TOTAL MAXIMUM DAILY LOAD (TMDL) DEVELOPMENT

for

AN UNNAMED TRIBUTARY OF BAUGHMAN FORK

and

BAUGHMAN FORK

(BOONE CREEK BASIN, FAYETTE COUNTY, KENTUCKY)

Natural Resources and Environmental Protection Cabinet

Kentucky Division of Water

July 2000

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KENTUCKY DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER

Frankfort, Kentucky

This report has been approved for release:

Jack A. Wilson, Director
Division of Water

11-6-00
Date

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List of Contributors

Dave Leist, Report Preparation and Data Analysis

Samuel M. Call, Data Collection and Analysis

Lythia Metzmeier, Data Collection and Analysis

Karen L. Smathers, Data Collection and Analysis

Mark Vogel, Data Collection and Analysis

Scott Hankla, GIS Mapping

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TMDL FACT SHEET

UNNAMED TRIBUTARY OF BAUGHMAN FORK AND BAUGHMAN FORK

Project Name: Unnamed Tributary: Organic Enrichment/low DO/Nutrients
Baughman Fork: Organic Enrichment/low DO/Nutrients

Location: Boone Creek Basin, Fayette County, Kentucky

Scope/Size: Unnamed Tributary: River mile 0.0 to 1.5
Baughman Fork: River mile 1.5 to 2.7

TMDL Issues: Point Sources

Data Sources: Kentucky Department for Environmental Protection
Division of Water

Control Measures: KPDES Regulations

Water Quality Standard/Target: Maintain Dissolved Oxygen (DO) concentration greater than 5.0 milligrams per liter (mg/L). Maintain ammonia concentrations less than 4 mg/L. Eliminate effluent toxicity through the use of limits for Total Residual Chlorine and Chronic Toxicity. Reduce phosphorus concentrations to avoid nuisance algal blooms. These standards are found within regulation 401 KAR 5:031.

Summary: The unnamed tributary of Baughman Fork and Baughman Fork were determined as not supporting the designated use of aquatic life. Therefore, the streams were listed on the 303(d) list for Total Maximum Daily Load (TMDL) development. The two stream segments are impacted by organic enrichment, low DO, and nutrients. Effluent toxicity is also a severe problem. The critical

conditions are low stream flow and warm summertime conditions. The primary cause for these problems is the discharge from the Blue Sky Wastewater Treatment Plant (WWTP), which has had, and continues to have, severe KPDES permit violations. Legal action against this facility is ongoing.

TMDL Development: Total maximum daily loads in pounds per day (lbs/day) were computed based on the allowable maximum concentration for carbonaceous biochemical oxygen demand (CBOD), nitrogen ammonia (NH3-N), total residual chlorine (TRC), and total phosphorus (TP) during the critical low-flow period. An effluent limit for toxicity is also required, but these are in a measurement of "units" and cannot be converted to a load. These parameters were chosen for TMDL development because they are the pollutants of concern for these stream segments.

Summary of Total Maximum Daily Load Allocations
(in pounds per day)

Source:	CBOD	NH3-N	TRC	TP
All Sources	55.1	7.35	0.014	1.25
Background	0	0	0	0
Waste Load Allocations (WLAs)				
Existing permits	55.1	7.35	0.014	1.25

Background loads are zero based on the critical low-flow conditions of these streams, which are dry during hot, summertime conditions. Permitted discharge loads were calculated using EPA-approved water-quality modeling procedures and regulatory water-quality standards. The loadings are based on a simple conversion of discharge permit concentrations multiplied by the WWTP size (gpd). Thus, if WWTPs

are in need of expansion, the model runs and effluent limits will be revisited. An increase in loading (lbs/day) could be approved.

Existing Loads and Load Reductions:

	Existing	TMDL	Reduction
CBOD:	10 lbs/day	55.1	None – both treatment plants doing better than permit requirements
NH3:	29 lbs/day	7.35	21.65 lbs/day
Total P:	7.5 lbs/day	1.25	6.25 lbs/day
TRC:	0.04 lbs/day	0.014	0.026 lbs/day

Implementation Controls:

A formal legal complaint was filed against the Blue Sky WWTP on March 27, 2000, in order to bring this facility into compliance with existing permit requirements. Considering the long history of violations and enforcement actions concerning this facility, the outcome and time frame for resolution of these problems are unknown. The Kentucky Division of Water's (KDOW) preferred outcome would be for the Lexington Fayette Urban County Government (LFUCG) to extend sewer lines to this area and eliminate the WWTP. A second option would be for the KDOW to revoke the permit, and operation of the facility would be taken over by LFUCG or another entity. A third option would be to allow the current owner to operate this facility, and the KDOW would continue to apply enforcement action, including monetary penalties, for failure to meet permit conditions. Under either the second or third option, the existing treatment plant will require significant upgrades or replacement, and phosphorus removal will be required. Other alternatives may be considered as the legal action progresses.

