

Missouri Department of Natural Resources

Total Maximum Daily Load Information Sheet

Turkey Creek

Water Body Segment at a Glance:

County: Jasper
Nearby City: Joplin
Water Body ID: 3216
Length of impaired segment: 7 miles
Water Body ID: 3217
Length of impaired segment: 5 miles
Pollutants: Cadmium, Lead and Zinc (S)¹
Cadmium (W) [WBID 3216 only]
Source: Mill Tailings (Abandoned)



Scheduled for TMDL development: 2012

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

Description of the Problem

Designated beneficial uses of Turkey Creek

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

Uses that are impaired

- Protection of Warm-Water Aquatic Life
- General Criteria (WBID 3217)

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 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.

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

- 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 for cadmium are calculated from the formulas shown below:

Dissolved Cadmium (DCd)

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

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

- 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 standards for metals in sediment. Likewise, the U.S. Environmental Protection Agency 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. al³, are used. PECs are the concentrations at which some toxic effect on aquatic life is likely.

Background information and water quality data

Two segments of Turkey Creek are on the 2008 303(d) List for high levels of metals in both the water column and the stream sediment. Several abandoned mine lands, or AMLs, provide metals to Turkey Creek, with the Duenweg mining area being the most significant contributor in the upper Turkey Creek watershed. In the middle portion of the watershed, the Lone Elm Hollow (around site #4) and Leadville Hollow areas are the most significant sources. See below for graphs summarizing the data and a map of the area (last page).

Turkey and Center⁴ creeks in Jasper County flow across the state line into the Spring River in Kansas. Kansas has completed a TMDL study on the Spring River and these two creeks are major sources of metals pollution in the Spring River. The department worked with Kansas in developing the TMDLs, choosing to include Kansas' WQS in the zinc targets.

The U.S. Environmental Protection Agency, or EPA, approved Missouri's TMDLs for dissolved zinc in both Turkey and Center creeks on October 25, 2006. For more information, see the Center 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.

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

⁴ Center Creek is included in the Center and Turkey Creeks TMDL. It is impaired for the same suite of metals.

Toxicity of cadmium, lead and zinc

Lead-zinc AMLs produce runoff with high levels of dissolved zinc. Zinc is one of the most mobile of all heavy metals. Because compounds of zinc dissolve easily, zinc is carried into waterways during rain events. Zinc is an essential nutrient to aquatic and terrestrial organisms, but in excess it can be very toxic and has a tendency to bio-accumulate (build up) in aquatic organisms. The hardness of the water, the amount of dissolved oxygen and temperature all affect the toxicity of zinc to aquatic life⁵. Synergistic effects can also occur to increase the toxicity of the zinc. This means when several compounds are combined, the result is more toxic than what would be expected from just adding the components together.

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

This impairment is based on data gathered by the US Geological Survey, or USGS, in 2001-2008. The chronic and acute water quality standards (see footnote 2) for protection of aquatic life for cadmium are based on the 25th percentile of all the hardness data for that water body. 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 ten times in Turkey Creek during that time period. All of the data were gathered at one site, Highway P (#1), so only WBID 3216 is judged to be impaired by dissolved cadmium. See Figure 1 below.

⁵ Upper Sacramento River TMDL for Metals, California Environmental Protection Agency, 9/25/01.
www.swrcb.ca.gov/rwqcb5/TMDL/upperSacCdCuZn.html

