Total Maximum Daily Load (TMDL)
For Creve Coeur Lake
Pollutant: Chlordane

August 3, 2001

Name: Creve Coeur Lake

Location: Near St. Louis in St. Louis County, Missouri

Hydrologic Unit Code (HUC): 10300200-130004

Water Body # (WBID): 7255

Missouri Lake Class[1]: L3

Beneficial Uses[2]:
- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life and Human Health associated with Fish Consumption
- Boating and Canoeing

Size of Impaired Segment: 300 acres

Location of Impaired Segment: Wholly contained in Section 20, T46N, R5E

Pollutant: Chlordane

Pollutant Source: Urban nonpoint runoff

TMDL Priority Ranking: Low

1. Background and Water Quality Problems

Creve Coeur Lake is a natural oxbow lake formed by the Missouri River shifting course. It is reportedly the largest natural lake in Missouri and is surrounded by a thousand-acre county park in north central St. Louis County. At one time there were two lakes; the Upper, or Little, Creve Coeur Lake, and the larger one called Creve Coeur Lake. The Upper Lake gradually filled with silt from the feeder creek and no longer exists. Creve Coeur Lake proper has been dredged to keep it from disappearing, also. It is situated on the Missouri River floodplain surrounded by bottomland soils. The primary soil types are Blake silty loam, Eudora silt loam and Wilber silt loam. These soils are nearly level and exhibit moderate permeability and slow runoff. The land

[1]Class L3 lakes are lakes other than major reservoirs or those used primarily for public drinking water supply. These lakes may be either public or private. See Missouri's Water Quality Standards 10 CSR 20-7.031(1)(F)
[2] The beneficial uses may be found at 10 CSR20-7.031 (1)(C) and Table G

at the southeast corner of the lake (Menfro silt loam) rises along the edge of the floodplain in a 20-45 percent slope and is rocky and wooded. Other nearby soils (also Menfro silt loams) are of varying steepness, and are characterized by moderate permeability and rapid runoff. The land above this rise is a heavily developed residential area that drains into Creve Coeur Lake.

The name Creve Coeur is French for "broken heart". There are many colorful stories as to how the lake received this name. In the1800s, the lake was utilized as a source of ice for St. Louis and has long been used for recreation. The first organized Lake Festival was in August 1881, and the lake was the site of the St. Louis County Fair for 30 years, starting in the late 1880s. Boating was another popular activity and included racing as well as pleasure excursions. In the late 1800s, Creve Coeur was "out in the country". Travel became more convenient when the Laclede and Creve Coeur Lake Railroad started passenger service on July 2, 1881. The lake today is still used for boating (non-gasoline boats only) and fishing, but no swimming is allowed.

The major source of chlordane to Creve Coeur Lake has been runoff from nearby urban areas where wide spread eradication of termites occurred around homes in the 1970s and 1980s. Chlordane is a pesticide that was once widely used for termite control and in agriculture. The substance was applied both in dwellings and around foundations to repel and kill termites, ants and a variety of other insects. The U.S. Environmental Protection Agency (EPA) banned chlordane for agricultural uses in 1975 and from all other uses in 1988. Even though it has been banned, chlordane degrades very slowly in the environment. Chlordane is not soluble and is not found in the water column of waterbodies, but attaches to soil and through erosion moves into a waterbody and accumulates in lake or streambed sediments. It bio-accumulates in fish tissue, and bottom-feeding fish, such as carp, become exposed to chlordane due to their feeding or dwelling preferences near chlordane-contaminated sediments. Eating fish contaminated by chlordane will not make a person immediately ill; however, over a long period of time, chlordane may damage the nervous system, digestive system and the liver. It also has produced cancers in laboratory animals.

