Human Health Risk Evaluation of Aroclor Polychlorinated Biphenyl (PCB) Concentrations in Sediments Collected in 2012 in Falls Reservoir, Yadkin-Pee Dee River System, North Carolina

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The North Carolina (NC) Division of Public Health's (DPH) Health Assessment, Consultation and Education (HACE) program has completed the review of sediment data collected in 2012 in Falls Reservoir of the Yadkin-Pee Dee River System located in central North Carolina. Falls Reservoir sediments were analyzed for Aroclor[1] polychlorinated biphenyls (PCBs) and the data were evaluated for human health risks associated with incidental ingestion and direct contact.

In 2011, sediment and fish were collected in multiple locations throughout the Yadkin-Pee Dee River System in a joint effort involving the N.C. Department of Environment and Natural Resources (DENR) Division of Waste Management (DWM) and Division of Water Quality (DWQ), the U.S. Environmental Protection Agency (EPA) and DPH. This 2011 study was undertaken as a follow-up to the 2008 Badin Lake PCB-congener fish tissue study. The Badin Lake study resulted in a fish consumption advisory issued in 2009 for catfish and largemouth bass [Badin 2009]. A summary of the Badin Lake study and the advisory is provided in the Appendix. The objective of the 2011 study, as well as the 2012 study, was to investigate potential risks to human health due to PCB concentrations in sediment and fish tissue in the Yadkin-Pee Dee River system.

In the 2011 Yadkin-Pee Dee River System study, sediments were collected from the inlet of High Rock Lake, Badin Lake, Lake Tillery and the uppermost reaches of Blewett Falls (Appendix Figure 1). Sediment was collected in depositional areas[2] of likely direct human contact (boat ramps and swimming beaches), as well as near the center channel to characterize sediments moving through the Yadkin-Pee Dee River system. Aroclor PCBs were detected in 2 of the 21 sediment samples (Appendix Table 1). The highest PCB concentration (500 µg/kg [3] Aroclor 1254 PCBs) was detected in Falls Reservoir, in a small cove just upstream of the Falls Dam (Figure 1 sediment location "SD013") [YRB 2013]. The 2012 study was undertaken to provide a more intensive characterization of sediment Aroclor PCB concentrations in Falls Reservoir. This report summarizes the 2012 sediment Aroclor PCB results for Falls Reservoir.

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[1] Aroclor is a trade name for PCB mixtures produced from approximately 1930 to 1979. PCBs were manufactured as a mixture of various PCB congeners with targeted levels of chlorine by weight for each mixture. Each type of Aroclor has a distinguishing suffix number that indicates the degree of chlorination (i.e., Aroclor-1232, Aroclor-1260, etc.). The first two digits generally refer to the number of carbon atoms in the phenyl rings (from 1-12), the second two numbers indicate the percentage of chlorine by mass in the mixture. U.S.EPA: http://www.epa.gov/osw/hazard/tsd/pcbs/pubs/aroclor.htm

[2] Finer sediments (detritus, fine particulate matter) collect in depositional areas. Lipophilic ("fat loving") contaminants such as PCBs will preferentially partition to finer sediment particles, which generally have a higher organic carbon content relative to coarser sediments (sands). As a result, depositional areas would be expected to represent locations of maximum sediment PCB concentrations not associated with a point source discharge (point source discharge: discharge from a discrete fixed source, such as a pipe).

[3] µg/kg = micrograms per kilogram (or, "parts per billion")

In addition to the 2011 and 2012 sediment Aroclor PCB studies, fish were collected from 3 water bodies in the Yadkin-Pee Dee River System: High Rock Lake and Lake Tillery in 2011, and Falls Reservoir in 2012. The fish collection locations are identified on Figure 1. More than 100 fish tissue samples were analyzed for 209-congener PCBs and evaluated for health risks associated with ingestion. The results of 2011 sediment study and the 3 fish tissue studies are reported in separate documents [YRB 2013, FR 2013, HR 2013, LT 2013].

