U.S. Environmental Protection Agency Region 7

Clear Creek
Vernon County, Missouri

Total Maximum Daily Load

September, 2006

Approved by:

/s/	11/15/2006
William A. Spratlin	Date
Director	
Water, Wetlands, and Pesticides Division	

Total Maximum Daily Load (TMDL)
For Clear Creek

Pollutant: Sediment


State map showing location of watershed

Name: Clear Creek

Location: Southeast Vernon County, Missouri

Hydrologic Unit Code (HUC): 10290105-030

Water Body Identifications (WBID): 1336

Missouri Stream Classification: 18.0 miles Class C[1]

Beneficial Uses[2]:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation – Category B for Class C water bodies

Impaired Use: Protection of Warm Water Aquatic Life

Size of Impaired Segment: 18 miles

Location of Impaired Segment: From (upstream) Section 16, T34N, R30W to (downstream) Section 10, T35N, R29W

Pollutant Source: Agricultural Nonpoint Sources

Pollutant: Sediment

TMDL Priority Ranking: High

[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): 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)

1. Introduction

This Clear Creek Total Maximum Daily Load (TMDL) for sediment is being established in accordance with Section 303(d) of the Clean Water Act, because the State of Missouri (the State or Missouri) determined on the 1998 and 2002 303(d) lists of impaired waters that the water quality standards (WQS) for Clear Creek were exceeded due to sediment. To meet the milestones 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 establishing this TMDL.

Clear Creek was placed on the Missouri 303(d) list for stream habitat degradation due to sedimentation. Little sediment data exists to directly document sediment as a significant impact to the stream. General fisheries data and the effect of sediment on fish were the initial data used to consider Clear Creek for 303(d) listing. For this TMDL sediment targets were derived using generalized information from the ecological drainage unit (EDU).

The purpose of a TMDL is to determine the pollutant loading a waterbody can assimilate without exceeding the 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

Background

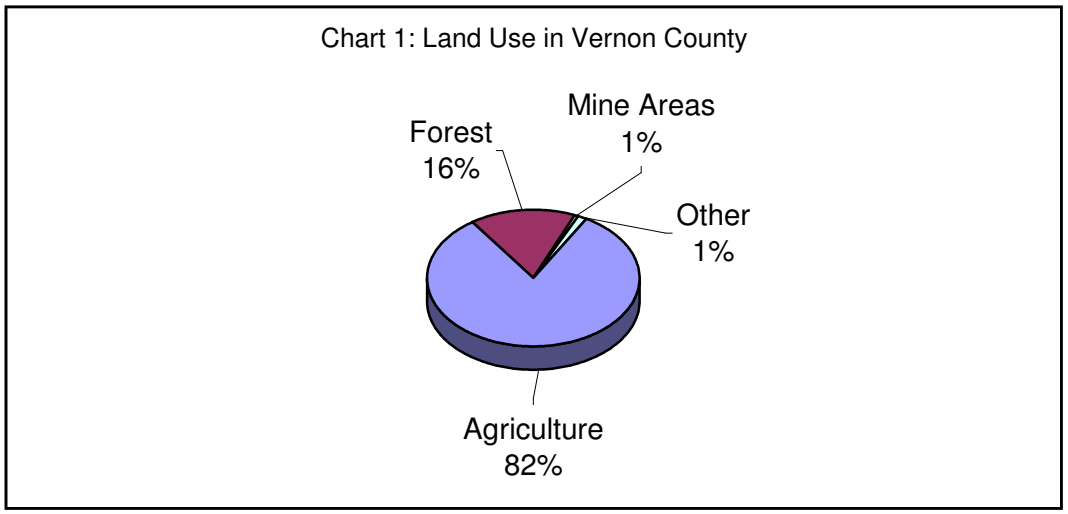
Clear Creek is a small west central Missouri tributary of the Osage River. Clear Creek originates in southeast Vernon County and northeast of Sheldon, Missouri. Clear Creek flows northeast through its watershed characterized by livestock agriculture and cropland to its confluence with the Osage River.

All waters of the State, as per Missouri WQS, must provide suitable conditions for aquatic life. The conditions include both the physical habitat and the quality of the water. TMDLs are not written to address habitat, but are written to correct water quality conditions. Because the water body addressed by this TMDL was assessed as to its biological function, many factors may have contributed to the impairment. The State of Missouri continues to do field evaluation and in the future, may define the role sediment is playing in the potential biological impairment of this waterbody. However, the water quality condition for which Clear Creek is currently listed is sedimentation; therefore, this TMDL addresses sediment. The State of Missouri may submit and EPA may approve another TMDL or a modified 303(d) listing for this water at a later time to address new information on the impairment.

The Clear Creek watershed lies within the West Osage Basin, which lies within the Central Plains – South Grand Osage EDU. Annual precipitation averages 38.5 inches.[3] The West Osage Basin encompasses 6,841 square miles in Kansas and Missouri (41% lies in Missouri). Clear Creek's watershed is approximately 124.5 mi^2 (entirely in Missouri) with land use primarily distributed as follows: 47% grassland, 23% cropland, 16% deciduous forest and 4% deciduous woody/herbaceous (Appendix A).

Historically, the basin was characterized by tall grass prairies and narrow oak-hickory forests along major streams. Much of the historic forests were converted to farmland and logged for building materials. Other impacts to the land resulted from mining operations (coal, limestone, galena, iron, copper and nickel). Today the land use in the basin is rural, characterized by an economy based primarily on agriculture, forest products, mining, and lake-oriented recreation and tourism. Agriculture is the major land use within the basin accounting for 82% of the land use in Vernon County (chart 1), which is high compared to the Missouri state average of 78% agriculture. Vernon County has the largest amount of Conservation Reserve Program land in the basin – totaling 55,337 acres which is 39% of the county's cropland.[4]

In Vernon County the percent of land used for agriculture is higher than the state percentage, see chart 1.[5]



Water Quality Problems

A combination of natural geology and land use in the prairie portions of the state (where Clear Creek is located) is believed to have reduced the amount and impaired the quality of habitat for aquatic life. The major problems are excessive rates of sediment deposition due to stream bank erosion and sheet erosion from agricultural lands, loss of stream length and loss of stream channel heterogeneity due to channelization, and changes in basin hydrology that have

[3] West Osage Watershed Inventory and Assessment, West Central Regional Fisheries, Missouri. http://mdc.mo.gov/fish/watershed/wosage/contents/310cotxt.htm
[4] http://www.fsa.usda.gov/dafp/cepd/crp.htm
[5] Source: U.S. Census of Agriculture. http://agebb.missouri.edu/mass/agrifact/vernon/index.htm

increased flood flows and prolonged low flow conditions. The number one pollutant entering Missouri's waters is sediment, with about 59 million tons of soil eroding from Missouri's land each year.[6] Sedimentation occurs when wind or water runoff carries soil particles from an area and transports them to a stream or lake. Excessive sedimentation clouds the water, which reduces the amount of sunlight reaching aquatic plants, covers fish spawning areas and food supplies, and clogs the gills of fish. In addition, other pollutants like phosphorus, pathogens, and heavy metals are often attached to the soil particles and wind up in the streams with the sediment.[7] TMDLs are not written to address habitat, but are written to correct water quality conditions. The water quality condition addressed by this TMDL is sediment.

Since little sediment data exists to directly document sediment as a significant impact to Clear Creek, Biological Assessments of Clear Creek were conducted by Missouri Department of Natural Resources (MDNR) Environmental Services Program (ESP) in fall 2003 and spring 2004; the data is shown in Appendix B and the report is Appendix F.

3. Description of Sources

Water quality problems in the Clear Creek subbasin are associated with agriculture, coal mining and municipal sewage effluent. Coal mining water quality problems are from strip-mined lands. Mine drainage increases erosion, sedimentation, conductivity, acidity, sulfate, iron and manganese concentrations; and decreases pH concentrations. Sewage discharges into Clear Creek's tributaries are from the City of Sheldon waste water treatment plant (WWTP) (MO-0040177), Camp Clark Military Reservation (MO-0037052), and several smaller un-permitted facilities. In general, sewage discharges elevate ammonia, fecal coliform and nutrient levels, excess aquatic plant growth, low dissolved oxygen (DO), high biological oxygen demand (BOD), among other problems.

The largest hog operation in Missouri, Murphy Farms or Murphy Family Ventures (MD Farms, MO-0131059) is located along Clear Creek and its tributaries. The three non-discharging, permitted Murphy Farms in the Clear Creek Watershed have a design number of 31,654 animal units.

Point Sources

Potential point sources of sediment include facilities with permits through the National Pollution Discharge Elimination System (NPDES). Clear Creek watershed's NPDES facilities are listed in Tables 1 and 2.

[6] Missouri Soil and Water Districts Commission, March 2003, Needs Assessment, Plan to Address Identified Needs and a Summary to Date, http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf.
[7] Agricultural Nonpoint Source (AgNPS), Special Area Land Treatment (SALT) Program, NPS Problems, http://www.dnr.mo.gov/env/swcp/service/Salt/nps_problems.htm#improper%20animal%20waste%20management.

Table 1: NPDES Permitted Facilities in the Clear Creek Watershed (Excluding CAFOs)

Facility Name	Permit Number	Receiving Creek	Permit Limit TSS*	Flow Design (MGD)	Facility Type
SHELDON WWTF	MO0040177	LITTLE CLEAR	80	0.071	MUNICIPAL POTW
ASH GROVE-MONTEVALLO QUARRY	MOG490112	MCCARTY	70	--	NON-MUNICIPAL LIMESTONE QUARRY
MIDWEST PROJECTS	MOG490883	TRIB CLEAR	70	--	NON-MUNICIPAL LIMESTONE QUARRY

*Permitted Final Effluent Limitations, 30 day average

Table 2: NPDES Permitted CAFOs in the Clear Creek Watershed with permitted outfalls

Facility Name	Permit Number	Receiving Creek	Permit Limit TSS*	Flow Design (MGD)	Facility Type
MURPHY FAMILY VENTURES, Outfall #1	MO0131059	CLEAR	0	0.06354	CAFO -- SWINE
MURPHY FAMILY VENTURES, Outfall #2	MO0131059	CLEAR	0	0.06354	CAFO -- SWINE
MURPHY FAMILY VENTURES, Outfall #3	MO0131059	CLEAR	0	0.06354	CAFO -- SWINE
MURPHY FAMILY VENTURES, Outfall #4	MO0131059	CLEAR	0	0.06354	CAFO -- SWINE
MURPHY FAMILY VENTURES, Outfall #1	MO0131067	WALNUT	0	0.132	CAFO -- SWINE
MURPHY FAMILY VENTURES, Outfall #2	MO0131067	WALNUT	0	0.132	CAFO -- SWINE
MURPHY FAMILY VENTURES, Outfall #3	MO0131067	MCCARTY	0	0.132	CAFO -- SWINE
MURPHY FAMILY VENTURES,Outfall #16	MO0131032	MCCARTY	0	0.23	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES Outfall #5	MO0131059	CLEAR	0	0.06354	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES Outfall #6	MO0131059	CLEAR	0	0.06354	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES, Outfall #8	MO0131059	CLEAR	0	0.06354	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES, Outfall #9	MO0131059	LITTLE CLEAR	0	0.06354	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES, Outfall #4	MO0131067	WALNUT	0	0.132	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES, Outfall #5	MO0131067	MCCARTY	0	0.132	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES, Outfall #6	MO0131067	CLEAR	0	0.132	NON-MUNICIPAL SWINE
MURPHY FAMILY VENTURES, Outfall #7	MO0131067	WALNUT	0	0.132	NON-MUNICIPAL SWINE

As seen in Tables 1 and 2, the Clear Creek Watershed includes several permitted facilities and their associated outfalls. CAFOs (Concentrated Animal Feeding Operations) in Table 2 include sixteen outfalls in the watershed operated by three permitted CAFOs. CAFOs are animal feeding operations in which animals are confined to areas that are roofed and utilize earthen or concrete structures to contain and store manure prior to land application. All permitted livestock facilities have waste management systems designed to minimize runoff entering their operations or detain runoff leaving their operations. Such systems are designed for the 25 year, 24 hour rainfall/runoff event. All CAFO outfalls in the watershed have a no

discharge requirement meaning that there is no discharge except during emergency conditions.[8] Non-CAFO permitted facilities are discussed in Section 7 of this document.

Nonpoint Sources

Sediment loading comes predominantly from nonpoint source pollution. Overland runoff carries sediment into the stream. Soil from exposed land runs into the creek which increases the turbidity and total suspended solids (TSS) concentration which decreases the transparency. Background levels of TSS come from natural fluvial processes. Sediment becomes suspended during high flow events as soil along the banks is eroded and bed sediment is re-suspended. Urban land may contribute to sediment pollution, but this watershed is less than 1% urban, so its contribution is negligible (Chart 1 and Appendix A). The main source of sediment is believed to be runoff from agricultural nonpoint sources. The dominant land use in Clear Creek watershed is agriculture, with cropland at 23%.[9] Cropland and livestock grazing in the watershed and discharges from unregulated or faulty animal waste facilities (lagoons or pits serving confined lots) can increase nutrification, nitrogen, coliform and BOD, turbidity, sedimentation, low DO, high nitrogen and phosphorous concentrations, high ammonia and high fecal coliform counts.