The Missouri Department of Conservation (MDC) has monitored levels of toxic contaminants in fish from Missouri lakes and rivers since 1984. At that time, MDC discovered elevated levels of chlordane in fish in the Missouri, Mississippi, and Meramec rivers. MDC provides these sample results to the Missouri Department of Health (DOH) for use in determining health risks to fish consumers. DOH, in turn, issues fish consumption advisories. DOH has issued advisories based on pesticide contaminants in fish since 1985. DOH fish advisories in the past instructed anglers to limit consumption of fatty fish (carp, catfish, buffalo, drum, suckers and paddlefish) to one meal per week. Trout also have a high level of fat, but are considered safe to eat from anywhere in the state. DOH issues its fish advisory every year around June-July. The advisory is made available to the public through press releases and may be accessed by calling DOH at 1-800-392-7245. DOH also distributes the advisory in brochures at fairs and MDC publishes the fish advisory in the Summary of Missouri Fishing Regulations pamphlet.

Missouri's protocol for removing or down grading an advisory requires at least two years of data. Fish tissue data from Creve Coeur Lake in the last two years shows chlordane has been below the 0.3 milligrams per kilogram (mg/kg) action level (see Specific Criteria in section 2). As a

result, DOH discontinued the warning on fatty fish in the latest fish advisory released July 9, 2001.

2. Description of the Applicable Water Quality Standards and Numeric Water Quality Targets

Beneficial Uses

The beneficial uses of Creve Coeur Lake, WBID 7255, are:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life and Human Health associated with Fish Consumption
- Boating and Canoeing

The use that is impaired is Protection of Human Health associated with Fish Consumption. Chlordane is not soluble in water and therefore is not a concern for boating or animal watering.

Anti-degradation Policy

Missouri's Water Quality Standards include the Environmental Protection Agency (EPA) "three-tiered" approach to anti-degradation, which may be found at 10 CSR 20-7.031(2).

Tier I defines baseline conditions for all waters and it requires that existing beneficial uses are protected. TMDLs would normally be based on this tier, assuring that numeric criteria (such as dissolved oxygen and ammonia) are met to protect uses.

Tier II requires that no degradation of high-quality waters occur unless limited lowering of quality is shown to be necessary for "economic and social development." A clear implementation policy for this tier has not been developed, although if sufficient data on high-quality waters are available, TMDLs could be based on maintaining existing conditions, rather than the minimal Tier I criteria.

Tier III (the most stringent tier) applies to waters designated in the water quality standards as outstanding state and national resource waters; Tier III requires that no degradation under any conditions occurs. Management may prohibit discharge or certain polluting activities. TMDLs would need to assure no measurable increase in pollutant loading.

This TMDL will result in the protection of existing beneficial uses, which conforms to Missouri's Tier I anti-degradation policy.

Specific Criteria

The specific criteria for chlordane are found in Missouri's Water Quality Standards, 10 CSR 20-7.031, Table A, under Persistent, Bioaccumulative, Man-made Toxics. The limit for chlordane *in water* related to human health protection associated with fish consumption is 0.00048 micrograms per liter (g/L or parts per billion). However, elevated chlordane levels in water

have never been a problem. As chlordane tends to bioaccumulate in fish, this TMDL will be based on fish tissue chlordane levels. Fish tissue levels refer to the amount of chlordane in the fillet, or edible portion, of fish. The U.S. Food and Drug Administration (FDA) developed a fish tissue action level of 0.3 milligrams per kilogram (mg/kg or parts per million) for technical grade chlordane.[3] Note: 1 kilogram equals approximately 2.2 pounds. If the level of a toxic contaminant exceeds the action level, a fish consumption advisory is issued regarding the potential health risk associated with long-term consumption of contaminated fish. The first documented exceedence for chlordane in Creve Coeur Lake was in 1985 and a fish consumption advisory was issued. As noted above, Missouri's protocol for removing or down grading an advisory requires at least two years of data below 0.3 mg/kg. Since this requirement has been met, the advisory was discontinued July 9, 2001.

3. Calculation of Load Capacity, Load Allocation and Waste Load Allocation

Load capacity is defined as the maximum pollutant load that a waterbody can assimilate and still attain water quality standards. EPA banned the use of chlordane in 1988, so no additional chlordane is being introduced into the environment. Thus, the Load Capacity, Load Allocation and Waste Load Allocation for this TMDL are zero.

4. Margin of Safety (MOS)

The fish consumption advisory that has been in effect for Creve Coeur Lake since 1985 has just been discontinued. Since chlordane has been banned, chlordane levels in fish are predicted to continue to decline. To ensure that public health and safety are protected, if future monitoring shows a rise in fish tissue chlordane, the fish consumption advisory will be reissued and the cause and cure for the increase will be investigated.

