Dioxin in the Ohio River Basin

The Ohio River Valley Water Sanitation Commission

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Introduction

The presence of dioxins in the environment has attracted considerable attention in recent years from the public and the scientific community. Several incidents in which humans and wildlife were exposed to dioxins have shed light on the toxic nature of these compounds. One of the best known incidents occurred during the Vietnam War, when Agent Orange was used as a forest defoliant. Thousands of U.S. servicemen were exposed to the herbicide which was later found to be contaminated with 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8 TCDD), one of the many dioxin congeners and believed to be the most toxic.

In Times Beach Missouri, dioxin contaminated waste oil was sprayed on roads to control dust during the 1970's. An estimated 22 kg of 2,3,7,8 TCDD was released causing such severe soil contamination that the entire town was permanently evacuated. Contaminated waste oil was also used at several horse arenas in Missouri to control dust. The deaths of seventy-five horses and numerous deaths of dogs, rodents, chickens, cats and birds were attributed to the dioxin exposure (USFWS, 1986).

In 1976, an explosion at a 2,4,5 trichlorophenol (2,4,5 TCP) production facility in Seveso, Italy resulted in widespread 2,3,7,8 TCDD contamination. Bioaccumulation of the dioxin congener was found in wildlife in the most heavily contaminated areas. All domestic livestock in the area were destroyed due to the elevated levels of 2,3,7,8 TCDD found in the milk of exposed cattle and in the tissues of other livestock (USFWS, 1986). An estimated 175 cases of allergic skin conditions (chloracne and dermatitis) were observed in humans following the incident (EPA, 1987).

These incidents and others like them have led to a great deal of scientific research to gain a better understanding of the toxicological effects of dioxin compounds to humans and wildlife. The 2,3,7,8 TCDD congener has been the focus of much of the initial research since it is the most toxic dioxin congener. Recent studies have begun looking collectively at all 17 dioxin and furan congeners which have similar toxicological effects.

Clinical research has shown dioxin can cause a wide array of health effects in wildlife and possibly humans. Dioxins and furans have been found to have carcinogenic, immunotoxic, fetotoxic, mutagenic, and reproductive effects in various animal species. Chloracne, a severe form of acne, is a common response to dioxin exposure in humans. Other effects on humans have yet to be confirmed. The US EPA considers the 2,3,7,8 TCDD congener a probable human carcinogen, while carrying the title of the most potent known animal carcinogen (EPA, 1993).

Dioxin is a difficult environmental problem to address due to the diverse nature of the sources and the persistence of these compounds in the environment. Numerous types of industries as well as fuel combustion in automobiles have been found to produce dioxin. Once in the environment, these compounds are very resistant to chemical breakdown, with half-lives in some media measured in years.

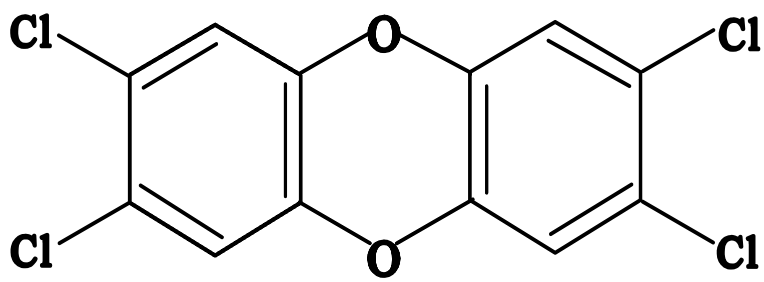
The purpose of this report is to summarize background information on dioxin and to characterize the extent and severity of dioxin contamination in the Ohio River Basin. This report is part of the Ohio River Watershed Pollutant Reduction Program being conducted by the Ohio River Valley Water Sanitation Commission (ORSANCO). The ultimate goal of the program is to generate the necessary information to achieve meaningful reductions of the pollutants inhibiting the beneficial uses of the Ohio River and its tributaries. Dioxin is the first pollutant to be addressed under this program.

Physical and Chemical Properties

Dioxins are a group of compounds made up of polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs). There is a total of 210 different dioxin and furan congeners. Dioxins are halogenated aromatic hydrocarbons with eight positions for substitution of chlorine or other atoms. Only the 17 congeners with chlorine substitution in the 2,3,7,8 positions have dioxin-like toxicity. 2,3,7,8 TCDD has been found to be the most toxic dioxin congener (see Figure 1), while the more chlorinated dioxin and furan species are the least toxic. PCDDs and PCDFs with fewer than four chlorine atoms substituted are not believed to be harmful.

A standardized method to evaluate the toxicity of complex mixtures of dioxin-like

Figure 1. Chemical Structure of 2,3,7,8 Tetrachlorodibenzo-para-dioxin.



compounds was developed by EPA and the North Atlantic Treaty Organization Committee on the Challenges of Modern Society (NATO CCMS, 1988). This procedure assigns a Toxicity Equivalency Factor (TEF) to each of the 17 dioxin and furan congeners with chlorine substitution in the 2,3,7, and 8 positions. Since the 2,3,7,8 TCDD congener is the most toxic, its TEF is set at 1. The TEFs of the other congeners are based on relative toxicity to the 2,3,7,8 TCDD congener, and range from 0.001 to 0.5 (see Table 1). To determine the risk posed by a mixture of dioxins and furans, the concentration of each congener is multiplied by its corresponding TEF. The resulting concentration is expressed in terms of 2,3,7,8 TCDD equivalents (TEQ). The summation of all the TEQs give the estimated total concentration in terms of a 2,3,7,8 TCDD equivalent concentration.

Table 1. Toxicity Equivalency Factors (TEFs) for Dioxins and Furans (NATO-CCMS, 1988).

Congener	**TEF**
2,3,7,8 TCDD	1
1,2,3,7,8 PeCDD	0.5
1,2,3,4,7,8 HxCDD	0.1
1,2,3,7,8,9 HxCDD	0.1
1,2,3,6,7,8 HxCDD	0.1
1,2,3,4,6,7,8 HpCDD	0.01
OCDD	0.001
2,3,7,8 TCDF	0.1
2,3,4,7,8 PeCDF	0.5
1,2,3,7,8 PeCDF	0.05
1,2,3,4,7,8 HxCDF	0.1
1,2,3,7,8,9 HxCDF	0.1
1,2,3,6,7,8 HxCDF	0.1
2,3,4,6,7,8 HxCDF	0.1
1,2,3,4,6,7,8 HpCDF	0.01
1,2,3,4,7,8,9 HpCDF	0.01
OCDF	0.001

Dioxins have a low water solubility, are very lipophilic, and readily bioaccumulate in humans and animals. PCDDs and PCDFs strongly bind to particulate matter in all media. Mobility through soil is believed to be extremely limited due to the strong sorptive nature of dioxins (EPA, 1987). These compounds are very stable and thus very persistent in the environment. The chemical half-life for 2,3,7,8 TCDD in the top few inches of soil is estimated to be 1 to 3 years (EPA, 1992), while more deeply buried 2,3,7,8 TCDD could have a half-life greater than 10 years (USFWS, 1986). The half-life of 2,3,7,8 TCDD in surface water is estimated to be 1 to 1.5 years (EPA, 1992).

Dioxins emitted to the atmosphere can be found in both the particulate and vapor phases. The more chlorinated PCDDs and PCDFs are typically found in the particulate phase. The less chlorinated congeners, such as the 2,3,7,8 TCDD congener, are predominantly found in the vapor phase in the summer months, and more evenly divided between the two phases during cooler periods (Eitzer and Hites, 1989a). Since the less chlorinated dioxin and furan congeners favor the vapor phase, they undergo photodegradation more readily (Eitzer and Hites, 1989b).

Some PCDD/Fs are removed from the atmosphere before photodegradation can occur. These compounds are removed by wet and dry deposition. Dry deposition is a process by which those compounds bound to the particulate phase settle to the ground due to gravity. Wet deposition occurs when rain scavenges these compounds from the atmosphere from both the particulate and vapor phases, and are deposited through precipitation.

The ultimate fate of dioxins in the environment is their accumulation in aquatic sediments. Dioxins deposited to soil surfaces tend to bind to particulate matter and are either buried in place, resuspended into air, or are transported to surface waters through erosion. Once in water, whether from direct atmospheric deposition, effluent discharge, or soil erosion, dioxins primarily sorb to suspended solids. These particles can be transported considerable distances downstream before settling to the bottom (EPA, 1987).

Environmental and Human Health Concerns

Humans are exposed to dioxin compounds through ingestion of contaminated foods and water, inhalation of contaminated air, and dermal contact with contaminated media. Ingestion of contaminated foods appears to be the major route of exposure to humans. Livestock such as cattle and poultry are exposed to dioxins much the same way humans are. Fish uptake dioxins through exposure to contaminated water and sediments, and consumption of aquatic organisms. Once absorbed, dioxin compounds accumulate and are stored in fatty tissues. Fruits and vegetables can also become contaminated through atmospheric deposition of dioxins onto plant surfaces.

Once absorbed into the blood stream, dioxins are distributed throughout the body to all organ systems. The primary disposition sites in most species are the liver and adipose tissues (EPA, 1984). These compounds are very persistent with half-lives in humans for the 2,3,7,8 TCDD congener ranging from 5.8 - 11.3 years (Poigner, et al., 1986; Pirkle, et al., 1989; Wolfe, et al., 1994). Additional research is needed to determine the persistence of the other toxic dioxin and furan congeners in humans.

Dioxins have been found to produce a wide array of responses in animals and humans. Chloracne, a severe form of acne, is the only response in humans clearly attributed to dioxin exposure. This skin condition can develop several weeks after dioxin exposure, and can persist from weeks to months. Severe cases of chloracne have been reported to have persisted for several years (EPA, 1984). Epidemiological studies suggest dioxin may cause decreased birth weights (Lucier, 1991), decreased growth (Guo, et al., 1994), delayed developmental milestones (Rogan, et al., 1988), decreased testis size (Egeland, et al., 1994) and cancer (Bertazzi, et al., 1993). Other responses observed in laboratory studies include liver tumor promotion in rats (Maronpot, et al., 1993), skin tumor promotion in mice (Poland, et al., 1982), and endometriosis (Hong, et al., 1989) in monkeys. There is also evidence of immunotoxicity of dioxin in various animal species with some supporting data from epidemiological studies.

Based on the collective results of the various laboratory studies and limited epidemiological studies, the EPA classifies 2,3,7,8 TCDD as a probable human carcinogen. The Maximum Contaminant Level (MCL) for 2,3,7,8 TCDD in finished drinking water is 0.00000003 mg/L, while the Maximum Contaminant Level Goal (MCLG) is set at 0 mg/L (EPA, 1996). An in-stream water quality criterion of 1.3 x 10 -8 ug/L has been established for the protection of human health from 2,3,7,8 TCDD exposure through the ingestion of contaminated water and aquatic organisms (EPA, 1984). Current analytical techniques, however, do not allow these low levels to be measured. The associated cancer risk at this concentration is one additional cancer case for every one million people exposed over a lifetime. The FDA established health advisory levels for fish for 2,3,7,8 TCDD (EPA, 1992). Fish with less than 25 parts per trillion (ppt) can be consumed with no serious health concerns. Consumption of fish with concentrations between 25 - 50 ppt of 2,3,7,8 TCDD should be limited to two meals per month. Fish with greater than 50 ppt is not recommended for consumption.

Formation and Sources of Dioxins

According to sediment core samples collected from the Great Lakes (Czuczwa and Hites, 1984) and three high altitude lakes in Switzerland (Hites, 1990) dioxin levels before the 1930's were very low. Concentrations showed increases from the 1930's through the 1970's. Since then concentrations have been gradually decreasing. It has been suggested the sudden introduction of dioxins to the environment was a result of changes in the chemical industry before World War II (Hites, 1990). During this time period there was a shift from producing primarily inorganic materials to organic products such as plastics. Some of these materials were organochlorine based and could produce dioxins when burned.

Dioxins have never been intentionally produced, but are an unwanted by-product of various combustion and chemical processes. Many different categories of potential dioxin sources have been identified by EPA and others. Many questions still remain about the impacts of these sources. Emission estimates for all source categories are highly uncertain and further research is needed to better characterize dioxin emissions. Most sources which have been identified are atmospheric sources. Limited available data implicate municipal and hospital incinerators, and cement kilns burning hazardous waste as the largest producers of dioxins. Other potential producers of dioxins include industrial and residential wood burners, secondary metals industries such as copper smelters, chemical manufacturers of chlorinated compounds, sewage sludge and hazardous waste incinerators, wastewater treatment plants, PCB transformer fires, wood treating facilities, and pulp & paper mills. Automobiles have also been identified as a source, with diesel fuel combustion being the main contributor. The use of unleaded fuel is believed to have greatly curbed dioxin emissions from cars. Some scientists contend forest fires are a significant source of dioxins, however, it is not conclusive whether the dioxins released from these fires are being produced by the forest fires or merely resuspended into the atmosphere. In the past, dioxins were also released unknowingly through the use of contaminated herbicides such as 2,4,5-T, Agent Orange, and Silvex. These herbicides are no longer produced.