The most significant agriculture product in the watershed is livestock (and associated operations). Table 3, on the next page, details livestock numbers for Vernon County in 2002, but does not take into account the 1,212,491 hogs and pigs sold in Vernon County in 2002. [10] In addition to the CAFOs discussed in the Point Sources section above, Animal Feeding Operations (AFOs) are prevalent in the watershed as demonstrated by the numbers in Table 3. AFOs are agricultural operations where animals are kept and raised in confined situations, but do not meet the regulatory definition of a CAFO. AFOs generally congregate animals, feed, manure, dead animals, and production operations on a small land area. Feed is brought to the animals rather than the animals grazing or otherwise seeking feed in pastures. Animal waste and wastewater can enter water bodies from spills or breaks of waste storage structures (due to accidents or excessive rain), and non-agricultural application of manure to crop land.

[8] For more information on AFOs (Animal Feeding Operations) or CAFOs visit http://cfpub.epa.gov/npdes/home.cfm?program_id=7

[9] West Osage Watershed Inventory and Assessment, West Central Regional Fisheries, Missouri. http://mdc.mo.gov/fish/watershed/wosage/contents/310cotxt.htm

[10] Census data pull for Vernon County, Missouri, http://151.121.3.33:8080/Census/Pull_Data_Census from http://www.nass.usda.gov/Census_of_Agriculture/index.asp

Table 3: Vernon County Est. Livestock in 2002[11]

Type of Livestock	No. of Animals
Cattle – Beef	33,201
Cattle – Milk	452
Cattle – Cow/Calf	62,046
Hogs/Pigs (Swine)	135,141
Sheep/Lambs	1,399
Poultry – Layers	1,865
Poultry -- Broilers	1,097
Total	**235,201**

4. Description of the Applicable WQS and Numeric Water Quality Targets

Beneficial Uses

The designated uses of Clear Creek, WBID 1336:

- Livestock and Wildlife Watering
- Protection of Warm Water Aquatic Life
- Human Health Protection (Fish Consumption)
- Whole Body Contact Recreation – Category B for Class C water bodies

The stream classifications and designated uses may be found at 10 CSR20-7.031(1)(C) and (F) and Table H.

Use that is impaired

Protection of Warm Water Aquatic Life

Antidegradation Policy

Missouri's WQS include the EPA "three-tiered" approach to antidegradation, 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.

Tier 2 – Protects the level of water quality necessary to support propagation of fish, shellfish, and wildlife and recreation in and on the water in waters that are currently of higher quality than required to support these uses. Before water quality in Tier 2 waters can be lowered,

[11] Ibid.

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 (BMPs) 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 general, or narrative, criteria contained in Missouri's WQS, 10 CSR 20-7.031(3)(A), (C) and (G).

(A) Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
(C) Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.
(G) Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community.

When the WQS is expressed as a narrative value, a measurable indicator of the pollutant may be selected to express the narrative as a numeric value. There are many quantitative indicators of sediment, such as, TSS, turbidity, and bedload sediment, which are appropriate to describe sediment in rivers and streams.[12] TSS was selected as the numeric target for this TMDL because it enables the use of the highest quality data available, including permit conditions and monitoring data.

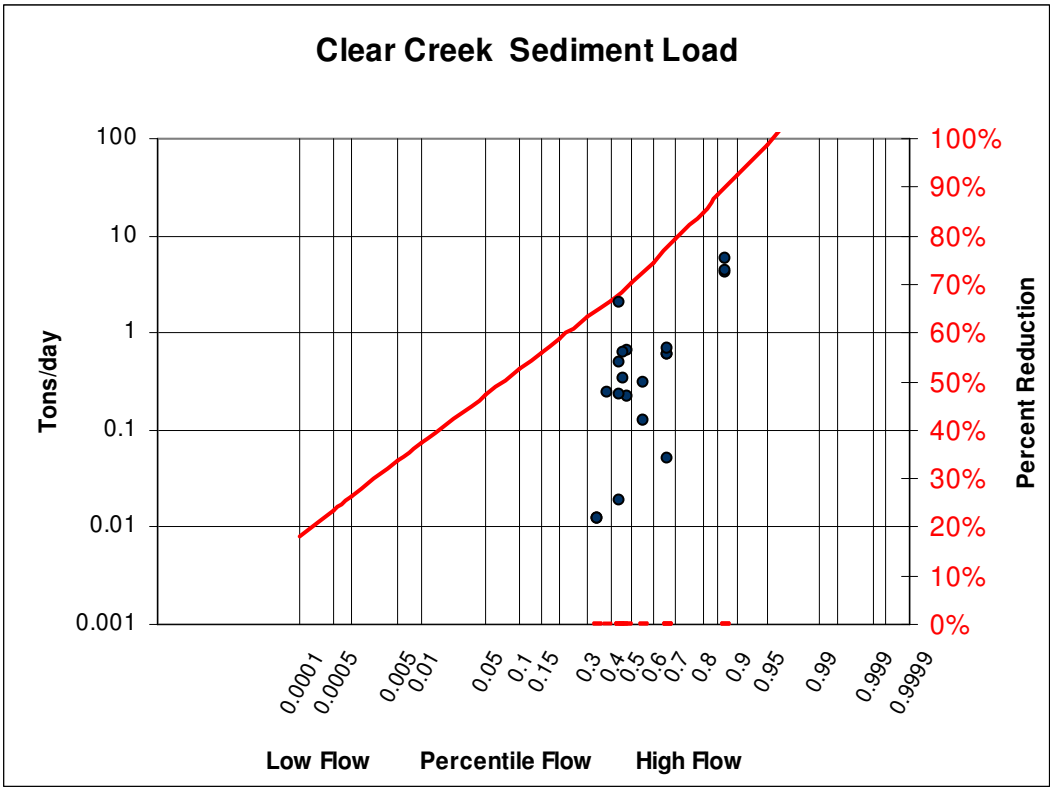
5. Calculation of Load Capacity

Load capacity (LC) is defined as the maximum pollutant load that a waterbody can assimilate and still attain WQS. This total load is then divided among a WLA for point sources, a LA for nonpoint sources and a MOS. The LC for this TMDL has been defined as a curve over the range of flows for Clear Creek; see Figure 1, where the solid (red) curve is the TMDL.

[12] Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, U.S. Environmental Protection Agency, EPA-822-R-06-001, May 2006.

Measurements are shown in Figure 1, where round (black) points are loads calculated from TSS concentrations in Clear Creek and any corresponding horizontal bars (red) are the percent reduction required to meet the TMDL. Turbidity measurements taken during the biological assessment were used to estimate TSS concentrations using relationships developed by Doisey and Rabeni (2004).[13] These estimates along with measured TSS data are shown in Figure 1.

Figure 1: TMDL curve over the range of flows.



Modeling Approach

In the case of Clear Creek where narrative standards are targeted for the impaired stream, a reference approach is used. In this approach, the target for pollutant loading is the 25th percentile of the current EDU condition calculated from all data available within the EDU in which the waterbody is located. Therefore, the 25th percentile is targeted as the TMDL load duration curve (LDC). For a full description of the development of suspended sediment targets using reference LDC refer to Appendix C. Specific data sources for this TMDL's flow and EDU-wide TSS data are listed in Appendix D. Appendix D also shows estimates of discharge at flow percentiles. The biological assessment (Appendix B) showed that Clear Creek is supporting the aquatic life use.

[13] Effects of Suspended Sediment on Native Missouri Fishes: A Literature Review and Synthesis. 2004. K.E. Doisey and C.F. Rabeni. University of Missouri.

6. Load Allocation (Nonpoint Source Loads)

LA is the allowable amount of the pollutant that can be assigned to nonpoint sources. In *Biological Assessment Report for Clear Creek*, included as Appendix F, the impairment to warm water aquatic life from stream habitat degradation due to sediment was not found for Clear Creek which is supporting a macroinvertebrate community similar to reference streams analyzed, see Appendix B. The modeling of Clear Creek shows no exceedance of the TMDL curve, refer to Figure 1. The TMDL curve is set at an estimate of expected reference conditions over the range of flows. The LA is the TMDL minus the WLA, over the range of flows.

7. Waste Load Allocation (Point Source Loads)

WLA is the allowable amount of the pollutant that can be assigned to point sources. The WLA is set to the lesser of current permit limits or technology based effluent limits (TBELs). TBELs are defined in a permit based on facility type. Mechanical WWTFs' permit limits are a weekly average TSS concentration of 45 mg/L and a monthly average TSS concentration of 30 mg/L. Secondary equivalent WWTFs' permit limits are a weekly average TSS concentration of 60 mg/L and a monthly average TSS concentration of 45 mg/L. Waste water treatment lagoon facilities' permit limits are up to a weekly average TSS concentration of 120 mg/L and a monthly average TSS concentration of 80 mg/L. Additionally, permits can be written to target lower limits if the specific facility is capable of performance exceeding TBELs. Table 4 lists the permitted point sources in the watershed and WLAs based on their current permit limits and permitted design flows. In addition any general permits need further evaluation to determine if a site specific permit is needed to address sediment loading. The WLAs listed in this TMDL do not preclude the establishment of future point sources of sediment loading in the watershed. Any future point sources should be evaluated in light of the TMDL established and the range of flows into which any additional load will impact.

Table 4: Waste Load Allocations for point sources of sediment in Clear Creek's watershed

Facility Name	Permit Number	WLA (tons/day) d/w/m*
FACILITY - WWTP -		
SHELDON WWTF	MO0040177	.023/120 /80
FACILITES - LIMESTONE QUARRIES -		
ASH GROVE-MONTEVALLO QUARRY	MOG490112	Site Specific BMPs
MIDWEST PROJECTS	MOG490883	Site Specific BMPs
FACILITES – CAFOS -		
MURPHY FAMILY VENTURES	MO0131059	0/0/0
MURPHY FAMILY VENTURES	MO0131067	0/0/0
MURPHY FAMILY VENTURES	MO0131032	0/0/0

*Permit limits based on current design loads where d=daily, w=weekly average, m=monthly average.

All permitted livestock facilities (CAFOs) in the Clear Creek watershed are non-discharging permits with permit numbers beginning with "MO-01". The WLAs are set at zero (Table 4).

In Clear Creek watershed there are two general permitted limestone quarries with permit numbers beginning "MO-G49" that limit non-stormwater discharges to a TSS concentration of 70 mg/L. Without designated flows the load can not be estimated but these concentration limits give a relative measure for potential impact of sediment loading from these facilities (Table 4). These operations are not expected to contribute to the sediment impairment if they are following a well conceived sediment control plan. BMPs should clearly be implemented as part of the permit conditions. The existing state "General Permit" requires sediment and erosion control sufficient to prevent pollution to waters of the state and comply with the effluent limitations and other permit conditions. This may require the construction of properly designed sediment basins or other treatment structures. However, site-specific BMPs are not currently defined; future permits should reflect BMPs to achieve the general permit requirements. Therefore, the WLAs for general permits are set to current conditions plus inclusion of site-specific BMPs.

8. Margin of Safety

A MOS is usually added to a TMDL 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 LC as a separate term in the TMDL.
(2) Implicit – Incorporate the MOS as part of the critical conditions for the WLA and the LA calculations by making conservative assumptions in the analysis.

All available data for Clear Creek indicates the TMDL is being met (Figure 1). This is conservative evidence that the TMDL will be protective of the designated beneficial uses and therefore an implicit MOS is assigned to this TMDL.

9. Seasonal Variation

The TMDL curve represents flow under all seasonal conditions. The LA and TMDL are applicable at all flow conditions, hence all seasons. The advantage of a LDC approach is to avoid the constraints associated with using a single-flow critical condition during the development of a TMDL. Therefore, all flow conditions including seasonal variation are taken into account for TMDL calculations. Bioassessment data used in this TMDL was generated by MDNR's ESP; invertebrate sampling was collected for two seasons, fall 2003 and spring 2004 (Appendix B). Stream Condition Index (SCI) sustainability scores of 20-16 qualify as fully sustaining, 14-10 is partially sustaining, and 8-4 is considered non-sustaining of aquatic life.

Table 5. Clear Creek Invertebrate Data

Aquatic Invertebrate Scores		
Location	**Fall 2003**	**Spring 2004**
Site 1	18	20
Site 2	20	16
Site 3	14	18

10. Monitoring Plans for Clear Creek

MDNR conducted a bioassessment on Clear Creek in 2003-4 and currently collects ambient water quality data four times a year on the stream at Highway E in Vernon County. MDNR gathers a variety of field and laboratory parameters in this on-going effort. The department will routinely examine physical habitat, water quality, invertebrate community, and fish community data collected by the Missouri Department of Conservation under its Resource Assessment and Monitoring (RAM) Program. This program randomly samples streams across Missouri on a five to six year rotating schedule.

11. Public Participation

EPA regulations, 40 CFR 130.7, require that TMDLs be subject to public review. EPA is providing public notice of this TMDL for Clear 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 Clear Creek in Vernon County, 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 Clear 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, state legislators, and potentially impacted cities, towns and facilities. The EPA public noticed this TMDL from September 29, 2006, to October 29, 2006, and the Summary of Response to Comments is posted on the EPA website: http://www.epa.gov/region07/water/apprtmdl.htm#Missouri.

