U.S. Environmental Protection Agency Region 7

Big Otter Creek Henry and St. Clair Counties, Missouri

Total Maximum Daily Load

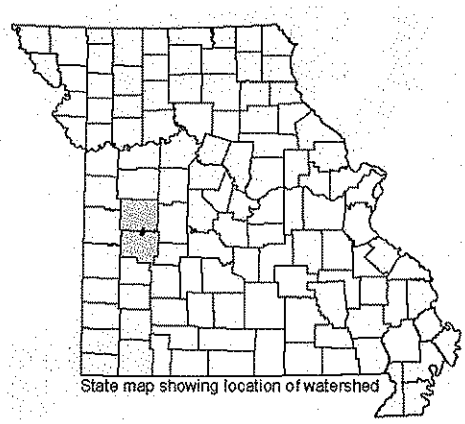
August, 2006

Approved by:

for William A. Spratlin
Director
Water, Wetlands, and Pesticides Division

08/17/06
Date

Total Maximum Daily Load (TMDL)
For Big Otter Creek
Pollutant: pH


State map showing location of watershed

Name: Big Otter Creek

Location: Near Brownington in Henry and St. Clair Counties, Missouri

Hydrologic Unit Code (HUC): 10290108-200004

Water Body Identification (WBID): 1224

Missouri Stream Classification: C[1]

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

Size of Impaired Segment: 1.0 mile

Location of Impaired Segment: From NE ¼, Section 31, T40N, R25W (upstream) to Center of Section 29, T40N, R 25W (downstream)

Pollutant Source: Otter Creek Coal Area

Pollutant: Acidity (low pH)

TMDL Priority Ranking: Medium

1. Introduction

This Big Otter Creek Total Maximum Daily Load (TMDL) for pH[3] is being established in accordance with Section 303(d) of the Clean Water Act. The State of Missouri placed Big Otter Creek on the 1998 and 2002 303(d) lists of impaired waters because water quality standards (WQS), were exceeded due to pH. To meet the milestones of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with

[1] Class C streams may cease to flow in dry periods but maintain permanent pools that support aquatic life. See Missouri Water Quality Standards (WQS) 10 Code of State Regulations 20-7.031(1)(F). The WQS can be found at the following uniform resource locator (URL): http://www.dnr.mo.gov/env/wpp/rules/index.html#Chap7

[2] For Beneficial uses see 10 CSR 20-7.031(1)(C) and Table (H)

[3] pH is a measure of the activity of hydrogen ions (H+) in a solution and, therefore, its acidity or alkalinity.

No. 98-4282-CV-W, February 27, 2001, EPA is establishing this TMDL. EPA will be responding to comments on this draft TMDL after public notice ends on July 31, 2006.

The purpose of a TMDL is to determine the pollutant loading a waterbody can assimilate without exceeding the water quality standard (WQS) for that pollutant. The TMDL also establishes the pollutant load allocation necessary to meet the WQS established for each waterbody based on the relationship between pollutant sources and in-stream water quality conditions. The TMDL consists of a wasteload allocation (WLA), a load allocation (LA), and margin of safety (MOS). The WLA is the fraction of the total pollutant load apportioned to point sources. The LA is the fraction of the total pollutant load apportioned to nonpoint sources. The MOS is a percentage of the TMDL that accounts for the uncertainty associated with the model assumption and data inadequacies.

2. Background and Water Quality Problems

2.1 Physical Characteristics of Basin

Henry County and St. Clair County are located in west central Missouri, where the annual precipitation averaged 39.99 inches for 1999-2002. Otter Creek flows northeast and drains into the South Grand River system. The South Grand River then flows into the Osage River, which is now impounded by Truman Dam in neighboring Benton County.

Otter Creek is in the Osage Plains natural division. The Osage Plains are typically less rugged and lower in elevation than the Ozarks Division and have few caves, springs or sinkholes. Historically, this area was unaffected by glaciers and is characterized by gently rolling hills and plains. The creek itself is on an upland prairie area with gently sloping to steep topography.

Soils in the area are derived from underlying bedrock rather than from deposition by glaciers or by wind-blown soil. The strip mined area is designated in the St. Clair County Soil Survey as Kanima shaly silty clay with 10 to 50 percent slopes. This very steep, well-drained soil is found in spoil banks in upland areas, ranging from 10 to 200 acres in size. Permeability is moderate and surface runoff is rapid. Organic matter content and fertility is low. This soil can be suitable for pasture if the area is shaped to conform to surrounding topography and if less acid soil is added to allow growth of vegetation. Most areas, however, are better suited for wildlife habitat or recreational use. The soil survey suggests planting warm season grasses or legumes to control erosion on this soil. Suggested natural vegetation for typical southern Henry County/northern St. Clair County soils include native grasses like big bluestem (Andropogon gerardii), little bluestem (Schizachyrium scoparius), Indian grass (Sorghastrum nutans) and switchgrass (Panicum virgatum).