Sources and Presence in the Ohio River Basin

Based on information provided by Ohio River Basin states, the US EPA (EPA, 1987 and 1992), and a publication on the release of dioxins in the Great Lakes region (Cohen, et al., 1995), 120 potential and confirmed dioxin sources have been identified in the Ohio River Basin (see Figure 2 and Table 2). These sites have been categorized by ORSANCO based on the facilities potential to cause dioxin contamination in surface waters. Type of facility, proximity to water, as well as, fish, sediment, and soil contaminant data were considered when categorizing the sources. Most of these potential and confirmed sources are atmospheric sources such as hazardous, municipal, and medical waste incinerators, cement kilns, sewage sludge incinerators, as well as primary and secondary metals industries. Very little is known about the impact of these sources on water quality. Only ten potential, direct sources to water were identified in the Basin. All of these are either pulp and paper mills or wood treating facilities. Some of these facilities have very little data concerning dioxin contamination.

Twenty sites known or suspected to have PCDD and/or PCDF soil contamination were identified in the Ohio River Basin, ten of which are along the Kanawha River in West Virginia. Seven of the twenty sites are chemical manufacturing facilities, and another eight are industrial waste dump sites. Many of these sites were involved in the production of phenoxy herbicides and the disposal of the associated chemical wastes. Fish tissue, sediment, and soil data have been collected at most of these sites. Contamination was also discovered at a railcar repair and maintenance facility just upstream of Winfield Locks and Dam on the Kanawha River. Residual compounds found in the railcars were dumped on-site. The former owner of the facility

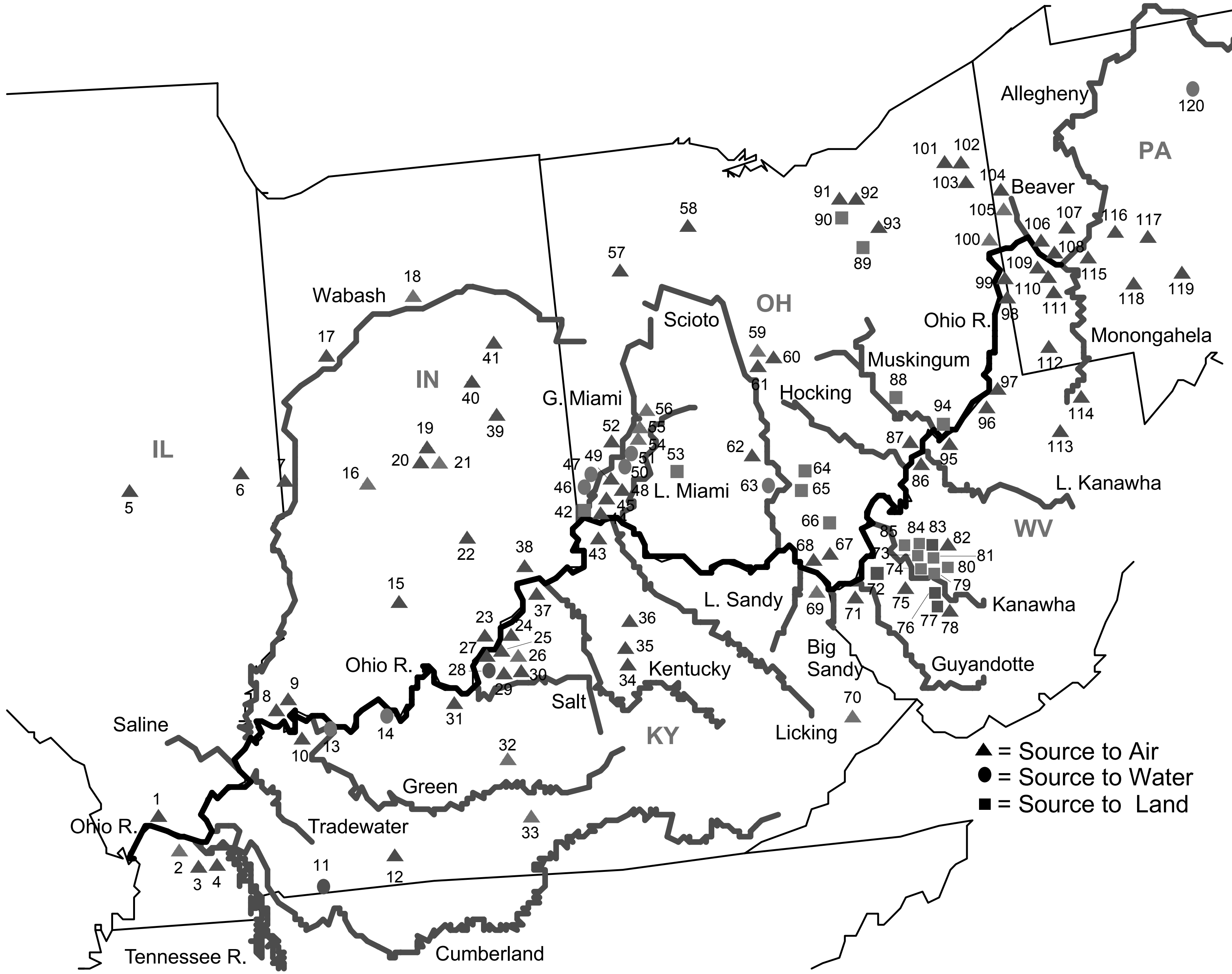


Figure 9. Potential Dioxin Sources in the Ohio River Basin

Table 2. Potential and Confirmed Dioxin Sources in the Ohio River Basin.

	PROBABILITY	POTENTIAL / CONFIRMED	SOURCE TYPE	SITE NAME	LOCATION	COMMENTS
1	Low	Potential	Cement Kiln	Lafarge	Grand Chain, IL	Does not burn hazardous waste.
2	High	Potential	Medical Waste Incinerator	Western Baptist Hospital	Paducah, KY	Facility is permitted for dioxin emissions.
3	Moderate	Potential	Hazardous Waste Incinerator	LWD, Inc.	Calvert City, KY	Facility near the Ohio and Tennesse Rivers.
4	Moderate	Potential	Hazardous Waste Incinerator	Atochem	Calvert City, KY	Near the Tennessee R.
5	Low	Potential	Sewage Sludge Incinerator	Decatur STP	Decatur, IL	Facility is west of the Ohio River Basin.
6	Low	Potential	Secondary Copper Smelting	RECONTEK	Newman, IL	Not close to major tribs.
7	Moderate	Potential	Hazardous Waste Incinerator	Eli Lily Corp.	Clinton, IN	Near the Wabash R.
8	Moderate	Potential	Medical Waste Incinerator	Welborn Baptist Hospital	Evansville, IN	Near the Ohio River.
9	Moderate	Potential	Medical Waste Incinerator	St. Mary's Med. Center	Evansville, IN	Near theOhio River.
10	Moderate	Potential	Medical Waste Incinerator	Community Methodist Hospital	Henderson, KY	Facility is permitted for dioxin emissions, but not expected to generate dioxin.
11	Low	Potential	Wood Treating Facility	Koppers Industries, Inc.	Guthrie, KY	Not close to any major tribs.
12	Low	Potential	Medical Waste Incinerator	B.G. - Warren Co. Hospital	Bowling Green, KY	Facility is permitted for dioxin emissions, but not expected to generate dioxin.
13	High	Confirmed	Recycle Paper Facility	Scott Paper Co.	Newman, KY	Discharges to the Ohio and Green Rivers. Monitoring requirement for dioxin.
14	High	Confirmed	Pulp & Paper Mill	Willamette Industries	Hawesville, KY	Discharges to the Ohio R. Monitoring requirement for dioxin.
15	Low	Potential	Cement Kiln	Lehigh Portland Cement	Mitchell, IN	Does not burn hazardous waste. Site near the East Fork White River.
16	High	Potential	Cement Kiln	Lone Star Industries	Greencastle, IN	Burns hazardous waste. Site is near the Eel River.
17	Moderate	Potential	Hazardous Waste Incinerator	Eli Lily Corp.	Lafayette, IN	Near the Wabash R.
18	High	Potential	Cement Kiln	Essroc Logansport Corp.	Logansport, IN	Burns hazardous waste.
19	Moderate	Potential	Sludge Incinerator	Indianapolis Sludge Incinerator	Indianapolis, IN	Near the Wabash R.
20	Moderate	Potential	Hazardous Waste Incinerator	Reily Industries	Indianapolis, IN	Near the White R.
21	High	Confirmed	Hazardous Waste Incinerator	OgdenMartin Systems	Indianapolis, IN	Monitors for dioxin. Site near the White R.
22	Low	Potential	Copper Wire Incinerator	The Kroot Corp.	Columbus, IN	
23	Low	Potential	Cement Kiln	Essroc Materials	Speed, IN	Does not burn hazardous waste.
24	Moderate	Potential	Hazardous Waste Incinerator	Rohm	Louisville, KY	Near the Ohio R.
25	Low	Potential	Cement Kiln	Kosmos Cement	Kosmosdale, KY	Does not burn hazardous waste.
26	Moderate	Potential	Hazardous Waste Incinerator	Dupont	Louisville, KY	Near the Ohio R.
27	High	Potential	Cement Kiln	Solite	Brooks, KY	Burns hazardous waste.
28	Moderate	Potential	Wood Treating Facility	James Graham Brown Foudation	Louisville, KY	Facilty near the Ohio R.
29	Moderate	Potential	Hazardous Waste Incinerator	Smiths Farm	Shepherdsville, KY	Near the Salt R.
30	Low	Potential	Cement Kiln	Environment	Brooks, KY	Does not burn hazardous waste.
31	Moderate	Potential	Hazardous Waste Incinerator	Olin Corp.	Brandenburg, KY	Near the Ohio R.
32	High	Confirmed	Medical Waste Incinerator	Taylor Co. Hospital	Campbellsville, KY	Facility is permitted for dioxin emissions. Not close to any major tribs.
33	High	Confirmed	Medical Waste Incinerator	Westlake Cumberland Hospital	Columbia, KY	Facility is permitted for dioxin emissions. Not close to any major tribs.
34	Low	Potential	Hazardous Waste Incinerator	US Lexington	Richmond, KY	
35	Low	Potential	Medical Waste Incinerator	University of Kentucky	Lexington, KY	Site is not near any major tribs.
36	Moderate	Potential	Sewage Sludge Incinerator	Cynthiana WWTP	Cythiana, KY	Near the South Fork of the Licking R.
37	Moderate	Potential	Hazardous Waste Incinerator	Atochem	Carrollton, KY	Near the Ohio R.
38	Moderate	Potential	Refuse Incinerator	U.S. Army Proving Ground	Madison, IN	Near the Ohio R. Not certain type of materials burned.
39	Moderate	Potential	Medical Waste Incinerator	St. John's Health System	Anderson, IN	Near the White R.
40	Low	Potential	Wire Insulation Incinerator	DASCO, Inc.	Elwood, IN	
41	Moderate	Potential	Secondary Copper Refinery	Essex Group	Marion, IN	
42	High	Confirmed	Wood Treating Facility	Koppers Company, Inc.	Cincinnati, OH	Facility is inactive. Confirmed on-site soil contamination.
43	Moderate	Potential	Sewage Sludge Incinerator	Kenton Co.	Fort Wright, KY	
44	Moderate	Potential	Hazardous Waste Incinerator	Monsanto	Addyston, OH	Near the Ohio R.
45	Moderate	Potential	Sewage Sludge Incinerator	Millcreek	Cincinnati, OH	
46	High	Potential	Wastewater Treatment Plant	Middletown WWTP	Middletown, OH	Treats wastewater from Sorg Pulp & Paper Co. Discharges to G. Miami River.
47	High	Potential	Pulp & Paper Mill	Baywest	Middletown, OH	Facility discharges to the Great Miami River.
48	Moderate	Potential	Sewage Sludge Incinerator	Little Miami WWTP	Cincinnati, OH	Near the Little Miami R.
49	Moderate	Potential	Iron Sintering Plant	AK Steel Co.	Midletown, OH	Near the Great Miami R.
50	High	Potential	Paper Mill	Miami Papers	Franklin, OH	Does not use chlorine. Facility near the G. Miami R.
51	High	Potential	Paper Mill	Appleton Papers	Franklin, OH	Does not use chlorine. Facility near the G. Miami R.
52	Moderate	Potential	Sewage Sludge Incinerator	Warren Co.	Franklin, OH	Near the Great Miami R.
53	High	Confirmed	Wood Treating Facility	Cowan Lake State Park	Clinton County, OH	Confirmed soil cotamination from inactive wood treating facility.
54	High	Confirmed	Municipal Waste Incinerator	Montgomery Co. (South) Incinerator	Dayton, OH	Near the G. Miami R.
55	High	Confirmed	Municipal Waste Incinerator	Montgomery Co. (North) Incinerator	Dayton, OH	Near the G. Miami R.
56	High	Potential	Cement Kiln	Southdown	Fairborn, OH	Facility burns hazardous waste.
57	Low	Potential	Hazardous Waste Incinerator	BP Chemical	Lima, OH	Facility north of the Ohio R. Basin
58	Low	Potential	Cement Kiln	National	Carey, OH	Does not burn hazardous waste. Facility north of the Ohio R. Basin.
59	High	Confirmed	Municipal Waste Incinerator	Columbus MWI	Columbus, OH	Site is no longer active.
60	Moderate	Potential	Sewage Sludge Incinerator	Jackson Pike WWTP	Columbus, OH	
61	Moderate	Potential	Sewage Sludge Incinerator	Columbus (South)	Columbus, OH	
62	Moderate	Potential	Hazardous Waste Incinerator	PPG Industries	Circleville, OH	Near the Scioto R.
63	High	Potential	Pulp & Paper Mill	Mead Corp.	Chilicothe, OH	Facility uses chlorine. Discharges to Paint Cr.
64	High	Potential	Landfill	Triangle Landfill	South Salem, OH	Received potentially contaminated sludge from Mead Paper.
65	High	Potential	Landfill	Basic Concrete	Chilicothe, OH	Back-filled quarry pit with potentially contaminated sludge from Mead Paper.
66	High	Confirmed	Wastewater Treatment Plant	Wellston WWTP	Wellston, OH	Confirmed sludge contamination. Remedial action was taken.