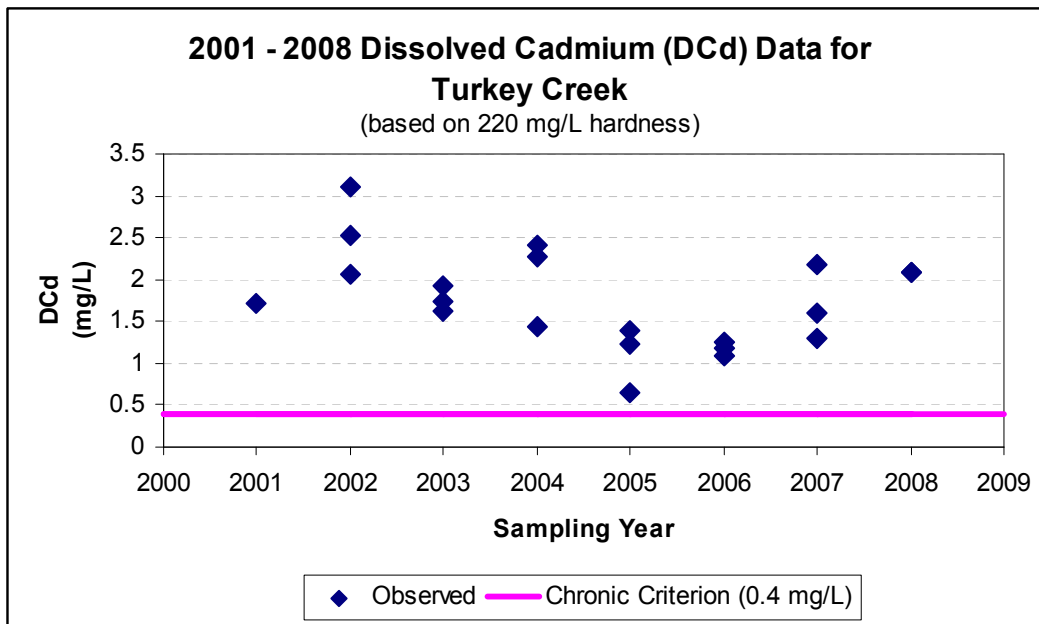


Figure 1

Cadmium, lead and zinc in sediment

As in Center Creek, the sediment in Turkey 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, this sediment (the chat) is contaminated by cadmium, lead and zinc. 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 USGS has reviewed of 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 discussed in “standards that apply”. The department conducted sediment monitoring in Turkey Creek in 2003, 2007 and 2008 and an EPA contractor gathered sediment data in 1995. In Figures 2-4 below, Sites 1-4 are on WBID 3216 and Sites 5-7 are on WBID 3217.

WBID 3216

The mean, or average, level of cadmium in the sediments for Turkey Creek WBID 3216 is 19.9 mg/kg, or milligrams per kilogram, which is the same as parts per million. This is four times the PEC, the concentration at which some toxic effect on aquatic life is likely. The mean level of lead in the sediments for Turkey Creek is 303 mg/kg, two times the PEC, and the mean level of zinc is 4050 mg/kg, eight times the PEC. Based on the location of sediment sampling sites and known or suspected sources of metals, all of WBID 3216 is judged to be impaired by cadmium, lead and zinc in the sediment. As previously noted, WBID 3216 is also impaired by dissolved cadmium.

WBID 3217

In WBID 3217 of Turkey Creek, the mean level of cadmium, lead and zinc are 29 mg/kg, 387 mg/kg and 3377 mg/kg exceeding the PEC by five times, three times and seven times respectively. Again, based on the location of sediment sampling sites and known or suspected sources of metals, all of WBID 3217 is also judged to be impaired by these three metals.

