

Final
Total Maximum Daily Load
Allegheny River, Allegheny County
PCBs

Lock and Dam 3 to mouth
March 1, 1999
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Introduction

Pennsylvania has conducted monitoring of fish tissue contaminants since 1976. Early efforts were comprised of special studies in major water bodies as well as smaller waters with suspected sources of contaminants. Routine sampling for tissue contaminants began in 1979 with implementation of the EPA "CORE" monitoring network that mandated collection of whole fish samples. Because Pennsylvania wanted the fish tissue monitoring program to focus on protection of public health, we began sampling both the edible portion and whole body at one-half of the stations. In 1987, Pennsylvania began sampling the edible portion almost exclusively. In order to increase spatial coverage, we also began rotating sampling through our routine ambient monitoring network and provided both Department of Environmental Protection (DEP) and Fish and Boat Commission field biologists the opportunity to sample suspected problem areas.

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Fishing is a wholesome, relaxing pastime, and fish are nutritious and good to eat. Some fish, however, may accumulate contaminants to levels that may be harmful to those who eat them over a long period of time. In an attempt to protect public health, the Commonwealth periodically (at least annually) issues fish consumption advisories based on monitoring data from a number of sources. Advisories are issued jointly by the Department of Health, the Fish and Boat Commission, and DEP. The list of advisories is published in the "Pennsylvania Summary of Fishing Regulations and Laws" which is provided to each fishing license buyer, and is also available from the Department in hard copy and through the Internet. In addition, the annual list and any individual advisories needed between lists are issued using press releases.

A number of Pennsylvania waterbodies with fish consumption advisories were listed on the Clean Water Act Section 303(d) List of Impaired Waters for 1996. They were listed because long-term, unrestricted consumption of these fish could potentially lead to human health problems. This document addresses contamination of fish tissue in the Allegheny River, Allegheny County, by PCB and chlordane.

Background

This Total Maximum Daily Load (TMDL) applies to the main stem of the Allegheny River (Stream Code 42122) from Lock and Dam 3 (River Mile 14.5) to the mouth (River Mile 0.0). This segment was included on the 1996 Section 303(d) list in State Water Plan Watershed 18-A as a low priority. It was also included on the 1998 303(d) list (Segment ID 9915) as a high priority for TMDL development.

"Do Not Eat" advice was first issued for this segment as part of a statewide release June 26, 1986 as the result of finding 1.3 ppm chlordane in carp and 2.63 ppm PCB in channel catfish. This advice was reissued a number of times based, in large part, on data collected in cooperation with the Ohio River Valley Water Sanitation Commission (ORSANCO). This advice remained in place until the 1998 advisory, when the Great Lakes protocol was applied. Carp and channel catfish remained "Do Not Eat" for consistency with the advice for the main stem Ohio River and with that issued by other states. In addition, smallmouth and spotted bass were added in the one meal per week category (Group 2).

TMDL Development

Endpoint Identification

The overall goal of a TMDL is to achieve the "fishable/swimmable" goal of the federal Clean Water Act. Because consumption advisories are in place for smallmouth bass, spotted bass and channel catfish due to PCB, and carp for both PCB and chlordane, these goals are not being met in this segment of the Allegheny River.

The specific goal of a TMDL is to outline a plan to achieve water quality standards in the water body. For this segment of the Allegheny River, the TMDL goal is for levels of PCB and chlordane in the water column to be equal to or less than the Commonwealth's water quality criteria. The criteria, found in the "Water Quality Toxics Management Strategy – Statement of Policy" (Chapter 16 of the Department's rules and regulations) are 0.00004 µg/L (micrograms per liter, equivalent to parts per billion) for PCB and 0.0005 µg/L for chlordane. Both of these compounds are probable human carcinogens, and these are human health criteria developed to protect against excess cancer risk. Specifically, the Department's water quality toxics management program controls carcinogens to an overall risk management level of one excess case of cancer in a population of 1 million (1 x 10⁶). Expressing this another way, the probability of an individual getting cancer is increased by a factor of 1 in 1 million.

Two means were employed in an effort to obtain readily available data on stream PCB and chlordane levels for comparison to the criteria. First, the

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Department's Southwest Field Office was asked to search for PCB or chlordane data in or upstream from the Allegheny River fish consumption advisory segment. That search failed to produce any instream data. Second, data from the EPA Storage and Retrieval System (STORET) was obtained. An "Inventory" retrieval that would include data collected by all agencies using STORET was run for an area with a five-mile radius around the Department's fish tissue sampling station. That location is Water Quality Network (WQN) Station 801 – Allegheny River at the Hulton Road bridge at Oakmont. Three sampling stations with PCB and chlordane data were found, but the samples were collected between 1974 and 1982. This data does not represent current conditions.