5. Seasonal Variation

There is no seasonal variation associated with this TMDL.

6. Monitoring Plan for TMDL under the Phased Approach

The department will continue to request the Missouri Department of Conservation to collect fish tissue samples from Creve Coeur Lake for chlordane analysis.

7. Implementation Plans

Since chlordane has been banned, there is no specific remediation plan for this impairment. This is a phased TMDL in that if future data indicates fish tissue chlordane levels are not continuing

[3] Data can be collected as sum-of-the-isomers chlordane and in that case the action level is 0.1 mg/kg sum-of-the-isomers chlordane. This is usually comparable to FDA's action level of 0.3 mg/kg technical grade chlordane when the contamination is recent because there is a lot of the technical chlordane still present. However, after a few years the chlordane all breaks down to the isomers, so the comparison no longer works well. For the purposes of this TMDL, 0.3 mg/kg technical grade chlordane will be used.

to decline, this TMDL will be re-opened and re-evaluated. This TMDL will be incorporated into Missouri's Water Quality Management Plan.

8. Public Participation

This water quality limited lake is included on the approved 1998 303(d) list for Missouri. Six public meetings on impaired waters to allow input from the public were held between August 18 and September 22, 1998. No comments pertaining to Creve Coeur Lake were received during the public meetings. TMDLs developed by Missouri are sent to EPA for examination and then the edited drafts are placed on public notice. This TMDL was placed on public notice from August 3 through September 2, 2001. No comments were received. A copy of the public notice was included in the Creve Coeur file.

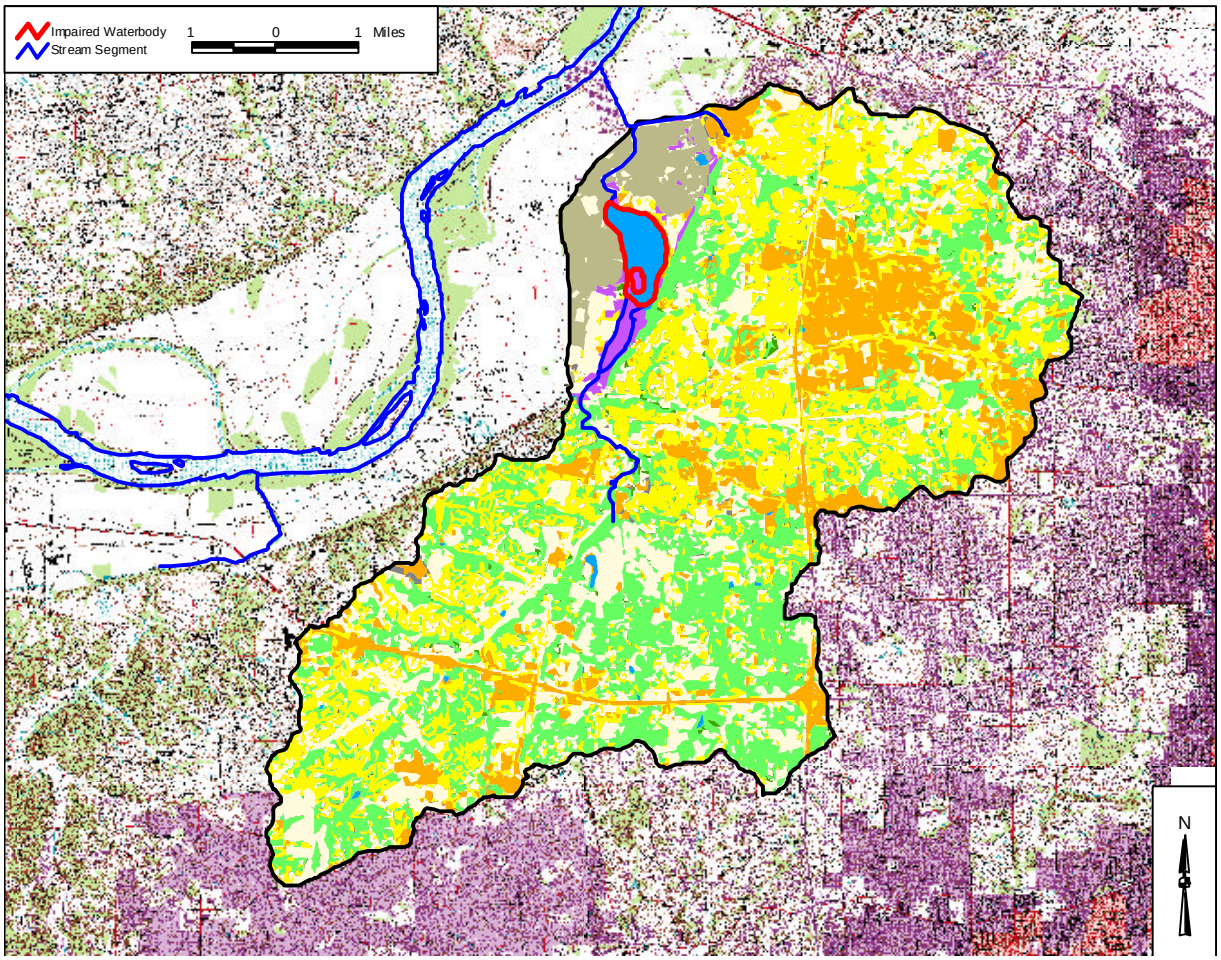
9. Appendices and List of Documents on File with the Department

