Human Health Risk Evaluation of Aroclor Polychlorinated Biphenyl (PCB) Concentrations in Sediments Collected in 2011 in the Yadkin-Pee Dee River System, North Carolina

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The North Carolina (N.C.) Division of Public Health's (DPH) Health Assessment, Consultation and Education (HACE) program has completed the review of sediment data collected in 2011 in the Yadkin-Pee Dee River system in central North Carolina. Sediments were analyzed for Aroclor[1] polychlorinated biphenyls (PCBs) and the data evaluated for human health risks associated with incidental ingestion and direct contact. This 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.

This report summarizes the Aroclor PCB results for sediments collected in 2011 in the Yadkin-Pee Dee River system. Sediments were collected in High Rock Lake, Badin Lake, Lake Tillery and the uppermost reaches of Blewett Falls . Additional sediments were collected in 2012 in the Falls Reservoir segment of the Yadkin-Pee Dee River system and also analyzed for Aroclor PCBs. In 2011 and 2012 fish were collected from 3 water bodies in the Yadkin-Pee Dee River system (High Rock Lake, Falls Reservoir and Lake Tillery). More than 100 fish tissue samples were analyzed for 209-congener PCBs. The results of 2012 sediment and the 3 fish tissue studies are reported in separate documents [FR 2013b, HR 2013, FR 2013a, LT 2013].

The 2011-12 Yadkin-Pee Dee River system sampling and analysis project was 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 United States Environmental Protection Agency (EPA), and DPH. The objective of the 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.

2011 Yadkin-Pee Dee River System Sediment Study -

From April 18-20, 2011 the EPA Region 4 Science and Ecosystem Support Division (SESD) and DENR's DWM conducted sediment sampling on the Yadkin-Pee Dee River system in Rowan, Davidson, Stanly and Montgomery Counties of North Carolina. Twenty-one (21) surface sediment locations were collected throughout the Yadkin-Pee

[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

Dee River system. 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 river system. Duplicate samples were collected at 2 locations for quality control purposes. DENR selected the sample locations and assisted EPA with collection. Samples were collected with a Ponar dredge or stainless steel scoop, mixed on site and transferred to glass jars for shipment to the analytical laboratory. EPA quality control/quality assurance guidance was referenced for the sediment collection, handling and analysis [EPA 2011a]. Sediment collection locations are identified and listed in Appendix Figure 1 and Table 1. The sediments were analyzed by EPA's Region 4 SESD Laboratory in Athens, Georgia. Sediments were analyzed for 9 Aroclor mixtures by EPA Method 8082 and reported as µg/kg (dry weight sediment). EPA's analytical report is dated July 8, 2011 [EPA 2011b]. All PCB results are reported as dry weight sediment.

Sediment Aroclor PCB Analytical Results Discussion -

One (1) Aroclor PCB was quantified in each of 2 sediment samples (Table 2 below). Appendix Figures 2 and 3 are photographs of these 2 sampling locations. Aroclor PCBs were not detected in either of the 2 duplicate samples. Sample Aroclor-specific reporting limits ranged from 12-510 µg/kg[3] Aroclor (Appendix Table 3).

Table 2. Summary of detected Aroclor PCBs for surface sediment composite samples. Yadkin River April 2011.

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

Health Risk Analysis –

Ingestion: The quantified sediment Aroclor PCB concentrations were evaluated for incidental ingestion risks for children 1-6 years old. This age range was selected to represent the age range with the highest relative risk compared to other age ranges of children (≥1 years old) and adults, based on the predicted sediment/soil ingestion rate to body weight (the estimated dose). Incidental ingestion is described as the unintended ingestion of the sediment by children while playing. A health-protective exposure scenario was developed that reflects children's exposure 1 day/week for 26 weeks/year for 6 years. The highest concentration of detected Aroclor PCBs (500 µg/kg

[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")

Aroclor 1254, sample SD013) was used for cancer and non-cancer health risk calculations. The Agency for Toxic Substances and Disease Registry (ATSDR) and EPA defined exposure parameters and health-effect comparison values were used in the calculations. Exposure parameters, health comparison values and calculated health risk results for ingestion are summarized in Appendix Table 4. The estimated ingestion dose for the highest detected PCB concentrations for children 1-6 years old was more than 2 orders of magnitude less than the non-cancer RfD[4] (reference dose) and the estimated increased life-time cancer risk is <1e-06 (less than one in 1 million). No health risks are indicated for incidental ingestion of the sediments