Table 2. Potential and Confirmed Dioxin Sources in the Ohio River Basin.

	PROBABILITY	POTENTIAL / CONFIRMED	SOURCE TYPE	SITE NAME	LOCATION	COMMENTS
67	Moderate	Potential	Chemical Manufacturer	Aristech	Haverhill, OH	Facility near the Ohio River.
68	Moderate	Potential	Hazardous Waste Incinerator	Dow Chemical	Ironton, OH	Near the Ohio River.
69	High	Confirmed	Medical Waste Incinerator	Kings Daughters Hospital	Ashland, KY	Permitted for dioxin emissions. Facility near the Ohio R.
70	High	Confirmed	Medical Waste Incinerator	Medisin, Inc.	Prestonburg, KY	Permitted for dioxin emissions. Near the Levisa Fork of the Big Sandy R.
71	Moderate	Potential	Sewage Sludge Incinerator	Huntington	Huntington, WV	Near the Ohio R.
72	Moderate	Potential	Chemical Manufacture	Holder Chemical	Ona, WV	No soil contamination. Low levels of dioxin found in fish.
73	High	Confirmed	Dump Site		Poca, WV	Dump site along Heizer Creek. Confirmed soil contamination.
74	High	Confirmed	Chemical Manufacture	Monsanto	Nitro, WV	Confirmed soil contamination.
75	Moderate	Potential	Hazardous Waste Incinerator	Rhone Poule	Institute, WV	Near the Kanawha R.
76	Moderate	Potential	Dump Site	South Charleston Landfill	South Charleston, WV	Disposal site 2,4,5-TCP production facility. No soil contamination found.
77	Moderate	Potential	Chemical Manufacture	Union Carbide	South Charleston, WV	2,4,5-TCP production facility. No soil contamination found.
78	Moderate	Potential	Hazardous Waste Incinerator	Union Carbide	South Charleston, WV	Near the Kanawha R.
79	High	Confirmed	Chemical Manufacture	Fike (Artel) Chemicals	Nitro, WV	Confirmed soil contamination.
80	High	Confirmed	Dump Site	Nitro Dump	Nitro, WV	Confirmed soil contamination.
81	High	Confirmed	Dump Site	Poca Landfill	Poca, WV	Confirmed soil contamination.
82	Moderate	Potential	Hazardous Waste Incinerator	Monsanto	Nitro, WV	Near the Kanawha R.
83	Moderate	Potential	Dump Site		Poca, WV	Dump site along Georges Creek. Dioxin not found in soil.
84	High	Confirmed	Dump Site		Poca, WV	Dump site along Manila Creek. Confirmed soil contamination.
85	High	Confirmed	Railcar Repair & Maintenance	American Car & Foundary	Winfield, WV	Confirmed soil contamination.
86	Moderate	Potential	Hazardous Waste Incinerator	Dupont	Parkersburg, WV	Near the Ohio R.
87	Moderate	Potential	Hazardous Waste Incinerator	Shell Chemical	Belpre, OH	Near the Ohio R.
88	High	Confirmed	Wood Treating Facility	Tomkins Industries	Malta, OH	Confirmed soil contamination. Facility near the Ohio River.
89	High	Confirmed	Chemical Manufacture	Dover Chemical	Dover, OH	Confirmed contamination. Facility near Sugar Cr.
90	High	Confirmed	Chemical Manufacture	PPG	Barberton, OH	Confirmed contamination. Facility near the Tuscarawas R.
91	Moderate	Potential	Municipal Waste Incinerator	Akron MWI	Akron, OH	Not close to major tribs
92	Low	Potential	Sewage Sludge Incinerator	Akron WWTP	Akron, OH	Not close to major tribs.
93	Low	Potential	Sewage Sludge Incinerator	Canton WWTP	Canton, OH	Not close to major tribs
94	High	Confirmed	Chemical Manufacture	Union Carbide	Marietta, OH	Confirmed soil contamination. Facility near the Ohio River.
95	Moderate	Potential	Hazrdous Waste Incinerator	American Cyanamid	Willow Island, WV	Near the Ohio River.
96	Moderate	Potential	Hazardous Waste Incinerator	OSI Special	Sisterville, WV	Near the Ohio R.
97	Moderate	Potential	Hazardous Waste Incinerator	Miles, Inc.	New Martinsville, WV	Near the Ohio R.
98	Moderate	Potential	Iron Sintering Plant	Wheeling - Pittsburgh Steel	East Steubenville, WV	Near the Ohio R.
99	Moderate	Potential	Iron Sintering Plant	Wierton Steel	Weirton, WV	Near the Ohio R.
100	High	Confirmed	Hazardous Waste Incinerator	Waste Technologies Industries	East Liverpool, OH	Air emissions monitored for dioxin. Facility near the Ohio R.
101	Low	Potential	Hazardous Waste Incinerator	LTV Steel	Warren, OH	
102	Moderate	Potential	Iron Sintering Plant	WCI Steel	Warren, OH	
103	Low	Potential	Sewage Sludge Incinerator	Youngstown WWTP	Youngstown, OH	Not close to major tribs.
104	Low	Potential	Cement Kiln	Essroc Mate	Bessemer, PA	Does not burn hazardous waste.
105	High	Potential	Cement Kiln	Cemtech Cement Co.	Wampum, PA	Burns hazardous waste.
106	Moderate	Potential	Sewage Sludge Incinerator	Ambridge STP	Ambridge, PA	Near the Ohio R.
107	Low	Potential	Cement Kiln	Armstrong Cement & Supply	Cabot, PA	Does not burn hazardous waste.
108	Low	Potential	Cement Kiln	Kosmos Cement	Pittsburgh, PA	Does not burn hazardous waste.
109	Moderate	Potential	Sewage Sludge Incinerator	Alcosan WWTP	Pittsburgh, PA	Near the Ohio R.
110	Low	Potential	Cement Kiln	Lafarge	Whitehall, PA	Does not burn hazardous waste.
111	Low	Potential	Cement Kiln	Hercules	West Elizabeth, PA	Does not burn hazardous waste.
112	Moderate	Potential	Municipal Waste Incinerator	Wheelabrator	Morrisville, PA	
113	Low	Potential	Sewage Sludge Incinerator	Clarksburg STP	Clarksburg, WV	Not close to major tribs.
114	Moderate	Potential	Hazardous Waste Incinerator	Ordnance	Morgantown, WV	
115	Moderate	Potential	Hazardous Waste Incinerator	Neville Chemical	Pittsburgh, PA	Near the Ohio R.
116	Moderate	Potential	Sewage Sludge Incinerator	Kiski VAlley Water Pollution Control	Leechburg, PA	
117	Moderate	Potential	Sewage Sludge Incinerator	Kiski Valley WP	Apollo, PA	Near the Kiskiminetas R.
118	Moderate	Potential	Municipal Waste Incinerator	Westmoreland MWI	Greensburg, PA	Not close to major tribs.
119	Low	Potential	Sewage Sludge Incinerator	City of Johnstown	Johnstown, PA	Facility on eastern edge of basin.
120	High	Potential	Pulp & Paper Mill	Penntech Papers, Inc.	Johnsonburg, PA	Facility uses chlorine in bleaching process.

Data compiled from the National Dioxin Study (EPA, 1987), the Quantitative Estimation of the Entry of Dioxins, Furans and hexachlorobenzene from Airborne and Waterborne Sources (Cohen and associates, 1995), and from information requests from Pennsylvania, Ohio, West Virginia, Kentucky, Indiana and Illinois.

remediated the site by excavating the contaminated soil and shipped it to a hazardous waste landfill in Utah (Mark Kessinger, personal communication). A wastewater treatment plant with contaminated sludge and three wood treating facilities were also identified as sources.

Dioxins have been detected throughout the Ohio River Basin in almost all media, however, data is very limited for most of the watershed. Most data on the presence of dioxin have been collected over the last 12 to 15 years. Only a handful of fish tissue samples have been analyzed for many of the major tributaries to the Ohio River. Some large tributaries have yet to be sampled. The area that has been best characterized for the presence of dioxin is the area just upstream of Huntington, WV where the Kanawha River drains into the Ohio River. Water and sediment data for other portions of the Ohio River Basin are almost nonexistent.

Several sites along the Kanawha River have been found to have contaminated soils, sediments, and/or fish. Most of these sites played some part in the manufacturing processes of certain phenoxy herbicides such as Agent Orange, 2,4,5-T, and Silvex. The majority of the sediment data were collected by the U.S. Army Corps of Engineers. Criteria have yet to be established for dioxin contamination in aquatic sediments. More than 130 sediment samples have been collected along the Kanawha River (see Appendix A). All but two samples had concentrations below 100 parts per trillion (ppt). Sediment samples collected along the lower reaches of Armour Creek and the Pocatalico River (tributaries to the Kanawha River) had considerably higher dioxin concentrations. Of the ten samples collected on Armour Creek, three were non-detects, while one had a concentration of 1889 ppt. Twelve of the fifteen sediment samples collected on the Pocatalico River were non-detects, however, two of the samples exceeded 2500 ppt. The only sediment data available for the mainstem of the Ohio River is for a 20 mile stretch from the Kanawha River confluence to just downstream of the Robert C. Byrd Lock & Dam. The highest recorded value for the Ohio River of 13.5 ppt was collected in 1993 at river mile 265.7.

Surface water data for dioxins is very limited for the Ohio River Basin (see Appendix B). The main reason for the lack of data is because water column concentrations in most instances are well below the analytical detection limit. The detection limit for regulatory purposes is 10 parts per quadrillion, however, some laboratories report values as low as 1 ppq. The U.S. EPA's 2,3,7,8 TCDD in-stream water quality criterion for the protection of human health from exposure through ingestion of water and aquatic organisms is 0.013 ppq (EPA, 1984). This value is three orders of magnitude lower than the analytical detection limit used for regulatory purposes. Water column samples were collected along the Kanawha River near the Winfield Lock & Dam facility in 1993, and again in 1994. Two samples had quantifiable 2,3,7,8 TCDD concentrations of 7.3 ppq and 1.9 ppq. Two other samples had estimated concentrations of 2.4 ppq and 1.4 ppq. All other samples analyzed had non-detectable levels of dioxin. A surface water sample collected on the mainstem of the Ohio River near Apple Grove, West Virginia was non-detect for dioxin.

Fish tissue samples have been collected throughout the Ohio River Basin, however, data is limited for most of the tributaries and some portions of the Ohio River (see Appendix C). Of the 22 major tributaries to the Ohio River, seven have yet to be sampled and only a single sample has been collected on seven others. As with sediment and water column data, the area that has been best characterized for the presence of dioxins in fish tissue is along the Kanawha River and the Ohio River just upstream of Huntington, WV. Recent catfish composite samples taken from the Kanawha River in March of 1995 had 2,3,7,8 TCDD concentrations as high as 35.8 ppt. The highest recorded value for 2,3,7,8 TCDD in fish tissue from the Kanawha River is 172 ppt collected in 1976. The highest 2,3,7,8 TCDD concentration recorded for the Ohio River is 26.4 ppt with a toxicity eqivalency (TEQ) of 29.9 ppt. This catfish composite sample was collected in 1995 approximately 20 miles downstream of the Kanawha River confluence. The FDA does not recommend consumption of fish with 2,3,7,8 TCDD levels exceeding 50 ppt, and suggest limiting consumption to two meals per month for fish with concentrations between 25 ppt and 50 ppt (EPA, 1992).