2.2 Land Use Information in Basin

Big Otter Creek's drainage area includes 75 acres of acidic coal wastes from the Otter Creek Abandoned Mine Land. Acid mine drainage was believed to affect all of Big Otter Creek between this coal waste area and Truman Reservoir. This resulted in numerous fish kills in the stream. The last mine-related fish kill in Big Otter Creek occurred in 1987. Landowners along

the creek asserted that the poor water quality was affecting their livestock.[4] The Department of Natural Resources reclaimed this area in 1998 at a cost of $955,964. A 25-acre lake provides water to dilute the acid mine drainage, and a small dilution pond was constructed to collect the numerous acid seeps. The area was revegetated with native warm and cool season grasses.

Sulfide minerals, commonly found in coal and the surrounding rock, oxidize when exposed to the air and are subsequently dissolved by surface flows and groundwater. This weathering process results in sulfuric acid forming and then showing up in the surface runoff and shallow groundwaters that feed the creeks. Fresh-water aquatic life cannot tolerate acidic (low pH) water. Water quality sampling in 1999 showed the Tributary to Big Otter contained water too acidic to meet state water quality standards. It was thought that during portions of the year, Big Otter Creek would also be impaired, so it was added to the 1998 impaired waters list. Water quality monitoring of Big Otter Creek continues (see Big Otter Creek data in Appendix C). A TMDL was approved for Tributary to Big Otter Creek on October 21, 2004. The 75 acres of AML is located on the Tributary to Big Otter Creek. The LA assigned to Tributary to Big Otter Creek is set at 45 mg/L of alkalinity which will allow the standard of 6.5 to 9.0 SU, for pH to be met (See Appendix F – Tributary to Big Otter Creek TMDL). Big Otter Creek above the confluence of Tributary to Big Otter Creek (sample site 1 in Appendix A) is unimpaired; therefore the primary cause of the impairment is believed to be the 75 acres of AML. The TMDL for Tributary to Big Otter Creek should be protective of the listed segment for Big Otter Creek.

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

Beneficial Uses:

The designated uses of Big Otter Creek, WBID 1224, are listed on page 1. The designated uses and stream classifications may be found at 10 CSR 20-7.031(1)(C) and (F) and in Table H.

Use that is impaired:

Protection of Warm Water Aquatic Life

Anti-degradation Policy:

Missouri's WQS include the U.S. Environmental Protection Agency's (EPA) "three-tiered" approach to anti-degradation, and may be found at 10 CSR 20-7.031(2).

Tier 1 – Protects existing uses and provides the absolute floor of water quality for all waters of the United States. Existing instream water uses are those uses that were attained on or after November 29, 1975, the date of EPA's first WQS Regulation, or uses for which existing water quality is suitable unless prevented by physical problems such as substrate or flow.

[4] Land Reclamation Program Biennial Report, 1997-1998, Missouri Department of Natural Resources, www.dnr.mo.gov/

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water for waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered, there must be an antidegradation review consisting of: (1) a finding that it is necessary to accommodate important economical or social development in the area where the waters are located; (2) full satisfaction of all intergovernmental coordination and public participation provisions; and (3) assurance that the highest statutory and regulatory requirements for point sources and best management practices for nonpoint sources are achieved. Furthermore, water quality may not be lowered to less than the level necessary to fully protect the "fishable/swimmable" uses and other existing uses.

Tier 3 – Protects the quality of outstanding national resources, such as waters of national and state parks, wildlife refuges and waters of exceptional recreational or ecological significance. There may be no new or increased discharges to these waters and no new or increased discharges to tributaries of these waters that would result in lower water quality (with the exception of some limited activities that result in temporary and short-term changes in water quality).

Specific Criteria:

The impairment of this waterbody is based on exceedence of the specific criteria contained in Missouri's WQS, 10 CSR 20-7.031(4)(E). There it states that water contaminants shall not cause pH to be outside of the range of 6.5-9.0 standard units.

Numeric Water Quality Target for pH: pH is the expression of hydrogen ion activity in water and is highly dependent on chemical reactions that consume or produce hydrogen ions. In natural waters these chemical reactions determine the assimilative "buffering" capacity of the solution to neutralize additional acidity or alkalinity. Therefore, for TMDL loading purposes, an alkalinity target is also being required to ensure the pH will not be below 6.5 SU in Big Otter Creek.

As discussed in the Margin of Safety (Section 7.0), the pH criterion alone may not provide sufficient assurance that the proper pH range will be maintained in Big Otter Creek. This is due to possible latent acidity. Net alkalinity is the preferred secondary water quality target because it may be treated as a conservative constituent. However, the lack of acidity data for the site makes a statistical analysis of net alkalinity difficult. Review of data from these sites suggests that total acidity will not be significant at higher total alkalinity values. Thus, total alkalinity is a good approximation of net alkalinity at Big Otter Creek. For this reason, total alkalinity will be used as the secondary numeric water quality target. To assure that the pH water quality standard is met and maintained in Big Otter Creek, a total alkalinity concentration of at least 45.0 mg/L should be maintained.