Direct (Dermal) Contact: The detected sediment Aroclor PCB concentrations were evaluated for health risks associated with direct (dermal) contact with the contaminated sediments. EPA's dermal contact Regional Screening Levels (RSLs) were used to evaluate direct contact health risks. ATSDR does not provide dermal comparison values. Industrial screening levels were selected (versus residential) to best represent the anticipated exposure frequency. The industrial screening levels likely represent a frequency and duration of exposure much greater than expected for the Yadkin sediments and thus reflect a highly health protective screening level. Dermal screening values and detected Aroclor PCBs are summarized in Appendix Table 5. The 2 detected Aroclor PCB concentrations were less than the EPA dermal screening values. No health risks are indicated for direct contact with the sediments.

Health Risk Summary: A health protective exposure scenario was used for the most vulnerable population (children 1-6 years old) that may be exposed to the sediments in the Yadkin River. Exposure to the highest detected sediment concentration in the 2011 sediment samples was used for the evaluation of both incidental (unintended) ingestion and dermal exposure. Neither exposure is indicated to present a health risk.

Conclusions -

Adverse health effects are not indicated for either direct contact with, or incidental ingestion of, the sediments collected in the Yadkin River in 2011.

Limitations of the Sediment PCB Study –

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

[4] An RfD is EPA's determination of a dose below which no adverse non-carcinogenic health effects should result from a lifetime of exposure.

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.

Recommended Action Items -

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 River
    b. DENR DWM project staff
    c. EPA project staff
    d. DPH Public Information Officer (PIO)
    e. 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 DENR, EPA and 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. Sediment collection location descriptions. Yadkin-Pee Dee River system April 2011.

EPA Sample Number	DENR Station	Sample Location Description	Detected Aroclor PCB	Aroclor PCB Concentration, µg/kg [1]
YRSD001SD	SD001	Outfall area of electric plant. Brown, sandy, some mica.	None	-NA-
YRSD002SD	SD002	Variability duplicate of YRS0001SD from station SD001.	None	-NA-
YRSD003SD	SD003	Right side of concrete culvert for rail yard. Dark brown sandy silt.	None	-NA-
YRSD004SD	SD003	Unable to get to north side of bridge, collected from south side. Green silt.	None	-NA-
YRSD004SD	SD004	NC Wildlife Dutch Second Creek Boat Access. Orange brown coarse sand, some silt and mica.	None	-NA-
YRSD005SD	SD005	Southmont Abbotts Creek Boat and Fishing Access. Orange brown coarse sand, mica and detritus.	None	-NA-
YRSD006SD	SD006	Near west side of river -500 feet from dam. Green silt.	None	-NA-
YRSD007SD	SD007	Boat ramp downstream from High Rock Dam. Left ramp area. Brown to green fine sand, some mica.	None	-NA-
YRSD008SD	SD008	NC Wildlife Flat Creek Boat Access (active). Right of dock. Greenish brown sandy silt, some mica.	None	-NA-
YRSD009SD	SD009	Water intake upstream from Tuckertown Dam @ City of Albemarle WTP right side of intake area. Green fine silt some mica.	None	-NA-
YRSD010SD	SD010	Original station hit refusal, not able to get sample. Drive to Old Whitney Picnic Area. Active, 4 boats fishing access, left side of ramp. Greenish brown sand and pebbles, some mica.	None	-NA-
YRSD011SD	SD011	Lakemont Boating Access, 241 Lakemont Road. Green sandy silt, shells and pebbles.	None	-NA-
YRSD012SD	SD012	Swimming area, orange sandy silt, gravelly beach. Orange silty sand and pebbles.	None	-NA-
YRSD013SD	SD013	Active boat ramp, boater coming in when we drove up. Grayish gray fine sand, some mica, some detritus.	**Aroclor 1254**	**500**
YRSD014SD	SD014	Morrow Mt. State Park, left side of ramp. Gray fine sand, some mica. (Boat ramp closed due to repairs of dock.	None	-NA-
YRSD015SD	SD015	Sediment from left dock outside ramp. Greenish yellow sandy silt, some pebble. Active boat ramp, 3 boats put in on trailers while sampling.	None	-NA-
YRSD016SD	SD016	Sediment from both sides of dock. Brown sandy silt with shells and pebbles. Stoney Point launch ramp, John Cook Marine (not active at this time).	None	-NA-
YRSD017SD	SD017	Left side of dock. Yellow brown sandy silt with shells and pebbles. Sample from marina that is active - one person launches boat.	None	-NA-
YRSD018SD	SD018	Upstream from Norwood Dam ~500 feet west of east shore inlet. Greenish brown silt; pudding.	None	-NA-
YRSD019SD	SD019	Lilly's Bridge Boating Access, 1097 Lilly's Bridge Road. Brown sandy silt, pebbles, mica.	None	-NA-
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**
YRSD021SD	SD021	Boat ramp north and west of 29/70 and 1-85, furthest upstream point. Green silt pudding.	None	-NA-
YRSD101SD	SD001	Duplicate sample analysis	None	-NA-
YRSD112SD	SD012	Duplicate sample analysis	None	-NA-