In 1995, ORSANCO collected 39 fish tissue composite samples at 12 Ohio River locations (see Table 3). A variety of fish species were collected and analyzed, including bottom dwelling (carp and catfish) and predator fish (sauger, white and black bass). The highest dioxin concentration observed was 16.45 ppt TEQ in a carp sample collected at Meldahl Locks and Dam, about 30 miles upstream of Cincinnati, OH. This concentration does not exceed the FDA's Health Advisory Level for fish which recommends limited consumption (no more than two meals per month) of fish with concentrations greater than 25 ppt (EPA, 1992)

Conclusions

Dioxins pose health concerns at extremely low levels (parts per quadrillion). These compounds have been found to cause a wide array of responses in animals and possibly in humans. Precautions should be taken to minimize exposure to humans and wildlife. This is a difficult task considering wide-spread dioxin contamination has been found in air, soil, sediment, water and aquatic organisms. Sources are very numerous and diverse in nature. While some sources such as pulp and paper mills pose the threat of localized contamination, atmospheric sources allow for long range transport of these compounds. Fortunately, sediment core samples from the Great Lakes (Czuczwa and Hites, 1984) and Switzerland (Hites, 1990) indicate levels of PCDDs and PCDFs peaked in the 1970's and have been declining ever since. Changes in industrial processes and the switch from leaded to unleaded fuel for automobiles are believed to be the reasons for the decline.

More than 100 potential sources have been identified in the Ohio River Basin. Emissions data is very limited and the impact of these sources is not fully understood. Contamination has been found throughout the Basin in fish tissue samples. Sediment data for the Basin is limited to the Kanawha River and a short stretch of the Ohio River. Low-level contamination of sediments has been found in this region with localized hot spots on tributaries to the Kanawha River. Water column data is almost nonexistent since typical water column concentrations are below the analytical detection limits. There is a definite need for additional sediment and water column data from throughout the Basin, as well as additional fish tissue data for many of the major tributaries.

Table 3. ORSANCO 1995 FISH TISSUE SAMPLES

LOCATION	RIVER MILE	SPECIES	LENGTH AVG. cm	WEIGHT AVG. kg	# FISH	LIPID %	2,3,7,8, TCDD ppt	TEQ (NATO) ppt
Montgomery	31.7	Carp	50.5	2.1	5	9	1.78	6.70
Montgomery	31.7	Channel Catfish	48.6	1.1	5	5.3	1.81	4.51
Montgomery	31.7	White Bass	28.5	0.35	5	4.9	0.32	1.75
Pike Island	84.2	Carp	53.6	2.1	5	5.5	1.68	6.48
Pike Island	84.2	Channel Catfish	53.9	1.7	5	9.6	1.86	6.35
Willow Island	161.7	Carp	53.1	2.3	5	8.1	4.07	12.40
Willow Island	161.7	Channel Catfish	61.7	2.9	5	7.8	2.74	6.99
Willow Island	161.7	White Bass	30.2	0.4	3	2.7	0.42	1.33
Willow Island	161.7	Bluegill	16.2	0.096	5	0.25	0.00	0.13
Racine	237.5	Channel Catfish	58.5	2.4	5	5.7	3.73	8.90
Byrd	279.2	Carp	53.3	2.1	7	4.2	11.30	14.14
Byrd	279.2	Channel Catfish	52.9	1.4	6	1.2	8.22	10.25
Greenup	341	Carp	49.3	1.5	5	1.3	1.83	3.21
Greenup	341	Channel Catfish	53.6	1.6	1	15	7.50	10.70
Greenup	341	Channel Catfish	64.1	3.1	5	9.3	7.37	10.20
Greenup	341	Channel Catfish	46	0.98	5	9.1	4.72	7.04
Greenup	341	Carp	68.4	4	1	1.4	1.86	2.98
Greenup	341	Smallmouth Buffalo	41.2	1	5	0.97	0.42	0.94
Greenup	341	Crappie	19.9	0.13	4	0.19	0.31	0.48
Big Sandy River	-1	Smallmouth Buffalo	46.2	1.1	4	3.6	0.82	1.41
Big Sandy River	-1	Channel Catfish	49.9	0.79	4	4.2	2.10	3.07
Big Sandy River	-1	Black Bass	28.6	0.23	4	0.17	0.15	0.25
Meldahl	436.2	Carp	60.4	3	5	5.1	13.76	16.45
Meldahl	436.2	Channel Catfish	63.7	3.2	5	15	6.57	9.24
Meldahl	436.2	White Bass	24.6	0.19	5	0.46	0.64	1.04
Markland #4	455	Channel Catfish	60.2	2.2	5	8.6	5.55	8.40
Cannelton	720.7	Carp	57.4	2.6	5	7	2.80	5.67
Cannelton	720.7	Hybrid White Bass	36.1	0.52	5	0.46	1.05	1.64
Cannelton	720.7	White Crappie	22.2	0.16	5	0.08	0.20	0.40

Table 3. ORSANCO 1995 FISH TISSUE SAMPLES

LOCATION	RIVER MILE	SPECIES	LENGTH AVG. cm	WEIGHT AVG. kg	# FISH	LIPID %	2,3,7,8, TCDD ppt	TEQ (NATO) ppt
Uniontown	846	Carp	60.6	3.1	5	2.8	2.19	4.15
Uniontown	846	Channel Catfish	59.4	2.4	4	8.5	4.27	6.74
Uniontown	846	Drum	39	0.82	5	8	0.20	0.48
Uniontown	846	White Crappie	18.9	0.095	5	0.17	0.16	0.34
Uniontown	846	Hybrid White Bass	34.9	0.62	3	2.3	0.78	1.34
Smithland	918.5	Carp	60.5	2.69	3	1.9	1.96	3.95
Smithland	918.5	Channel Catfish	65.2	3.9	5	6.5	2.91	4.67
Smithland	918.5	Hybrid White Bass	31	0.37	2	2.1	0.33	0.58
Smithland	918.5	Sauger	33.7	0.32	3	0.61	0.40	0.71
Smithland	918.5	White Bass	23	0.17	5	0.62	0.28	0.55

Legend
Location - Name of navigation pool, lock & dam, or water body if other than the Ohio River
River Mile - Miles downstream of Pittsburgh, PA, or above the confluence with the Ohio River
Length/Weight Avg. - Average length (total) or weight (pre-fillet) of fish in the composite
Fish - Number of fish in a composite sample, 2 fillets (left and right) processed per fish
Analytes - All data expressed as wet weight
TEQ - Relates cumulative toxicity of the 17 toxic dibenzodioxin and dibenzofuran congeners to a 2,3,7,8 TCDD concentratio
Non-detects = 0

A work plan was developed, as part of ORSANCO's Watershed Pollutant Reduction Program, to address some of these data needs. One objective of the work plan is to conduct a basin-wide screening for dioxin in fish tissue from the Ohio River and its major tributaries. Thirty-three sites throughout the Basin have been selected for sampling. A second objective is to conduct intensive dioxin sampling along the Kanawha River and the Ohio River near Apple Grove, West Virginia. High volume water sampling, ambient air sampling, and suspended solids data will be used to support a mass balance accounting of dioxin in the geographically targeted region. The collection of these data (fish tissue, water, and air) will be extremely valuable in providing the necessary information to better characterize the geographic extent and severity of dioxin contamination in the Ohio River Valley.

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APPENDIX A

Summary of Dioxin Sediment Data for the Ohio River Basin

SUMMARY OF DIOXIN SEDIMENT DATA FOR THE OHIO RIVER BASIN

STREAM	MILEPOINT	SIDE	DATE	2,3,7,8 TCDD, PPT	LOCATION	SOURCE
ARMOUR CREEK	0.6	RDB	04/86	ND		(3)
ARMOUR CREEK	0.6	RDB	04/86	81		(3)
ARMOUR CREEK	0.4	LDB	04/86	ND		(3)
ARMOUR CREEK	0.3	LDB	04/86	47		(3)
ARMOUR CREEK	0.2	RDB	04/86	260		(3)
ARMOUR CREEK	0.2	RDB	04/86	136		(3)
ARMOUR CREEK	0.2	LDB	04/86	ND		(3)
ARMOUR CREEK	0.2	LDB	09/93	18		(2)
ARMOUR CREEK	0.1	LDB	04/86	91		(3)
ARMOUR CREEK	0.1	LDB	04/86	1889		(3)
BIG SANDY	1		06/96	4.59 TEQ	CATLETTSBURG, KY	(10)
COAL RIVER	1.0	LDB	04/86	ND		(3)
COAL RIVER	0.9		09/93	<1.4		(2)
COAL RIVER	0.4	RDB	04/86	43		(3)
ELK RIVER	2.2		09/93	<0.1		(2)
ELK RIVER	0.3	RDB	04/86	ND		(3)
GOETTGE RUN			12/91	4.1 TEQ	DOVER, OH	(7)
HEBBLE CREEK	1.65		1992	75.93 TEQ	DAYTON, OH	(9)
HUDSON RUN	4.03		1993	5.52 TEQ	BARBERTON, OH	(8)
HUDSON RUN	3.7		1993	0.66 TEQ	BARBERTON, OH	(8)
HUDSON RUN	2.0		1993	6.73 TEQ	BARBERTON, OH	(8)
HUDSON RUN	1.4		1993	4.52 TEQ	BARBERTON, OH	(8)
HUDSON RUN	0.35		1993	4.52 TEQ	BARBERTON, OH	(8)
HUDSON RUN	0.05		1993	19.62 TEQ	BARBERTON, OH	(8)
HUDSON RUN RESERV.	0.40		1993	152.39 TEQ	BARBERTON, OH	(8)
HUDSON RUN RESERV.	0.45		1993	0.97 TEQ	BARBERTON, OH	(8)
HUDSON RUN RESERV.	0.45		1993	3028.04 TEQ	BARBERTON, OH	(8)
KANAWHA RIVER	90.7	LDB	09/93	0.49	BELOW NORFOLK TRESTLE	(2)
KANAWHA RIVER	88.3	LDB	09/93	1980	ABOVE WHEELER ISLANDS	(2)
KANAWHA RIVER	83.5	RDB	09/93	<0.3	ABOVE LONDON L & D	(2)
KANAWHA RIVER	79.4	RDB	09/93	<1	BELOW OLD LOCK 3	(2)
KANAWHA RIVER	74.2	RDB	09/93	1.5	ABOVE CHELYAN BRIDGE	(2)
KANAWHA RIVER	73.8		10/91	1000	CHELYAN, WV	(2)
KANAWHA RIVER	73.8		10/91	<840	CHELYAN, WV	(2)
KANAWHA RIVER	68.8	LDB	09/93	<6.2	BELOW LENS CREEK	(2)
KANAWHA RIVER	68.4	RDB	09/93	0.68	BELOW DUPONT	(2)
KANAWHA RIVER	67.5		06/93	<110	MARMET LOCKS & DAM	(2)
KANAWHA RIVER	67.5		06/93	<110	MARMET LOCKS & DAM	(2)
KANAWHA RIVER	67.4		10/87	<1	BELOW MARMET L & D	(2)
KANAWHA RIVER	59.8	LDB	04/86	ND		(3)
KANAWHA RIVER	59	LDB	04/86	ND		(3)
KANAWHA RIVER	56.3	LDB	04/86	ND		(3)
KANAWHA RIVER	56.1	RDB	04/86	ND		(3)
KANAWHA RIVER	54.8	RDB	09/93	<3.1	BELOW BLAINES ISLAND	(2)
KANAWHA RIVER	53.4		09/93	2.9	WILSONS ISLAND	(2)
KANAWHA RIVER	53.3	LDB	09/93	1.6	AT MOUTH OF DAVIS CR	(2)
KANAWHA RIVER	53	LDB	04/86	ND		(3)
KANAWHA RIVER	52.9	RDB	04/86	ND		(3)
KANAWHA RIVER	51.5		10/87	<1		(2)
KANAWHA RIVER	48	RDB	04/86	ND		(3)
KANAWHA RIVER	48	RDB	04/86	ND		(3)
KANAWHA RIVER	47.5	LDB	04/86	ND		(3)
KANAWHA RIVER	44.3	RDB	04/86	ND		(3)
KANAWHA RIVER	44.3	LDB	04/86	ND		(3)
KANAWHA RIVER	43.4	RDB	09/93	<0.1	BY WATER PLANT INTAKE	(2)
KANAWHA RIVER	42.1	RDB	09/93	69.3	BELOW MONSANTO	(2)
KANAWHA RIVER	41.8	LDB	04/86	36		(3)
KANAWHA RIVER	41.8	LDB	04/86	40		(3)