4. Calculation of Load Capacity

The Loading Capacity (LC) is the greatest amount of pollutant loading that a stream can assimilate without becoming impaired. It is equal to the sum of the Load Allocation (LA), the Wasteload Allocation (WLA) and the Margin of Safety (MOS) and can be expressed as an

equation:

$$LC = LA + WLA + MOS$$

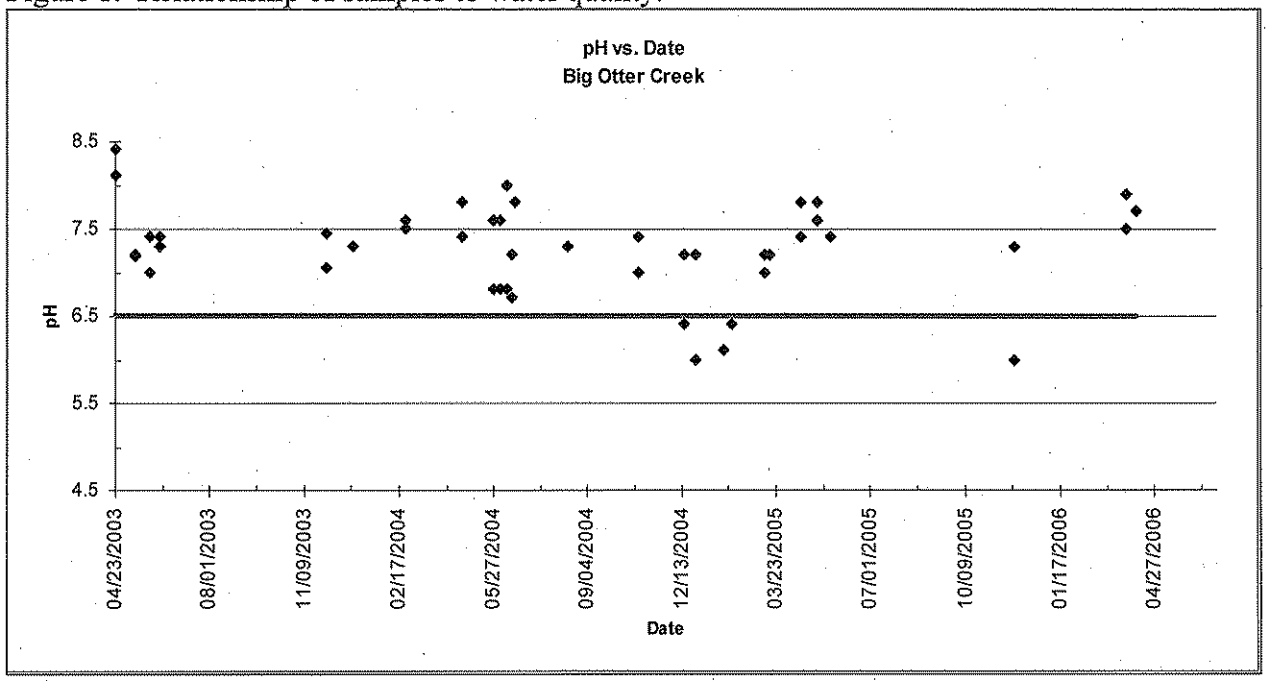
Dry weather design flow from the Otter Creek AML can not be accurately determined because surface flow and seepage rates from this area are variable. Big Otter Creek, a Class C stream, ceases to flow in dry periods but maintains permanent pools that support aquatic life. Dry weather design flow is therefore 0.1 cfs or less. Since there can be minimal upstream dilution during dry weather conditions, the flow of water coming from the Otter Creek AML areas will have to meet in-stream water quality standards for pH (6.5-9.0 SU) and an alkalinity concentration of at least 45.0 mg/L. The pH and alkalinity concentrations used as the TMDL endpoints can not be expressed as Load Allocations (LAs) + Wasteload Allocations (WLAs) + Margin of Safety (MOS). The standard Load Capacity equation shown above is not applicable when calculating pH and concentration-based endpoints. To ensure that the pH WQS is met and maintained in Big Otter Creek, the alkalinity target is set at 45.0 mg/L or greater year round.

5. Load Allocation (Nonpoint Source Loads)

LA is the allowable amount of the pollutant that can be assigned to nonpoint sources. As has already been stated, the 75 acres of AML is located on the Tributary to Big Otter Creek. The LA assigned to Tributary to Big Otter Creek is set at 45 mg/L of alkalinity which will allow the standard of 6.5 to 9.0 SU, for pH to be met (See Appendix F – Tributary to Big Otter Creek TMDL). Big Otter Creek above the confluence of Tributary to Big Otter Creek (sample site 1 in Appendix A) is unimpaired; therefore the primary cause of the impairment is believed to be the 75 acres of AML.

The load capacity for Big Otter Creek is concentration based; discharges to the stream will also be required to meet the 45 mg/L alkalinity target. With current alkalinity levels at an average of 86.2 mg/L, there appears to be sufficient buffering in the system to maintain a pH of 6.5 or better. This target will allow the standard of 6.5 to 9.0 SU to be met. No net change in the current condition is required; figure 1 on the next page shows the relationship of samples to water quality. The LA is no net change for the TMDL.

Figure 1. Relationship of samples to water quality.



