

Missouri Department of Natural Resources

Total Maximum Daily Load Information Sheet

Center Creek

Water Body Segment at a Glance:

County: Jasper
Nearby City: Joplin
Length of impaired segment: 26 miles
Length of impairment within segment: 12.8 miles
Pollutants: Cadmium (S,W)¹, Lead (S) and Zinc (S)
Source: Mill Tailings (Abandoned)
Water Body ID: 3203



State map showing location of watershed

Schedule for TMDL development: 2012

Prior TMDL: A TMDL for zinc (W) was approved in 2006

Description of the Problem

Designated beneficial uses of Center Creek

- Livestock and Wildlife Watering
- Protection of Warm-Water Aquatic Life
- Human Health Protection (Fish Consumption)
- Cool-Water Fishery
- Whole Body Contact Recreation
- Secondary Contact Recreation
- Irrigation
- Industrial

Uses that are impaired

- Protection of Warm-Water Aquatic Life
- General Criteria

Standards that apply

- Missouri Water Quality Standards found in 10 CSR 20-7.031(4)(B)1 state:

Water contaminants shall not cause the criteria in Tables A and B to be exceeded.

Concentrations of these substances in bottom sediments or waters shall not harm benthic

¹ (S) = in sediment/soil; (W) = in water as dissolved metal

organisms and shall not accumulate through the food chain in harmful concentrations, nor shall state and federal maximum fish tissue levels for fish consumption be exceeded.

- Table A of the Water Quality Standards contains dissolved metals criteria for the protection of aquatic life designated use. These criteria are hardness dependent and limits are calculated from the formulas shown below:

Dissolved Cadmium (DCd)

$$\text{Acute}^2 = e^{(1.0166 * \ln(\text{hardness}) - 3.062490)} * (1.136672 - (\ln(\text{hardness}) * 0.041838)) = \mu\text{g/L, or} \\ \text{micrograms per liter}$$

$$\text{Chronic} = e^{(0.7409 * \ln(\text{hardness}) - 4.719948)} * (1.101672 - (\ln(\text{hardness}) * 0.041838)) = \mu\text{g/L}$$

- Missouri streams are also protected by the general criteria found at 10 CSR 20-7.031(3). The particular general criteria that apply to Center Creek include:

(D) Waters shall be free from substances or conditions in sufficient amounts to result in toxicity to human, animal or aquatic life.

(G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

- Missouri has no numeric criteria for metals in sediment. Likewise, the U.S. Environmental Protection Agency, or EPA, has not yet established federal guidelines for toxic chemicals in stream or lake sediments. In lieu of such criteria, Probable Effect Concentrations, or PECs, suggested by McDonald, et al.³, are used. PECs are the concentrations at which some toxic effect on aquatic life is likely.

Background information and water quality data

Center Creek flows through the Tri-State Historic Mining District in southwest Missouri. Joplin is located near the center of this district. Mining for lead and zinc began in 1848 and lasted until 1957. Between 1848 and 1945, 50 percent of the zinc and 10 percent of the lead mined worldwide came from the Tri-State district.

Mine drainage, both in the form of surface flows and resurgence of groundwater from flooded mines, contributes significant amounts of metals to Center Creek. In addition to dissolved metals in the water column, studies by the U.S. Geological Survey (USGS) also indicated that at some locations pore water, water within the sediment on the bottom of Center Creek, was toxic to aquatic life.

Information relating to approved TMDL: dissolved zinc

In the case of zinc, the average dissolved zinc concentration in Center Creek upstream of the mining district (near Fidelity) is 7 µg/L. At the Highway HH bridge, which is just within the upstream

² Acute criteria apply to short exposures to toxic conditions that aquatic creatures can survive without harm. Chronic criteria apply to conditions producing adverse effects on aquatic life or wildlife following long-term exposure but having no readily observable effect over a short time period. Chronic criteria are much lower than the acute criteria.

³ *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems*, D. MacDonald, et al., 2000. USGS

portion of the mining district, it is 124 µg/L and rises to 366 µg/L within the mining area at Smithfield.

