, which is 1,000,000 ng/m^3. While the OSHA PEL is strictly applicable only to occupational exposures, which are considered to be 40 hours per week, even if the OSHA PEL is divided by a factor of 4.2 to adjust for potential residential exposures, the levels reported in the Anniston area are still several orders of magnitude below the adjusted PEL.

Response: The health-based screening level was developed by EPA for residents of New York City after the 2001 collapse of the World Trade Center. A screening level developed for an emergency event and based on no more than one year of exposure is not applicable to multiple (chronic) year exposures.

Comment: Conclusion 2. Solutia disagrees with this conclusion for the reasons discussed in the *Occupational Health Implications* section. The ATSDR should have relied on the OSHA PEL, which is the standard for occupational exposures to PCBs. EPA has acknowledged the protective nature of PELs by incorporating them as Tier 2 screening levels for industrial settings in the agency's new *Draft Guidance for Evaluating the Vapor Intrusion to Indoor Air Pathway from Groundwater and Soils.*

Response: The Draft EPA Guidance [*Draft guidance for evaluating the vapor intrusion to indoor air pathway from groundwater and soils (subsurface vapor intrusion guidance)* does not make reference to using ambient air results for determining the indoor risk posed by subsurface contaminant migration into buildings for Tier 2, secondary screening. In the Session 3 presentation slides of the *US EPA Seminar on Indoor Air Vapor Intrusion*, February 25–26, 2003, Atlanta, GA, OSHA standards for industrial exposures are mentioned in the "Acceptable Risk Level" slide that discusses guidelines for indoor air.

In the introduction section of the former document, the following statement is made:

"1. Occupational settings where persons are in a working situation."

"There may be occupational settings where persons present are employees and hazardous substances may be intruding into the air space from the vapor intrusion pathway. Such settings could include workplaces where workers are handling hazardous chemicals (e.g., manufacturing facilities) similar to or different from those in the subsurface contamination, as well as other workplaces, such as administrative and other office buildings where chemicals are not routinely handled in daily activities. OSHA and EPA have agreed that OSHA generally will take the lead role in addressing occupational exposures. Workers will generally understand the workplace (e.g., Occupational Safety and Health Administration, OSHA) regulations (and monitoring, as needed) that already apply and provide for their protection. For example, workplaces are subject to a written Hazard Communication and Monitoring Plan."

"In general, therefore, EPA does not expect this guidance to be used in settings that are primarily occupational.[1] However, employees and their employers may not be aware of subsurface contaminants that may be contributing to the indoor air environment of their workplaces, particularly since vapor intrusion may include constituents that are no longer or were never used in a particular workplace, may originate from elsewhere, or be modified by bio-degradation or other subsurface transformation process. Therefore, we recommend that regional or State authorities notify the facility of the potential for this exposure pathway to cause a hazard or be

recognized as a hazard and suggest that they consider any potential risk that may result. Any change in the future use of the building/facility might suggest a need to reevaluate the indoor air pathway."

> "[1]It should be noted that at CERCLA sites, the cleanup levels are generally driven either by ARARs or risk range concentrations; the OSHA standards are not ARARs under the CERCLA statute and regulations. Therefore, there may be instances (under CERCLA and other cleanup programs) where standards other than the OSHA standards are used to determine whether the exposure pathway presents a risk to human health."

Comment: Conclusion 2, cont'd. All results for air levels of PCBs on the plant site and in the residential areas are orders of magnitude below the OSHA PEL, and it is inconceivable that exposures to levels anywhere near the PEL could be occurring. This information and the fact that Solutia is working with local contractors and utilities also assure potential exposures do not pose a health hazard to workers involved in soil excavation activities.

Response: Without worker personal air sampling results, ATSDR errs on the side of protecting health. If worker monitoring data exists, ATSDR would be happy to provide this information to NIOSH for review.

The NIOSH REL is based on the risk of skin, liver, and reproductive effects, and on the potential for cancer. It is also based on tumors of the liver and pituitary gland and leukemias noted in animals [NIOSH 1992]. The American Conference of Governmental Industrial Hygienists (ACGIH) guidelines for Aroclors 1242 and 1254 are 1 mg/m^3 and 0.5 mg/m^3, respectively. These guidelines are based on the risk of systemic toxicity [ACGIH 1991]. It should be noted that OSHA, NIOSH, and ACGIH recommend that exposures to PCBs through skin contact should be avoided/minimized.