6. Waste Load Allocation (Point Source Loads)

WLA is the allowable amount of the pollutant that can be assigned to point sources. There are no major point sources of pollution in the Big Otter Creek watershed. Any future discharges would be required by the Missouri State Operating Permit (per the EPA NPDES permit) to protect the stream from excursions outside of the pH range of 6.5 – 9.0 SU and a secondary requirement for a total alkalinity of 45 mg/L. No net change in the current condition is required. The WLA is no net change for this TMDL.

7. Margin of Safety

A Margin of Safety (MOS) is usually added to a TMDL, if a TMDL is necessary, to account for the uncertainties inherent in the calculations and data gathering. The MOS is intended to account for such uncertainties in a conservative manner. Based on EPA guidance, the MOS can be achieved through one of two approaches:

(1) Explicit – Reserve a numeric portion of the loading capacity as a separate term in the TMDL.

(2) Implicit – Incorporate the MOS as part of the critical conditions for the waste load allocation and the load allocation calculations by making conservative assumptions in the analysis.

The MOS in this case is implicit.

The pH criterion alone does not provide sufficient assurance that the proper pH range will be maintained in Big Otter Creek due to possible latent acidity. Net alkalinity would be the

preferred secondary water quality target, but the lack of sufficient acidity data makes this analysis difficult. As a result, in-stream alkalinity will be used as the secondary water quality target. Alkalinity is a measurable characteristic in Big Otter Creek and can be linked to the pH water quality criterion. Alkalinity has units of mg/L as CaCO3 (calcium carbonate) as discussed in Standard Methods for the Examination of Water and Wastewater.

An Ordinary Least Squares (OLS) approach was used to calculate a regression line and associated statistics for Big Otter Creek pH and alkalinity values found in Appendix C. Alkalinity standard residuals were computed and plotted. Residuals were also tested for normality and found to adhere to a normal distribution. In a previous MDNR TMDL, (Tributary to Big Otter Creek), the predicted alkalinity of 45 mg/L provided sufficient buffer capacity to ensure adequate buffering to prevent instream pH values from dropping below 6.5.

8. Seasonal Variation

The water quality data collected to this point represents all seasons. The primary process involved in the formation of acid is not significantly affected by differences in air and water temperatures associated with seasonal change. Missouri standards do not distinguish between summer and winter for pH.

9. Monitoring Plans for Big Otter Creek

Monitoring on Big Otter Creek and Tributary to Big Otter Creek is ongoing and conducted eight times each year. Parameters collected are water temperature, chloride, sulfate, alkalinity/acidity, pH and conductivity.

10. Public Participation

EPA regulations require that TMDLs be subject to public review (40 CFR 130.7). EPA is providing public notice of this TMDL for Big Otter Creek on the EPA, Region 7, TMDL website: http://www.epa.gov/region07/water/tmdl_public_notice.htm. The response to comments and final TMDL will be available at: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

This water quality limited segment of Big Otter Creek in Henry and St. Clair Counties, Missouri, is included on the approved 1998 and 2002 303(d) lists for Missouri. This TMDL is being produced by EPA to meet the requirements of the 2001 Consent Decree, *American Canoe Association, et al. v. EPA*, No. 98-1195-CV-W in consolidation with No. 98-4282-CV-W, February 27, 2001. EPA is developing this TMDL in cooperation with the State of Missouri, and EPA is establishing this TMDL at this time to fulfill the *American Canoe* consent decree obligations. Missouri may submit and EPA may approve another TMDL for this water at a later time.

As part of the public notice process, MDNR will assist EPA by providing a distribution list of interested persons to which EPA will provide an announcement of the Big Otter Creek TMDL. Groups that receive the public notice announcement will include the Missouri Clean Water Commission, the Missouri Water Quality Coordinating Committee, Stream Team

Volunteers in the county, county legislators, and potentially impacted cities, towns and facilities. EPA will respond to comments on this draft TMDL after public notice ends on July 31, 2006, and will post the response to comments on the EPA website: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

11. Appendices

Appendices:

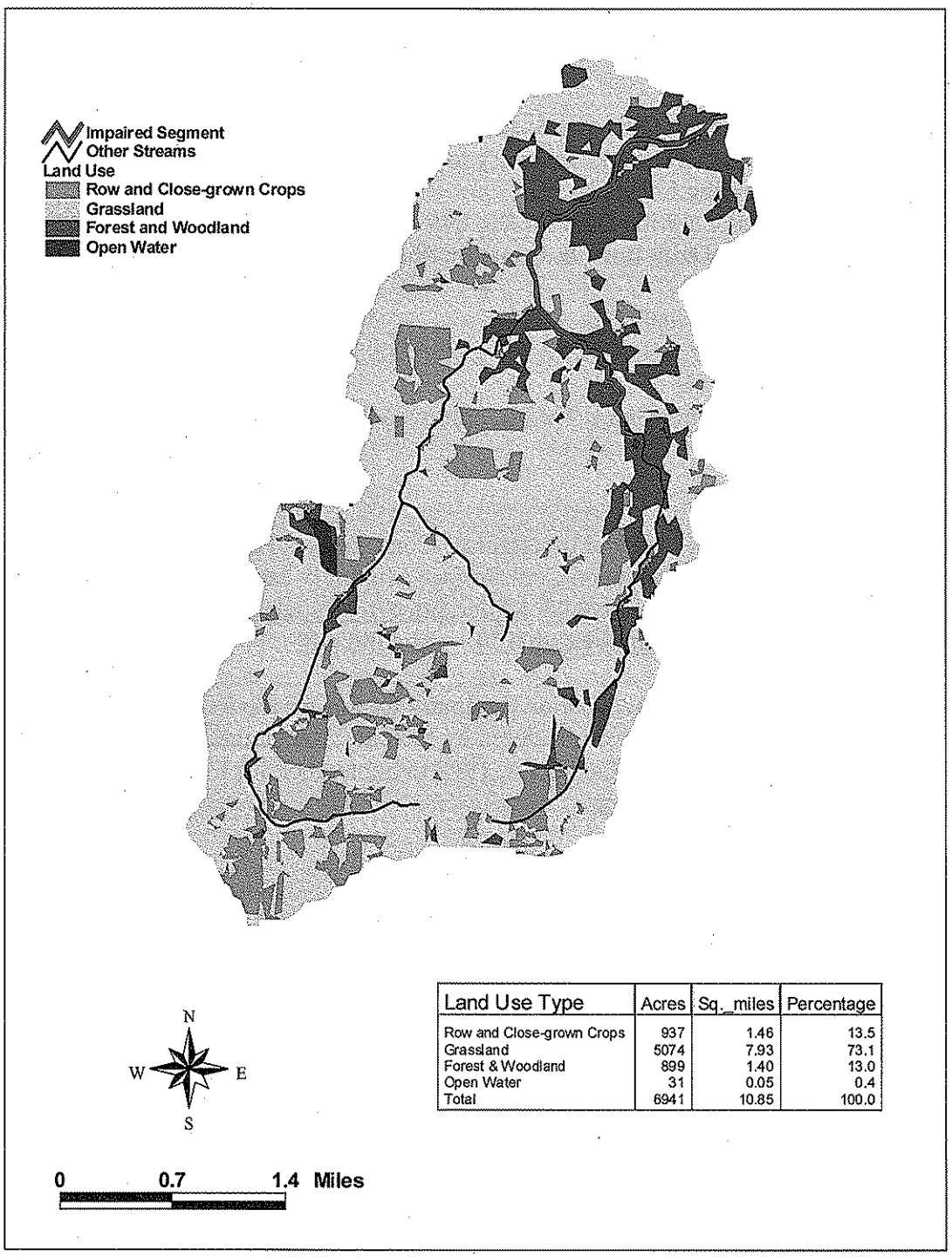
Appendix A – Land use map of Big Otter Creek Area
Appendix B – Map of Big Otter Creek and Tributary to Big Otter Creek
Showing Sampling Locations
Appendix C – Sulfate, pH and Chloride Data for Big Otter Creek, 1999-2004
Appendix D – Total Maximum Daily Load Information Sheet for Big Otter Creek
Appendix E –
Figure 2 – Alkalinity Residuals Plot
Figure 3 – Normality Plot
Figure 4 – Alkalinity vs pH
Appendix F – Tributary to Big Otter Creek TMDL, approved October 21, 2004

Basin Water Quality Studies:

- Evaluation of the Recovery of Fish and Invertebrate Communities Following Reclamation of a Watershed Impacted by an Abandoned Coal Surface Mine. By James F. Fairchild, Barry C. Poulton, Thomas W. May, and Stuart M. Miller, http://toxics.usgs.gov/pubs/wri99-4018/Volume1/sectionD/1501_Fairchild/pdf/1501_Fairchild.pdf