12. References

- Conservation Commission of Missouri, 1995-2006, West Osage Watershed Inventory and Assessment, West Central Regional Fisheries, Missouri. http://mdc.mo.gov/fish/watershed/wosage/contents/310cotxt.htm.

- K.E. Doisey and C.F. Rabeni, 2004, Effects of Suspended Sediment on Native Missouri Fishes: A Literature Review and Synthesis, University of Missouri.

- Kansas Department of Health and Environment, 2000, Upper Wakarusa River TMDL (Sediment Impact on Aquatic Life), http://www.kdheks.gov/tmdl/klr/upwakatss.pdf and Little Arkansas River TMDL (Sediment Impact on Aquatic Life), http://www.kdheks.gov/tmdl/la/littlearksed.pdf.

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- Missouri Department of Natural Resources, 2005, Total Maximum Daily Load Information Sheet for Streams with Aquatic Habitat Loss that are Listed for Sediment, http://www.dnr.mo.gov/env/wpp/tmdl/info/habitat-info.pdf.

- Missouri Department of Natural Resources, 2007, Quality Assurance Project Plan for Wasteload Allocations/Special Studies.

- Missouri Department of Natural Resources, Agricultural Nonpoint Source (AgNPS), Special Area Land Treatment (SALT) Program, NPS Problems, 2006, http://www.dnr.mo.gov/env/swcp/service/Salt/nps_problems.htm#improper%20animal%20waste%20management.

- Missouri Soil and Water Districts Commission, March 2003, Needs Assessment, Plan to Address Identified Needs and a Summary to Date, http://www.dnr.mo.gov/env/swcp/2003%20needs%20assessment.pdf.

- Missouri Water Quality Standards (WQS) 10 Code of State Regulations 20-7.031(1)(F), www.dnr.mo.gov/env/wpp/rules/index.html#Chap7, For Beneficial uses see 10 CSR 20-7.031(1)(C) and Table (H).

- United States Department of Agriculture, 2006, NASS Quick Stats (Livestock) Census of Agriculture, Census data pull for Vernon County, Missouri, http://151.121.3.33:8080/Census/Pull_Data_Census from http://www.nass.usda.gov/Census_of_Agriculture/index.asp.

- United States Department of Agriculture, Farm Service Agency, Conservation Reserve Program, 2006, http://www.fsa.usda.gov/dafp/cepd/crp.htm.

- United States Environmental Protection Agency, 2006, Development of Suspended Sediment Targets using Reference Load Duration Curves, EPA Region 7, Kansas City, KS.

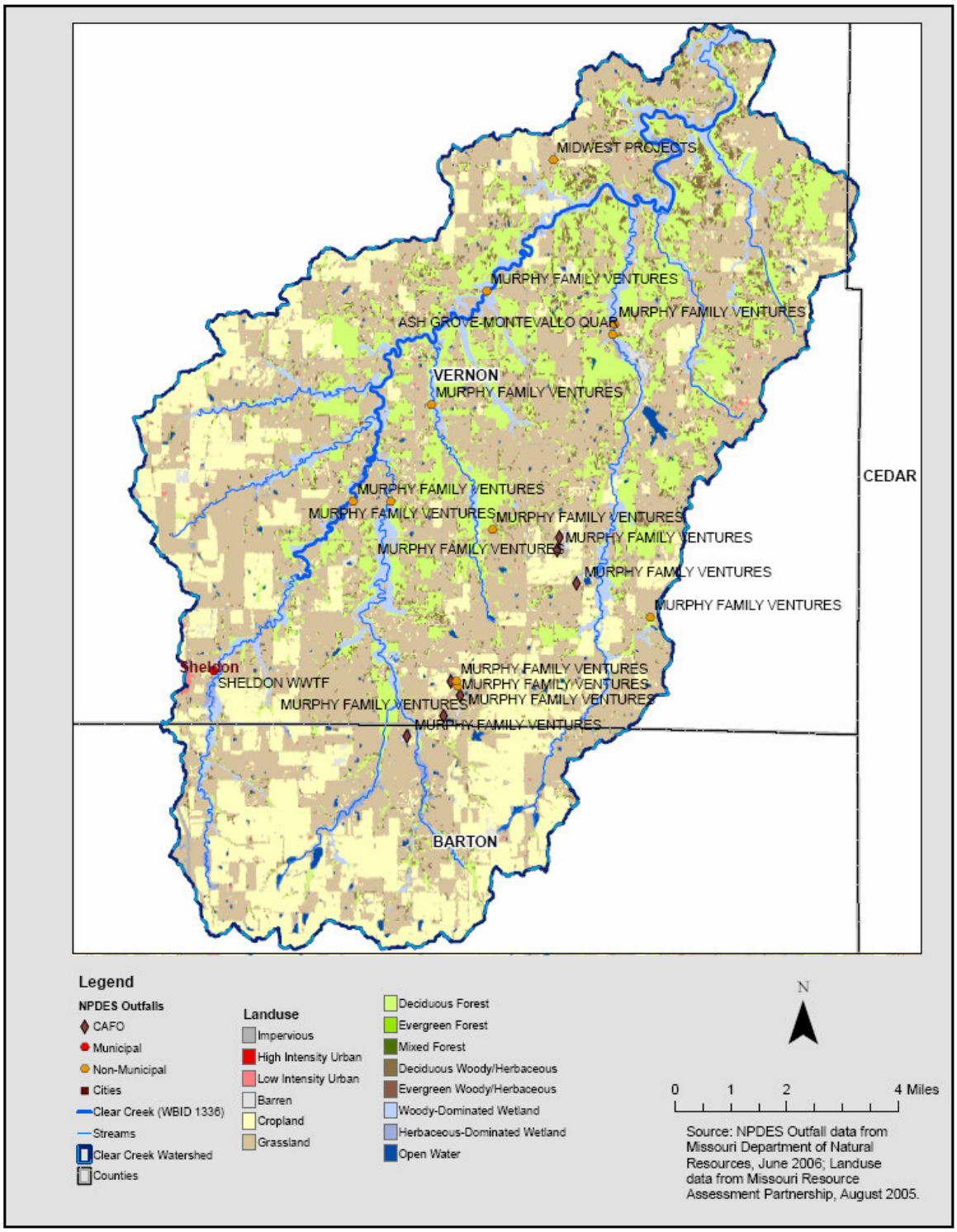
- United States Environmental Protection Agency, May 2006, Framework for Developing Suspended and Bedded Sediments (SABS) Water Quality Criteria, , EPA-822-R-06-001.

- United States Environmental Protection Agency, National Pollutant Discharge Elimination System, 2006, For more information on AFOs or CAFOs visit http://cfpub.epa.gov/npdes/home.cfm?program_id=7.

13. Appendices

Appendix A – Map Of Clear Creek Watershed And Impaired Segment – MO_1336
Appendix B – Clear Creek Invertebrate Data
Appendix C – Development of Pollutant Targets using Reference Load Duration Curves
Appendix D – Estimated Flow For Range Of Percentiles At The Impaired Segment Outlet
Appendix E – Total Maximum Daily Load Information Sheet for Clear Creek
Appendix F – Biological Assessment Report: Clear Creek in Vernon County, September 2003 – April 2004, by Missouri Department of Natural Resources

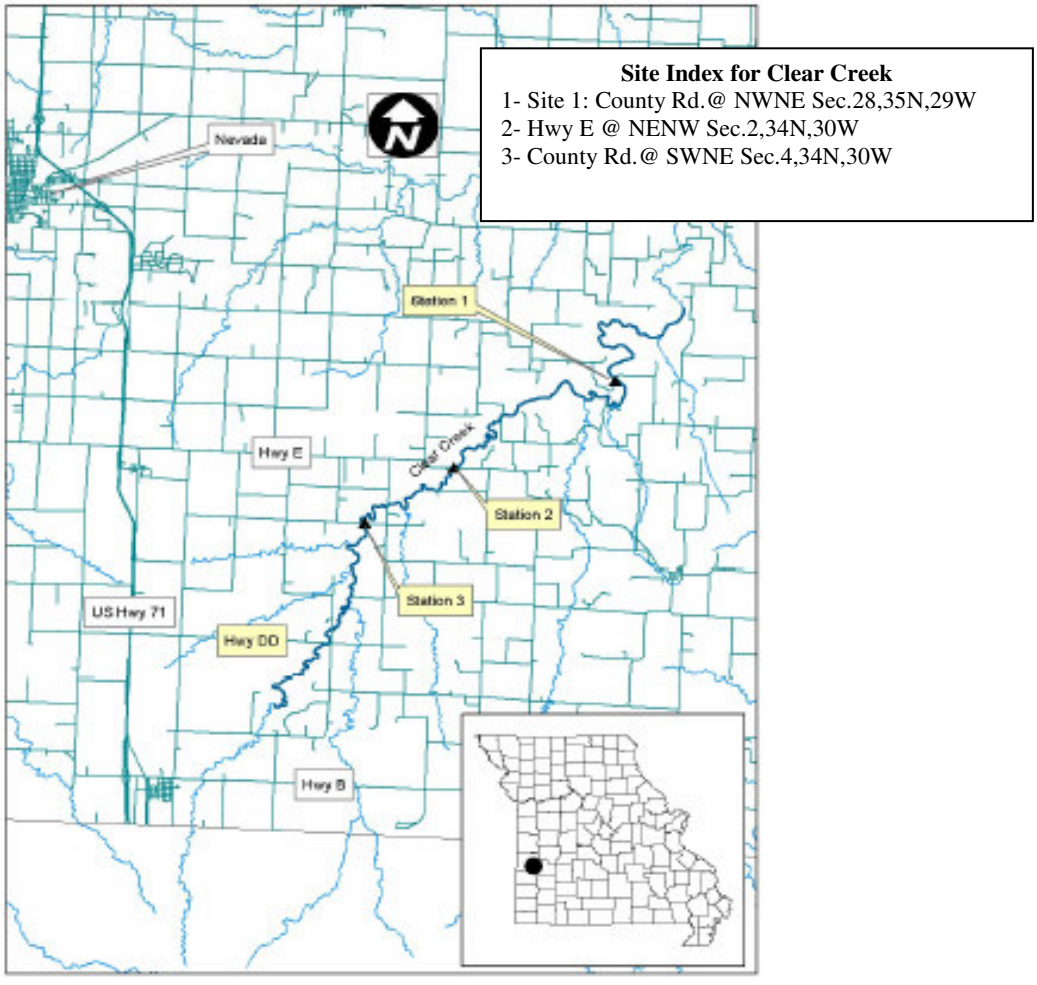
Appendix A
Map of Clear Creek Watershed and Impaired Segment – MO_1336



Appendix B
Clear Creek Invertebrate Data

Aquatic Invertebrate Scores		
Location	**Fall 2003**	**Spring 2004**
Site 1	18	20
Site 2	20	16
Site 3	14	18

Note: MDNR has developed a sediment protocol to determine if sediment is actually the pollutant in the streams so listed and to arrive at a standard way to measure sediment. The first step of that protocol is a biological assessment to see if the biological community is actually impaired. In the case of Clear Creek, the study[14] measured habitat quality, water quality, and macroinvertebrate (like larval mayflies and crayfish) communities. It found that those three measures are similar among Clear Creek stream segments and are similar between Clear Creek and biocriteria reference (high quality) streams within the same Ecological Drainage Unit (see map in Appendix A). Invertebrate scores of 16 or greater are judged to indicate unimpaired streams. Scores 14 or less are judged to be impaired. Therefore, the stream is considered not impaired by MDNR. For more details, refer to the study itself (Appendix F).



[14] Biological Assessment Report, Clear Creek, Vernon County, 2003-2004. Department of Natural Resources, Environmental Services Program (Appendix F on this document).

Appendix C
Development of Suspended Sediment Targets using Reference Load Duration Curves

Overview

This procedure is used when a lotic system is placed on the 303(d) impaired waterbody list for a pollutant and the designated use being addressed is aquatic life. In cases where pollutant data for the impaired stream is not available a reference approach is used. The target for pollutant loading is the 25th percentile calculated from all data available within the ecological drainage unit (EDU) in which the waterbody is located. Additionally, it is also unlikely that a flow record for the impaired stream is available. If this is the case a synthetic flow record is needed. In order to develop a synthetic flow record calculate an average of the log discharge per square mile of USGS gaged rivers for which the drainage area is entirely contained within the EDU. From this synthetic record develop a flow duration from which to build a load duration curve for the pollutant within the EDU.

From this population of load durations follow the reference method used in setting nutrient targets in lakes and reservoirs. In this methodology the average concentration of either the 75th percentile of reference lakes or the 25th percentile of all lakes in the region is targeted in the TMDL. For most cases available pollutant data for reference streams is also not likely to be available. Therefore follow the alternative method and target the 25th percentile of load duration of the available data within the EDU as the TMDL load duration curve. During periods of low flow the actual pollutant concentration may be more important than load. To account for this during periods of low flow the load duration curve uses the 25th percentile of EDU concentration at flows where surface runoff is less than 1% of the stream flow. This result in an inflection point in the curve below which the TMDL is calculated using load calculated with this reference concentration.