Appendix A – Land Use Types for the Creve Coeur Lake Watershed
Appendix B – Location Map of Impaired Water Body
Appendix C – Data with Discussion

Other Information on File:

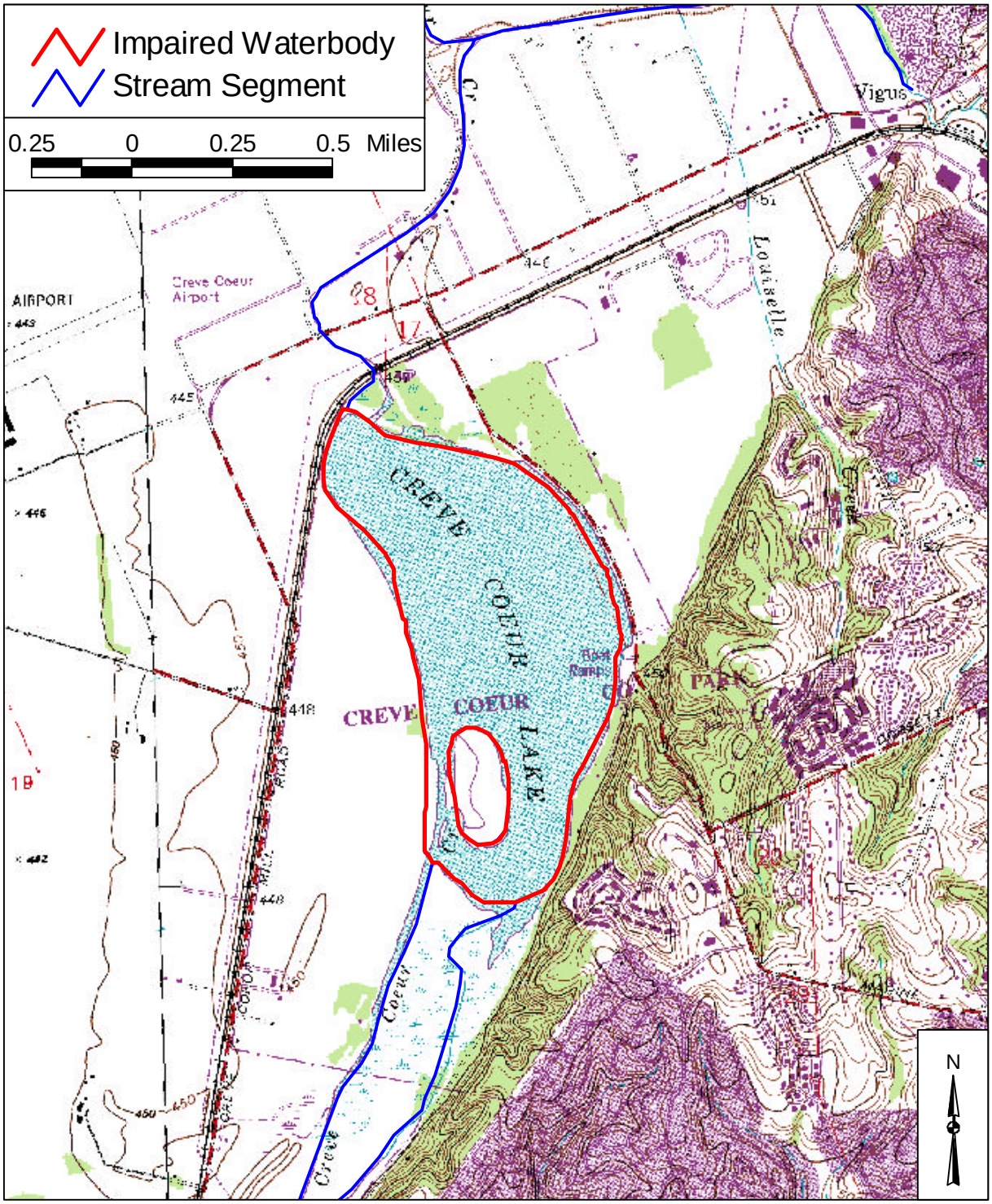
- Fish Consumption Advisories from 1985 to the present outlining safe consumption of fish.
- "Relationship Between Fish Consumption and Serum Chlordane Levels" by Evans, et al, 6/94, *Journal of Environmental Health.* This paper studied the appropriateness of fish consumption advisories in Missouri rivers. It concluded health advisories based upon fish sampling techniques do not reflect the risk of exposure to chlordane. After this study, the Missouri Department of Health changed its fish advisories from *where* fish were taken to *how much* fish was consumed.