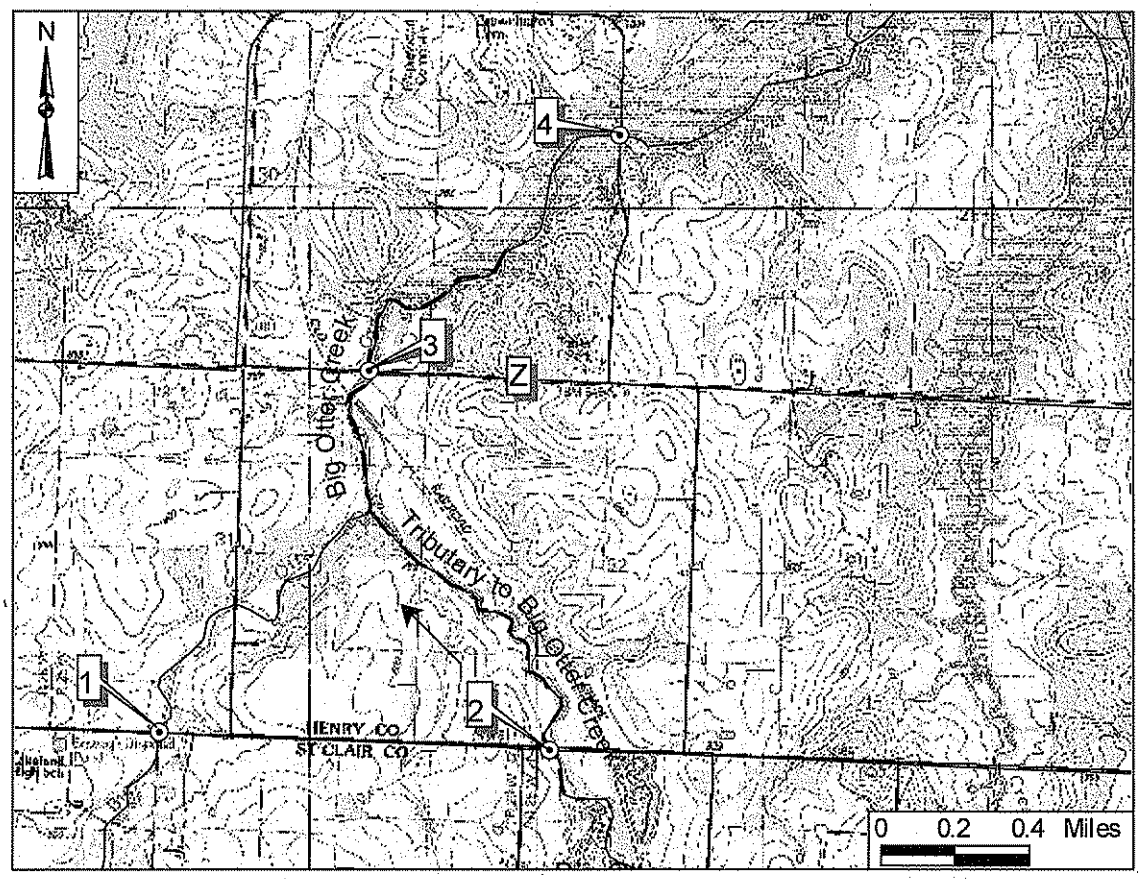
- Office of Surface Mining Annual Evaluation Summary Report for the Regulatory and Abandoned Mined Land Programs Administered by the Land Reclamation Program of Missouri for Evaluation Year 1998 (October 1, 1997 to September 30, 1998) November 1998 http://www.osmre.gov/missouri98.htm

Appendix A
Land Use Map of Big Otter Creek Area



Land Use Type	Acres	Sq._miles	Percentage
Row and Close-grown Crops	937	1.46	13.5
Grassland	5074	7.93	73.1
Forest & Woodland	899	1.40	13.0
Open Water	31	0.05	0.4
Total	6941	10.85	100.0

Appendix B
Map of Big Otter Creek and Tributary to Big Otter Creek Showing Sampling Locations



Sampling Sites

1 - Big Otter Creek upstream of Tributary
2 - Tributary of Big Otter Cr. 0.5 miles below AML
3 - Big Otter Creek at Hwy Z
4 - Big Otter Creek near mouth

Appendix C

Sulfate, pH and Chloride Data for Big Otter Creek, 1999-2006

Site Name	Yr	Mo	Dy	pH	ALK	SO4	Cl	SO4+Cl
Big Otter Cr. near mouth	2003	4	23	8.4	72	114	20	134
Big Otter Cr. near mouth	2003	5	14	7.18	85	95	19	114
Big Otter Cr. near mouth	2003	5	29	7.4	90	74	19	93
Big Otter Cr. near mouth	2003	6	10	7.4	88	65	18	83
Big Otter Cr. near mouth	2003	12	3	7.45	90	93.7	27	120.7
Big Otter Cr. near mouth	2004	2	25	7.6	57	93	19	112
Big Otter Cr. near mouth	2004	4	23	7.4	78	109	14	123
Big Otter Cr. near mouth	2004	5	26	7.6	90	45	14	59
Big Otter Cr. near mouth	2004	6	3	7.6	82	87	11	98
Big Otter Cr. near mouth	2004	6	10	8	82	87	11	98
Big Otter Cr. near mouth	2004	6	15	7.2	103	63	16	79
Big Otter Cr. near mouth	2004	6	18	7.8	90	68	16	84
Big Otter Cr. near mouth	2004	10	28	7.4	112	16	21	37
Big Otter Cr. near mouth	2004	12	15	7.2	80	73	16	89
Big Otter Cr. near mouth	2004	12	28	7.2	79	92	12	104
Big Otter Cr. near mouth	2005	3	10	7.2	61			
Big Otter Cr. near mouth	2005	4	19	7.8	74			
Big Otter Cr. near mouth	2005	5	6	7.8	97			
Big Otter Cr. near mouth	2005	11	30	7.3	183			
Big Otter Cr. near mouth	2006	3	28	7.9	120			
Big Otter Cr.@Hwy Z	1999	6	3	7.1	71	108	9	117
Big Otter Cr.@Hwy Z	2000	8	4	7.3	84	66	6	72
Big Otter Cr.@Hwy Z	2002	7	5	7.2	156	95.8	50.4	146.2
Big Otter Cr.@Hwy Z	2003	4	23	8.1	67	108	19	127
Big Otter Cr.@Hwy Z	2003	5	14	7.2	86	75	16	91
Big Otter Cr.@Hwy Z	2003	5	29	7	101	78	17	95
Big Otter Cr.@Hwy Z	2003	6	10	7.3	95	66	17	83
Big Otter Cr.@Hwy Z	2003	12	3	7.05	124	98.2	39.5	137.7
Big Otter Cr.@Hwy Z	2003	12	30	7.3	56	69	14	83
Big Otter Cr.@Hwy Z	2004	2	25	7.5	66	81	19	100
Big Otter Cr.@Hwy Z	2004	4	23	7.8	50	147	15	162
Big Otter Cr.@Hwy Z	2004	5	26	6.8	84	76	15	91
Big Otter Cr.@Hwy Z	2004	6	3	6.8	60	94	12	106
Big Otter Cr.@Hwy Z	2004	6	10	6.8	61	93	12	105
Big Otter Cr.@Hwy Z	2004	6	15	6.7	72	102	17	119
Big Otter Cr.@Hwy Z	2004	8	13	7.3	165	54	13	67
Big Otter Cr.@Hwy Z	2004	10	28	7.0	97	11	21	32