Most of the zinc in Center Creek comes from dissolution of zinc minerals lying on the land surface or in the walls of flooded mines. As these surfaces continue to weather, less available zinc minerals remain to be dissolved. As a result, the long-term levels of zinc in runoff, groundwater and Center Creek should decline. This trend is shown in Figure 1 below that plots dissolved zinc levels in Center Creek near Smithfield from 1970 to 2002.

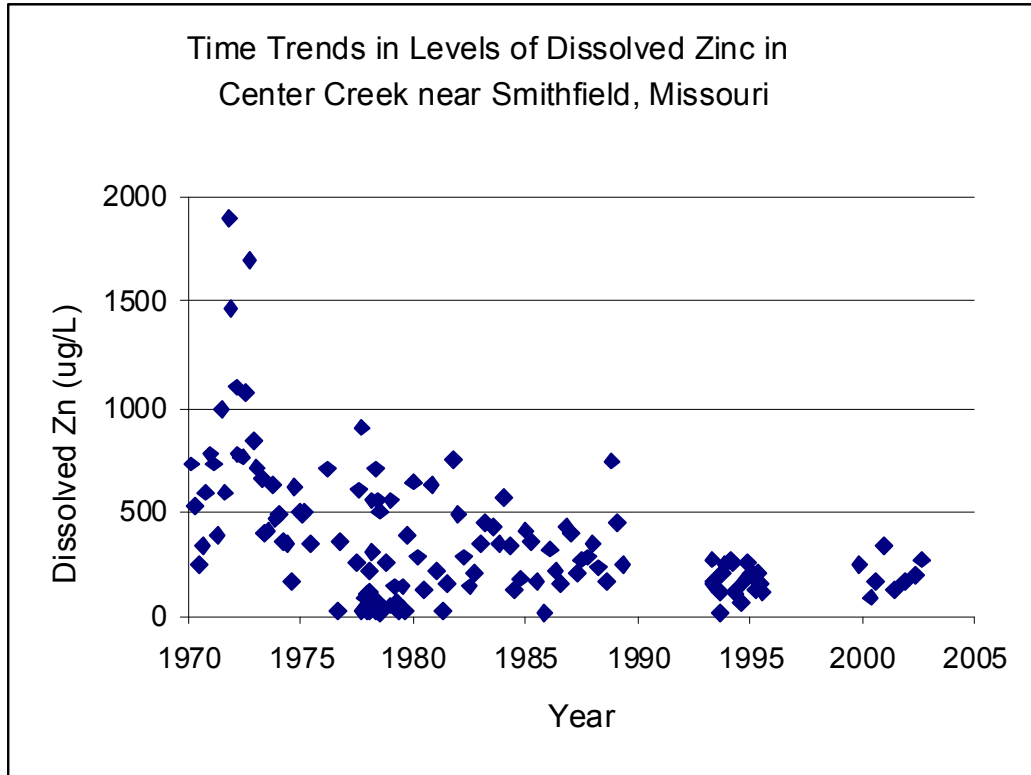


Figure 1

Center Creek and nearby Turkey Creek in Jasper County flow across the state line into the Spring River in Kansas. Kansas has completed a TMDL study on the Spring River. The two creeks are major sources of metals pollution in the Spring River. As a result, Missouri chose to include Kansas' WQS in the zinc targets for these TMDLs, which were approved by the EPA on October 25, 2006.

For more information, see the Turkey Creek Information Sheet. The approved 2006 TMDL for dissolved zinc is available online at www.dnr.mo.gov/env/wpp/tmdl/3203-center-3216-3217-turkey-cks-tmdl.pdf.

Toxicity of lead and cadmium

New data shows that Center Creek is also contaminated by dissolved cadmium in the water column and cadmium, lead and zinc in the sediment. The toxicity of zinc is detailed in the Turkey Creek

Information Sheet. It is already known that lead bioaccumulates in the bodies of aquatic creatures, which has been documented in the levels of lead in fish in Big River, another water body in Missouri that is contaminated with mine tailings. New studies done in the Big River are showing that the lead and other metals in these tailings are toxic to mussels, crayfish and other small invertebrates that inhabit the bottom of the river. These conclusions may be transferrable to Center Creek. Lastly, cadmium is a minor component in most lead ores and therefore is a by-product of lead production. It is known to be highly toxic and carcinogenic.