[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; NA = Not Applicable; µg/kg – micrograms per kilogram (“parts per billion”)

Table 3. Aroclor mixtures reported by EPA for the 2011 Yadkin-Pee Dee River system surface sediment composite study.

EPA Method 8082 Polychlorinated Biphenyls	Range of Reporting Limits, µg/kg	Detected PCB Aroclor Concentrations µg/kg [1]	Number of Detections
Aroclor 1016	12-110	None	0
Aroclor 1221	27-220	None	0
Aroclor 1232	12-110	**100**	1
Aroclor 1242	12-110	None	0
Aroclor 1248	12-110	None	0
Aroclor 1254	12-76	**500**	1
Aroclor 1260	12-510	None	0
Aroclor 1262	12-510	None	0
Aroclor 1268	12-510	None	0

[1] as dry weight sediment
PCB – polychlorinated biphenyl; µg/kg – micrograms per kilogram ("parts per billion")

Table 4. Incidental ingestion exposure parameters, health risk comparison values and health risk results for exposures to 1-6 year old children. Yadkin-Pee Dee River system 2011 sediments.

Exposure Parameter	Value
Ingestion rate	100 mg/d sediment
Body weight	17 kg
Exposure factor	26 days per year for 6 years
PCB concentration [1]	500 µg/kg Arolcor-1254
Health Risk Comparison Values - Ingestion	
Minimal Risk Level, Intermediate Oral Exposure [2] (non-cancer effects)	3e-05 mg/kg-d as PCBs
RfD [3]	2e-05 mg/kg-d Aroclor 1254
Cancer Slope Factor, Oral [2]	2 mg/kg-d PCBs
Health Risk Results - Ingestion	
Calculated dose	2.1e-07 mg/kg-d Aroclor-1254
Hazard Quotient (HQ, non-cancer effects)	< 0.01
Estimated increased lifetime cancer risk	<1e-06

[1] Maximum detected Aroclor concentration for 2011 Yadkin River sediment samples
[2] ATSDR Comparison Values, August 2012
[3] EPA Regional Screening Level (RSL), November 2012
kg – kilogram; mg/d – milligrams per day; mg/kg-d - micrograms per kilogram per day;
PCB – polychlorinated biphenyl; µg/kg – micrograms per kilogram ("parts per billion");
RfD – Reference dose, EPA non-cancer health-effect screening value; < - "less than";
<1e-06 – less than 1 in 1 million

Table 5. Dermal screening levels and highest detected sediment Aroclor concentrations. Yadkin-Pee Dee River system 2011.

PCB Aroclor	Dermal Screening Levels, µg/kg [1]	Highest Detected Concentration, µg/kg
Aroclor 1016	44,000	-NA-
Aroclor 1221	1500	-NA-
Aroclor 1232	1500	**100**
Aroclor 1242	1500	-NA-
Aroclor 1248	1500	-NA-
Aroclor 1254	1500	**500**
Aroclor 1260	1500	-NA-
Aroclor 1262	-NA-	-NA-
Aroclor 1268	-NA-	-NA-

[1] Source: EPA Regional Screening Levels (RSLs), November 2012, industrial exposures
PCB – polychlorinated biphenyl; µg/kg – micrograms per kilogram