Comment: Recommendation 1. Solutia is going to implement an air sampling work plan that includes installation of samplers off-site. This work plan will address the uncertainties noted in the health consultation.

Response: Comment noted. ATSDR would like to participate in the development of a community-based air sampling plan and recommends that all interested parties agree on a plan prior to implementation.

Comment: Recommendation 2. Based on the discussion of the *Occupational Health Implications* section, Solutia disagrees that personal air sampling is appropriate on the facility property.

Response: See previous responses to this comment.

Comment: Recommendation 3. Solutia currently works with utilities and excavation contractors to address the potential for exposure from impacted soils during soil excavation activities.

Response: Comment noted.

Comment: Solutia will continue to provide air-sampling results to ATSDR and the other regulatory agencies, as we have done in the past.

Response: Comment noted.

Comment: Appendix 1. In the first table on page 15, there is a typographical error in the "Location Description" for the west Sample Location. "50 fee" should read "50 feet". Also, the Sample Locations north and northeast are within the Solutia property boundary not, ¼ and ½ miles, respectively, from the border, as indicated at the bottom of the table.

Response: The text has been revised.

Comment: Appendix 2, Table 1. This table also indicates that the north and northeast sampling locations are located off of Solutia Inc. property. They are, in fact, on Solutia property and within Solutia fence lines.

Response: The text has been revised.

Comment: Appendix 2, Table 2. *Aroclor*® is spelled incorrectly as *Arochlor* in the title and fourth column of the table.

Response: The text has been revised.

Comment: Appendix 2, Table 3. The five sampling locations selected by Solutia for monitoring air levels of PCBs provide information about air levels at different locations along our fence line. We do not believe aggregating and averaging the results for these five locations provides useful information. The table as presented does not allow the reader to understand that any particular mean could be strongly influenced by one high reading at a single sampling location on a given day.
Similar information on a station-specific basis can easily be presented on a table such as Table A attached to these comments.

Response: Aggregating the results provides information about general air PCB concentrations in the area of Solutia's property. In order to determine if any particular mean value was strongly influenced by one high reading a single location, the median value is provided.

Comment: Appendix 2, Table 4. *Aroclor*® is spelled incorrectly as *Arochlor* in the title and third column of the table.

Response: The text has been revised.

General comment: In the first paragraph on page 2 and throughout the document, in almost every case where the company name appears in this document, it is followed by comma, *i.e.*, "Solutia Inc.,". In almost every case, the comma is unnecessary; it is not a part of the company name.

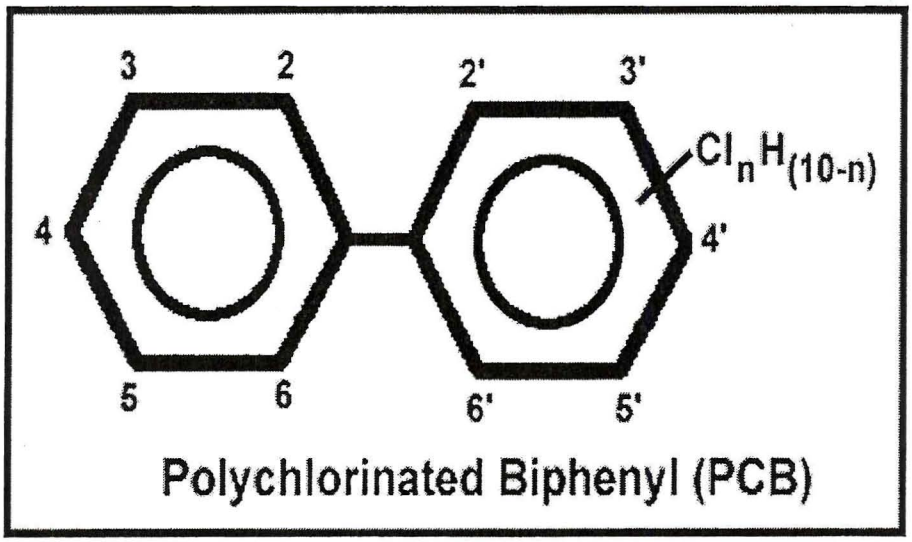
Response: The text has been revised.

Appendix 5
PCB Definitions

Helpful Definitions for PCBs
(modified from the EPA website, http://www.epa.gov/toxteam/pcbid/)

Polychlorinated Biphenyl (PCB)

PCB (or PCBs) is a family of chemical compounds formed by the addition of chlorine to biphenyl, which is a two-ring structure. There are 10 possible positions for chlorines to attach. The chemical with one chlorine is called "Monochlorobiphenyl." With two chlorines, it is called "Dichlorobiphenyl", and those with three through ten chlorines, in order, are called: "Tri...", "Tetra...", "Penta...", "Hexa...", "Hepta...", "Octa...", "Nona...", and "Decachlorobiphenyl". The positions of the chlorines on the rings are assigned numbers, as seen in the diagram below.