SUMMARY OF DIOXIN SEDIMENT DATA FOR THE OHIO RIVER BASIN

STREAM	MILEPOINT	SIDE	DATE	2,3,7,8 TCDD, PPT	LOCATION	SOURCE
KANAWHA RIVER	41.6	RDB	04/86	100		(3)
KANAWHA RIVER	40.9		10/91	85.3	AT ARMOUR CREEK	(2)
KANAWHA RIVER	40.4	RDB	04/86	26		(3)
KANAWHA RIVER	40.4	LDB	04/86	17		(3)
KANAWHA RIVER	39.2		10/87	2		(2)
KANAWHA RIVER	38.4	LDB	04/86	ND		(3)
KANAWHA RIVER	38.4	RDB	04/86	ND		(3)
KANAWHA RIVER	38.4	RDB	04/86	ND		(3)
KANAWHA RIVER	36		10/87	<1	NEAR GUANO CREEK	(2)
KANAWHA RIVER	35.5	RDB	09/93	<0.09	BELOW GUANO CREEK	(2)
KANAWHA RIVER	33.9	LDB	04/86	14		(3)
KANAWHA RIVER	32.3	LDB	04/86	ND		(3)
KANAWHA RIVER	32.3	RDB	04/86	21		(3)
KANAWHA RIVER	32.3	LDB	09/93	8.3	ABOVE WINFIELD BRIDGE	(2)
KANAWHA RIVER	32.1	RDB	04/86	20		(3)
KANAWHA RIVER	32		12/87	10	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	10	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	2	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	<0.1	WINFIELD	(2)
KANAWHA RIVER	32		12/87	0.3	WINFIELD	(2)
KANAWHA RIVER	31.5	LDB	04/86	ND		(3)
KANAWHA RIVER	31.1			<0.1	WINFIELD LOCK & DAM	(4)
KANAWHA RIVER	31.1			<0.1 DUP	WINFIELD LOCK & DAM	(4)
KANAWHA RIVER	31.1			0.1 (ESTIMATED)	WINFIELD LOCK & DAM	(4)
KANAWHA RIVER	31.1			ND	WINFIELD LOCK & DAM	(4)
KANAWHA RIVER	31.1			ND	WINFIELD LOCK & DAM	(4)
KANAWHA RIVER	31.1			2.4	WINFIELD LOCK & DAM	(4)
KANAWHA RIVER	31.1			ND	WINFIELD LOCK & DAM	(4)
KANAWHA RIVER	31.1		1992	13 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	9.3 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	16 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	110 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	18 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	15 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	1.4 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	0.20 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	ND	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	6.3 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	12 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	8.3 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	3.4 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	0.30 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	480 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	22 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	4.2 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	0.20 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		1992	610 TEQ	WINFIELD LOCK & DAM	(6)
KANAWHA RIVER	31.1		6/93	18.4	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	18.9 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	1.9	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	19.3	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	23.8 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	20.6	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	23.1 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND (CONF.)	WINFIELD LOCK & DAM	(1)

SUMMARY OF DIOXIN SEDIMENT DATA FOR THE OHIO RIVER BASIN

STREAM	MILEPOINT	SIDE	DATE	2,3,7,8 TCDD, PPT	LOCATION	SOURCE
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	5.5 (ESTIMATED)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	4.5 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	8.1	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	9.1 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	0.85	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	0.62 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	0.52	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	0.73 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	0.43	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	21.1	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	21.3 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	19.5	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	19.6 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	31.8	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	38.6 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	16.0 (DUP)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	18.7 (CONF. DUP)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	49.8	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	51.4 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	51.7	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	56.3 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	6.4	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	6.7 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	2.5 (ESTIMATED)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	3.3 (CONF.)	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	31.1		6/93	ND	WINFIELD LOCK & DAM	(1)
KANAWHA RIVER	30.8		10/87	5	NEAR L. HURRICANE CR	(2)
KANAWHA RIVER	28.9		10/87	3	NEAR HURRICANE CR	(2)
KANAWHA RIVER	28.2		10/87	16	NEAR BUFFALO CR	(2)
KANAWHA RIVER	16.7	RDB	09/93	<0.3	ABOVE UNION CARBIDE	(2)
KANAWHA RIVER	9.5	LDB	09/93	12.9		(2)
KANAWHA RIVER	4.4	LDB	04/86	28		(3)
KANAWHA RIVER	4.4	RDB	04/86	26		(3)
KANAWHA RIVER	2.8	RDB	09/93	<0.8	NEAR THREEMILE CR	(2)
KANAWHA RIVER	0.1	RDB	09/93	27.6	POINT PLEASANT	(2)
KANAWHA RIVER	0.1		10/87	28	POINT PLEASANT	(2)
MAD RIVER	1.67		1992	17.98 TEQ	DAYTON, OH	(9)
MAD RIVER	6.13		1992	5.60 TEQ	DAYTON, OH	(9)
MAD RIVER	7.41		1992	2.91 TEQ	DAYTON, OH	(9)
MAD RIVER	7.75		1992	9.53 TEQ	DAYTON, OH	(9)
MAD RIVER	8.18		1992	9.44 TEQ	DAYTON, OH	(9)
MAD RIVER	8.18		1992	17.63 TEQ	DAYTON, OH	(9)
MAD RIVER	8.62		1992	11.81 TEQ	DAYTON, OH	(9)
MAD RIVER	11.44		1992	8.73 TEQ	DAYTON, OH	(9)
MUD RIVER				ND	HOLDER CORP, ONA, WV	(5)
MUD RIVER				ND	HOLDER CORP, ONA, WV	(5)
MUD RIVER				ND	HOLDER CORP, ONA, WV	(5)
MUD RIVER				ND	HOLDER CORP, ONA, WV	(5)
MUD RIVER				ND	HOLDER CORP, ONA, WV	(5)
OHIO RIVER	264.6	RDB	09/93	<2.2	ABOVE CONRAIL TRESTLE	(2)
OHIO RIVER	265.7	LDB	09/93	13.5	AT KANAWHA RIVER	(2)
OHIO RIVER	279.2		06/96	9.19 TEQ	GALLIPOLIS LOCK & DAM	(10)
OHIO RIVER	279.2		06/96	9.12 TEQ (DUP)	GALLIPOLIS LOCK & DAM	(10)
OHIO RIVER	279.2		12/87	4	GALLIPOLIS	(2)
OHIO RIVER	279.2		12/87	<0.1	GALLIPOLIS	(2)
OHIO RIVER	279.2		12/87	10	GALLIPOLIS	(2)
OHIO RIVER	279.2		12/87	<0.4	GALLIPOLIS	(2)

SUMMARY OF DIOXIN SEDIMENT DATA FOR THE OHIO RIVER BASIN

STREAM	MILEPOINT	SIDE	DATE	2,3,7,8 TCDD, PPT	LOCATION	SOURCE
OHIO RIVER	279.2		12/87	<0.4	GALLIPOLIS	(2)
OHIO RIVER	280.7		12/87	2		(2)
OHIO RIVER	341		06/96	71.57 TEQ	GREENUP LOCK & DAM	(10)
POCATALICO RIVER	1.7	RDB	04/86	ND		(3)
POCATALICO RIVER	1.7	RDB	04/86	ND		(3)
POCATALICO RIVER	1.6	LDB	04/86	ND		(3)
POCATALICO RIVER	1.6	LDB	04/86	80		(3)
POCATALICO RIVER	1.4	RDB	04/86	ND	MOUTH OF MANILA CR	(3)
POCATALICO RIVER	1.4	RDB	04/86	ND	MOUTH OF MANILA CR	(3)
POCATALICO RIVER	1.4	LDB	04/86	ND	MOUTH OF MANILA CR	(3)
POCATALICO RIVER	1.4	LDB	04/86	ND	MOUTH OF MANILA CR	(3)
POCATALICO RIVER	0.3	LDB	04/86	3044		(3)
POCATALICO RIVER	0.3	LDB	04/86	2516		(3)
POCATALICO RIVER	0.3	LDB	09/93	<1.8		(2)
POCATALICO RIVER	0.2	RDB	04/86	ND		(3)
POCATALICO RIVER	0.2	RDB	04/86	ND		(3)
POCATALICO RIVER	0.0		10/87	<1		(2)
POCATALICO RIVER	0.0		10/87	<1		(2)
SUGAR CREEK			12/91	109.7 TEQ	DOVER, OH	(7)
SUGAR CREEK			12/91	288.0 TEQ	DOVER, OH	(7)
SUGAR CREEK			12/91	145.3 TEQ	DOVER, OH	(7)
SUGAR CREEK			12/91	83.5 TEQ	DOVER, OH	(7)
TUSCARAWAS RIVER	94.84		1993	79.84 TEQ	STARK CO., OH	(8)
TUSCARAWAS RIVER	104.30		1993	63.94 TEQ	CLINTON, OH	(8)
TUSCARAWAS RIVER	106.0		1993	20.56 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	107.4		1993	103.77 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	107.97		1993	129.91 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	108.4		1993	6.46 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	109.1		1993	95.04 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	109.47		1993	142.40 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	110.2		1993	7.52 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	111.6		1993	32.08 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	112.1		1993	181.58 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	119.28		1993	7.87 TEQ	BARBERTON, OH	(8)
TUSCARAWAS RIVER	119.4		1993	0.95 TEQ	BARBERTON, OH	(8)
WOLF CREEK	0.1		1993	3.81 TEQ	BARBERTON, OH	(8)
WOLF CREEK	0.27		1993	6.36 TEQ	BARBERTON, OH	(8)
WOLF CREEK	0.7		1993	290.03 TEQ	BARBERTON, OH	(8)
WOLF CREEK	2.0		1993	2.58 TEQ	BARBERTON, OH	(8)

*RDB = RIGHT DESCENDING BANK; LDB = LEFT DESCENDING BANK; ND = NOT DETECTED; DUP = DUPLICATE
CONF = CONFIRMATION SAMPLE; TEQ = 2,3,7,8 TCDD TOXICITY EQUIVALENT

(1) WV DEP 2,3,7,8 TCDD DATA SUMMARY & ANALYSIS: OHIO & KANAWHA RIVERS: APPENDIX 16 (DAMES & MOORE)
(2) SAMPLES COLLECTED BY US CORPS OF ENGINEERS
(3) CONCENTRATIONS OF 2,3,7,8 TCDD IN SEDIMENTS IN THE KANAWHA RIVER, WV AND PROPOSAL FOR FURTHER SEDIMENT SAMPLING (US EPA REGION III)
(4) WV DEP 2,3,7,8 TCDD DATA SUMMARY & ANALYSIS: OHIO & KANAWHA RIVERS: APPENDIX 18 (LAW ENVIRONMENTAL)
(5) NATIONAL DIOXIN STUDY (US EPA, 1987)
(6) WV DEP 2,3,7,8 TCDD DATA SUMMARY & ANALYSIS: OHIO & KANAWHA RIVERS: APPENDIX 16 (LAW ENVIRONMENTAL)
(7) DOVER CHEMICAL CORPORATION REMEDIAL INVESTIGATION REPORT (WESTON / OHIO EPA, 1994)
(8) BIOLOGICAL, SEDIMENT AND WATER QUALITY STUDY OF THE TUSCARAWAS RIVER, WOLF CREEK AND HUDSON RUN (OHIO EPA, 1994)
(9) BIOLOGICAL, SEDIMENT, AND WATER QUALITY STUDY OF THE LOWER MAD RIVER AND HEBBLE CREEK (OH EPA, 1994)
(10) SEDIMENT SAMPLES COLLECTED BY THE OHIO RIVER VALLEY WATER SANITATION COMMISSION (1996)

Updated 10/96

APPENDIX B

Summary of Dioxin Surface Water Data for the Ohio & Kanawha Rivers

SUMMARY OF DIOXIN SURFACE WATER DATA FOR THE OHIO & KANAWHA RIVERS

STREAM	MILE POINT	2,3,7,8 TCDD ppq	DETECTION LIMIT ppq	DATE	LOCATION	SOURCE
KANAWHA RIVER	33.6	ND	4.1	07/94	WINFIELD	(2)
KANAWHA RIVER	33.6	ND	7.8	07/94	WINFIELD	(2)
KANAWHA RIVER	33.6	ND	5.7	07/94	WINFIELD	(2)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	7.3		06/93	WINFIELD	(1)
KANAWHA RIVER	31	2.4 ESTIMATED		06/93	WINFIELD	(1)
KANAWHA RIVER	31	1.9		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	1.4 ESTIMATED		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	31	ND		06/93	WINFIELD	(1)
KANAWHA RIVER	28.4	ND	9.8	07/94	WINFIELD	(2)
KANAWHA RIVER	28.4	ND	4.3	07/94	WINFIELD	(2)
KANAWHA RIVER	28.4	ND	4.6	07/94	WINFIELD	(2)
KANAWHA RIVER	28.4	ND	8.2	07/94	WINFIELD	(2)
OHIO RIVER	282	ND	6	11/94	APPLE GROVE, WV	(3)
SUGAR CREEK		17.7 TEQ		12/91	DOVER, OH	(4)
SUGAR CREEK		16.0 TEQ		12/91	DOVER, OH	(4)
SUGAR CREEK		171.4 TEQ		12/91	DOVER, OH	(4)
SUGAR CREEK		1.1 TEQ		12/91	DOVER, OH	(4)