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

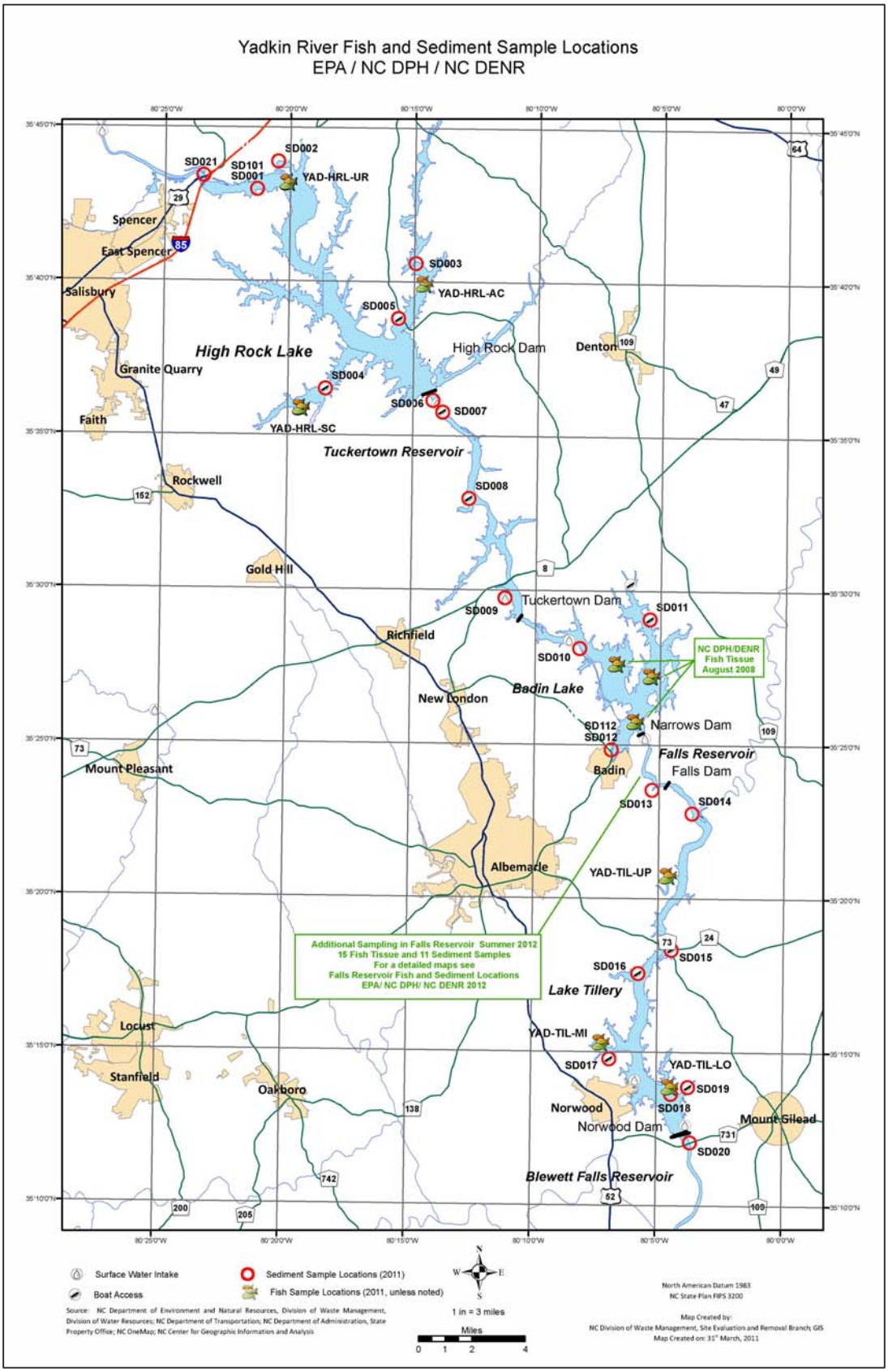

Figure 3. Falls Reservoir 2011 sediment collection location “SD013”. Location of 500 mg/kg Aroclor 1254 detection.

Figure 4. Falls Reservoir 2011 sediment collection location “SD020”. Location of 100 mg/kg Aroclor 1232 detection (J, I-5).

POLYCHLORINATED BIPHENYLS (PCBS)
FACT SHEET AND FAQS
JULY 2008

ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

NCPH
North Carolina Public Health

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 breast-feeding 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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