2012 Falls Reservoir Sediment Study -

On September 25, 2012 DENR staff collected surface sediment samples from 10 locations in Falls Reservoir, between the Narrows Dam to the north (upstream) and Falls Dam to the south (downstream) (Appendix Figure 2). Duplicate samples were submitted at 2 locations for quality control purposes (Appendix Figure 2, sample locations "falls3" and "falls8"). Surface sediment composites were collected in areas where direct human contact would be expected, such as wading near fishing areas and boat ramps. Sediments were also collected near the Badin Lake spillway. Three samples, including one in duplicate (Figure 2, locations "falls8" in duplicate, "falls9" and "falls10"), were collected in the cove where the highest PCB concentration was reported in the 2011 sediment study [YRB 2013]. The sediments were collected with a Ponar dredge or stainless steel scoop, mixed on site and transferred to glass jars for shipment to the analytical laboratory. DENR quality control/quality assurance guidance was referenced for the sediment collection and handling [DENR 2012]. The sediments were analyzed by EPA's Region 4 Science and Ecosystem Support Division (SESD) Laboratory in Athens, GA. Each sediment was analyzed for 9 Aroclor mixtures (Appendix Table 2) by EPA Method 8082 and reported as µg/kg (dry weight sediment). EPA's analytical report is dated October 24, 2012 [EPA 2012].

Sediment Aroclor PCB Analytical Results Discussion -

None of the 9 Aroclor PCBs were detected at concentrations exceeding sample-specific minimum reporting limits (MRLs)[4] in any of the 10 Falls Reservoir sediment samples (or 2 duplicates) collected by DENR in 2012. Sample-specific Aroclor PCB reporting limits ranged from 40-110 µg/kg per Aroclor (Appendix Table 3).

Discussion of Health Risk Analysis –

No Aroclor PCBs were detected in the 2012 Falls River surface sediments and therefore no adverse health effects associated with Aroclor PCB ingestion or direct contact are indicated for these sediments.

The combined results of the 2011 Yadkin-Pee Dee River System and 2012 Falls Reservoir sediment studies indicate that detectable levels of Aroclor PCBs are not likely widespread in these areas. The detection of Aroclor PCBs found in the cove sediments above Falls Dam in 2011 may have been restricted to a small, transient depositional

[4] Minimum Reporting Limit (MRL) - Analyte concentration that corresponds to the sample-specific lowest demonstrated level of acceptable quantitation.

area that was later washed downstream, dissipated by elevated flows, or not captured in the 2012 samples. Additionally, the 2011 sediment was collected near the boat ramp and an old equipment hoist (Appendix Figure 3). Hydraulic fluids have been known to contain PCBs. It is possible that a hydraulic fluid leak may have been the source of the PCBs detected in the 2011 sediment sample. A health risk analysis was performed on the highest detected Aroclor PCB sediment concentration (found in a Falls Reservoir cove above Falls Dam, sediment location "SD013", Figure 1) to evaluate both incidental (unintended) ingestion and direct (dermal) exposure. Neither exposure route is indicated to present a health risk [YRB 2013]. A health-protective ingestion exposure scenario was used for the most vulnerable population (children 1-6 years old).

<u>Conclusions</u> -

Adverse health effects are not indicated for either direct contact with, or incidental ingestion of, the sediments collected in Falls Reservoir in 2012.

<u>Limitations of the Sediment PCB Study</u> –

Analysis of environmental matrices (soil, sediment, water, fish) for Aroclor PCBs is complicated by comparison of the Aroclor analytical reference standards to the modified PCB patterns that result from differential partitioning of the original PCB commercial mixture(s) released into the environment as they move through successive matrices. Each Aroclor PCB commercial mixture consisted of a sub-set of generally 50-100 individual congeners from the possible 209 congeners. The congeners making up a particular commercial mixture were not exclusive to that Aroclor mixture. Because of their specific chemical structure, each of the 209 congeners interacts uniquely with each transition from one type of environmental matrix to another, as well as between like matrices with variable physicochemical characteristics (such as sediment organic carbon or fish lipid content). The result is the congener make-up of an Aroclor mixture released into the environment is significantly altered over time and distance, complicating the ability to identify and quantify environmental PCB concentrations using Aroclor fingerprinting methods. Congener-specific analyses eliminate this bias by identifying and quantifying individual congeners, but at a cost approximately 5-10 times that of Aroclor analyses. Detection sensitivity is also enhanced by 2-3 orders of magnitude in congener-specific methods relative to Aroclor finger-printing methods. The sediment Aroclor PCB concentrations evaluated in this study are representative of the time and location of collection.