As a means to compare current conditions to the water quality criteria, estimated water column concentrations were calculated based on the fish tissue concentrations and bioconcentration factors. The calculation involves dividing the average fish tissue concentration by the bioconcentration factor to obtain a projected water column concentration. The equation is:

$$\frac{TC}{BCF} = WC \times 1000$$

TC = Tissue Concentration in mg/kg (equivalent to mg/L)

BCF = EPA Bioconcentration Factor in L/kg

WC = Water Column Concentration (estimated) in mg/L

Multiply by 1000 to obtain µg/L

The average fish tissue concentration is the mean of all samples. The average concentration is used for two main reasons. First, the fish tissue samples are composites. This means that the sample result represents the average tissue concentration in three to five individuals, and not an exact value. Second, use of an average value considers the natural variation in tissue burden found in wild fish populations. The PCB Bioconcentration Factor (BCF) of 31,200 from the EPA criteria development document (EPA 440/5-80-068, October 1980) was used. The chlordane BCF of 14,100 from the EPA criteria development document (EPA 440/5-80-027, October 1980) was also applied. These BCFs were used because no Bioaccumulation Factors (BAFs) are available for statewide use. The use of the BCFs is consistent with the provisions of the Department's water quality toxics management strategy. An estimated water column concentration was calculated for each species. These were then averaged in order to provide a single estimated concentration for the segment.

The average PCB level in carp from this Allegheny River segment is 1.32 ppm; channel catfish average 0.812 ppm; and the bass species average 0.145 ppm. The estimated concentration of PCB in the water column is 0.02433 µg/L. The average chlordane concentration in carp is 0.30 ppm. The corresponding estimated water column concentration is 0.02128 µg/L. These estimated concentrations exceed the applicable water quality criteria. These values most likely do not represent the actual existing instream concentrations due to the basis for the back-calculation. The back-calculations from tissue level to water column concentration were performed using data on species for which consumption advisories have been issued, i.e., fish with elevated tissue levels of these compounds. It must also be noted that the average tissue concentrations may be artificially elevated because of the use of one-half of the detection limit for data reported as less than detection. The actual concentration could lie anywhere between zero and the detection limit. The use of one-half of the detection limit is merely a means of obtaining a reasonable value to use in calculating the average. While the actual concentrations in the water column are not known, they are likely to be lower than the calculated estimates.

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Source Assessment

The production and use of PCB in the United States was banned in July of 1979. While it is now illegal to manufacture, distribute, or use PCB in the United States, these synthetic oils were used in the past as insulating fluids in electrical transformers and other products, as cutting oils, and in carbonless paper. PCB was introduced into the environment while use was unrestricted, and occasional releases still occur. In addition, some permitted discharges and Superfund sites contribute PCB to surface water. Once in a waterbody, PCB becomes associated with solids particles and enters the sediments. PCB is very resistant to breakdown and thus remains in river and lake sediments for many years.

Chlordane is a man-made organochlorine compound that was widely used as a broad-spectrum agricultural pesticide before its use was restricted to termite control around building foundations. All uses of chlordane have been banned since April 1988. Chlordane may be introduced to surface waters through contaminated ground water or surface runoff, i.e., it is a nonpoint source contaminant. Once in a waterbody, chlordane becomes associated with solids particles and enters the sediments. Fish are exposed to and accumulate PCB and chlordane from the water, through contact with or ingestion of sediments, and in the food they eat.

Two methods were employed in order to locate known sources of PCB or chlordane to this segment of the Allegheny River. First, the Southwest Field Office was asked to provide information on known existing or historical sources that might contribute PCB or chlordane in or upstream from the fish consumption advisory reach. For any known sources, they were requested to provide the name and location as well as flow rate and the long-term discharge concentration (to help establish load). Second, the EPA Permit Compliance System (PCS) database was searched for any major discharge permits containing PCB or chlordane as an effluent limitation. While no major dischargers for either compound were found on PCS, the Southwest Field Office provided information on a known point source discharge of PCB to a tributary to this segment of the Allegheny River. There is an NPDES permitted discharge of treated groundwater from the Texas Eastern Transmission Corporation's Delmont Compressor Station site to Beaver Run (Stream Code 42391). The discharge is upstream from the Beaver Run Reservoir.

TMDL Calculation

Development of TMDLs includes consideration of background pollutant contribution, appropriate and/or critical stream flow, and seasonal variation. The natural instream background concentration of both PCB and chlordane are assumed to be zero because they are man-made compounds and there are no natural sources.