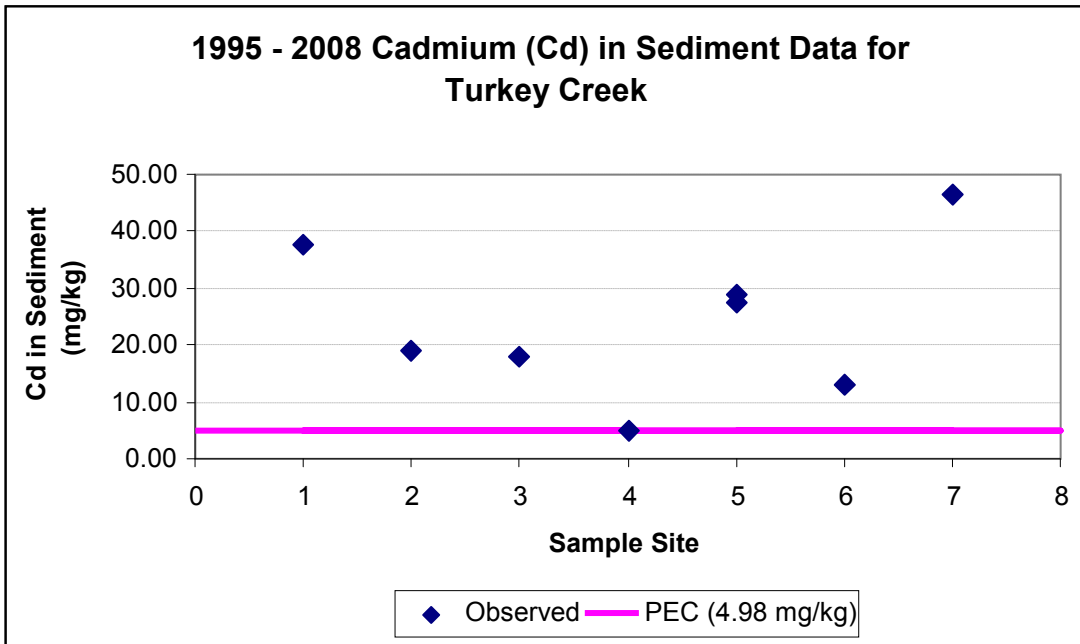


Figure 2

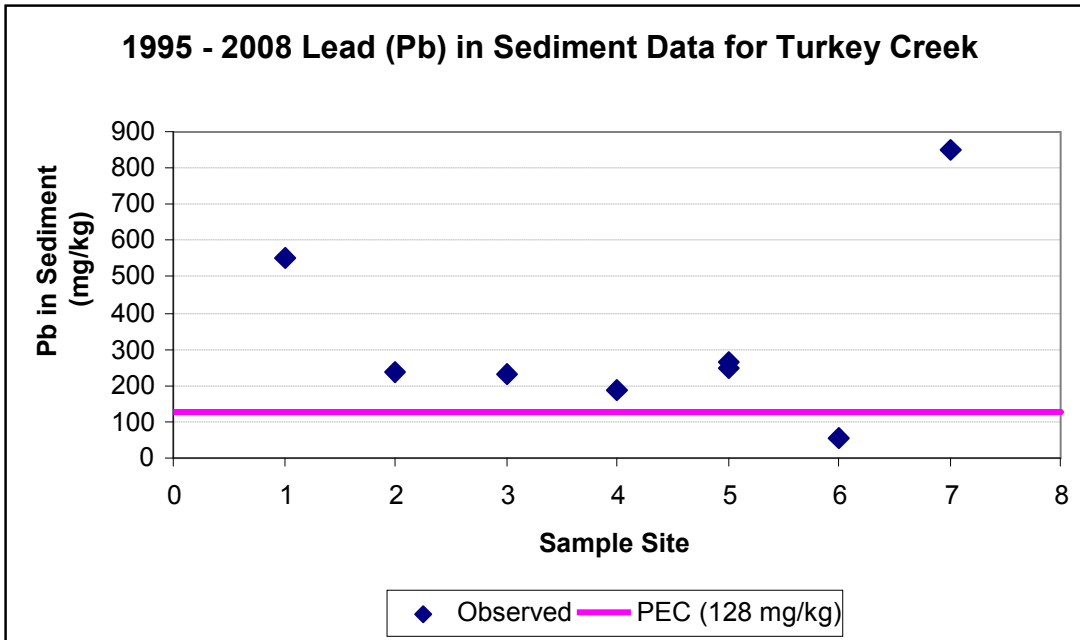


Figure 3

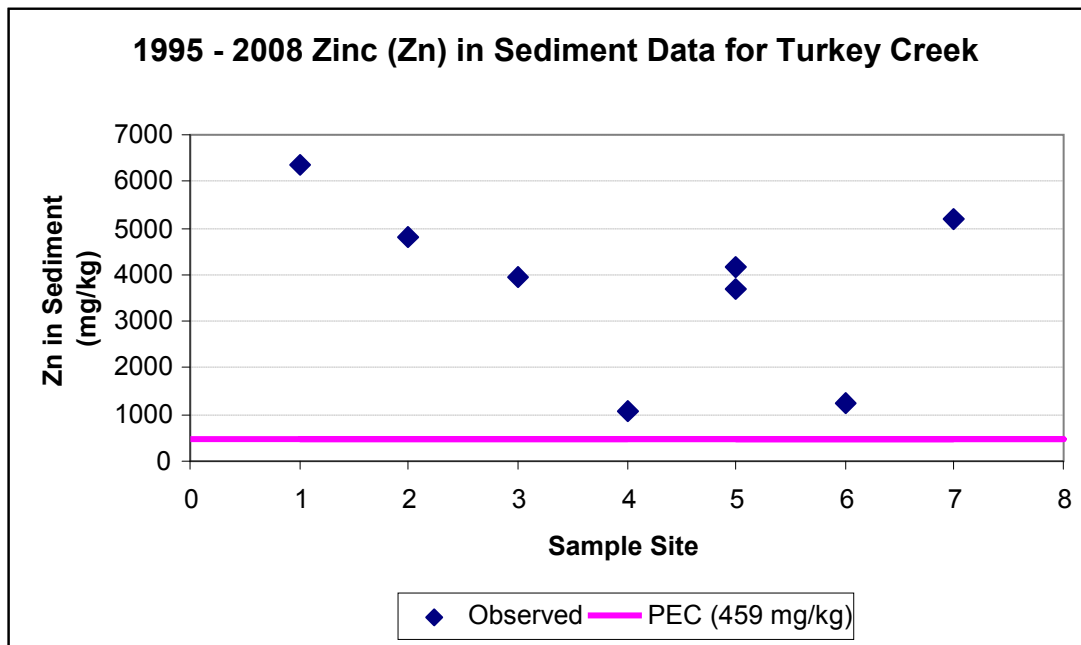


Figure 4

Remedial actions

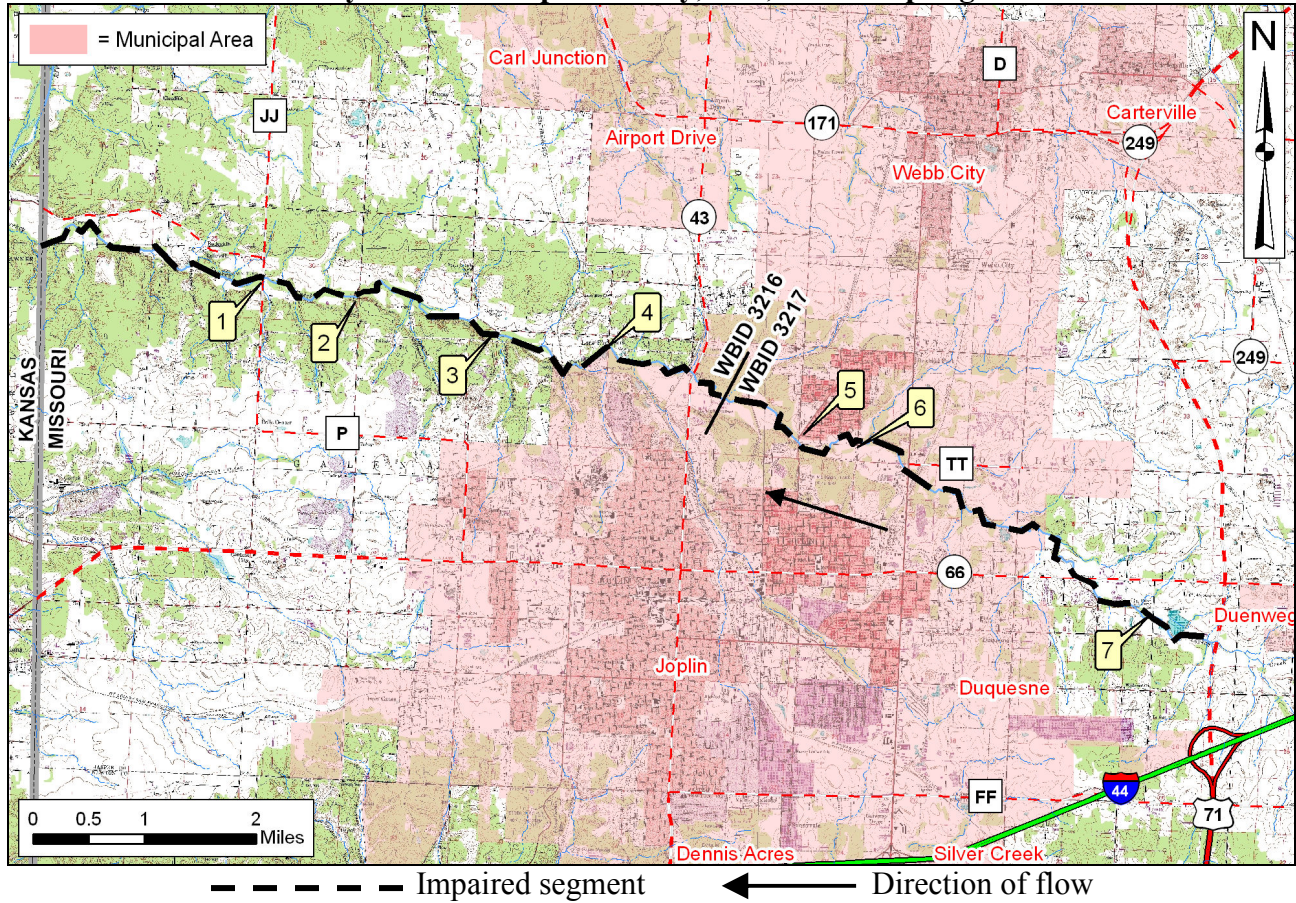
The old lead mining area in Jasper County, where Turkey Creek is located, has been designated as a Superfund Site⁶. Restoration methods for addressing the huge chat piles were evaluated through pilot projects in the watershed. The potential responsible parties, the EPA and the Missouri Department of Natural Resources funded these efforts. Remediation activities have included closing shafts, returning mined materials to the subsurface (subaqueous disposal) and preventing erosion by grading and revegetating chat piles. Water quality monitoring continues on a regular basis.

These actions are steps towards improving the water quality in both Turkey and Center creeks. One major problem that has not been addressed is the contaminated sediment already present in the two streams. A strategy being considered is to completely dredge the streams. Dredging is usually not an option in this size of a water body as it causes major harm to aquatic habitats. However, due to the extent of the damage already present in these streams, dredging could provide positive changes.

A map of Turkey Creek showing the impaired segments and sampling site is on the next page.

⁶ Superfund is the common name used to refer to the federal environmental program established to address abandoned hazardous waste sites. It is also the name of the fund established by the Comprehensive Environmental Response, Compensation and Liability Act of 1980, or CERCLA.

Turkey Creek in Jasper County, Mo., with sampling sites



Sample Site Index	
1	Turkey Creek at State Highway JJ
2	Turkey Creek at Blackcat Road
3	Turkey Creek at Schifferdecker Ave
4	Turkey Creek at Lone Elm Road
5	Turkey Creek at St. Louis Ave
6	Turkey Creek at Florida Ave
7	Turkey Creek at Kenser Road (Hwy P)

For more information call or write:
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