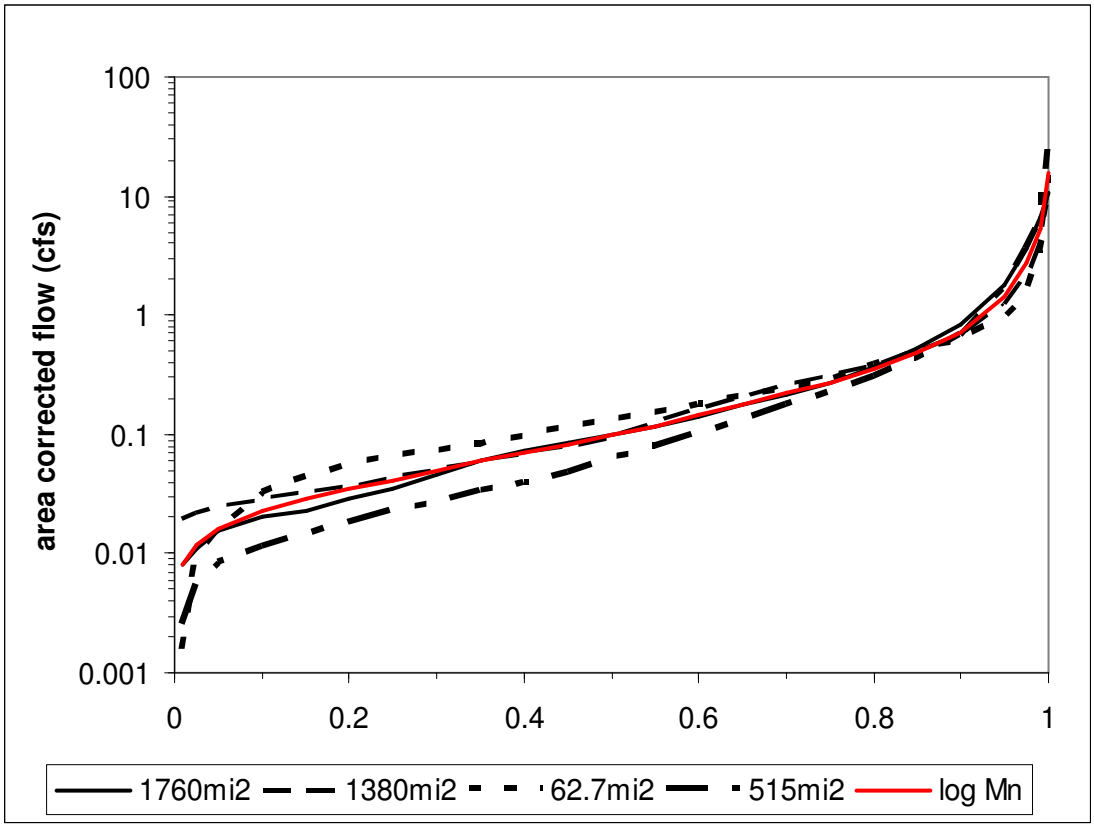
Methodology

The first step in this procedure is to locate available pollutant data within the EDU of interest. These data along with the instantaneous flow measurement taken at the time of sample collection for the specific date are recorded to create the population from which to develop the load duration. Both the date and pollutant concentration are needed in order to match the measured data to the synthetic EDU flow record.

Secondly, collect average daily flow data for gages with a variety of drainage areas for a period of time to cover the pollutant record. From these flow records normalize the flow to a per square mile basis. Average the log transformations of the average daily discharge for each day in the period of record. For each gage record used to build this synthetic flow record calculate the Nash-Sutcliffe statistic to determine if the relationship is valid for each record. This relationship must be valid in order to use this methodology. This new synthetic record of flow per square mile is used to develop the load duration for the EDU. The flow record should be of sufficient length to be able to calculate percentiles of flow.

The following examples show the application of the approach to one Missouri EDU.

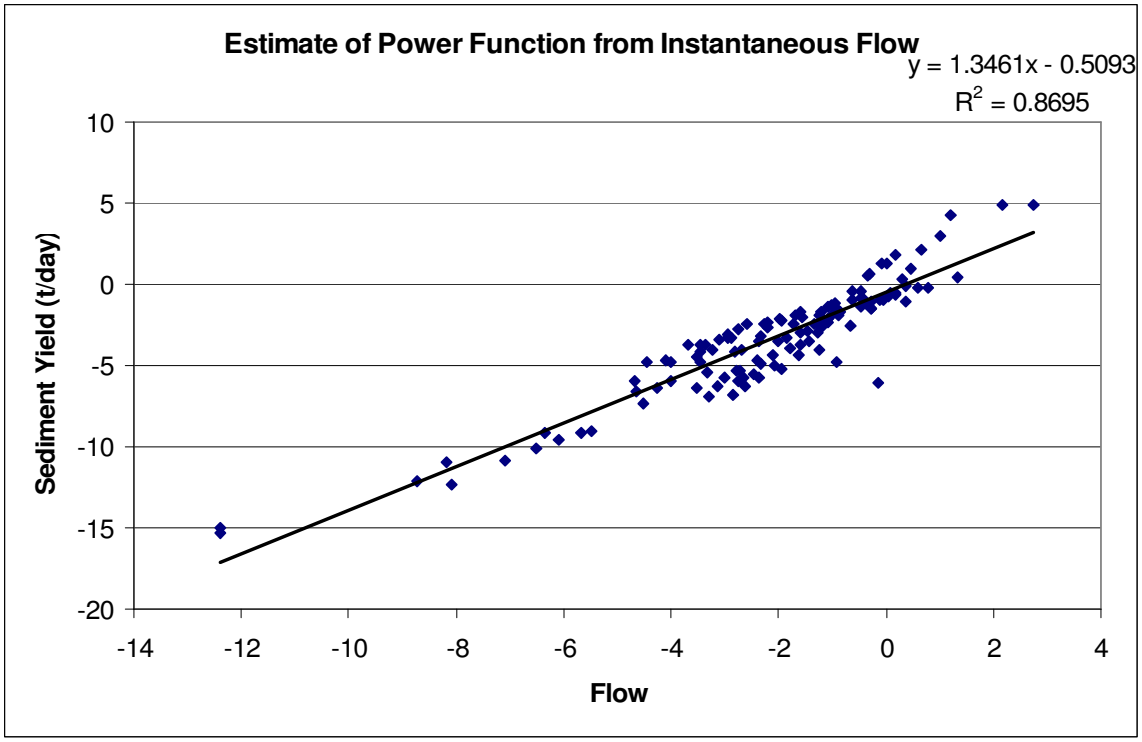
The watershed-size normalized data for the individual gages in the EDU were calculated and compared to a pooled data set including all of the gages. The results of this analysis are displayed in the following figure and table:



Gage	gage	area (mi^2)	normal Nash-Sutcliffe	lognormal Nash-Sutcliffe
Platte River	06820500	1760	80%	99%
Nodaway River	06817700	1380	90%	96%
Squaw Creek	06815575	62.7	86%	95%
102 River	06819500	515	99%	96%

This demonstrates the pooled data set can confidently be used as a surrogate for the EDU analyses.

The next step is to calculate pollutant-discharge relationships for the EDU, these are log transformed data for the yield (tons/mi^2/day) and the instantaneous flow (cfs/mi^2.) The following graph shows the EDU relationship:



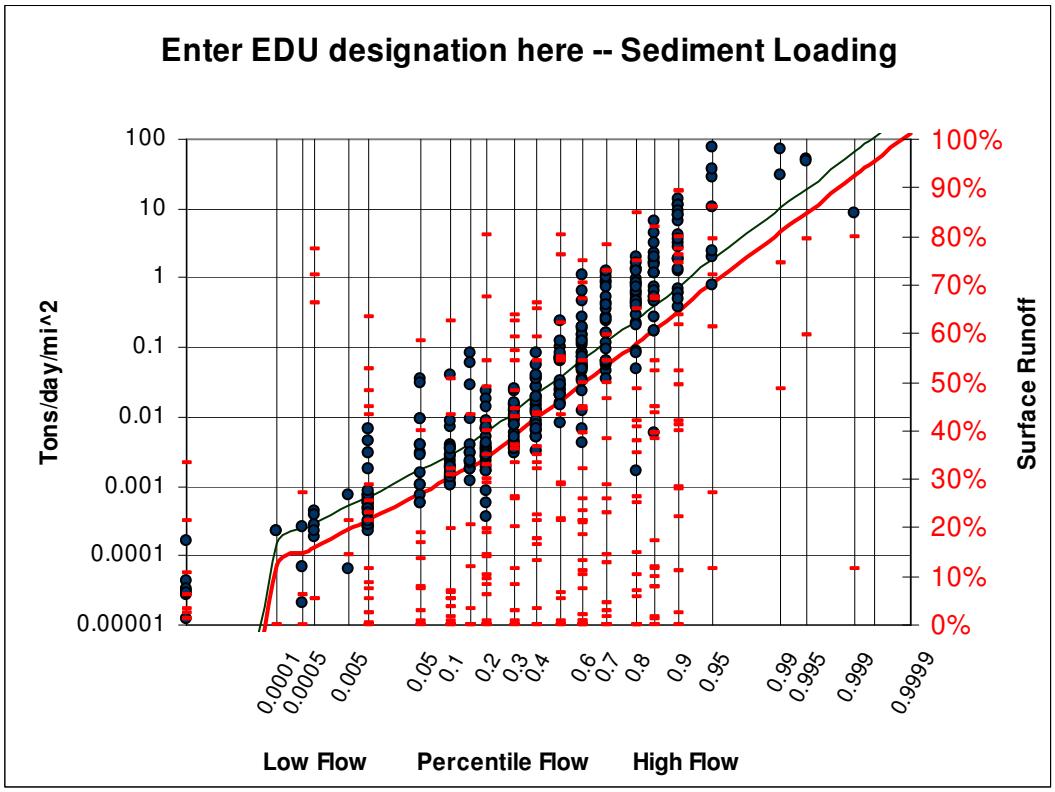
Further statistical analyses on this relationship are included in the following Table:

m	1.34608498	b	-0.509320019
Standard Error (m)	0.04721684	Standard Error (b)	0.152201589
r^2	0.86948229	Standard Error (y)	1.269553159
F	812.739077	DF	122
SSreg	1309.94458	SSres	196.6353573

The standard error of y was used to estimate the 25%ile level for the TMDL line. This was done by adjusting the intercept (b) by subtracting the product of the one-sided Z_{75} statistic times the standard error of (y). The resulting TMDL Equation is the following:

*Sediment yield (t/day/mi^2) = exp (1.34608498 * ln (flow) - 1.36627)*

A resulting pooled TMDL of all data in the watershed is shown in the following graph:



To apply this process to a specific watershed would entail using the individual watershed data compared to the above TMDL curve that has been multiplied by the watershed area. Data from the impaired segment is then plotted as a load (tons/day) for the y-axis and as the percentile of flow for the EDU on the day the sample was taken for the x-axis.

For more information contact:
Environmental Protection Agency, Region 7
Water, Wetlands, and Pesticides Division
Total Maximum Daily Load Program
901 North 5th Street
Kansas City, Kansas 66101
Website: http://www.epa.gov/region07/water/tmdl.htm

Appendix D
Estimated Flow For Range Of Percentiles
At The Impaired Segment Outlet

Estimated flow for range of percentiles at the impaired segment outlet.

	Percentile of Flow	Discharge (cubic feet per second)
Flow estimate for Clear Creek based on drainage area and synthetic ecological drainage unit flow.	10	2.4
	30	8.2
	50	18.6
	70	41.0
	90	125

USGS stream gages used to generate synthetic flow:

Big Bull near Hillsdale KS	06915000
Osage River above Schell City	06918070
Turnback Creek above Greenfield	06918460
Cedar Creek near Pleasant View	06919500
South Grand River at Archie	06921590
South Grand River near Clinton	06921760

USGS stream sample sites used to generate EDU TMDL:

South Grand River near Clinton	06921760
Osage River above Schell City	06918070
Marais des Cygnes R near KS-MO State Ln.	06916600
L Osage River at Fulton KS	06917000
Dry Wood Creek near Deerfield MO	06917680
South Grand River below Freeman MO	06921582
South Grgand River at Urich MO	06921600

Appendix E

Missouri Department of Natural Resources

Total Maximum Daily Load Information Sheet

For Streams with Aquatic Habitat Loss that are Listed for Sediment

Waterbody Segment at a Glance:

Location: Streams in Northern and West Central Missouri and in the Mississippi Embayment of Southeast Missouri and the Missouri and Mississippi Rivers.

Impairment: In 1998 the Department of Natural Resources listed 38 streams with habitat impairment due to agricultural nonpoint source problems. Twelve of them were delisted because new data showed they were higher quality reference streams, not impaired by sediment. One of them was retained on the list for "unknown" pollutants. The other 25 of them appear on the 2002 US EPA 303(d) list for Missouri as being impaired by "sediment".