<u>Recommended Action Items</u> -

Recommended actions for the results of the human health risk evaluation of 2011 Yadkin-Pee Dee River System sediments:

1. Alert the following persons/agencies of the sediment health risk results:
    a. Local Health Directors and Environmental Health Directors for all counties bordering the Yadkin-Pee Dee River System
    b. N.C. DENR DWM project staff

    c. U.S.EPA project staff
    d. N.C. DPH Public Information Officer (PIO)
    e. N.C. DPH Occupational and Environmental Epidemiology Branch (OEEB)
2. Post the report on the HACE web page.
3. Present the results at the proposed May 13, 2013 combined N.C. DENR, U.S. EPA and N.C. DPH community meeting. Proposed location is Albemarle or Badin, Stanly County N.C.
4. Provide public availability sessions as requested in other communities in the Yadkin-Pee Dee River System for the sediment and fish tissue study results.
5. Submit health risk assessment documents for the 2011 and 2012 Yadkin-Pee Dee River System sediment studies, and the fish tissue studies for High Rock Lake, Falls Reservoir and Lake Tillery to DPH. Follow the above steps for dissemination of that data.
6. Submit all Yadkin-Pee Dee River System fish tissue and sediment assessments to ATSDR as part of the HACE program's deliverables.

- APPENDIX -

Summary of the 2008 Badin Lake fish tissue total PCBs study:

1. 27 total fish tissue samples, 9 each from 3 regions of the lake
2. Total PCBs greater than the DPH Action Level were found in 3 catfish (2 channel catfish and 1 white catfish) and 1 largemouth bass
3. The fish consumption advisory issued in February 2009 recommended:

Do not eat more than one (1) meal a week of catfish or largemouth bass from Badin Lake. If you are pregnant, may become pregnant, are nursing, or are a child under 15 years of age, do not eat any of these fish. *Elevated levels of polychlorinated biphenyls (PCBs) have been found in some catfish and largemouth bass. Swimming, boating, and handling fish do not present a known health risk.*

Table 1. Aroclor PCB detections reported in the Yadkin-Pee Dee River System 2011 sediment study.

EPA SN	DENR SN	Sample Location Description	Detected Aroclor PCB	Aroclor PCB Concentration, µg/kg [1]
YRSD013SD	SD013	Active boat ramp, boater coming in when we drove up. Grayish gray fine sand, some mica, some detritus.	Aroclor 1254	500
YRD020SD	SD020	Stop on east side of river off 731, take trail to river sample from under bridge. Brown silty sand with slate, pebbles and pieces; some quartz, glass fine ground up mica.	Aroclor 1232	100 J,I-5

[1] as dry weight sediment

I-5 - Mixture of Aroclors in sample; predominant Aroclors reported; J - The identification of the analyte is acceptable; the reported value is an estimate; SN - sample number; µg/kg = micrograms per kilogram ("parts per billion")

Table 2. Aroclor mixtures reported by EPA for the 2012 Falls Reservoir surface sediment composite study.

U.S. EPA Method 8082 Polychlorinated Biphenyls (PCBs)
Aroclor 1016
Aroclor 1221
Aroclor 1232
Aroclor 1242
Aroclor 1248
Aroclor 1254
Aroclor 1260
Aroclor 1262
Aroclor 1268

Table 3. Summary of Aroclor PCBs surface sediment composite sample results. Falls Reservoir, Yadkin-Pee Dee River System, 2012. DENR sample identification refers to Figure 2 locations.

Figure 2 Location	DENR Station	EPA Lab SN	Aroclor PCB Results	Aroclor PCB Reporting Limits, µg/kg [1]
falls1	001	01	ND	43
falls2	002	02	ND	44
falls3	003	03	ND	44
falls3 duplicate	011	04	ND	45
falls4	004	05	ND	50
falls5	005	06	ND	110
falls6	006	07	ND	40
falls7	007	08	ND	67
falls8	008	09	ND	62
falls8 duplicate	008D	10	ND	69
falls9	009	11	ND	59
falls10	010	12	ND	93

[1] as dry weight sediment, for each of the Aroclors 1016, 1221, 1232, 1242, 1248, 1254, 1260, 1262 and 1268

DENR – N.C. Department of Environment and Natural Resources; EPA - U.S. Environmental Protection Agency; ND - each Aroclor not detected at sample-specific reporting limit; SN - sample number; PCB – polychlorinated biphenyls; µg/kg = micrograms per kilogram (“parts per billion”)

Figure 1. Fish and sediment collection locations in the Yadkin-Pee Dee River System, 2011 and 2012.