pendix A. Land Use Types for Creve Coeur Lake Watershed (10300200-13000



Land Use Type	Area (acres)
Urban Impervious	3813
Urban Vegetated	8806
Barren or Sparsely Vegetated	55
Row and Close Grown Crops	1135
Cool-season Grassland	7527
Warm Season Grassland	0
Glade Complex	0
Eastern Redcedar and Redcedar-Deciduous Forest and Woodland	0
Deciduous Woodland	116
Upland Deciduous Forest	7695
Shortleaf Pine-Oak Forest and Woodland	0
Shortleaf Pine Forest and Woodland	0
Bottomland Deciduous Forest and Woodland	350
Swamp	0
Marsh and Wet Herbaceous Vegetation	0
Open Water	360

Appendix B. Map of Impaired Waterbody
Creve Coeur Lake, St. Louis County, Missouri



Appendix C
Data for Creve Coeur Lake with Discussion

The data for Creve Coeur Lake (Table 1) are spotty. Though MDC analyzes fish tissue every year, it does not analyze fish from Creve Coeur Lake every year. Table 2, shows that channel catfish and carp are the fish of concern since their chlordane levels exceed the U.S. Food and Drug Administration action level of 0.3 mg/kg (see Specific Criteria in section 2). They are bottom dwelling organisms and are exposed to chlordane while feeding or dwelling near chlordane-contaminated sediments. The data for channel catfish were collected until 1988, the year when chlordane was banned. As there is no recent data for channel catfish, Table 3 lists the data for carp, showing the decline in fish tissue chlordane in the years since chlordane was banned. The graph uses the data from Table 3.

Table 1. Available Data on Chlordane in Fish Tissue from Creve Coeur Lake St. Louis County, MO (mg/kg)

SPECIES	DATE	CHLORDANE
LARGE MOUTH BASS	1985	0.017
BLUE GILL	1985	0.056
CARP	1985	1.034
CARP	1985	0.386
CHANNEL CATFISH	1985	0.485
WHITE CRAPPIE	1985	0.037
CARP	1987	0.945
CARP	1987	0.379
CARP	1987	0.231
CHANNEL CATFISH	1987	0.306
CHANNEL CATFISH	1987	1.512
CHANNEL CATFISH	1987	0.433
LARGE MOUTH BASS	1987	0.217
BLUE GILL	1987	0.005
CARP	1988	0.61
CHANNEL CATFISH	1988	1.229
CARP	1994	0.869
CARP	1997	0.416
CARP	1998	0.081
CARP	2000	0.028