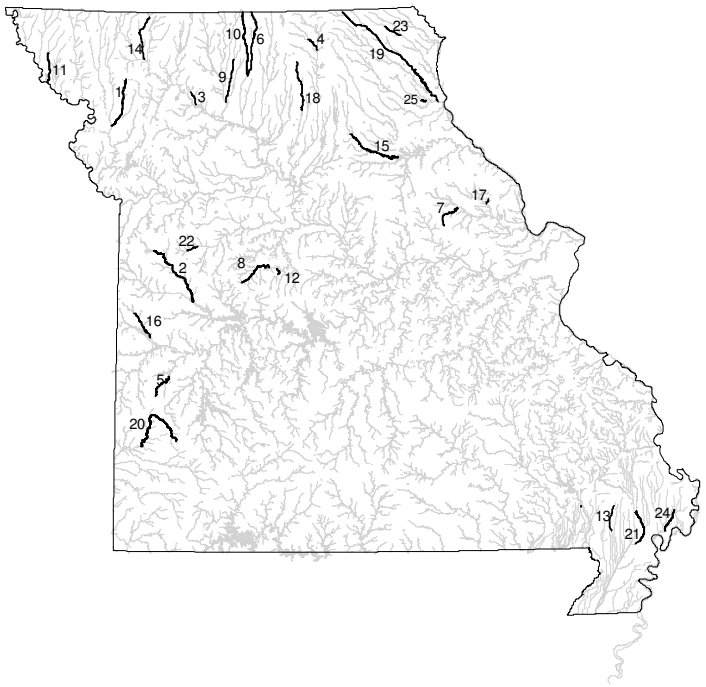
Description of the Problem

All of these waters, as per Missouri Water Quality Standards, must provide a suitable home for aquatic life. A combination of natural geology and land use in the prairie portions of the state and the Mississippi Embayment is believed to have reduced the amount and impaired the quality of aquatic habitat. The major problems are excessive rates of sediment deposition due to streambank erosion and sheet erosion from agricultural lands, loss of stream length and loss of stream channel heterogeneity due to channelization, and changes in basin hydrology that have increased flood flows and prolonged low flow conditions. Loss of tree cover in riparian zones has caused elevated water temperatures in summer and a reduction in woody debris, a critical aquatic habitat component in prairie streams. The most compelling evidence of loss or impairment of aquatic habitat is the historical change in distribution of fishes in Missouri. Many species of fish no longer appear in portions of the state where they once lived.

The department proposed changing the listing of "sediment" to "habitat loss." This change was proposed because sediment is often an important, but certainly not the only, pollutant or condition causing degradation of aquatic habitat in these streams. With this proposed change, other problems such as channelization, alteration of streambanks and riparian zones, and alteration of normal flow regimes would be included as conditions contributing to impairment. The US Environmental Protection Agency denied this change because habitat loss is "pollution", not a specific "pollutant" that can be measured and calculated. This is necessary because a TMDL (Total Maximum Daily Load) is a numeric calculation.

The department is developing a sediment protocol to determine if sediment is actually the pollutant in these streams and a standard way to measure sediment.

Missouri Streams with Loss of Habitat due to Agricultural Nonpoint Source Pollution



#	Waterbody	County (lower section)	Miles affected		#	Waterbody	County (lower section)	Miles affected
1	3rd Fork Platte River	Buchanan	31.5		14	M. Fork Grand River	Gentry	25
2	Big Creek	Henry	49		15	M. Fork Salt River	Monroe	49
3	Big Muddy Creek	Daviess	8		16	Miami Creek	Bates	18
4	Blackbird Creek	Adair	10.5		17	Mill Creek	Lincoln	4
5	Clear Creek	Vernon	18		18	Mussel Fork	Macon	29
6	E. Fork Medicine Cr.	Grundy	36		19	N. Fabius River	Marion	82
7	Elkhorn Creek	Montgomery	19		20	N. Fork Spring River	Jasper	51.5
8	Flat Creek	Pettis	20		21	Old Channel Little R.	New Madrid	20
9	Honey Creek	Livingston	23		22	S. Fork Blackwater R.	Johnson	5
10	Little Medicine Creek	Grundy	40		23	S. Wyaconda River	Clark	9
11	Little Tarkio Creek	Holt	17.5		24	Spillway Ditch	New Madrid	13.5
12	Lake Creek	Pettis	5		25	Troublesome Creek	Marion	3.5
13	Lateral #2 Main Ditch	Stoddard	11.5					

For more information call or write:
Missouri Department of Natural Resources
Water Protection Program
P.O. Box 176, Jefferson City, MO 65102-0176
1-800-361-4827 or (573) 751-1300 office or (573) 751-9396 fax
Program Home Page: www.dnr.state.mo.us/deq/wpcp

Appendix F

Biological Assessment Report:
Clear Creek in Vernon County, September 2003 – April 2004,
by Missouri Department of Natural Resources

Biological Assessment Report

Clear Creek
Vernon County

September 2003 – April 2004

Prepared for:

Missouri Department of Natural Resources
Water Protection and Soil Conservation Division
Water Protection Program

Prepared by:

Missouri Department of Natural Resources
Air and Land Protection Division
Environmental Services Program
Water Quality Monitoring Section

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Tables

Attachments

1.0 Introduction

At the request of the Water Protection Program (**WPP**), the Environmental Services Program's (**ESP**) Water Quality Monitoring Section (**WQMS**) conducted a biological assessment of Clear Creek, which flows through a rural watershed in eastern Vernon County, Missouri.

Sampling at Clear Creek was conducted on September 15, 2003 and March 16 and 17, 2004. Sampling was conducted by Brian Nodine and Carl Wakefield of the ESP, Air and Land Protection Division (**ALPD**).

On August 19, 2003 a study plan was submitted to the WPP (formerly Water Pollution Control Program) (Appendix A). Two null hypotheses were stated in this plan. The first was that macroinvertebrate communities would not differ significantly from macroinvertebrate communities in similar sized reaches of reference streams (see Table 1 for reference streams) within the Plains/Osage Ecological Drainage Unit (**EDU**). The second was that macroinvertebrate communities would not differ significantly between longitudinally separate reaches of Clear Creek. A null hypothesis that macroinvertebrate communities will not differ significantly between seasons is also addressed in this study.

2.0 Study Area

Clear Creek originates in southern Vernon County just northeast of the city of Sheldon and flows northeast through its watershed of rural pasture and cropland (Table 1) until its confluence with the Osage River in St. Clair County. According to Chapter 7 of the State of Missouri Water Quality Standards (10 CSR 20-7.031), the 15.0-mile section from sec. 10, T. 35 N., R. 29 W. to sec. 16, T. 34 N., R. 30 W. is designated class "C". Beneficial use designations are for "livestock and wildlife watering" and "warm water aquatic life protection". The15.0-mile section from sec. 10, T. 35 N., R. 29 W. to the confluence with the Osage River is designated as a class "P" stream with the same beneficial uses plus "whole body contact recreation". The upper fifteen-mile class "C" section of Clear Creek plus the upper three miles of the class "P" section were listed by the Clean Water Commission under section 303(d) of the Clean Water Act for impairment due to sediment.

Clear Creek and the reference streams are located within the Plains/Osage EDU. An EDU is a region where biological communities and habitat conditions can be expected to be similar. See Appendix B for maps of the EDUs and the 14-digit Hydrologic Units (**HU**) that contain the sampling reaches for Clear Creek. See Table 1 for a comparison of land use for the EDU and the 14-digit HUs. Land cover data were derived from the Thematic Mapper satellite data from 1991-1993, and interpreted by the Missouri Resource Assessment Partnership (MoRAP).

Table 1
Percent Land Cover

	14-digit HU	Urban	Cropland	Grassland	Forest	Swamp
Plains/Osage EDU		0.2	23	54.9	17.9	0.3
Clear Cr. #1	10290105030005	0	10.7	51.4	37	0
Clear Cr. #2 & #3	10290105030002	0	12.2	49.3	37.9	0
Reference Streams						
E. Fork Crooked R.	10300101140007	0.1	67.1	22.3	8.5	0
Little Drywood Cr.	10290104060001	0	19.1	60.9	18.8	0
Little Drywood Cr.	10290104060003	1.3	13.9	62.7	19.7	0
Little Drywood Cr.	10290104060002	0.2	16.2	64.2	20	0

3.0 Site Descriptions

All sampling locations were located within Vernon County (see map Appendix B). The average width and discharge measurements during both survey periods are given for each sampling station in Table 2 of the results section. All stations are within Class C segments.

Clear Creek Station #1 (NW ¼ NE ¼ sec. 28, T. 35 N., R. 29 W.) was located immediately downstream of the unnamed county road crossing. Geographic coordinates at the upstream terminus of this station were Lat. 37.784667º, Long. –94.132472º.

Clear Creek Station #2 (NE ¼ NW ¼ sec. 2, T. 34 N., R. 30 W.) was located immediately upstream of the Highway E crossing. Geographic coordinates at the downstream terminus of this station were Lat. 37.757472º, Long. –94.190917º.

Clear Creek Station #3 (SW ¼ NE ¼ sec. 4, T. 34 N., R. 30 W.) was located immediately downstream of an unnamed county road crossing. Geographic coordinates at the upstream terminus of this station were 37.740167º, Long. –94.223194º.

4.0 Methods

4.1 Macroinvertebrate Collection and Analysis

A standardized sample collection procedure was followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (**SMSBPP**) (MDNR 2003a). Three standard habitats, non-flowing water with depositional substrate (**NF**), large woody debris (**SG**), and rootmat (**RM**) at the stream edge were sampled at all locations.

A standardized sample analysis procedure was followed as described in the SMSBPP. The following four metrics were used: 1) Taxa Richness (**TR**); 2) total number of taxa in the orders Ephemeroptera, Plecoptera, and Trichoptera (**EPTT**); 3) Biotic Index (**BI**); and 4) Shannon Diversity Index (**SDI**).

Macroinvertebrate data were analyzed in three specific ways. First, Clear Creek stations were compared to biological criteria for the Plains/Osage EDU. Second, a longitudinal comparison between the three Clear Creek sites was performed. Finally, a comparison was made of Clear Creek data between fall and spring sampling seasons.

4.2 Physicochemical Data Collection and Analysis

During each survey period, *in situ* water quality measurements were collected at all stations for temperature (°C), dissolved oxygen concentration (mg/L), conductivity (µS/cm), and pH. These measurements followed Standard Operating Procedures MDNR-FSS-101 Field Measurement of Water Temperature (MDNR 1993), MDNR-WQMS-103 Sample Collection and Field Analysis for Dissolved Oxygen Using a Membrane Electrode Meter (MDNR 2002b), MDNR-FSS-102 Field Analysis for Specific Conductance (MDNR 2000a), and MDNR-FSS-100 Field Analysis of Water Samples for pH (MDNR 2001a) respectively. Additionally, water samples were collected and analyzed by ESP's Chemical Analysis Section for chloride (spring 2004 only), total phosphorus, ammonia-N, nitrate + nitrite-N, and total Kjeldahl nitrogen (TKN) and analyzed for turbidity (NTU) by WQMS.

Stream discharge in cubic feet per second (cfs) was measured during each survey period using a Marsh-McBirney Flo-Mate Model 2000. At sample station 2, the stream was pooled preventing discharge measurement during fall 2003 sampling. Discharge was calculated per the methods in the Standard Operating Procedure MDNR-FSS-113 Flow Measurement in Open Channels (2001b).

Stream habitat characteristics for each sampling station were measured during the spring 2004 survey period using a standardized assessment analysis procedure as described for glide/pool habitat in the Stream Habitat Assessment Project Procedure (MDNR 2003b).

Physicochemical data were summarized and presented in tabular form for comparison among the three stations and between sample seasons on Clear Creek.

4.3 Quality Assurance/Quality Control (QA/QC)

QA/QC procedures were followed as described in the Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (MDNR 2003a).

5.0 Data Results

5.1 Physicochemical Data

Physical characteristics of Clear Creek are presented in Table 2. Average stream widths at Clear Creek stations ranged from 29 feet at the most upstream station to 46 feet at the most downstream station.

Table 2
Clear Creek Physical Characteristics of the Stations

Station		Fall 2003	Spring 2004
	Ave. Width (feet)	Flow (cfs)	Flow (cfs)
1	46	0.18	82.4
2	40	-	40.4
3	29	0.03	34.3

In situ water quality measurements and turbidity are summarized in Table 3 (fall 2003) and Table 4 (spring 2004). Mean temperatures at Clear Creek stations were 20.7°C and 7.7°C in the fall 2003 and spring 2004 surveys, respectively.

Conductivity levels were consistent among stations and between seasons. Dissolved oxygen levels were consistent between stations within each season. Dissolved oxygen during the fall did fall below the Water Quality Standards minimum concentration for warm-water and cool-water fisheries (5.0 mg/L). The difference in DO levels between seasons is likely because of the seasonal difference in water temperatures and flows. Turbidity levels were notably higher at stations 2 and 3 during the fall season.