PCB and chlordane are probable human carcinogens. Carcinogenesis is a nonthreshold effect, an adverse impact that may occur at any exposure greater than zero. Such an effect is often related to long-term exposure to low levels of a particular chemical or compound, rather than an immediate effect due to a short duration exposure to a high level. As noted earlier, the Department's water quality toxics management program uses a cancer risk level of 1×10^{-6} to protect human health. Attainment of this risk level is predicated on exposure that includes drinking 2 liters of water and ingesting 6.5 grams of fish per day over a 70-year lifetime. The Department uses harmonic mean flow as the appropriate design condition for dealing with exposure to carcinogens. This is a long-term flow condition that will, when applied to the Total Maximum Daily Load, represent long-term average exposure. Because seasonal increases and decreases in concentration are less important than the long-term exposure to a carcinogen, use of harmonic mean flow adequately considers seasonal variations in PCB and chlordane concentrations.

The calculation of the Allegheny River TMDLs uses the water quality criteria and flow data from the U.S. Geological Survey surface water discharge station

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just upstream from Lock and Dam 4 at Natrona, PA (03049500). The harmonic mean flow was calculated using the low flow yield method found in the Department's "Implementation Guidance - Design Stream Flows" (Document No. 391-2000-023, p 4). This method requires that the harmonic mean flow (Q_{hm}) from the USGS gage used be divided by the gage drainage area to arrive at a UnitQ_{hm} that is multiplied by the drainage area of the segment to produce a Segment Q_{hm} in cubic feet per second (cfs). The Segment Q_{hm} for the Allegheny River is 10,542.55 cfs.

The Segment Q_{hm} is used in calculating the Total Daily Maximum Load (TMDL) by multiplying it by the water quality criterion and a multiplier to convert from cfs x µg/L to lbs/day (pounds per day). The PCB TMDL is calculated as follows:

$$10,542.55 \text{ cfs} \times 0.00004 \text{ } \mu\text{g/l} = 0.421702 \text{ cfs} \times \mu\text{g/l} \times 0.00539 = 0.0022730 \text{ lbs/day.}$$

The chlordane TMDL is calculated as follows:

$$10,542.55 \text{ cfs} \times 0.0005 \text{ } \mu\text{g/l} = 5.271275 \text{ cfs} \times \mu\text{g/l} \times 0.00539 = 0.0284122 \text{ lbs/day.}$$

The Total Maximum Daily Load of PCB for this segment of the Allegheny River is 0.0022730 pounds per day. The chlordane TMDL is 0.0284122 pounds per day.

Percent Reduction

The goal of this TMDL is to achieve the water quality criteria in order to protect public health. In order to achieve this, the stream concentration must be reduced from the estimated current levels to the criteria. Percent reduction is calculated using the following formula:

$$\% \text{ Reduction} = (1 - \text{TMDL Goal} / \text{Existing Concentration}) \times 100$$

The percent reduction for PCB is calculated as follows:

$$\begin{aligned} \% \text{ Reduction} &= (1 - 0.00004 / 0.02433) \times 100 \\ \% \text{ Reduction} &= (1 - 0.0016) \times 100 = 99.8\% \end{aligned}$$

Percent reduction for chlordane is:

$$\begin{aligned} \% \text{ Reduction} &= (1 - 0.0005 / 0.02128) \times 100 \\ \% \text{ Reduction} &= (1 - 0.0235) \times 100 = 97.6\% \end{aligned}$$

Overall reductions of 99.8% for PCB and 97.6% for chlordane are needed to achieve the TMDL goal.

Margin of Safety (MOS)

Achievement of the TMDLs will generally ensure achievement of the water quality criteria. To account for uncertainties that may be associated with the

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TMDL calculations, the Department proposes to hold 10% of the TMDLs in reserve. Applying this 10% margin of safety results in a PCB TMDL of 0.0020457 pounds per day and a chlordane TMDL of 0.025571 pounds per day for allocation to all sources.

Wasteload Allocations (WLAs) and Load Allocations (LAs)

No data is available on PCB or chlordane concentrations in this segment of the Allegheny River. For this reason, and because these are man-made compounds, natural and background concentrations are assumed to be zero.

A Wasteload Allocation (WLA) is the portion of the load contributed by point source discharges. Recent Discharge Monitoring Report (DMR) data from the Texas Eastern Delmont site show an average flow of 0.0056247 cubic feet per second (cfs). Discharge concentration was set to the PCB effluent limitation of 1 µg/l to be conservative. The DMRs reviewed list actual discharge concentrations of less than 0.5 µg/L. The Texas Eastern WLA is calculated as follows:

$$0.005625 \text{ cfs} \times 1.0 \text{ } \mu\text{g/L} = 0.005625 \text{ cfs} \times \mu\text{g/L} \times 0.00539 = 0.0000303 \text{ lbs/day}$$

The remainder of the PCB load is assumed to be contributed by nonpoint sources and may be introduced to surface water through contaminated ground water or surface runoff. The remaining PCB load in the Allegheny River is assigned to the Load Allocation (LA), that portion of the load contributed by nonpoint sources. The Source Assessment notes that once in a water body, PCB becomes associated with soil particles and enters the sediments. Fish tissue contamination results from this sediment load. Because of this, the remaining PCB load of 0.0020154 pounds per day is assigned to a Load Allocation for the instream sediment.