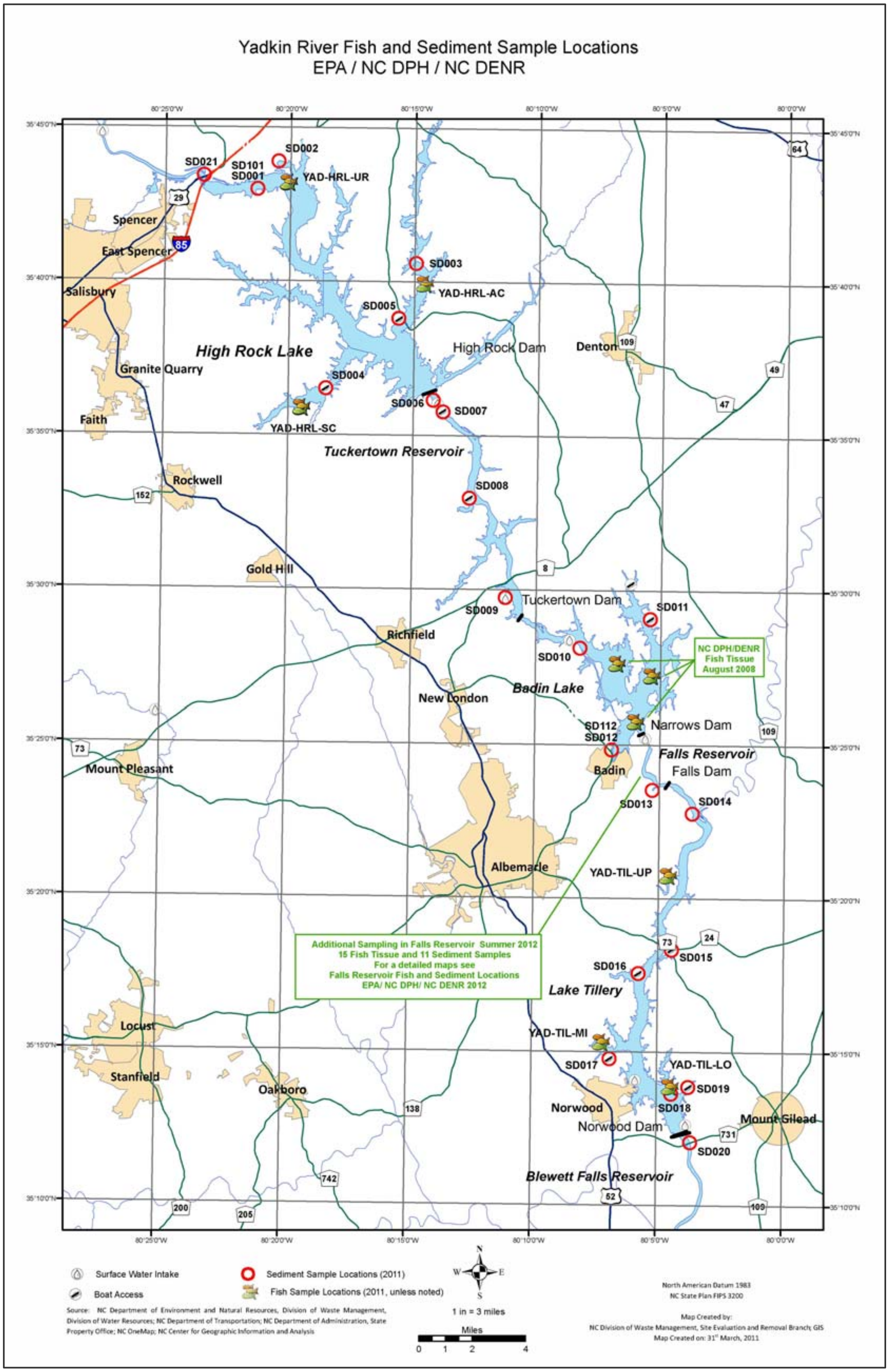

Figure 2. Falls Reservoir 2012 sediment collection locations, Yadkin-Pee Dee River System, N.C. No sediment was present at location “falls 11a”.