* PPQ = PARTS PER QUADRILLION; ND = NOT DETECTED; TEQ = 2,3,7,8 TCDD TOXICITY EQUIVALENT

(1) WV DEP 2,3,7,8 TCDD DATA SUMMARY & ANALYSIS: OHIO AND KANAWHA RIVERS: APPENDIX 18 (1995)
DATA COLLECTED BY DAMES & MOORE FOR THE U.S. ARMY CORPS OF ENGINEERS
(2) WV DEP 2,3,7,8 TCDD DATA SUMMARY & ANALYSIS: OHIO AND KANAWHA RIVERS: APPENDIX 18 (1995)
DATA COLLECTED BY THE U.S. ARMY CORPS OF ENGINEERS
(3) WV DEP 2,3,7,8 TCDD DATA SUMMARY & ANALYSIS: OHIO AND KANAWHA RIVERS: APPENDIX 15 (1995)
DATA COLLECTED BY WEST VIRGINIA DEP
(4) DOVER CHEMICAL CORPORATION REMEDIAL INVESTIGATION REPORT (WESTON / OHIO EPA, 1994)

Updated 10/96

APPENDIX C

Summary of Dioxin Fish Tissue Data for the Ohio River Basin

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
ALLEGHENY R.	19.0			ND	BOTTOM FEEDER	WHOLE	FRANKLIN, PA	(4)
ALLEGHENY R.	19.0			1.7	BOTTOM FEEDER	WHOLE	NEW KENSINGTON, PA	(4)
ALLEGHENY R.	19.0			ND	PREDATOR	WHOLE	NEW KENSINGTON, PA	(4)
ARMOUR CREEK		04/86		2	BLUEGILL	FILLET	KANAWHA R. BACKWATERS, W	(8)
ARMOUR CREEK		04/86		36	CHANNEL CAT	FILLET	KANAWHA R. BACKWATERS, W	(8)
ARMOUR CREEK		04/86		45	CHANNEL CAT	FILLET	KANAWHA R. BACKWATERS, W	(8)
ARMOUR CREEK		04/86		2	LARGEMOUTH BASS	FILLET	KANAWHA R. BACKWATERS, W	(8)
ARMOUR CREEK		04/86		3	LARGEMOUTH BASS	FILLET	KANAWHA R. BACKWATERS, W	(8)
ARMOUR CREEK		07/90		20.4	CHANNEL CAT	FILLET	BACKWATERS, WV	(6)
ARMOUR CREEK		07/90		2.3	LARGEMOUTH BASS	FILLET	BACKWATERS, WV	(6)
ARMOUR CREEK		10/93	1.7	1.7		FILLET	BACKWATERS, WV	(3)
ARMOUR CREEK		10/93	63.3	62.6		FILLET	BACKWATERS, WV	(3)
BIG SANDY RIVER				ND	BOTTOM FEEDER	WHOLE	LOUISA, KY	(4)
BIG SANDY RIVER		10/87	7.62 TEQ	4.38	CARP	WHOLE	CATTLETSBURG, KY	(7)
		10/87	0.68 TEQ	0.67	SAUGER	FILLET	CATTLETSBURG, KY	(7)
BIG SANDY RIVER		07/89	22.80 TEQ	21.55	STRIPED BASS	FILLET	CATTLETSBURG, KY	(7)
BIG SANDY RIVER		07/89	1.97 TEQ	1.90	CARPSUCKER	WHOLE	CATTLETSBURG, KY	(7)
BIG SANDY RIVER		07/89	4.47 TEQ	3.22	CARP	WHOLE	CATTLETSBURG, KY	(7)
BIG SANDY RIVER		07/89	3.64 TEQ (DUP)	2.26	CARP	WHOLE	CATTLETSBURG, KY	(7)
BIG SANDY RIVER	2.1	07/90		17			CATLETTSBURG, KY	(6)
BIG SANDY RIVER	2.1	07/90		0.72			CATLETTSBURG, KY	(6)
BIG SANDY RIVER		07/90		0.8			FORT GAY	(6)
BIG SANDY RIVER		8/90		1.30				(6)
BIG SANDY RIVER		8/90		<1.60				(6)
BIG SANDY RIVER		8/90		<0.20				(6)
BIG SANDY RIVER		8/90		<0.36				(6)
BIG SANDY RIVER		8/90		<0.06				(6)
BIG SANDY RIVER		8/90		<0.30				(6)
BIG SANDY RIVER		8/90		1.4				(6)
BIG SANDY RIVER		8/90		<0.50				(6)
BIG SANDY RIVER		8/90		<0.70				(6)
BIG SANDY RIVER		8/90		<1.10				(6)
BIG SANDY RIVER		8/90		<0.28				(6)
BIG SANDY RIVER		8/90		<0.30				(6)
BIG SANDY RIVER				2.2				(6)
BIG SANDY RIVER	1	09/95	0.25 TEQ	0.15	BLACK BASS	FILLET	CATTLETSBURG, KY	(9)
BIG SANDY RIVER	1	09/95	1.41 TEQ	0.82	SMALLMOUTH BUFFAL	FILLET	CATTLETSBURG, KY	(9)
BIG SANDY RIVER	1	09/95	3.07 TEQ	2.1	CHANNEL CAT	FILLET	CATTLETSBURG, KY	(9)
CLARION RIVER		09/87	10.4 TEQ	5.79	WHITE SUCKER	WHOLE	RIDGWAY, PA	(7)
CLARION RIVER		09/87	4.36 TEQ	3.55	BROWN TROUT	FILLET	RIDGWAY, PA	(7)
CLARION RIVER		10/89		ND	BROWN TROUT	FILLET	JOHNSONBURG, PA	(13)
CLARION RIVER		10/89		ND	WHITE SUCKER	WHOLE	JOHNSONBURG, PA	(13)

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
CLARION RIVER		10/89		0.42	PUMPKINSEED	FILLET	JOHNSONBURG, PA	(13)
CLARION RIVER		10/89		3.0	CARP	WHOLE	JOHNSONBURG, PA	(13)
CLARION RIVER		10/89		0.53	SMALLMOUTH BASS	FILLET	JOHNSONBURG, PA	(13)
CLARION RIVER		10/89		1.0	WHITE SUCKER	WHOLE	JOHNSONBURG, PA	(13)
GREAT MIAMI R		10/84	13.44 TEQ	4.2	CARP	WHOLE	FRANKLIN, OH	(7)
GREAT MIAMI R				4.8	BOTTOM FEEDER	WHOLE	FRANKLIN, OH	(4)
GREAT MIAMI R				1.8	PREDATOR	WHOLE	FRANKLIN, OH	(4)
GREAT MIAMI R		10/84	3.33 TEQ	2.23	CARP	WHOLE	NEW BALTIMORE, OH	(7)
GREAT MIAMI R		10/84	6.00 TEQ	1.75	SMALLMOUTH BASS	WHOLE	NEW BALTIMORE, OH	(7)
GREAT MIAMI R				ND	BOTTOM FEEDER	WHOLE	NEW BALTIMORE, OH	(4)
GREAT MIAMI R				1.2	PREDATOR	WHOLE	NEW BALTIMORE, OH	(4)
GREAT MIAMI R				3.7	BOTTOM FEEDER	WHOLE	HAMILTON, OH	(4)
GREAT MIAMI R				ND	BOTTOM FEEDER	FILLET	HAMILTON, OH	(4)
GREEN RIVER				ND	BOTTOM FEEDER	WHOLE	BEECH GROVE, KY	(4)
GUYANDOTTE R				ND	BOTTOM FEEDER	FILLET	SALT ROCK, WV	(4)
GUYANDOTTE R				ND	PREDATOR	FILLET	SALT ROCK, WV	(4)
GUYANDOTTE R				ND	BOTTOM FEEDER	WHOLE	SALT ROCK, WV	(4)
GUYANDOTTE R				ND	PREDATOR	WHOLE	SALT ROCK, WV	(4)
HAMILTON CANAL		10/84	11.65 TEQ	3.96	CARP	WHOLE	HAMILTON, OH	(7)
HAMILTON CANAL		10/84	5.42	2.10	QUILLBACK	WHOLE	HAMILTON, OH	(7)
HAMILTON CANAL		10/84	5.13 TEQ (DUP)	1.73	QUILLBACK	WHOLE	HAMILTON, OH	(7)
HAMILTON CANAL		10/84	4.21 TEQ	1.64	CARP	FILLET	HAMILTON, OH	(7)
KANAWHA RIVER				ND	PREDATOR	WHOLE	GAULEY BRIDGE, WV	(4)
KANAWHA RIVER	87.8	10/93	0.56	0.56		FILLET	WHEELER ISLAND, WV	(3)
KANAWHA RIVER	82.8	10/86		< 0.89		WHOLE	LONDON LOCKS & DAM, WV	(6)
KANAWHA RIVER	82.8	10/86		< 1.00		WHOLE	LONDON LOCKS & DAM, WV	(6)
KANAWHA RIVER	67.7	05/86		<1.0			MARMET TAILWATERS, WV	(6)
KANAWHA RIVER	67.7	06/86		< 1.00			MARMET TAILWATERS, WV	(6)
KANAWHA RIVER	67.7	06/86		36.3			MARMET TAILWATERS, WV	(6)
KANAWHA RIVER	67.7	06/86	ND		CHANNEL CATFISH	WHOLE	MARMET TAILWATERS, WV	(1)
KANAWHA RIVER	67.7	06/86	26.48		CHANNEL CATFISH	WHOLE	MARMET TAILWATERS, WV	(1)
KANAWHA RIVER	67.7	08/86		<.599			MARMET TAILWATERS, WV	(6)
KANAWHA RIVER	67.5	08/90		7.3	CHANNEL CAT	FILLET	BELOW MARMET LOCKS, WV	(6)
KANAWHA RIVER	67.5	10/93	1.5	1.5		FILLET	BELOW MARMET LOCKS, WV	(3)
KANAWHA RIVER	49.5	04/86		0	CHANNEL CAT	FILLET	INSTITUTE, WV	(8)
KANAWHA RIVER	49.5	04/86		5	CHANNEL CAT	FILLET	INSTITUTE, WV	(8)
KANAWHA RIVER	49.5	04/86		2	SPOTTED BASS	FILLET	INSTITUTE, WV	(8)
KANAWHA RIVER	49.5	04/86		1	SPOTTED BASS	FILLET	INSTITUTE, WV	(8)
KANAWHA RIVER	46.1	04/86		5	CHANNEL CAT	FILLET	ST. ALBANS, WV	(8)
KANAWHA RIVER	46.1	04/86		2	CHANNEL CAT	FILLET	ST. ALBANS, WV	(8)

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
KANAWHA RIVER	46.1	04/86		4	LARGEMOUTH BASS	FILLET	ST. ALBANS, WV	(8)
KANAWHA RIVER	46.1	04/86		3	SPOTTED BASS	FILLET	ST. ALBANS, WV	(8)
KANAWHA RIVER	46	10/93	4.8	4.8		FILLET	NITRO-ST. ALBANS BRIDGE, WV	(3)
KANAWHA RIVER	46	10/93	2.0	2.0		FILLET	NITRO-ST. ALBANS BRIDGE, WV	(3)
KANAWHA RIVER	44	09/84	31.0		SMALLMOUTH BASS	WHOLE	NITRO, WV	(1)
KANAWHA RIVER	44	09/84	51		SPOTTED BASS	WHOLE	NITRO, WV	(1)
KANAWHA RIVER	44	09/84	13		LARGEMOUTH BASS	FILLET	NITRO, WV	(1)
KANAWHA RIVER	44	09/84	33		SMALLMOUTH BASS	FILLET	NITRO, WV	(1)
KANAWHA RIVER	44	09/84	22		SMALLMOUTH BASS	FILLET	NITRO, WV	(1)
KANAWHA RIVER	44	11/84	10.51 TEQ	10.40	BASS	FILLET	NITRO, WV	(7)
KANAWHA RIVER	44	11/84	ND	ND	BLACK BUFFALO	WHOLE	NITRO, WV	(7)
KANAWHA RIVER	44	04/86		21	CHANNEL CAT	FILLET	NITRO, WV	(8)
KANAWHA RIVER	44	04/86		17	CHANNEL CAT	FILLET	NITRO, WV	(8)
KANAWHA RIVER	44	04/86		3	LARGEMOUTH BASS	FILLET	NITRO, WV	(8)
KANAWHA RIVER	44	04/86		12	SPOTTED BASS	FILLET	NITRO, WV	(8)
KANAWHA RIVER	44	07/90		49.7	CHANNEL CAT	FILLET	NITRO, WV	(6)
KANAWHA RIVER	42.8	10/93	18.4	18.4		FILLET	NITRO ABOVE ARMOUR CR, WV	(3)
KANAWHA RIVER	42.8	10/93	4.4	4.4		FILLET	NITRO ABOVE ARMOUR CR, WV	(3)
KANAWHA RIVER	41.8	09/85	6.9		CHANNEL CATFISH	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	38.1		CHANNEL CATFISH	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	7.1		FRESHWATER DRUM	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	9.5		FRESHWATER DRUM	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	2.1		LARGEMOUTH BASS	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	4.6		LARGEMOUTH BASS	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	3.3		LARGEMOUTH BASS	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	3.3		LARGEMOUTH BASS	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	3.3		LARGEMOUTH BASS	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	6.0		SAUGER	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	6.4		SAUGER	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	19.8		SMALLMOUTH BUFFALO	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	56.0		SMALLMOUTH BUFFALO	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	37.9		SMALLMOUTH BUFFALO	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	37.9		SMALLMOUTH BUFFALO	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	37.9		SMALLMOUTH BUFFALO	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	41.8	09/85	13		SPOTTED BASS	FILLET	NITRO I-64 BRIDGE, WV	(1)
KANAWHA RIVER	36	04/86		10	CHANNEL CAT	FILLET	PLYMOUTH, WV	(8)
KANAWHA RIVER	36	04/86		35	CHANNEL CAT	FILLET	PLYMOUTH, WV	(8)
KANAWHA RIVER	36	04/86		4	LARGEMOUTH BASS	FILLET	PLYMOUTH, WV	(8)
KANAWHA RIVER	36	04/86		4	LARGEMOUTH BASS	FILLET	PLYMOUTH, WV	(8)
KANAWHA RIVER	31.1	09/79		47	FRESHWATER DRUM	WHOLE	WINFIELD LOCKS & DAM, WV	(8)
KANAWHA RIVER	31.1	10/86		3.86	WHITE BASS	FILLET	WINFIELD LOCKS & DAM, WV	(6)
KANAWHA RIVER	31.1	10/86		31.62	CHANNEL CAT	FILLET	WINFIELD LOCKS & DAM, WV	(6)
KANAWHA RIVER	31	09/74		63	BLACK CRAPPIE	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/74		130	BLACK CRAPPIE	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/74		33	BROWN BULLHEAD	WHOLE	WINFIELD TAILWATERS, WV	(8)