Big Otter Cr.@Hwy Z	2004	12	15	6.4	66	86	13	99
Big Otter Cr.@Hwy Z	2004	12	28	6.0	68	111	17	128
Big Otter Cr.@Hwy Z	2005	1	26	6.1	28			
Big Otter Cr.@Hwy Z	2005	2	3	6.4	25			
Big Otter Cr.@Hwy Z	2005	3	10	7	44			
Big Otter Cr.@Hwy Z	2005	3	16	7.2	46			
Big Otter Cr.@Hwy Z	2005	4	19	7.4	55			
Big Otter Cr.@Hwy Z	2005	5	6	7.6	86			
Big Otter Cr.@Hwy Z	2005	5	19	7.4	49			
Big Otter Cr.@Hwy Z	2005	11	30	6	166			
Big Otter Cr.@Hwy Z	2006	3	28	7.5	139			
Big Otter Cr.@Hwy Z	2006	4	7	7.7	143			
% of observations exceeding Water Quality Standards In Big Otter				**17.2%**				0%

Five out of twenty-nine samples taken from Big Otter Creek at Hwy. Z in the past eight years showed a pH below Missouri's WQS of 6.5. This is an exceedence rate of 17.2%.

Appendix D
Total Maximum Daily Load Information Sheet for Big Otter Creek

This document is provided as a link in electronic copies and will be included as a hard copy appendix in hard copy distributions of this TMDL.