Dissolved cadmium

The chronic and acute water quality standards for protection of aquatic life for cadmium and zinc are based on the 25th percentile hardness level of the water. A water body is judged to be impaired if chronic or acute numeric criteria are exceeded on more than one occasion during the last three years for which data is available. The chronic criterion for cadmium was exceeded four times on Center Creek during this time period (Figure 2). Therefore, the portion of this water body below the abandoned tailings piles is judged to be impaired by dissolved cadmium.

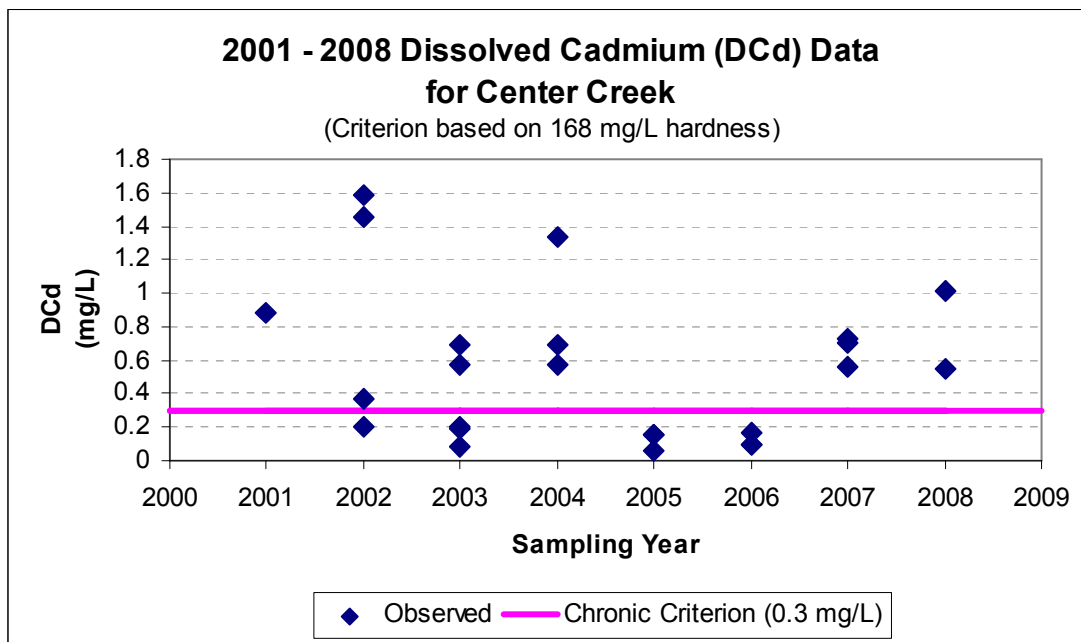


Figure 2

Cadmium, lead and zinc in sediment

The sediment in Center Creek eroded from formerly huge chat piles created by mining lead and zinc. Chat is the crushed limestone and other ore rock left over after the lead and zinc were extracted. As previously noted, the sediment in Center Creek is contaminated by cadmium, lead and zinc (see Figures 3-5). The relationship between the amount of a toxicant in sediment and the strength of the toxicity it exerts on aquatic life is not simple or straightforward. While neither Missouri nor EPA has standards or guidelines for sediment toxicity, the U.S. Geological Survey, or USGS, has reviewed a large number of research papers on the subject. Based on this review, the USGS suggests numeric guidelines that could be used to judge the potential for toxicity to aquatic life. These are the PECs mentioned in the discussion of “standards that apply”.