Table 3
In situ Water Quality Measurements and Turbidity at all Clear Creek Stations (Fall 2003)

Station	Parameter				
	Temp. (°C)	Diss. O_2 (mg/l)	Cond. (µmhos/cm)	pH	Turb. (NTU)
1	21	3.8	178	7.96	13.2
2	21	2.1	179	7.59	47.0
3	20	3.0	192	7.51	40.0

Table 4
In situ Water Quality Measurements and Turbidity at all Clear Creek Stations
(Spring 2004)

Station	Parameter				
	Temp. (°C)	Diss. O_2 (mg/l)	Cond. (µmhos/cm)	pH	Turb. (NTU
1	7.2	11.0	191	7.46	14.0
2	8.5	12.2	204	7.09	14.5
3	7.4	11.9	220	7.4	18.1

Nutrient and chloride concentrations are presented in Table 5 (fall 2003) and Table 6 (spring 2004). Ammonia results were below detectable limits with the exception of stations 2 and 3 during the fall 2003 season where levels, although detectable, were below general warm-water fishery chronic criteria for total ammonia. Nitrate + nitrite concentrations were below detection limits during the fall season and generally consistent between stations during spring sampling. Total phosphorous levels were slightly higher during the fall season. Chloride levels during the spring were consistent and well below chronic criteria for protection of aquatic life and drinking water supply.

Table 5
Nutrient Concentrations at all Clear Creek Stations (Fall 2003)

Station	Sample #	Parameter (mg/L)				
		NH_3-N	NO_3+NO_2-N	TKN	Total Phos.	Chloride
1	0333713	<0.03	<0.01	0.96	0.11	
2	0333714	0.21	<0.01	1.39	0.19	
3	0333715	0.18	<0.01	1.93	0.35	

Table 6
Nutrient Concentrations at all Clear Creek Stations (Spring 2004)

Station	Sample #	Parameter (mg/L)				
		NH_3-N	NO_3+NO_2-N	TKN	Total Phos.	Chloride
1	0411770	<0.03	0.48	0.30	0.05	7.24
2	0411772	<0.03	0.53	0.27	0.05	8.57
3	0411771	<0.03	0.57	0.36	0.07	9.53

5.2 Habitat Assessment

Habitat assessment scores were recorded for each sampling station. Results are presented in Table 7. According to the project procedure guidance the total score from the physical habitat assessment should be at least 75% to 100% similar to the total score of the control

site for a study site to support a similar biological community. The habitat score for the control stream, Little Dry Wood Creek, is 127. All Clear Creek stations had habitat scores that exceeded the aforementioned range of similarity. It was therefore inferred that based on habitat, the sites should support comparable biological communities.

Table 7
Clear Creek and Control Stream Habitat Scores (2004)

Control Stream	Habitat Score	Clear Creek	Habitat Score	% of Mean Control
Little Dry Wood Cr.	127	Station #1	143	112.6
		Station #2	144	113.4
		Station #3	133	104.7

5.3 Biological Assessment

5.3.1 Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP)

The SMSBPP evaluation used biological criteria that were calculated from ESP's database of Biological Criteria for Wadeable and Perennial Streams within the Plains/Osage EDU as explained in Biological Criteria for Wadeable/Perennial Streams of Missouri (MDNR 2002a). These criteria are listed for fall and spring seasons in Tables 8 and 9 respectively. Stream Condition Index (**SCI**) sustainability scores of 20-16 qualify as fully sustaining, 14-10 is partially sustaining, and 8-4 is considered non-sustaining of aquatic life.

Table 8
Biological Criteria for Warm Water Reference Streams in the Plains/Osage EDU Fall Season

	Score = 5	Score = 3	Score = 1
TR	>57	28-57	0-27
EPTT	>6	3-6	0-2
SDI	>2.86	1.43-2.86	0-1.42
BI	<7.63	7.63-8.82	8.83-10

Table 9
Biological Criteria for Warm Water Reference Streams in the Plains/Osage EDU Spring Season

	Score = 5	Score = 3	Score =1
TR	>50	25-50	0-24
EPTT	>8	4-8	0-3
SDI	>2.29	1.14-2.29	0-1.13
BI	<7.16	7.16-8.58	8.59-10

5.3.2 Comparisons of Clear Creek with Regional Reference Streams in the Plains/Osage EDU

Stream Condition Indices were calculated for Clear Creek as derived from biological criteria from regional Plains/Osage EDU reference streams. The four metrics, total scores, and SCI sustainability rankings for Clear Creek during fall 2003 and spring 2004 are presented in Tables 10 and 11 respectively. All stations during both seasons received a "fully sustainable" ranking with the exception of station 3 during the fall season that received a "partially sustainable" ranking. A possible reason for the lower score at station 3 during the fall season is because of the lower relative channel flow and water volume. This sample however was very close to a higher total score and would have received a "fully sustainable" score if just two more taxa or just one more EPT taxon were collected.

Table 10
Metric Values and Stream Condition Indices for Clear Creek, Fall 2003 Sampling Season

Station	TR	EPTT	SDI	BI	T-Score	Sustainability
1	68	8	3.03	7.86	18	**Fully**
2	60	7	2.94	7.42	20	**Fully**
3	56	6	2.97	8.08	14	**Partially**

Table 11
Metric Values and Stream Condition Indices for Clear Creek, Spring 2004 Sampling Season

Station	TR	EPTT	SDI	BI	T-Score	Sustainability
1	61	11	2.63	6.74	20	**Fully**
2	57	6	2.51	7.8	16	**Fully**
3	58	9	3.05	7.46	18	**Fully**

5.3.3 Clear Creek Longitudinal Comparison

There are no significant differences between SCIs and metrics longitudinally. With the exception of station 3 receiving a SCI of "partially sustaining" during the fall season, all other sampling stations during both seasons received an SCI of "fully sustainable".

5.3.4 Clear Creek Seasonal Comparison

There are no substantial differences between SCIs between seasons. During the fall season, SCI total scores ranged from 14 to 20 and during the spring season SCI total scores ranged from 16 to 20.

5.3.5 Macroinvertebrate Percent and Community Composition

Macroinvertebrate taxa richness, EPT taxa, and percent EPT relative abundance are presented in Table 12. These tables also present percent composition for the five dominant macroinvertebrate taxa at the three Clear Creek sites. The percent of relative abundance data were averaged from the sum of the three macroinvertebrate habitats (depositional non-flow, woody debris, and rootmat) sampled at each station.

Diptera was the dominant order and Chironomidae was the dominant family at all three sample stations during both seasons. Chironomidae was especially dominant at stations 1 and 2 during the spring 2004 season. During the fall 2003 season Tubificidae, Hyalellidae, and Arachnoidea were also well represented.

Taxa richness and total EPTT scores were consistent between stations and seasons.

Table 12
Clear Creek Macroinvertebrate Composition

	Fall 2003			Spring 2004		
	Station #1	Station #2	Station #3	Station #1	Station #2	Station #3
Taxa Richness	68	60	56	61	57	58
EPTT	8	7	6	11	6	9
% Ephemeroptera	1.3	1.5	1.9	3.2	2.1	2.3
% Plecoptera	0	0	0	7.2	2.2	3.2
% Trichoptera	0.4	0.1	0.2	0.4	0.4	1.1
Total EPT %	1.7	1.6	2.1	10.8	4.7	6.6
% Diptera	41.7	39.1	44.3	79.1	75.1	50
% Dominant Families						
Chironomidae	40.5	31.3	36.9	73.4	70.9	40.4
Physidae			4.4			
Hyalellidae	14.2	13.9	8.5		2.9	
Tubificidae	16	9.3	21.7	2.5	9.5	10.5
Arachnoidea	5.9	20.9				6.1
Ceratopogonidae	5	5.8	4.4		2.5	
Perlidae				5.7	2.2	
Simuliidae				4.2		4
Leptophlebiidae				2.6		
Asellidae						13.7

6.0 Discussion

Physicochemical results reveal few definitive trends other than typical seasonal differences.

Macroinvertebrate data do not reveal any notable impairment in Clear Creek and tend to indicate a healthy community for its EDU. The only sample that did not receive a "fully sustainable" ranking failed to do so by a very narrow margin.

Habitat assessments also do not reveal any impairment in Clear Creek. Clear Creek is typical of streams in the Plains/Osage EDU with mostly steep banks and soft substrates littered with woody debris. At the three stations, banks and riparian zones appeared predominantly well managed which should limit the quantity of sediment runoff entering the stream if consistent throughout its entire length.

7.0 Conclusions

Based on this study, there can be no conclusion drawn that Clear Creek is biologically impaired by sediment.

8.0 Recommendations

Because no impairment was revealed by this study and Clear Creek appears to be maintaining a healthy macroinvertebrate community, it is recommended it be removed from the 303(d) list of impaired waters.

9.0 Summary

1. The null hypothesis that macroinvertebrate assemblages will not differ substantially between Clear Creek and reference streams in the same EDU is accepted.

2. The null hypothesis that macroinvertebrate assemblages will not differ between longitudinally separate reaches of Clear Creek is accepted.

3. The null hypothesis that macroinvertebrate assemblages will not differ between seasons in Clear Creek is accepted.

10.0 References

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Missouri Department of Natural Resources. 2000b. Title 10. Rules of Department of Natural Resources Division 20-Clean Water Commission, Chapter 7-Water Quality. 10 CSR 20-7.031 Water Quality Standards. Missouri Department of Natural Resources, Water Pollution Control Program, P.O. Box 176, Jefferson City, Missouri 65102. pp. 10-136.

Missouri Department of Natural Resources. 2001a. Field Analysis of Water Samples for pH. MDNR-FSS-100. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 10 pp.

Missouri Department of Natural Resources. 2001b. Flow Measurement in Open Channels. Standard Operating Procedure MDNR-FSS-113. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 9 pp.

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Missouri Department of Natural Resources. 2002b. Sample Collection and Field Analysis for Dissolved Oxygen Using a Membrane Electrode Meter. MDNR-FSS-103. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 13 pp.

Missouri Department of Natural Resources. 2003a. Semi-quantitative Macroinvertebrate Stream Bioassessment Project Procedure. MDNR-FSS-030. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 24 pp.

Missouri Department of Natural Resources. 2003b. Stream Habitat Assessment Project Procedure. MDNR-FSS-032. Missouri Department of Natural Resources, Environmental Services Program, P.O. Box 176, Jefferson City, Missouri 65102. 40 pp.

Submitted by: _____

Brian L. Nodine
Environmental Specialist III
Environmental Services Program
Water Quality Monitoring Section

Date: _____

Approved by: _____

Earl W. Pabst
Director
Environmental Services Program

BN:th

c: Bruce Martin, Regional Director, SWRO
John Ford, QAPP Project Manager, WPP

Appendix A

Proposed Bioassessment Study Plan
Clear Creek
August 19, 2003

Missouri Department of Natural Resources
Bioassessment Study Plan
Clear Creek, Vernon County
August 19, 2003

Objective

This study will characterize the macroinvertebrate communities in Clear Creek at three sites within the 18 miles of 303(d) listed section to determine if the stream is impaired and justifies continued 303(d) listing. The objective of this study is to determine if aquatic macroinvertebrate life is impaired along the listed section of Clear Creek.

Null Hypotheses

1). Macroinvertebrate communities in Clear Creek will not differ significantly from macroinvertebrate communities in similar sized reaches of reference streams within the Plains/Osage Ecological Drainage Unit (EDU).

2). Macroinvertebrate communities will not differ significantly between longitudinally separate reaches of Clear Creek.

Background

Clear Creek is located in southwestern Vernon County. An eighteen mile segment from Sec. 19/20, T 34 N, R 30 W to Sec. 15, T 35 N, R 29 W is listed on the 303(d) list as impaired by aquatic habitat loss. Stream segments listed as impaired by "sediment" are proposed to have the pollutant changed to "habitat loss". Sediment is just one of several problems affecting habitat including channelization, bank alteration, and loss of riparian corridor. Changes in distribution of fish species are among the evidence used to list streams as habitat impaired. Land use that is typical in prairie regions of the state is a contributing factor to aquatic habitat loss. The goal of this study is to evaluate the listed segment of Clear Creek for impairment. If impairment is not demonstrated, rationale will be provided for removing Clear Creek from the 303(d) list.

Study Design

General: Three Clear Creek stations will be surveyed. The site locations are: 1) at the county road crossing in NW ¼ NE ¼ Sec. 28, T 35 N, R 29 W.; 2) at the Hwy. E crossing in NE ¼ NW ¼ Sec. 2, T 34 N, R 30 W.; and 3) at the county road crossing in SW ¼ NE ¼ Sec. 4, T 34 N, R 30 W. Data from these three sites will be compared against biological criteria reference data from similar streams.

At each station, the length sampled will extend 20 times the average stream width as outlined in MDNR-WQMS-032. To assess comparability between sampling stations and

reference streams, stream discharge, habitat assessment and water chemistry will be determined during macroinvertebrate surveys. Sampling will be conducted during the fall of 2003 (mid September through mid October) and the spring of 2004 (mid March through mid April).

Biological Sampling Methods: Macroinvertebrates will be sampled as per the guidelines of the Semi-Quantitative Macroinvertebrate Stream Bioassessment Project Procedure (SMSBPP). Clear Creek will be considered a "glide/pool" predominant stream; therefore samples will be collected from flow over depositional (non-flow), root-mat, and wood debris (snag) habitats. Each macroinvertebrate sample will be a composite of six subsamples within each habitat.

Habitat Sampling Methods: Stream habitat assessments will be conducted within each study area following the guidelines of MDNR-FSS-032.

Water Quality Sampling Methods: Stream discharge will be measured at each sampling location using a Marsh-McBirney flow meter. Water samples from all sampled stations will be analyzed at the ESP laboratory for ammonia, nitrogen as NO_2 +NO_3, total Kjeldahl nitrogen, total phosphorus, chloride and turbidity. Field measurements will include pH, conductivity, temperature and dissolved oxygen.