PCB Congener

Each different PCB compound is called a "Congener". The name of a congener specifies the total number of chlorines and the position of each chlorine. For example, 4, 4'-Dichlorobiphenyl is a Biphenyl PCB with two chlorines, one on each of the two carbons at the "4" positions of the two rings. There are 209 PCB congeners.

Congener Names: For any given PCB congener (except decachlorobiphenyl, with all positions chlorinated), there is always more than one possible way to number the positions of the chlorines. For example, 2, 3', 4'-trichlorobiphenyl is the same as 2', 3, 4-tri... and is the same as 2, 4', 5'-tri.... This is because the two rings are identical.

Congener Numbers: This is a system of numbering the 209 PCB congeners.

PCB Homolog

"Homologs" are subcategories of PCB congeners having equal numbers of chlorines. For example, the "Tetrachlorobiphenyls" (or "Tetra-PCBs" or "Tetra-CBs" or just "Tetras") are all PCB congeners with exactly 4 chlorines in any arrangement. The number of congeners in each homolog is given in the following table:

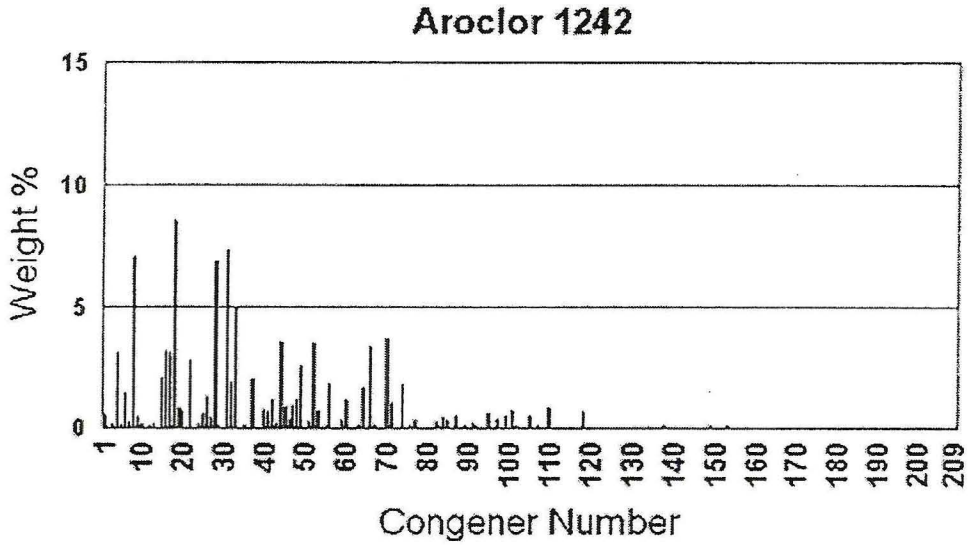
PCB Homologs		
Homolog	**Number of Chlorines**	**PCB Congeners**
Monochlorobiphenyl	1	3
Dichlorobiphenyl	2	12
Trichlorobiphenyl	3	24
Tetrachlorobiphenyl	4	42
Pentachlorobiphenyl	5	46
Hexachlorobiphenyl	6	42
Heptachlorobiphenyl	7	24
Octachlorobiphenyl	8	12
Nonachlorobiphenyl	9	3
Decachlorobiphenyl	10	1