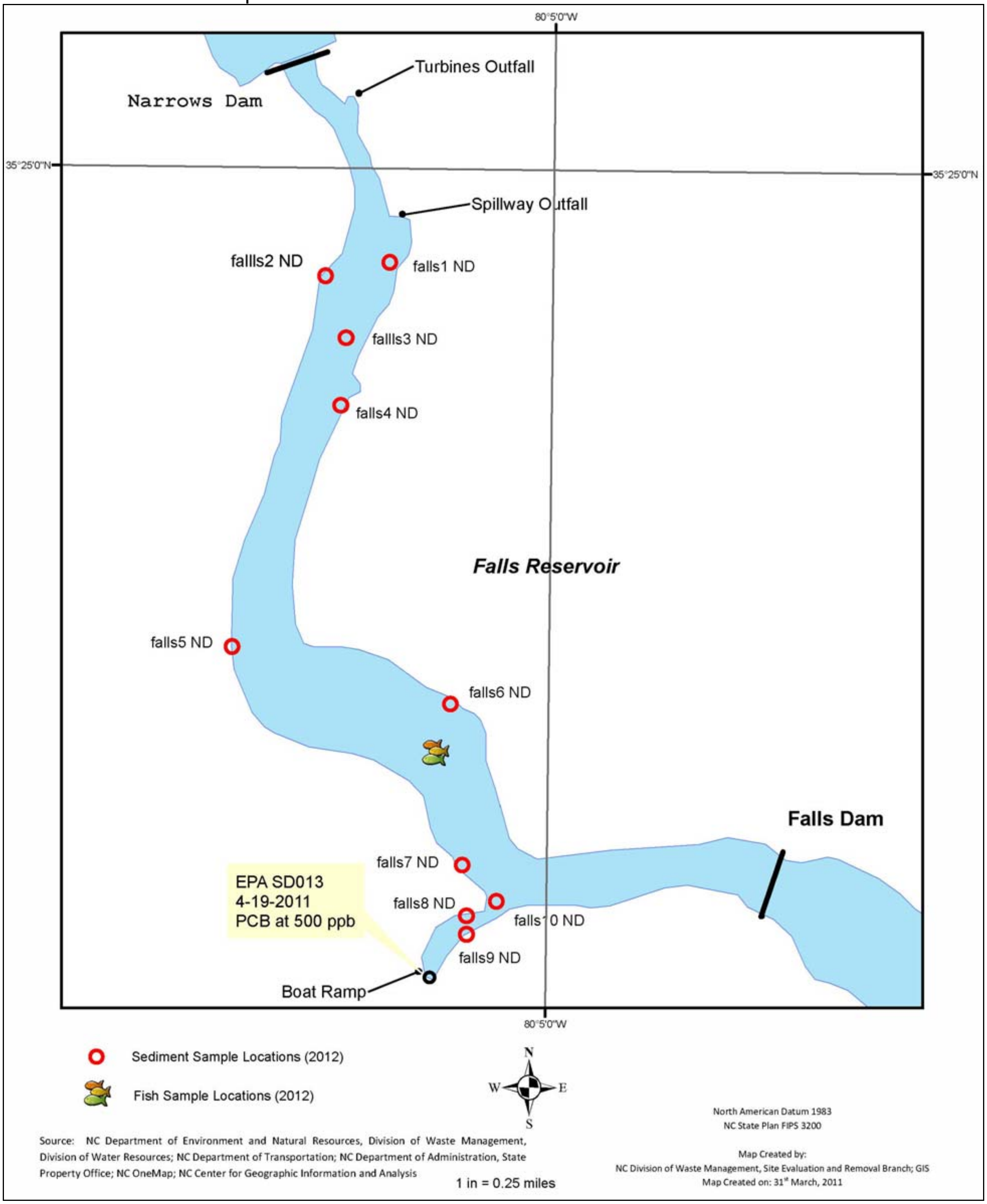

Figure 3. Falls Reservoir 2011 sediment collection location "SD013".

POLYCHLORINATED BIPHENYLS (PCBS)
FACT SHEET AND FAQS
JULY 2008

This fact sheet answers the most frequently asked health questions (FAQs) about polychlorinated biphenyls (PCBs). This information is important because PCBs have the potential to cause negative health effects in people. The effects of exposure to any hazardous substance depend on the dose, duration, how you are exposed, personal traits and habits, and whether other chemicals are present.