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
KANAWHA RIVER	31	09/76		37	BLACK CRAPPIE	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/76		172	BROWN BULLHEAD	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/78		ND	CHANNEL CAT	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/78		81	CHANNEL CAT	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/78		ND	SAUGER	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/80		ND	CHANNEL CAT	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/80		78	CHANNEL CAT	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/80		22	SAUGER	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/84		78	CHANNEL CAT	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/84		18	CRAPPIE	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/84		17	HYBRID WHITE BASS	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/84		19	HYBRID WHITE BASS	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	09/84		56	SAUGER	WHOLE	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER		05/86		8	CHANNEL CAT	FILLET	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	05/86		15	CHANNEL CAT	FILLET	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	05/86		5	SMALLMOUTH BASS	FILLET	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	05/86		8	SMALLMOUTH BASS	FILLET	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	05/86		16	WHITE BASS	FILLET	WINFIELD TAILWATERS, WV	(8)
KANAWHA RIVER	31	05/86		ND	CRAPPIE	FILLET	WINFIELD TAILWATERS, WV	(1)
KANAWHA RIVER	31	05/86		ND	SAUGER	FILLET	WINFIELD TAILWATERS, WV	(1)
KANAWHA RIVER	31	10/87	61.07 TEQ	56.34	CHANNEL CAT	WHOLE	NEAR WINFIELD, WV	(7)
KANAWHA RIVER	31	10/87	48.97 TEQ	47.1	CHANNEL CAT	WHOLE	NEAR WINFIELD, WV	(7)
KANAWHA RIVER	31	10/87	8.27 TEQ	7.20	WHITE BASS	FILLET	NEAR WINFIELD, WV	(7)
KANAWHA RIVER	31	10/87	6.84 TEQ	6.22	WHITE BASS	FILLET	NEAR WINFIELD, WV	(7)
KANAWHA RIVER	31	07/90		<1.4	FRESHWATER DRUM	FILLET	WINFIELD TAILWATERS, WV	(6)
KANAWHA RIVER	31	07/90		4.2	HYBRID STRIPED BASS	FILLET	WINFIELD TAILWATERS, WV	(6)
KANAWHA RIVER	31	07/90		25.8	CHANNEL CAT	FILLET	WINFIELD TAILWATERS, WV	(6)
KANAWHA RIVER	31	10/93	22.7	20.9		FILLET	WINFIELD TAILWATERS, WV	(3)
KANAWHA RIVER	31	10/93	5.5	5.5		FILLET	WINFIELD TAILWATERS, WV	(3)
KANAWHA RIVER	(3-3.5)	03/95	35.8 TEQ	35.8	CHANNEL CATFISH	FILLET		(5)
KANAWHA RIVER	(3-3.5)	03/95	28.5 TEQ	28.5	CHANNEL CATFISH	FILLET		(5)
KANAWHA RIVER	(3-3.5)	03/95	23.10 TEQ	23.1	CHANNEL CATFISH	FILLET		(5)
KANAWHA RIVER	0.1	10/93	5.6	5.6		FILLET	HENDERSON, WV	(3)
KANAWHA RIVER	0.1	10/93	1.1	1.0		FILLET	HENDERSON, WV	(3)
KANAWHA RIVER		08/86	ND		SPOTTED BASS	WHOLE	NEAR PAINT CREEK, WV	(1)
KENTUCKY RIVER				0.8	BOTTOM FEEDER	FILLET	GEST, KY	(4)
KENTUCKY RIVER				ND	PREDATOR	FILLET	GEST, KY	(4)
KENTUCKY RIVER				ND	BOTTOM FEEDER	WHOLE	GEST, KY	(4)
KENTUCKY RIVER				ND	PREDATOR	WHOLE	GEST, KY	(4)
LICKING RIVER				ND	BOTTOM FEEDER	WHOLE	CAVE RUN LAKE, KY	(4)
LITTLE BEAVER CR				ND	PREDATOR	WHOLE	DAMASCUS, OH	(4)

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
LITTLE KANAWHA				ND	BOTTOM FEEDER	WHOLE	PALESTINE, WV	(4)
LITTLE MIAMI R.				1.2	BOTTOM FEEDER	WHOLE	MILFORD, OH	(4)
MEADOW RUN	0.8	10/95	19.3486 TEQ	8.8	YELLOW BULLHEAD	WHOLE	WELLSTON, OH	(12)
MEADOW RUN	0.8	10/95	15.0486 TEQ	7.2	BLACK BULLHEAD	WHOLE	WELLSTON, OH	(12)
MEADOW RUN	1.6	10/95	17.5337 TEQ	8.4	BLACK BULLHEAD	WHOLE	WELLSTON, OH	(12)
MEADOW RUN	1.6	10/95	20.9996 TEQ	10.0	YELLOW BULLHEAD	WHOLE	WELLSTON, OH	(12)
MISSISSNEWA R.				1	BOTTOM FEEDER	WHOLE	MATHEWS, IN	(4)
MISSISSNEWA R.				ND	BOTTOM FEEDER	FILLET	MATHEWS, IN	(4)
MISSISSNEWA R.				2	PREDATOR	WHOLE	MATHEWS, IN	(4)
MISSISSNEWA R.				ND	PREDATOR	FILLET	MATHEWS, IN	(4)
MONONGAHELA R	20.5	08/84	1.57 TEQ	ND	CARP	WHOLE	CLAIRTON, PA	(7)
MUD RIVER				(0.5 - 2.9)			ONA, WV	(4)
MUSKINGUM R.				ND	BOTTOM FEEDER	WHOLE	ZANESVILLE, OH	(4)
OHIO RIVER	31.7	09/95	6.70 TEQ	1.78	CARP	FILLET	MONTGOMERY LOCK & DAM	(9)
OHIO RIVER	31.7	09/95	4.51 TEQ	1.81	CHANNEL CAT	FILLET	MONTGOMERY LOCK & DAM	(9)
OHIO RIVER	31.7	09/95	1.75 TEQ	0.32	WHITE BASS	FILLET	MONTGOMERY LOCK & DAM	(9)
OHIO RIVER	40.2			0.9	BOTTOM FEEDER	WHOLE	EAST LIVERPOOL	(4)
OHIO RIVER	40.2			1.08	PREDATOR	WHOLE	EAST LIVERPOOL	(4)
OHIO RIVER	84.2			ND	BOTTOM FEEDER	FILLET	PIKE ISLAND LOCK & DAM	(4)
OHIO RIVER	84.2			ND	PREDATOR	FILLET	PIKE ISLAND LOCK & DAM	(4)
OHIO RIVER	84.2			1.2	BOTTOM FEEDER	WHOLE	PIKE ISLAND LOCK & DAM	(4)
OHIO RIVER	84.2			1.2	PREDATOR	WHOLE	PIKE ISLAND LOCK & DAM	(4)
OHIO RIVER	84.2	09/95	6.48 TEQ	1.68	CARP	FILLET	PIKE ISLAND LOCK & DAM	(9)
OHIO RIVER	84.2	09/95	6.35 TEQ	1.86	CHANNEL CAT	FILLET	PIKE ISLAND LOCK & DAM	(9)
OHIO RIVER	86.0	09/87	1.51 TEQ	ND	REDHORSE SUCKER	WHOLE	WHEELING	(7)
OHIO RIVER	86.0	09/87	0.22 TEQ	ND	SMALLMOUTH BASS	FILLET	WHEELING	(7)
OHIO RIVER	128.0	09/87	0.98 TEQ	ND	REDHORSE SUCKER	WHOLE	NEW MARTINSVILLE	(7)
OHIO RIVER	128.0	09/87	0.10 TEQ	ND	SMALLMOUTH BASS	FILLET	NEW MARTINSVILLE	(7)
OHIO RIVER	161.7	07/90		2.8	CHANNEL CAT	WHOLE	WILLOW ISLAND TAILWATERS	(6)
OHIO RIVER	161.7	09/95	12.40 TEQ	4.30	CARP	FILLET	WILLOW ISLAND TAILWATERS	(9)
OHIO RIVER	161.7	09/95	6.99 TEQ	5.40	CHANNEL CAT	FILLET	WILLOW ISLAND TAILWATERS	(9)
OHIO RIVER	161.7	09/95	1.33 TEQ	0.30	WHITE BASS	FILLET	WILLOW ISLAND TAILWATERS	(9)
OHIO RIVER	161.7	09/95	0.13 TEQ	0.03	BLUEGILL	FILLET	WILLOW ISLAND TAILWATERS	(9)
OHIO RIVER	171.9			3.6	BOTTOM FEEDER	WHOLE	MARIETTA	(4)
OHIO RIVER	171.9			0.97	PREDATOR	WHOLE	MARIETTA	(4)
OHIO RIVER	237.5	09/95	8.90 TEQ	3.73	CHANNEL CAT	FILLET	RACINE LOCK & DAM	(9)
OHIO RIVER	237.5	07/90		4.4	CHANNEL CAT	FILLET	RACINE TAILWATERS	(6)
OHIO RIVER	(258.0 - 259.2)	03/95	7.82 TEQ	4.65	CHANNEL CATFISH	FILLET		(5)