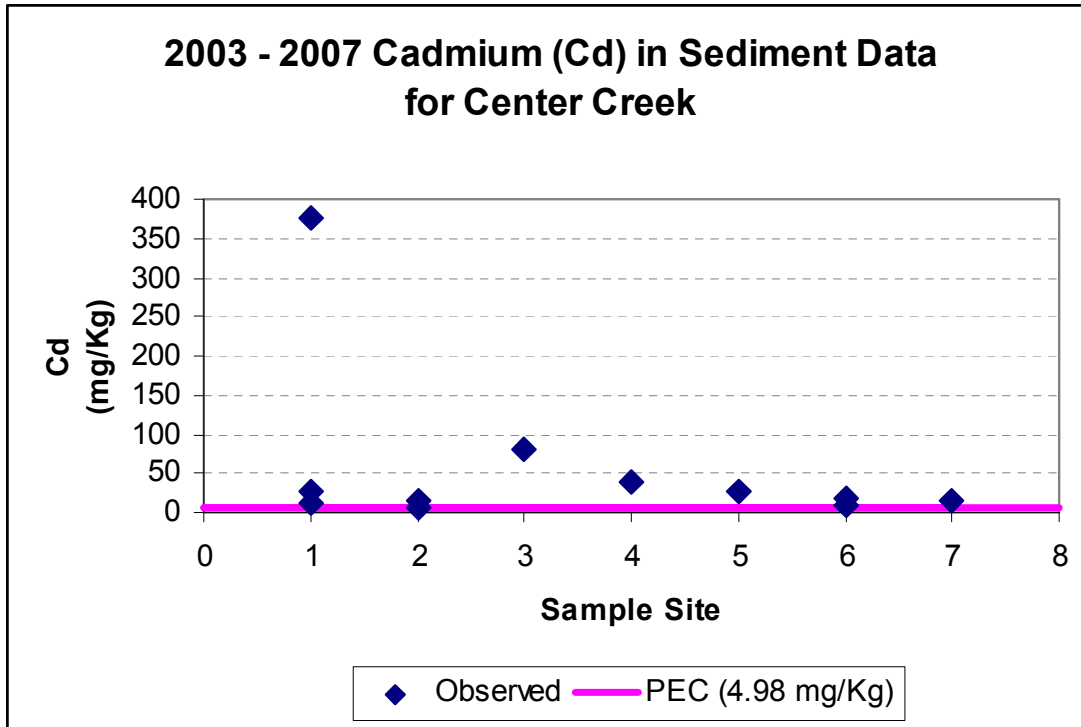


Figure 3

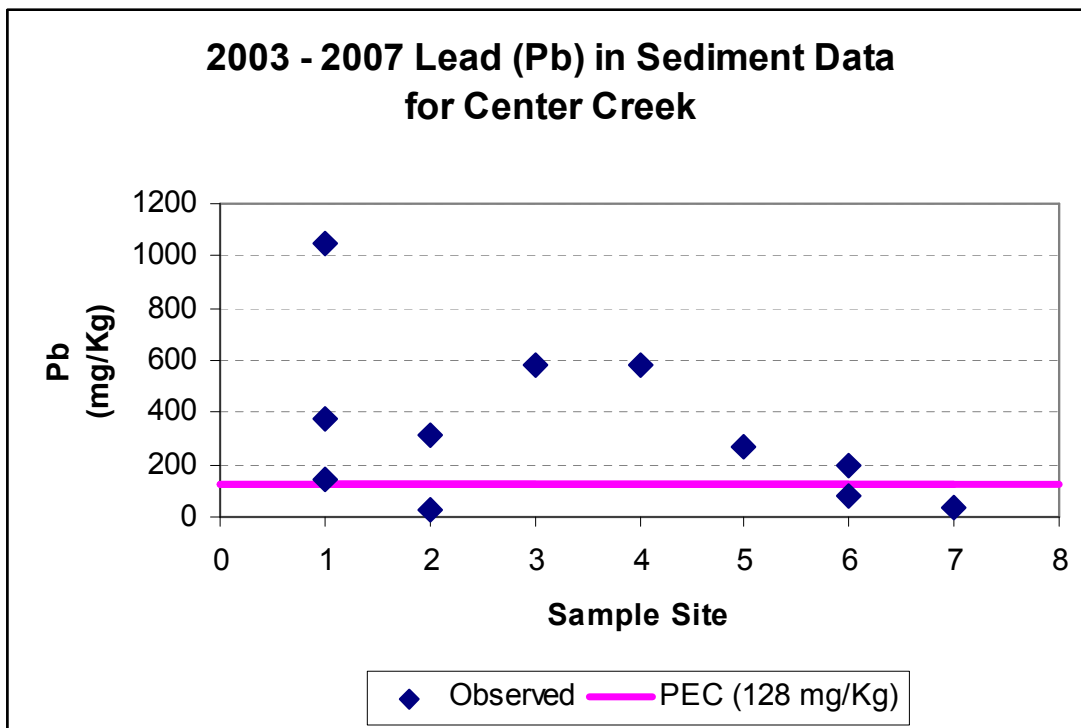


Figure 4

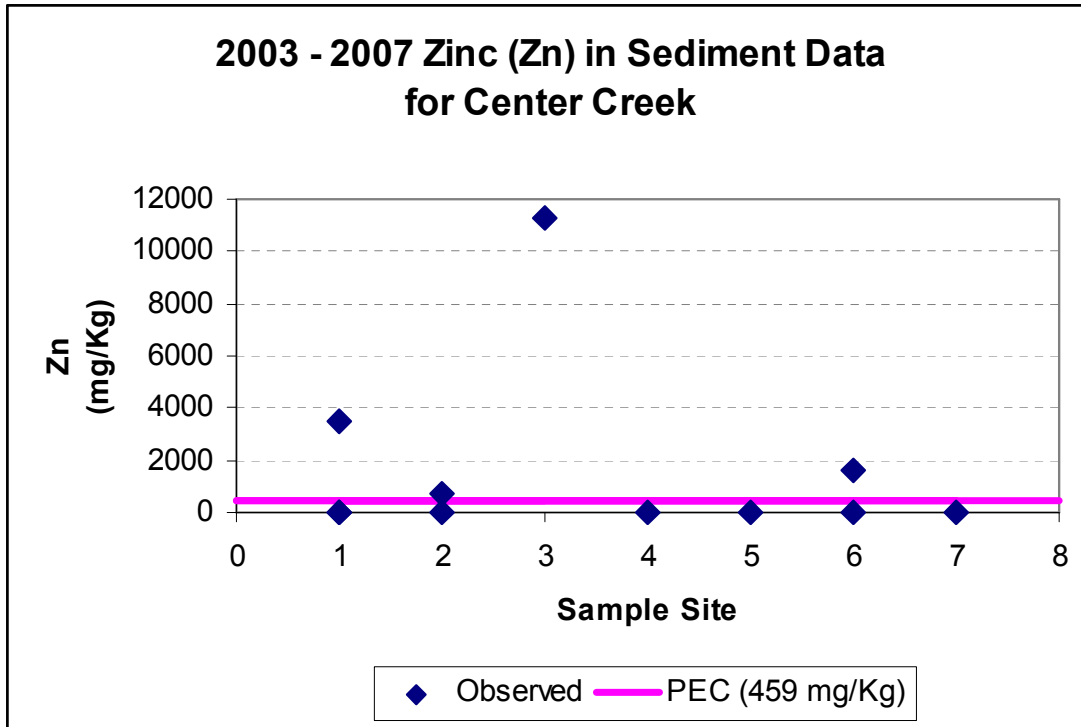
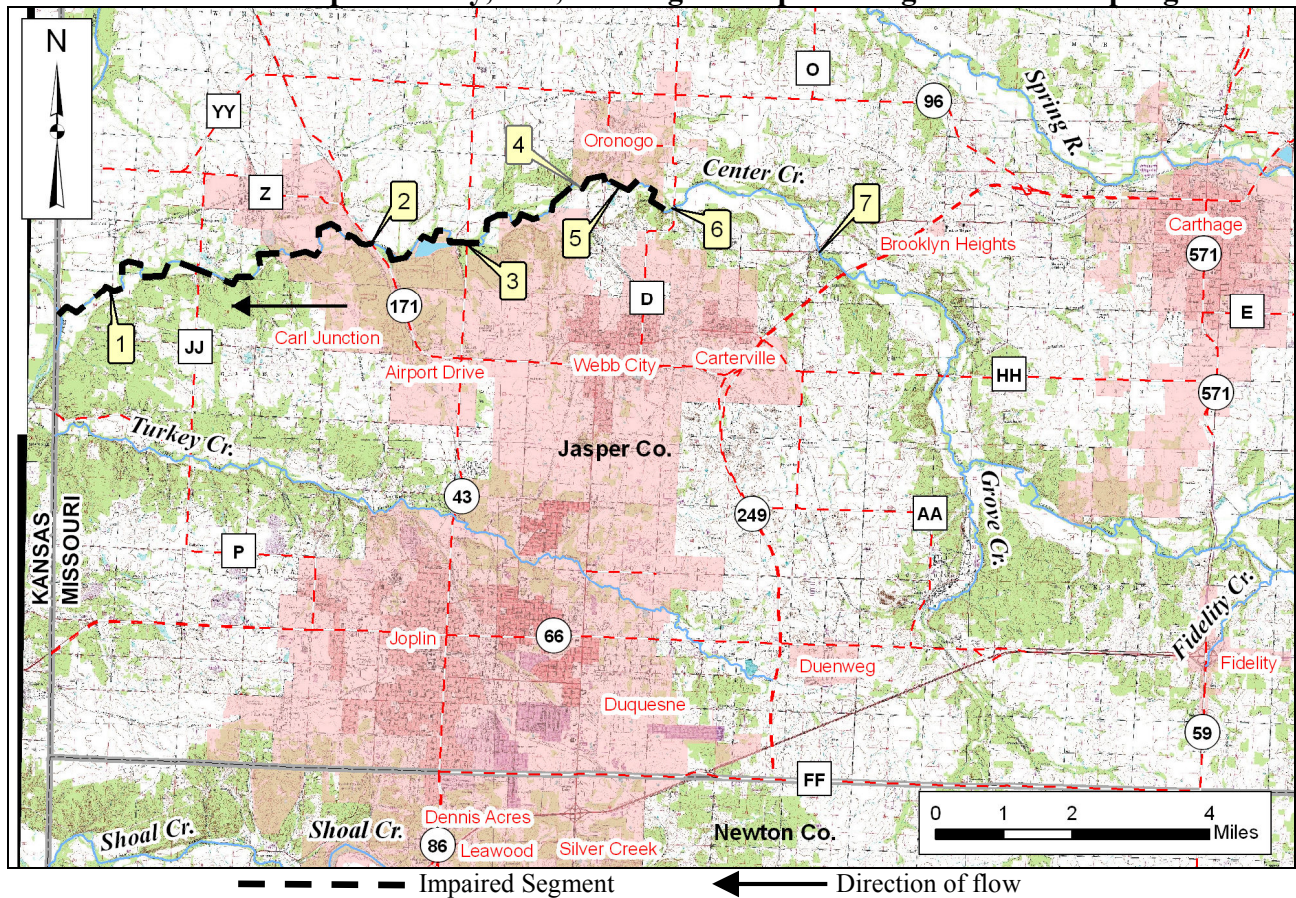


Figure 5

The department conducted sediment monitoring in 2003 and 2007. The mean, or average, level of cadmium in the sediments for Center Creek is 56.2 mg/kg, or milligrams per kilogram, which is the same as parts per million. This is more than 11 times the PEC. The mean level of lead in the sediments for Center Creek is 332.7 mg/kg. This is more than two and a half times the PEC. The mean level of zinc in the sediments for Center Creek is 1556.8 mg/kg. This is more than three times the PEC. Based on the location of sediment sampling sites and known or suspected sources of metals, 3.5 miles of the creek were judged to be impaired by cadmium, lead and zinc in the sediment.

Center Creek in Jasper County, Mo., showing the impaired segment and sampling sites



- Sample Sites**
- 1 – Center Cr. near Carl Junction at County Road 303
 - 2 – Center Cr. at State Highway 171
 - 3 – Center Cr. at State Highway 43
 - 4 – Center Cr. downstream of County Road 23
 - 5 – Center Cr. upstream of County Road 23
 - 6 – Center Cr. at State Highway D (Main Street)
 - 7 – Center Cr. at Hyacinth Road

For more information call or write:
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