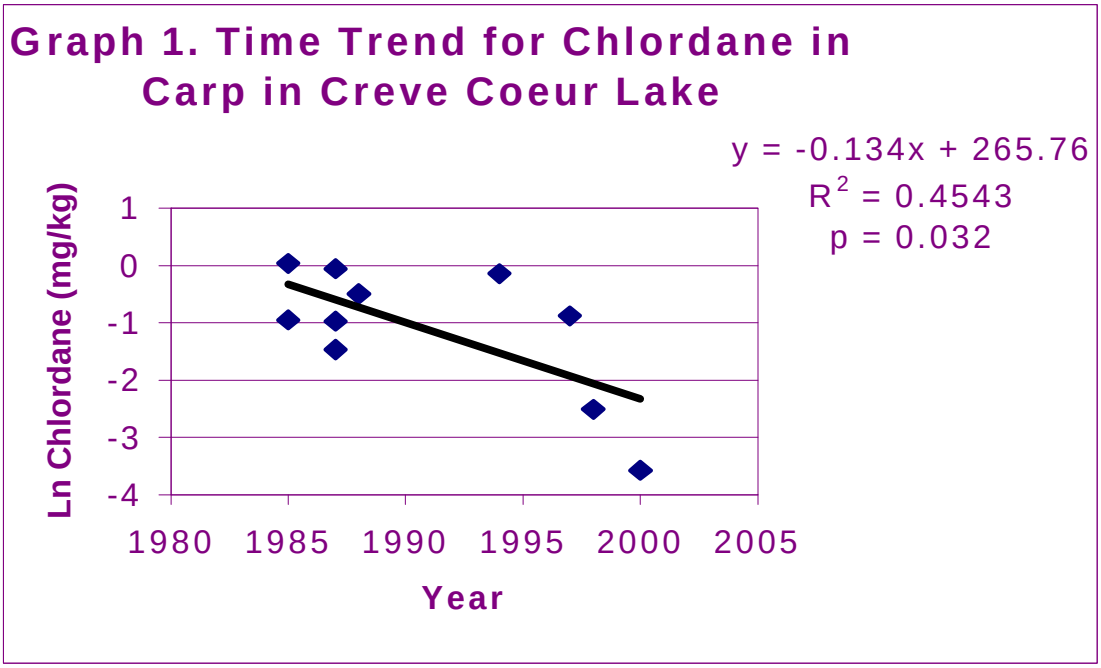
Table 2. Average Chlordane Level by Species (mg/kg)

SPECIES	CHLORDANE	# OF SAMPLES
BLUEGILL	0.0305	2
CARP	0.498	9
CHANNEL CAT	0.793	5
LARGEMOUTH BASS	0.117	2
WHITE CRAPPIE	0.037	1

Table 3. Chlordane in Carp by Year (mg/kg)

YEAR	CHLORDANE	NATURAL LOG (Ln) CHLORDANE
1985	1.034	0.033434776
1985	0.386	-0.95191791
1987	0.945	-0.056570351
1987	0.379	-0.970219074
1987	0.231	-1.465337568
1988	0.61	-0.494296322
1994	0.869	-0.140412154
1997	0.416	-0.877070019
1998	0.081	-2.513306124
2000	0.028	-3.575550769

Graph 1 below is based on the natural log (Ln) of the chlordane data, which allows a linear regression (straight-line graph). From this graph, an analysis was performed to determine if the chlordane concentrations are decreasing with time. The result was that the data cannot be explained by chance, such as environmental variations or sampling and analytical errors, alone. That is, the data is apparently decreasing with time. The statewide fish consumption advisory has been discontinued by DOH due to fish tissue samples of less than the FDA action level of 0.3 mg/kg of chlordane for at least two consecutive monitoring. The department intends to continue monitoring for chlordane in fish tissue to document the decline.



Data Sources: Missouri Departments of Natural Resources and Conservation