Polychlorinated Biphenyls

What are Polychlorinated Biphenyls (PCBs)? Polychlorinated biphenyls are mixtures of up to 209 individual chlorinated compounds (known as congeners). There are no known natural sources of PCBs. PCBs are either oily liquids or solids that are colorless to light yellow. Some PCBs can exist as a vapor in air. PCBs have no known smell or taste. Many commercial PCB mixtures are known in the U.S. by the trade name Aroclor. PCBs have been used as coolants and lubricants in transformers, capacitors and other electrical equipment because they don't burn easily and are good insulators. The manufacture of PCBs was stopped in the U.S. in 1977 because of evidence they build up in the environment and can cause harmful health effects. Products made before 1977 that may contain PCBs include old fluorescent lighting fixtures and electrical devices containing PCB capacitors, and old microscope and hydraulic oils.

What happens when PCBs enter the environment? PCBs entered the air, water and soil during their manufacture, use and disposal; from accidental spills and leaks during their transport; and from leaks or fires in products containing PCBs. PCBs can still be released to the environment from hazardous waste sites; illegal or improper disposal of industrial wastes and consumer products; leaks from old electrical transformers containing PCBs; and burning of some wastes in incinerators. PCBs do not readily break down in the environment and thus may remain there for very long periods of time. PCBs can travel long distances in the air and be deposited in areas far away from where they were released. In water, a small amount of PCBs may remain dissolved, but most stick to organic particles and bottom sediments. PCBs also bind strongly to soil. PCBs are taken up by small organisms and fish in water. They are also taken up by other animals that eat these aquatic animals as food. PCBs accumulate in fish and marine mammals, reaching levels that may be many thousands of times higher than in water.

How might I be exposed to PCBs? Using old fluorescent lighting fixtures and electrical devices and appliances, such as television sets and refrigerators, that were made 30 or more years ago can expose you to PCBs. These items may leak small amounts of PCBs into the air when they get hot during operation, and could be a source of skin exposure. Eating contaminated food is another way to be exposed.

The main dietary sources of PCBs are fish (especially sportfish caught in contaminated lakes or rivers), meat and dairy products. Breathing air near hazardous waste sites and drinking contaminated well water can cause exposure. Workplace exposure can occur during repair and maintenance of PCB transformers; accidents, fires or spills involving transformers, fluorescent lights and other old electrical devices; and disposal of PCB materials.

How can PCBs affect my health? The most commonly observed health effects in people exposed to large amounts of PCBs are skin conditions such as acne and rashes. Studies in exposed workers have shown changes in blood and urine that may indicate liver damage. PCB exposures in the general population are not likely to result in skin and liver effects. Most of the studies of health effects of PCBs in the general population examined children of mothers who were exposed to PCBs. Animals that ate food containing large amounts of PCBs for short periods of time had mild liver damage and some died. Animals that ate smaller amounts of PCBs in food over several weeks or months developed various kinds of health effects, including anemia; acne-like skin conditions; and liver, stomach, and thyroid gland injuries. Other effects of PCBs in animals include changes in the immune system, behavioral alterations, and impaired reproduction. PCBs are not known to cause birth defects.

How likely are PCBs to cause cancer? The U.S. Department of Health and Human Services has concluded that PCBs may reasonably be anticipated to be carcinogens. The Environmental Protection Agency and the International Agency for Research on Cancer have determined that PCBs are probably carcinogenic to humans (liver and biliary tract).

How can PCBs affect children? Women who were exposed to relatively high levels of PCBs in the workplace or ate large amounts of fish contaminated with PCBs had babies who weighed slightly less than babies from women who did not have these exposures. Babies born to women who ate PCB-contaminated fish also showed abnormal responses in tests of infant behavior. Some of these behaviors, such as problems with motor skills and a decrease in short-term memory, lasted for several years. Other studies suggest that the immune system was affected in children born to and nursed by mothers exposed to increased levels of PCBs. There are no reports of structural birth defects caused by exposure to PCBs or of health effects of PCBs in older children. The most likely way infants will be exposed to PCBs is from breast milk. PCBs may be passed from mother to unborn child. In most cases, the benefits of breastfeeding outweigh any risks from exposure to PCBs in mothers' milk.

Additional Information

NC Fish Consumption Advisories www.epi.state.nc.us/epi/fish/
Agency for Toxic Substances and Disease Registry www.atsdr.cdc.gov

Polychlorinated Biphenyls Fact Sheet and FAQs – July 2008 N.C. Division of Public Health

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