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
OHIO RIVER	279.2			4	PREDATOR	WHOLE	GALLIPOLIS	(4)
OHIO RIVER	279.2	09/86		< 0.34		WHOLE	GALLIPOLIS LOCK AND DAM	(6)
OHIO RIVER	279.2	09/86		< 0.40		WHOLE	GALLIPOLIS LOCK AND DAM	(6)
OHIO RIVER	279.2	09/86		21.92	CHANNEL CAT	WHOLE	GALLIPOLIS LOCK AND DAM	(6)
OHIO RIVER	279.2	09/95	14.10 TEQ	11.3	CARP	FILLET	GALLIPOLIS LOCK AND DAM	(9)
OHIO RIVER	279.2	09/95	10.25 TEQ	8.22	CHANNEL CAT	FILLET	GALLIPOLIS LOCK AND DAM	(9)
OHIO RIVER	279.4	07/90		3.8	CHANNEL CAT	FILLET	GALLIPOLIS TAILWATERS	(6)
OHIO RIVER	279.4	07/90		2.7	HYBRID STRIPED BASS	FILLET	GALLIPOLIS TAILWATERS	(6)
OHIO RIVER	280.7	06/90		14.2	CHANNEL CATFISH	WHOLE	APPLE GROVE	(2)
OHIO RIVER	284.6 - 289.6)	03/95	29.9 TEQ	26.4	CHANNEL CATFISH	FILLET		(5)
OHIO RIVER	284.6 - 289.6)	03/95	18.75 TEQ	15.9	CHANNEL CATFISH	FILLET		(5)
OHIO RIVER	284.6 - 289.6)	03/95	8.67 TEQ	8.67	CHANNEL CATFISH	FILLET		(5)
OHIO RIVER	310	07/90		9.2	CHANNEL CAT	FILLET	HUNTINGTON	(6)
OHIO RIVER	317	06/90		4.38	CARP	WHOLE	AT BIG SANDY RIVER	(2)
OHIO RIVER	341	09/95	3.21 TEQ	1.83	CARP	FILLET	GREENUP LOCK & DAM	(9)
OHIO RIVER	341	09/95	10.70 TEQ	7.5	CHANNEL CAT	FILLET	GREENUP LOCK & DAM	(9)
OHIO RIVER	341	09/95	10.20 TEQ	7.37	CHANNEL CAT	FILLET	GREENUP LOCK & DAM	(9)
OHIO RIVER	341	09/95	7.04 TEQ	4.72	CHANNEL CAT	FILLET	GREENUP LOCK & DAM	(9)
OHIO RIVER	341	09/95	2.98 TEQ	1.86	CARP	FILLET	GREENUP LOCK & DAM	(9)
OHIO RIVER	341	09/95	.94 TEQ	0.42	SMALLMOUTH BUFFAL(	FILLET	GREENUP LOCK & DAM	(9)
OHIO RIVER	341	09/95	0.48 TEQ	0.31	CRAPPIE	FILLET	GREENUP LOCK & DAM	(9)
OHIO RIVER	359.3			2	BOTTOM FEEDER	WHOLE	PORTSMOUTH	(4)
OHIO RIVER	359.3			3.1	PREDATOR	WHOLE	PORTSMOUTH	(4)
OHIO RIVER	436.2	09/95	16.45 TEQ	13.76	CARP	FILLET	MELDAHL LOCK & DAM	(9)
OHIO RIVER	436.2	09/95	9.24 TEQ	6.57	CHANNEL CAT	FILLET	MELDAHL LOCK & DAM	(9)
OHIO RIVER	436.2	09/95	1.04 TEQ	0.64	WHITE BASS	FILLET	MELDAHL LOCK & DAM	(9)
OHIO RIVER	455	09/95	8.40 TEQ	5.55	CARP	FILLET	ROSS, KY	(9)
OHIO RIVER	531.5	07/84	8.57 TEQ	4.42	CARPSUCKER	WHOLE	MARKLAND DAM	(7)
OHIO RIVER	531.5	04/85	3.21 TEQ	2.14	LARGEMOUTH BASS	FILLET	MARKLAND DAM	(7)
OHIO RIVER	531.5			6.4	BOTTOM FEEDER	FILLET	MARKLAND DAM	(4)
OHIO RIVER	531.5			ND	PREDATOR	FILLET	MARKLAND DAM	(4)
OHIO RIVER	531.5			13	BOTTOM FEEDER	WHOLE	MARKLAND DAM	(4)
OHIO RIVER	531.5			4.2	PREDATOR	WHOLE	MARKLAND DAM	(4)
OHIO RIVER	625.9	08/84	6.32 TEQ	4.23	CARP	WHOLE	WESTPOINT	(7)
OHIO RIVER	625.9	10/87	11.56 TEQ	4.38	CARP	WHOLE	WESTPOINT	(7)
OHIO RIVER	625.9	10/87	ND	ND	LARGEMOUTH BASS	FILLET	WESTPOINT	(7)
OHIO RIVER	625.9			5.2	BOTTOM FEEDER	WHOLE	WESTPOINT	(4)
OHIO RIVER	625.9			2.1	PREDATOR	WHOLE	WESTPOINT	(4)
OHIO RIVER	720.7			3.9	BOTTOM FEEDER	WHOLE	CANNELTON DAM	(4)
OHIO RIVER	720.7			4.1	PREDATOR	WHOLE	CANNELTON DAM	(4)
OHIO RIVER	720.7			ND	BOTTOM FEEDER	FILLET	CANNELTON DAM	(4)
OHIO RIVER	720.7			ND	PREDATOR	FILLET	CANNELTON DAM	(4)
OHIO RIVER	720.7	09/95	5.70 TEQ	2.8	CARP	FILLET	CANNELTON DAM	(9)
OHIO RIVER	720.7	09/95	1.64 TEQ	1.05	HYBRID WHITE BASS	FILLET	CANNELTON DAM	(9)
OHIO RIVER	720.7	09/95	0.40 TEQ	0.2	WHUTE CRAPPIE	FILLET	CANNELTON DAM	(9)

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
OHIO RIVER	846			3.4	BOTTOM FEEDER	WHOLE	UNIONTOWN	(4)
OHIO RIVER	846			ND	PREDATOR	WHOLE	UNIONTOWN	(4)
OHIO RIVER	846	09/95	4.15 TEQ	2.19	CARP	FILLET	UNIONTOWN	(9)
OHIO RIVER	846	09/95	6.74 TEQ	4.27	CHANNEL CAT	FILLET	UNIONTOWN	(9)
OHIO RIVER	846	09/95	0.48 TEQ	0.20	DRUM	FILLET	UNIONTOWN	(9)
OHIO RIVER	846	09/95	0.34 TEQ	0.16	WHITE CRAPPIE	FILLET	UNIONTOWN	(9)
OHIO RIVER	846	09/95	1.34 TEQ	0.78	HYBRID WHITE BASS	FILLET	UNIONTOWN	(9)
OHIO RIVER	918.5	09/95	3.95 TEQ	1.96	CARP	FILLET	SMITHLAND LOCK & DAM	(9)
OHIO RIVER	918.5	09/95	4.67 TEQ	2.91	CHANNEL CAT	FILLET	SMITHLAND LOCK & DAM	(9)
OHIO RIVER	918.5	09/95	0.58 TEQ	0.33	HYBRID WHITE BASS	FILLET	SMITHLAND LOCK & DAM	(9)
OHIO RIVER	918.5	09/95	0.71 TEQ	0.40	SAUGER	FILLET	SMITHLAND LOCK & DAM	(9)
OHIO RIVER	918.5	09/95	0.55 TEQ	0.28	WHITE BASS	FILLET	SMITHLAND LOCK & DAM	(9)
POCATALICO R.	2.0	10/93	14.4	13.6		FILLET	POCA, WV	(3)
POCATALICO R.	2.0	10/93	4.6	4.6		FILLET	POCA, WV	(3)
POCATALICO R.	1.4	04/86		6	CHANNEL CAT	FILLET	AT HEIZER CREEK, WV	(8)
POCATALICO R.	1.4	04/86		18	CHANNEL CAT	FILLET	AT HEIZER CREEK, WV	(8)
POCATALICO R.	1.4	04/86		9	LARGEMOUTH BASS	FILLET	AT HEIZER CREEK, WV	(8)
POCATALICO R.	1.4	04/86		5	LARGEMOUTH BASS	FILLET	AT HEIZER CREEK, WV	(8)
POCATALICO R.	1.4	07/90		10.3	CHANNEL CATFISH	FILLET	AT HEIZER CREEK, WV	(6)
POCATALICO R.	1.4	07/90		9.2	LARGEMOUTH BASS	FILLET	AT HEIZER CREEK, WV	(6)
SCIOTO RIVER		09/85	14.34 TEQ	8.58	CARP	WHOLE	CHILICOTHE, OH	(7)
SCIOTO RIVER		09/85	20.31 TEQ	14.75	CHANNEL CAT	WHOLE	CHILICOTHE, OH	(7)
SCIOTO RIVER				3.2	BOTTOM FEEDER	WHOLE	CIRCLEVILLE, OH	(4)
SCIOTO RIVER				2.7	PREDATOR	WHOLE	CIRCLEVILLE, OH	(4)
SUGAR CREEK	0.6	1994	2.066 TEQ	0.85	SMALLMOUTH BASS	FILLET	DOVER, OH	(10)
SUGAR CREEK	0.6	1994	8.737 TEQ	2.7	CARP	FILLET	DOVER, OH	(10)
SUGAR CREEK	3.7	1994	0.192 TEQ	ND	SMALLMOUTH BASS	FILLET	DOVER, OH	(10)
SUGAR CREEK	3.7	1994	0.177 TEQ	ND	CARP	FILLET	DOVER, OH	(10)
SUGAR CREEK		12/91	0.6184 TEQ	0.28	ROCK BASS	WHOLE	DOVER, OH	(11)
SUGAR CREEK		12/91	6.4116 TEQ	1.1	N. HOGSUCKER	WHOLE	DOVER, OH	(11)
SUGAR CREEK		12/91	32.3531 TEQ	11.8	N. HOGSUCKER	WHOLE	DOVER, OH	(11)
SUGAR CREEK		12/91	1.6429 TEQ	0.8	LARGEMOUTH BASS	WHOLE	DOVER, OH	(11)
SUGAR CREEK		12/91	5.0889 TEQ	2.2	LARGEMOUTH BASS	WHOLE	DOVER, OH	(11)
SUGAR CREEK		12/91	11.4927 TEQ	ND	N. HOGSUCKER	WHOLE	DOVER, OH	(11)
SUGAR CREEK		12/91	15.0620 TEQ (DUP)	6.1	N. HOGSUCKER	WHOLE	DOVER, OH	(11)
TENNESSEE R.				ND	BOTTOM FEEDER	WHOLE	KENTUCKY LAKE, KY	(4)
TUSCARAWAS R.	55.0	1994	2.636 TEQ	0.71	CARP	FILLET	NEW PHILADELPHIA, OH	(10)
TUSCARAWAS R.	55.0	1994	0.323 TEQ	0.11	SMALLMOUTH BASS	FILLET	NEW PHILADELPHIA, OH	(10)
TUSCARAWAS R.	55.0	1994	1.631 TEQ	0.59	CHANNEL CATFISH	FILLET	NEW PHILADELPHIA, OH	(10)
TUSCARAWAS R.	57.8	1994	2.824 TEQ	0.92	CARP	FILLET	DOVER, OH	(10)

SUMMARY OF DIOXIN FISH TISSUE DATA FOR THE OHIO RIVER BASIN

STREAM	MILE POINT	DATE	TOTAL DIOXIN, PPT	2,3,7,8 TCDD, PPT	SPECIES	SAMPLE TYPE	SAMPLE SITE	SOURCE
TUSCARAWAS R.	57.8	1994	2.576 TEQ	0.95	FLATHEAD CATFISH	FILLET	DOVER, OH	(10)
TUSCARAWAS R.	58.5	1994	1.882 TEQ	0.43	CARP	FILLET	DOVER, OH	(10)
TUSCARAWAS R.	58.5	1994	0.37 TEQ	ND	SMALLMOUTH BASS	FILLET	DOVER, OH	(10)
WABASH RIVER		10/84	2.14 TEQ	1.76	CARP	WHOLE	NEW HARMONY, IN	(7)
WABASH RIVER				2	BOTTOM FEEDER	WHOLE	NEW HARMONY, IN	(4)
WABASH RIVER				ND	BOTTOM FEEDER	FILLET	NEW HARMONY, IN	(4)
WABASH RIVER				ND	PREDATOR	WHOLE	NEW HARMONY, IN	(4)
WABASH RIVER				ND	PREDATOR	FILLET	NEW HARMONY, IN	(4)
WABASH RIVER				ND	BOTTOM FEEDER	WHOLE	DARWINS FERRY, IN	(4)
WABASH RIVER				1.4	BOTTOM FEEDER	WHOLE	BLACKROCK, IN	(4)
WABASH RIVER				ND	BOTTOM FEEDER	FILLET	BLACKROCK, IN	(4)
WHITE RIVER		10/84	1.36 TEQ	ND	CARP	WHOLE	PETERSBURG, IN	(7)

TEQ = 2,3,7,8 TCDD TOXICITY EQUIVALENT; ND = NOT DETECTED; DUP = DUPLICATE SAMPLE ANALYSIS

(1) WV DEP 2,3,7,8 TCDD DATA SUMMARY & ANALYSIS: OHIO & KANAWHA RIVERS: APPENDIX 16
(2) CONCENTRATIONS OF DIOXIN, ORGANOCHLORIDES, AND TRACE ELEMENTS IN FRESHWATER MUSSELS AND FISH FROM THE OHIO RIVER AT APPLE GROVE, WV (USFWS, 1993)
(3) DATA COLLECTED BY THE WEST VIRGINIA DEPARTMENT OF NATURAL RESOURCES (1993)
(4) THE NATIONAL DIOXIN STUDY: TIERS 3,5,6, AND 7 (US EPA, 1987)
(5) OHIO/KANAWHA RIVER DIOXIN ANALYSIS (US EPA REGION III, 1995)
(6) DATA COLLECTED BY THE U.S. ARMY CORPS OF ENGINEERS
(7) NATIONAL STUDY OF CHEMICAL RESIDUES IN FISH, (US EPA 1992)
(8) DIOXIN CONTAMINATION IN 1986 FISH TISSUE SAMPLES FROM THE KANAWHA RIVER, ARMOUR CREEK, AND THE POCATALICO RIVER, WV (US EPA & WV DNR, 1986)
(9) DATA COLLECTED BY THE OHIO RIVER VALLEY WATER SANITATION COMMISSION (1995)
(10) FISH TISSUE STUDY OF THE TUSCARAWAS RIVER AND SUGAR CREEK (OHIO EPA, 1995)
(11) DOVER CHEMICAL CORPORATION REMEDIAL INVESTIGATION REPORT (WESTON / OHIO EPA, 1994)
(12) DATA COLLECTED BY OHIO EPA (1995)
(13) RESULTS OF 1989 FISH TISSUE AND EFFLUENT SAMPLING (PENNTECH PAPERS, INC. / EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC., 1990)

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