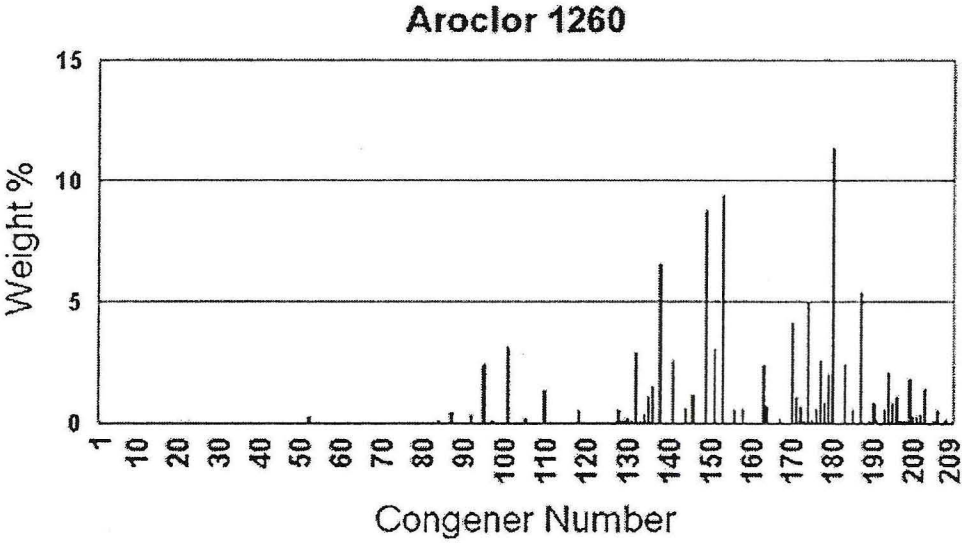
PCB Mixture

PCBs were almost always made as mixtures of congeners by adding batches of PCBs with more and more chlorines until a certain target percentage of chlorine by weight was reached. Commercial mixtures with higher percentages of chlorine contained higher proportions of the more heavily chlorinated congeners, but all congeners are present at some level in all mixtures.

Once a mixture isreleased into the environment and subjected to "weathering" or taken in by plants or animals and partially stored/metabolized/excreted, substantial changes in the congener ratios occurred, and continue to occur. Thus, determination of the parent mixture(s) ultimately resulting in a given environmental sample may be difficult or impossible.

While PCBs were manufactured and sold under many names, the most common were the "Aroclor" series, in many of which a numerical identifier included the percentage of Chlorine (e.g., "Aroclor 1254", with 54 percent Chlorine). As examples, the congener composition of Aroclors 1242 and 1260 (common Aroclors) are displayed in the figure below.


Aroclor 1242
Weight %
15
10
5
0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
209
Congener Number


Aroclor 1260
Weight %
15
10
5
0
1
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
209
Congener Number

PCB Trade Names and Other Synonyms

PCBs were manufactured and sold under many different names. The names in the following table have been reported as used to refer to PCBs or to products or formulations containing PCBs. However, please note:

- Some of these names also may have been used (and may currently be used) for substances or mixtures NOT containing chlorinated biphenyl.
- Many of these names were used with distinguishing suffixes, indicating degree of chlorination, type of formulation, or other properties (e.g., Aroclor 1254; Clophen A60).
- Some of these names appear to be misspellings of the correct names, but are included here for completeness because they may have been published in that form.

PCB Trade Names and Other Synonyms

Aceclor	Diaclor	PCB
Adkarel	Dicolor	PCB's
ALC	Diconal	PCBs
Apirolio	Diphenyl, chlorinated	Pheaoclor
Apirorlio	DK	Phenochlor
Arochlor	Duconal	Phenoclor
Arochlors	Dykanol	Plastivar
Aroclor	Educarel	Polychlorinated biphenyl
Aroclors	EEC-18	Polychlorinated biphenyls
Arubren	Elaol	Polychlorinated diphenyl
Asbestol	Electrophenyl	Polychlorinated diphenyls
ASK	Elemex	Polychlorobiphenyl
Askael	Elinol	Polychlorodiphenyl
Askarel	Eucarel	Prodelec
Auxol	Fenchlor	Pydraul
Bakola	Fenclor	Pyraclor
Biphenyl, chlorinated	Fenocloro	Pyralene
Chlophen	Gilotherm	Pyranol
Chloretol	Hydol	Pyroclor
Chlorextol	Hyrol	Pyronol
Chlorinated biphenyl	Hyvol	Saf-T-Kuhl
Chlorinated diphenyl	Inclor	Saf-T-Kohl
Chlorinol	Inerteen	Santosol
Chlorobiphenyl	Inertenn	Santotherm
Chlorodiphenyl	Kanechlor	Santothern
Chlorphen	Kaneclor	Santovac

Chorextol
Chorinol
Chorinol
Clophen
Clophenharz
Cloresil
Clorinal
Clorphen
Decachlorodiphenyl
Delor
Delorene
Kennechlor
Kenneclor
Leromoll
Magvar
MCS 1489
Montar
Nepolin
No-Flamol
NoFlamol
Non-Flamol
Olex-sf-d
Orophene
Solvol
Sorol
Soval
Sovol
Sovtol
Terphenychlore
Therminal
Therminol
Turbinol