Laboratory Methods: All samples of macroinvertebrates will be processed and identified as per MDNR-FSS-209, Taxonomic Levels for Macroinvertebrate Identification. Turbidity samples will be analyzed at the MDNR biological laboratory.

Data Recording and Analyses: Macroinvertebrate data will be entered in a Microsoft Access database in accordance with MDNR-WQMS-214, Quality Control Procedures for Data Processing. Data analysis is automated within the Access database. Four standard metrics are calculated according to the SMSBPP: Total Taxa (TT); Ephemeroptera, Plecoptera, Trichoptera Taxa (EPTT); Biotic Index (BI); and the Shannon Index (SI) will be calculated for each reach.

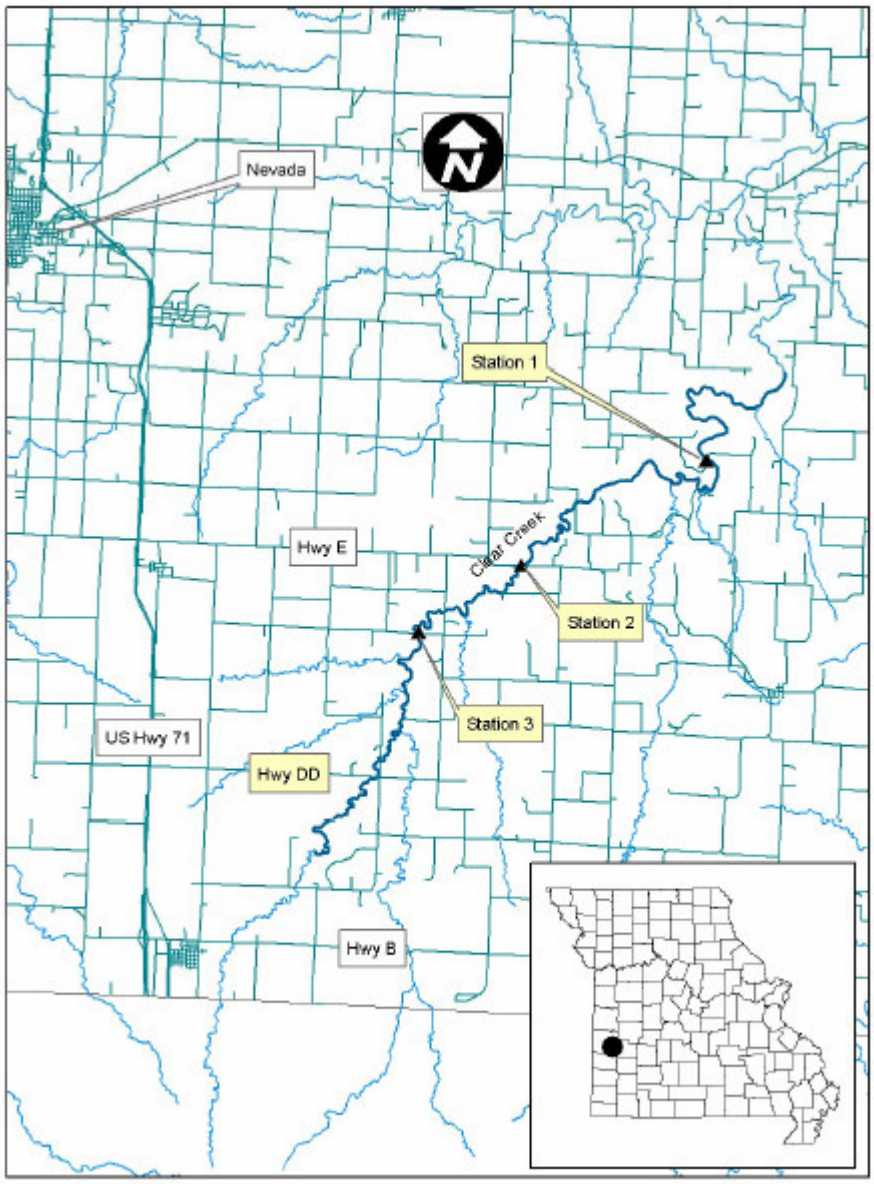
Macroinvertebrate data will be analyzed in two ways. First, a longitudinal comparison between the three Clear Creek reaches will be performed. Secondly, the data from the Clear Creek sites will be compared to biological criteria from wadeable/perennial reference streams with similar geology and watershed size classification.

Data Reporting: Results of the study will be summarized and interpreted in report format.

Quality Control: As stated in the various MDNR Project Procedures and Standard Operating Procedures.

Attachments

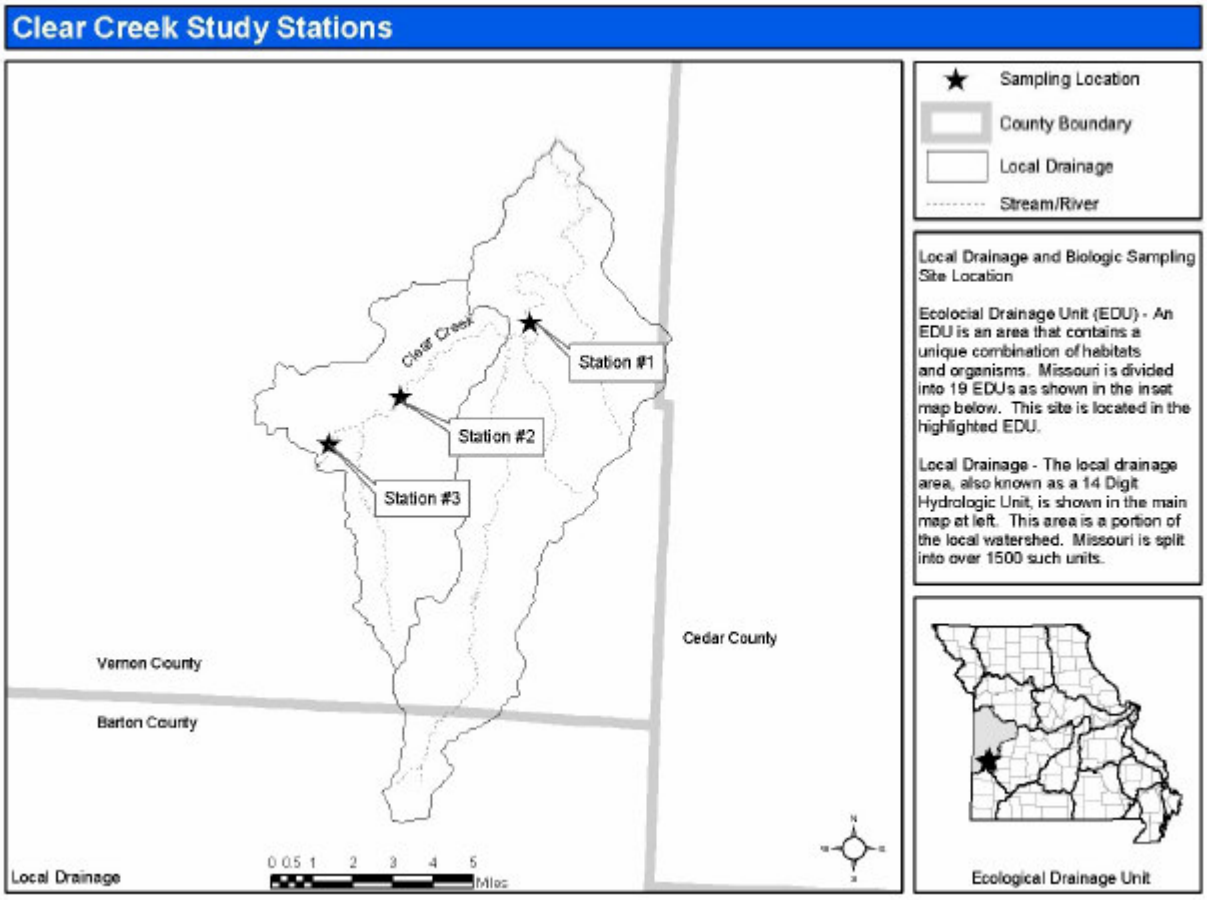
Map of all sampling stations in this study


Nevada
Station 1
Hwy E
Clear Creek
Station 2
Station 3
US Hwy 71
Hwy DD
Hwy B

Appendix B

Map

Clear Creek
Plains/Osage EDU



Appendix C

Macroinvertebrate Bench Sheets

Clear Creek Station #1
Fall 2003, Sample #0318697 (1 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Planariidae			5	Planariidae
Branchiobdellida			5	
Tubificidae	110	1	5	Tubificidae
Branchiura sowerbyi	19			Tubificidae
Aulodrilus	1			Tubificidae
Limnodrilus cervix	1			Tubificidae
Limnodrilus hoffmeisteri	3		2	Tubificidae
Lumbriculidae	1			Lumbriculidae
Glossiphoniidae		3	-99	Glossiphoniidae
Lirceus		1	4	Asellidae
Hyalella azteca		1	125	Hyalellidae
Palaemonetes			1	Palaemonidae
Orconectes virilis			1	Cambaridae
Callibaetis			1	Baetidae
Paracloeodes		1		Baetidae
Stenacron			1	Heptageniidae
Tricorythodes	2			Tricorythidae
Caenis latipennis	4		1	Caenidae
Leptophlebiidae		2		Leptophlebiidae
Argia			3	Coenagrionidae
Enallagma			6	Coenagrionidae
Nasiaeschna			1	Aeshnidae
Gomphus	-99			Gomphidae
Libellula	1		6	Libellulidae
Belostoma			-99	Belostomatidae
Mesovelia			1	Mesoveliidae
Nectopsyche	1			Leptoceridae
Triaenodes			3	Leptoceridae
Hydroporus			1	Dytiscidae
Tropisternus			-99	Hydrophilidae
Helichus lithophilus			6	Dryopidae
Scirtes		1	6	Scirtidae
Ancyronyx variegatus			1	Elmidae
Dubiraphia	7		26	Elmidae
Stenelmis	2		2	Elmidae
Climacia			1	Sisyridae
Anopheles			1	Culicidae
Chaoborus	12	1		Chaoboridae
Ceratopogoninae	41		4	Ceratopogonidae
Ablabesmyia		1	1	Chironomidae
Procladius	19			Chironomidae
Pseudosmittia	1			Chironomidae

Clear Creek Station #1
Fall 2003, Sample #0318697 (2 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Chironomus	23	3	1	Chironomidae
Cryptochironomus	1	1		Chironomidae
Dicrotendipes	2	64	3	Chironomidae
Glyptotendipes	12	128	13	Chironomidae
Cryptotendipes	7	2	1	Chironomidae
Paralauterborniella	1			Chironomidae
Kiefferulus	2	9		Chironomidae
Paratendipes	2			Chironomidae
Parachironomus	1		8	Chironomidae
Phaenopsectra		3		Chironomidae
Polypedilum illinoense			1	Chironomidae
Polypedilum scalaenum	2	1		Chironomidae
Stictochironomus	1			Chironomidae
Tribelos		2		Chironomidae
Cladotanytarsus	5	4		Chironomidae
Paratanytarsus			1	Chironomidae
Tanytarsus	8	6	3	Chironomidae
Clinotanypus			1	Chironomidae
Tanypus	8			Chironomidae
Thienemannimyia grp.		2		Chironomidae
Labrundinia		1	4	Chironomidae
Acarina	9	37	7	
Physella	1		7	Physidae
Menetus			10	Planorbidae
Ancylidae	3	1	1	Ancylidae
Sphaerium	8	2	6	Sphaeriidae

NF = Non-flow Habitat
SG = Woody Debris (Snag) Habitat
RM = Rootmat Habitat
-99 = Present

Clear Creek Station #2
Fall 2003, Sample #0318698 (1 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Planariidae			15	Planariidae
Branchiobdellida			15	
Tubificidae	78	1	4	Tubificidae
Branchiura sowerbyi	5		5	Tubificidae
Aulodrilus	6			Tubificidae
Lumbriculidae			4	Lumbriculida
Glossiphoniidae	2	11	11	Glossiphonii
Erpobdellidae	-99		2	Erpobdellida
Lirceus		1	1	Asellidae
Hyalella azteca		69	79	Hyalellidae
Orconectes virilis			-99	Cambaridae
Callibaetis	1			Baetidae
Procloeon			1	Baetidae
Stenacron		2		Heptageniida
Caenis latipennis	5	2	2	Caenidae
Leptophlebiidae		2	1	Leptophlebiid
Argia			1	Coenagrionid
Enallagma			3	Coenagrionid
Libellula	3	2	2	Libellulidae
Rheumatobates			1	Gerridae
Trepobates			1	Gerridae
Neoplea		1		Pleidae
Phryganeidae			1	Phryganeida
Oecetis	1			Leptoceridae
Hydroporus	1		1	Dytiscidae
Hydrochus		1		Hydrochidae
Scirtes		6	6	Scirtidae
Dubiraphia		3	9	Elmidae
Anopheles			1	Culicidae
Culex			3	Culicidae
Chaoborus	16			Chaoboridae
Forcipomyiinae		1		Ceratopogon
Ceratopogoninae	43	16	2	Ceratopogon
Larsia		1		Chironomida
Procladius	31	2		Chironomida
Nanocladius			1	Chironomida
Chironomus	13	1		Chironomida
Cladopelma		1		Chironomida
Cryptochironomus	1			Chironomida
Dicrotendipes	7	81	1	Chironomida
Glyptotendipes	1	87	6	Chironomida
Cryptotendipes	21	3		Chironomida