http://www.dnr.mo.gov/env/wpp/tmdl/info/big-otter-ck-and-trib-info.pdf

Appendix E

Figure 2

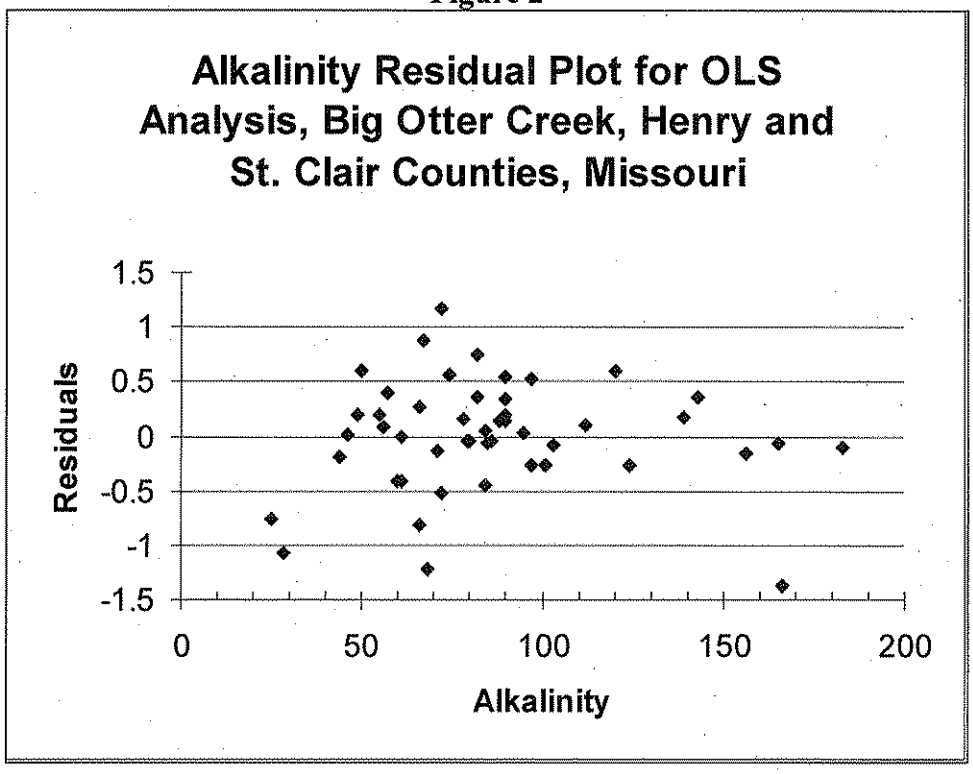


Figure 3

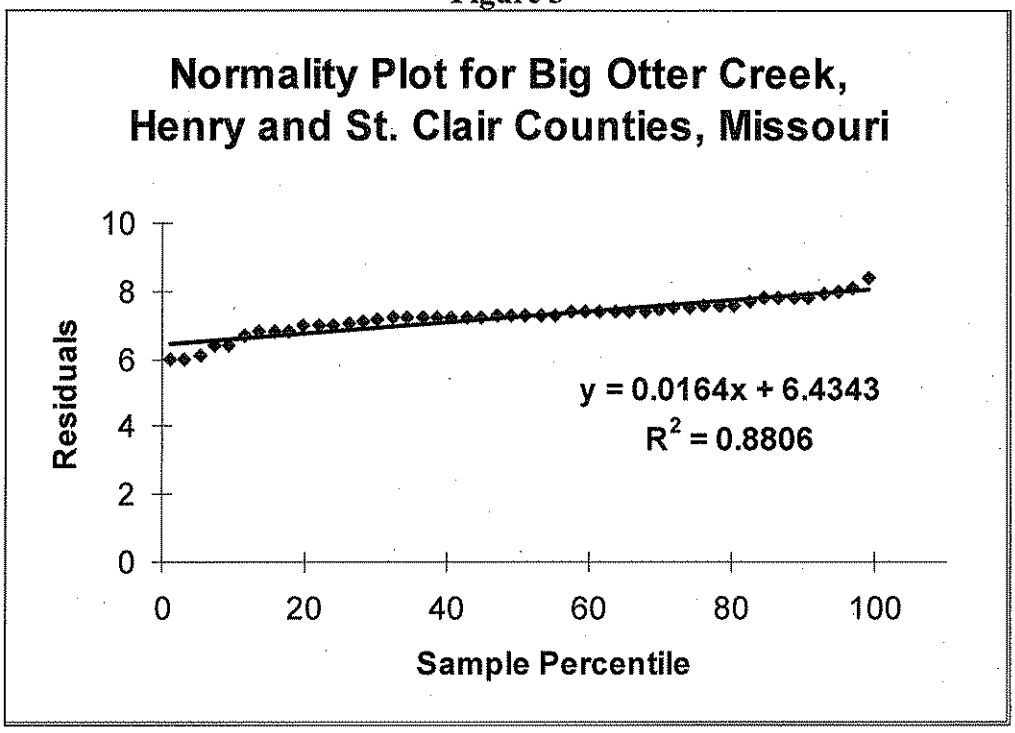
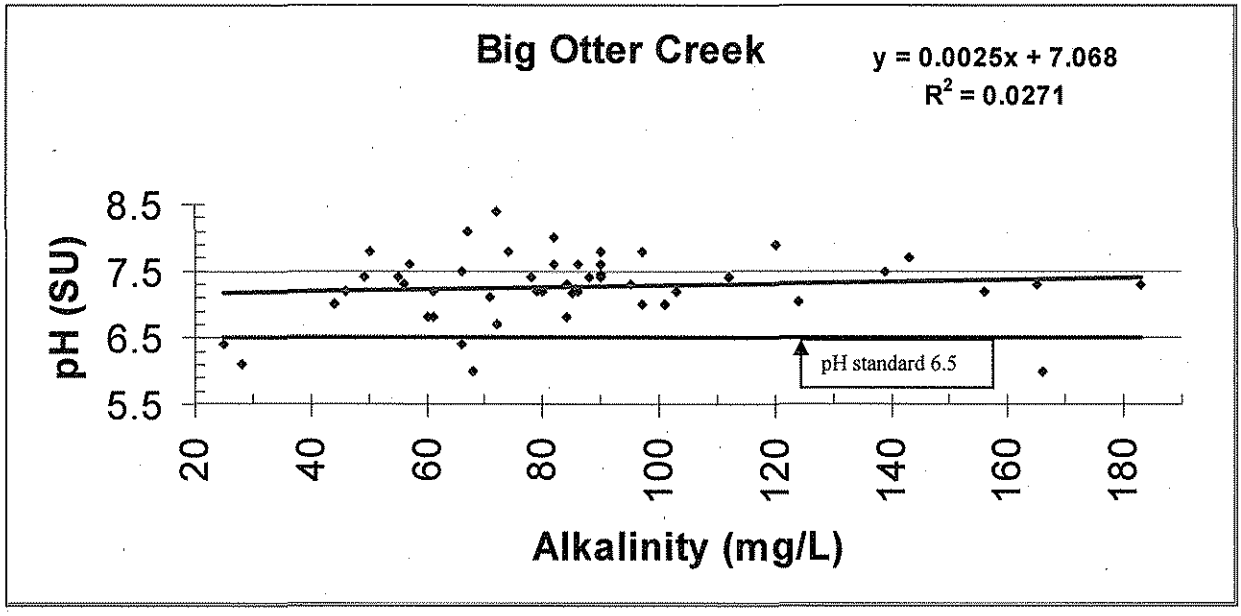


Figure 4


Big Otter Creek
y = 0.0025x + 7.068
R2 = 0.0271
pH (SU)
8.5
7.5
6.5
5.5
20
40
60
80
100
120
140
160
180
Alkalinity (mg/L)
pH standard 6.5

Appendix F
Total Maximum Daily Load for Tributary to Big Otter Creek

This document is provided as a link in electronic copies and will be included as a hard copy appendix in hard copy distributions of this TMDL.

http://www.epa.gov/region07/water/pdf/big_otter_big_otter_trib_final_tmdlpdf.pdf

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