Because there are no known sources of or chlordane to this Allegheny River Segment, it is treated as a nonpoint source contaminant that may be introduced to surface water through contaminated ground water or surface runoff. As a result, the entire TMDL for chlordane is assigned to the Load Allocation (LA), that portion of the load contributed by nonpoint sources. Chlordane also becomes associated with soil particles and enters the sediments once in a water body. Fish tissue contamination results from this sediment load. Because of this, the entire TMDL for chlordane in this reach of the Allegheny River is assigned to a Load Allocation for the instream sediment.

TMDL Summary

The TMDLs for the Allegheny River from Lock and Dam 3 (RM 14.5) to the mouth (RM 0.0) can be summarized as follows:

TMDL Summary				
Pollutant	TMDL	WLA	LA	MOS
PCB	0.0022730 lbs/day	0.0000303 lbs/day	0.0020154 lbs/day	0.0002273 lbs/day
Chlordane	0.0284122 lbs/day	0	0.025571 lbs/day	0.0028412 lbs/day

TMDL Verification

The stated goal of this TMDL is to meet the PCB and chlordane water quality criteria for the protection of public health in this reach of the Allegheny River. Another way to state the goal is to reach a point where fish consumption advisories are no longer needed because tissue levels of PCB and chlordane are no longer above the levels of concern.

The three agencies involved with the issuance of fish consumption advisories in Pennsylvania currently apply the "Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory" (commonly referred to as the Great Lakes protocol) for issuance of consumption advisories due to PCB. Following this method, meal-specific consumption advice is issued by species. The first level of consumption advice, eat no more than one meal per week, is issued when the tissue PCB concentration is 0.06 to 0.20 mg/kg. The upper limit for unrestricted consumption is 0.05 mg/kg. In order to verify the protectiveness of the PCB TMDL, the estimated fish tissue concentration that would be expected to accumulate at a water column concentration of 0.00004 µg/L was calculated. Reaching the PCB criterion would result in an estimated tissue concentration of 0.001 mg/kg, well below the 0.05 mg/kg level for unrestricted consumption.

Pennsylvania currently uses the U.S. Food and Drug Administration (FDA) Action Level of 0.3 mg/kg for issuance of advisories due to chlordane contamination. Achievement of the chlordane water quality criterion would result in an estimated fish tissue concentration of 0.007 mg/kg, much lower than the Action Level. The consumption advisory could be lifted at that level.

Even though a WLA was developed for the Texas Eastern Delmont Compressor Station site, its impact on fish tissue contamination in the Allegheny River is unknown. This small volume discharge is upstream from an impoundment, the Beaver Run Reservoir. The reservoir may act as a pollutant sink, i.e., PCB may be retained in the impoundment and not reach the river. A 1998 sample of largemouth bass, a predator, from the Beaver Run Reservoir showed PCB concentrations of less than 0.051 µg/L in the edible portion. The bass sampled ranged from 14.6 to 19.4 inches in length and from 1 pound 7 ounces to 2 pounds 4 ounces in weight.

TMDL Implementation

The Texas Eastern Delmont site will continue to be evaluated for compliance with its PCB effluent limitations. This will be accomplished through review of self-monitoring data (DMRs) and periodic Department inspections.

PCB and chlordane present in the main stem of the Allegheny River are believed to reside primarily in the sediment due to historical use. Generally, the levels of PCB and chlordane are expected to decline over time due to the bans on use through natural attenuation. Examples of processes in natural attenuation are covering of contaminated sediments with newer, less contaminated materials, and flushing of sediments during periods of high stream flow. Natural attenuation may be the best implementation method because it involves less habitat disturbance/destruction than active removal of contaminated sediments. Mechanical or vacuum dredging removes the habitat needed by certain benthic macroinvertebrates. In addition, some of these organisms will be killed during the dredging process. Suspension of sediments during dredging may also cause abrasive damage to the gills and/or sensory organs of benthic macroinvertebrates or the gills of fish. Suspended sediments can also affect the prey gathering ability of sight-feeding fish. In addition, active removal may cause resuspension of contaminated materials thus making PCB and chlordane available for additional uptake. This alternative is, of course, also the least costly option.

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Monitoring

Pennsylvania will continue to monitor PCB and chlordane in bass, carp, and channel catfish tissue in this reach of the Allegheny River. Samples will be collected once every five years. The data will be used to evaluate the possible threat to public health and to determine progress toward meeting the TMDL. The consumption advisories will remain in place until the water quality criteria are achieved and advisories are no longer needed.