Clear Creek Station #2
Fall 2003, Sample #0318698 (2 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Kiefferulus	3	8	2	Chironomida
Parachironomus	1	1	15	Chironomida
Polypedilum halterale grp			2	Chironomida
Polypedilum illinoense		1	2	Chironomida
Cladotanytarsus	1		1	Chironomida
Paratanytarsus			2	Chironomida
Tanytarsus	4	2	1	Chironomida
Xestochironomus		1		Chironomida
Chlorotabanus		1		Tabanidae
Clinotanypus			1	Chironomida
Tanypus	7	1		Chironomida
Thienemannimyia grp.		4		Chironomida
Labrundinia		1	13	Chironomida
Acarina	73	87	62	
Physella	1	1	5	Physidae
Menetus		5	16	Planorbidae
Ancylidae	5	6	1	Ancylidae
Sphaerium	13	1	-99	Sphaeriidae

NF = Non-flow Habitat
SG = Woody Debris (Snag) Habitat
RM = Rootmat Habitat
-99 = Present

Clear Creek Station #3
Fall 2003, Sample #0318699 (1 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Branchiobdellida			5	
Tubificidae	175	15	2	Tubificidae
Aulodrilus	1			Tubificidae
Limnodrilus hoffmeisteri	9			Tubificidae
Glossiphoniidae		6	2	Glossiphoniidae
Erpobdellidae	5	2		Erpobdellidae
Lirceus		15	23	Asellidae
Hyalella azteca	1	2	76	Hyalellidae
Baetidae	1			Baetidae
Callibaetis		1		Baetidae
Caenis latipennis	1			Caenidae
Leptophlebiidae		2	13	Leptophlebiidae
Argia		2	3	Coenagrionidae
Enallagma			4	Coenagrionidae
Nasiaeschna			3	Aeshnidae
Libellula	4	1	5	Libellulidae
Pachydiplax longipennis	1			Libellulidae
Steinovelia			1	Veliidae
Rheumatobates			1	Gerridae
Neoplea			1	Pleidae
Corixidae	2	4		Corixidae
Phryganeidae			1	Phryganeidae
Triaenodes			1	Leptoceridae
Hydroporus		2	2	Dytiscidae
Helochares			1	Hydrophilidae
Hydrochus			1	Hydrochidae
Tropisternus		1		Hydrophilidae
Scirtes			20	Scirtidae
Anopheles			2	Culicidae
Chaoborus	25	1		Chaoboridae
Forcipomyiinae		2		Ceratopogonidae
Ceratopogoninae	28	9	2	Ceratopogonidae
Larsia		1		Chironomidae
Procladius	53	5	1	Chironomidae
Parakiefferiella		6	21	Chironomidae
Chironomus	9	2		Chironomidae
Cladopelma	1			Chironomidae
Dicrotendipes		31	6	Chironomidae
Glyptotendipes	11	125	4	Chironomidae
Kiefferulus	1	7	4	Chironomidae
Parachironomus		1	9	Chironomidae
Polypedilum halterale grp		4	1	Chironomidae

Clear Creek Station #3
Fall 2003, Sample #0318699 (2 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Stenochironomus		1		Chironomidae
Polypedilum illinoense		1		Chironomidae
Tanytarsus	8	12		Chironomidae
Clinotanypus	1			Chironomidae
Tanypus	12			Chironomidae
Thienemannimyia grp.		2		Chironomidae
Labrundinia		2	1	Chironomidae
Acarina	21	1	6	
Physella		9	32	Physidae
Helisoma		1		Planorbidae
Menetus			7	Planorbidae
Planorbella			1	Planorbidae
Ancylidae	3	2		Ancylidae
Sphaerium	2	6	8	Sphaeriidae

NF = Non-flow Habitat
SG = Woody Debris (Snag) Habitat
RM = Rootmat Habitat

Clear Creek Station #1
Spring 2004, Sample #0418710 (1 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Lumbricidae	1			Lumbricidae
Tubificidae	9		1	Tubificidae
Branchiura sowerbyi	2			Tubificidae
Limnodrilus cervix	2			Tubificidae
Limnodrilus hoffmeisteri	3	1		Tubificidae
Limnodrilus	3	1		Tubificidae
Enchytraeidae	1	1	3	Enchytraeidae
Erpobdellidae	2			Erpobdellidae
Lirceus		1	3	Asellidae
Hyalella azteca	2	2	6	Hyalellidae
Orconectes virilis			1	Cambaridae
Ameletus			-99	Ameletidae
Stenonema femoratum	1			Heptageniidae
Caenis latipennis	2		2	Caenidae
Leptophlebiidae	3		20	Leptophlebiidae
Libellula			-99	Libellulidae
Amphinemura		1	8	Nemouridae
Taeniopteryx		1		Taeniopterygidae
Perlesta	9	3	37	Perlidae
Isoperla		1	2	Perlodidae
Rhyacophila			3	Rhyacophilidae
Ironoquia			1	Limnephilidae
Pycnopsyche			-99	Limnephilidae
Hydroporus	3		5	Dytiscidae
Helichus lithophilus		3		Dryopidae
Dubiraphia	2		1	Elmidae
Tipula			-99	Tipulidae
Ceratopogoninae	8	1		Ceratopogonidae
Simulium		6	30	Simuliidae
Ablabesmyia	4	1	1	Chironomidae
Procladius	4			Chironomidae
Cricotopus bicinctus	1	1	3	Chironomidae
Mesocricotopus	1		1	Chironomidae
Corynoneura	4			Chironomidae
Cricotopus/Orthocladius	32	76	72	Chironomidae
Diplocladius		1	2	Chironomidae
Eukiefferiella	1	64	4	Chironomidae
Nanocladius	1			Chironomidae
Parakiefferiella	2	1		Chironomidae
Paraphaenocladius	1			Chironomidae
Smittia	2			Chironomidae
Hydrobaenus	96	115	44	Chironomidae

Clear Creek Station #1
Spring 2004, Sample #0418710 (2 of 2)

CmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Tvetenia	1	2	21	Chironomidae
Bryophaenocladius			1	Chironomidae
Chironomus	3			Chironomidae
Dicrotendipes	1	2	2	Chironomidae
Glyptotendipes	3	3	1	Chironomidae
Microtendipes			1	Chironomidae
Polypedilum convictum			1	Chironomidae
Polypedilum illinoense		2		Chironomidae
Stictochironomus	25			Chironomidae
Paratanytarsus	3		13	Chironomidae
Tanytarsus	1	2	1	Chironomidae
Tabanus	1			Tabanidae
Thienemannimyia grp.		1	1	Chironomidae
Diptera	2			
Acarina	8		1	
Fossaria			1	Lymnaeidae
Physella			3	Physidae
Menetus		1		Planorbidae
Sphaeriidae	10		1	Sphaeriidae

NF = Non-flow Habitat
SG = Woody Debris (Snag) Habitat
RM = Rootmat Habitat
-99 = Present

Clear Creek Station #2
Spring 2004, Sample #0418712 (1 of 2)

cmbTAXACODE	TxtNF	txtSG	txtR	txtFamily
Planariidae			1	Planariidae
Branchiobdellida	6		7	
Tubificidae	60	1		Tubificidae
Limnodrilus cervix	6			Tubificidae
Limnodrilus hoffmeisteri	7	3	1	Tubificidae
Limnodrilus	7			Tubificidae
Enchytraeidae		6	7	Enchytraeidae
Glossiphoniidae	-99	-99	1	Glossiphoniidae
Lirceus		3	3	Asellidae
Hyalella azteca	-99	4	22	Hyalellidae
Palaemonetes			1	Palaemonidae
Orconectes virilis	-99		-99	Cambaridae
Caenis latipennis	2		6	Caenidae
Leptophlebiidae	4		7	Leptophlebiidae
Ischnura			-99	Coenagrionidae
Nasiaeschna			1	Aeshnidae
Perlesta	8	12		Perlidae
Cheumatopsyche			1	Hydropsychidae
Agrypnia	-99	1	1	Phryganeidae
Pycnopsyche			1	Limnephilidae
Hydroporus	2	1	3	Dytiscidae
Helichus basalis		1	1	Dryopidae
Helichus lithophilus			1	Dryopidae
Scirtes		1		Scirtidae
Gonomyia			1	Tipulidae
Ceratopogoninae	22		1	Ceratopogonidae
Simuliidae		1		Simuliidae
Simulium		11		Simuliidae
Ablabesmyia	1		1	Chironomidae
Procladius	10		1	Chironomidae
Cricotopus bicinctus		1	2	Chironomidae
Mesocricotopus	2			Chironomidae
Cricotopus/Orthocladius	14	95	106	Chironomidae
Diplocladius			3	Chironomidae
Eukiefferiella		3		Chironomidae
Parakiefferiella	1		1	Chironomidae
Paraphaenocladius			1	Chironomidae
Hydrobaenus	126	104	63	Chironomidae
Tvetenia	2		2	Chironomidae
Chironomus	3			Chironomidae
Dicrotendipes	2	15		Chironomidae
Glyptotendipes	3	15		Chironomidae

Clear Creek Station #2
Spring 2004, Sample #0418712 (2 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Cryptotendipes	9			Chironomidae
Kiefferulus	1	2		Chironomidae
Microtendipes	1			Chironomidae
Polypedilum halterale grp	1			Chironomidae
Polypedilum illinoense			2	Chironomidae
Polypedilum scalaenum		1		Chironomidae
Stictochironomus	5			Chironomidae
Tribelos		1		Chironomidae
Paratanytarsus	1	2	22	Chironomidae
Tanytarsus	3	2	3	Chironomidae
Clinocera		1	1	Empididae
Thienemannimyia grp.		1		Chironomidae
Acarina	9	1	8	
Fossaria		1		Lymnaeidae
Sphaerium	3			Sphaeriidae

NF = Non-flow Habitat
SG = Woody Debris (Snag) Habitat
RM = Rootmat Habitat
-99 = Present

Clear Creek Station #3
Spring 2004, Sample #0418711 (1 of 2)

cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Tubificidae	58	4		Tubificidae
Limnodrilus cervix	1			Tubificidae
Limnodrilus hoffmeisteri	6			Tubificidae
Limnodrilus	2			Tubificidae
Enchytraeidae	2	5	8	Enchytraeidae
Glossiphoniidae	5		2	Glossiphoniidae
Erpobdellidae	2			Erpobdellidae
Lirceus	3	3	86	Asellidae
Hyalella azteca	1		18	Hyalellidae
Siphlonurus			2	Siphlonuridae
Caenis latipennis	3			Caenidae
Leptophlebia			1	Leptophlebiidae
Paraleptophlebia	1		9	Leptophlebiidae
Enallagma	2			Coenagrionidae
Nasiaeschna			1	Aeshnidae
Plathemis	1			Libellulidae
Perlesta	1	5	15	Perlidae
Isoperla			1	Perlodidae
Polycentropodidae			1	Polycentropodidae
Agrypnia	1			Phryganeidae
Ironoquia		1	5	Limnephilidae
Hydroporus	1	1		Dytiscidae
Helichus basalis		2	6	Dryopidae
Scirtes			1	Scirtidae
Tipula			1	Tipulidae
Ormosia		1	4	Tipulidae
Ceratopogoninae	23	1		Ceratopogonidae
Simulium	1	7	19	Simuliidae
Procladius	28		1	Chironomidae
Cricotopus bicinctus			1	Chironomidae
Mesocricotopus	1			Chironomidae
Corynoneura			1	Chironomidae
Cricotopus/Orthocladius	12	15	35	Chironomidae
Diplocladius			2	Chironomidae
Nanocladius			2	Chironomidae
Parakiefferiella			1	Chironomidae
Paraphaenocladius			1	Chironomidae
Mesosmittia			1	Chironomidae
Hydrobaenus	59	30	23	Chironomidae
Thienemanniella			1	Chironomidae
Tvetenia			3	Chironomidae
Dicrotendipes	2	1		Chironomidae

Clear Creek Station #3
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cmbTAXACODE	txtNF	txtSG	txtR	txtFamily
Glyptotendipes	5	12	5	Chironomidae
Cryptotendipes	2			Chironomidae
Kiefferulus		1	1	Chironomidae
Paratendipes	3			Chironomidae
Polypedilum halterale	8			Chironomidae
Polypedilum illinoense	1		4	Chironomidae
Paratanytarsus			3	Chironomidae
Tanytarsus	5			Chironomidae
Tabanus	4	1		Tabanidae
Labrundinia	1			Chironomidae
Diptera			2	
Acarina	27		14	
Fossaria	1	1	2	Lymnaeidae
Physella			5	Physidae
Ancylidae		1		Ancylidae
Sphaerium	13		4	Sphaeriidae

NF = Non-flow Habitat
SG = Woody Debris (Snag) Habitat
RM = Rootmat Habitat