TMDL DEVELOPMENT

Unnamed Tributary of Baughman Fork and Baughman Fork
Boone Creek Basin, Fayette County, Kentucky

Introduction

Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA) Water Quality Planning and Management Regulations (40 CFR Part 130) require states to develop total maximum daily loads (TMDLs) for water bodies that are not meeting designated uses under technology-based controls for pollution. The TMDL process establishes the allowable loadings of pollutants or other quantifiable parameters for a water body based on the relation between pollution sources and in-stream water quality conditions. States can then establish water-quality based controls to reduce pollution from both point and nonpoint sources and restore the quality of their water resources.

Problem Definition

Baughman Fork from mile 0.0 to mile 1.1 was first listed in Kentucky's 1994 303(d) list as failing to support its designated use of Warm Water Aquatic Habitat because of organic enrichment, low dissolved oxygen (DO), and nutrients. Review of the data and topographic maps reveal that this designation is in error. The actual stream reach of non-support is an unnamed tributary (UT) to Baughman Fork, from mile 0.0 to mile 1.5, and roughly 1.2 miles of Baughman Fork below this tributary. This is from mile 2.7 down to about mile 1.5. Baughman Fork below this area, at mile 0.9, is published as fully supporting designated uses (but threatened) based on data collected in 1992 (Kentucky Division of Water - KDOW 1998). More recent data, as yet unpublished, indicates the site has been downgraded to partially supporting uses. The period of greatest impact to these streams is during low-flow, summertime stream conditions. The primary cause for these problems is the Blue Sky Wastewater Treatment Plant (WWTP), which discharges into the UT at mile 1.5. This facility has a design flow of 150,000 gallons per day and has been in significant violation of its permit limits for many years. In addition to violating numerical criteria, the facility consistently fails biomonitoring tests, indicating that the effluent is toxic to aquatic life. Legal action has been, and continues to

be, undertaken to bring this facility into compliance with permit requirements. A secondary problem noted throughout Baughman Fork and its receiving stream, Boone Creek, is nutrient enrichment and siltation from agricultural practices, occurring primarily during runoff events. The purpose of this TMDL report is to further describe these problems and recommend solutions.

Description of Study Area

Baughman Fork flows about six (6) miles from its headwater in eastern Fayette County to its mouth and empties into Boone Creek at mile 7.4 (Figure 1). The drainage area of Baughman Fork is roughly nine (9) square miles and drains primarily agricultural lands. The UT under study for this report is about 2.5 miles long and flows into Baughman Fork at mile 2.7. It flows from west to east and has a drainage area of almost two (2) square miles. The headwaters are in an agricultural area; then the stream flows through a developing commercial area, under a major highway (I-75), through an industrial park from mile 1.6 to mile 0.5, and then primarily through pasture land for the remaining 0.5 miles to its confluence with Baughman Fork.

Boone Creek rises in east–central Fayette County and west-central Clark County. The stream flows about 17 miles in a southerly direction, forming the Fayette-Clark County border for most of its length before its confluence with the Kentucky River at mile 170.6, near Clays Ferry. The drainage area of Boone Creek at its mouth is 44 square miles, primarily within the Inner Bluegrass Physiographic Region. This region has gently rolling topography underlain by the Lexington Limestone geologic formation, which is high in calcium phosphate. The area is dominated by karst topography, and springs can be found throughout the area. Land use is primarily agricultural throughout the drainage. The lower six miles cut through steep gorges of Ordovician limestone, and the banks are steep and heavily wooded. In 1982 the Kentucky State Nature Preserves Commission recommended Boone Creek for Outstanding Resource Water (ORW) status because it has exceptional aesthetic value, a diverse and unique aquatic biota, and a unique aquatic environment within a physiographic region. The KDOW did not, however, reclassify the stream to ORW because it does not meet the strict legal requirements necessary for this classification.

Figure 1. Boone Creek Basin, Fayette County, Kentucky, and Sampling Stations

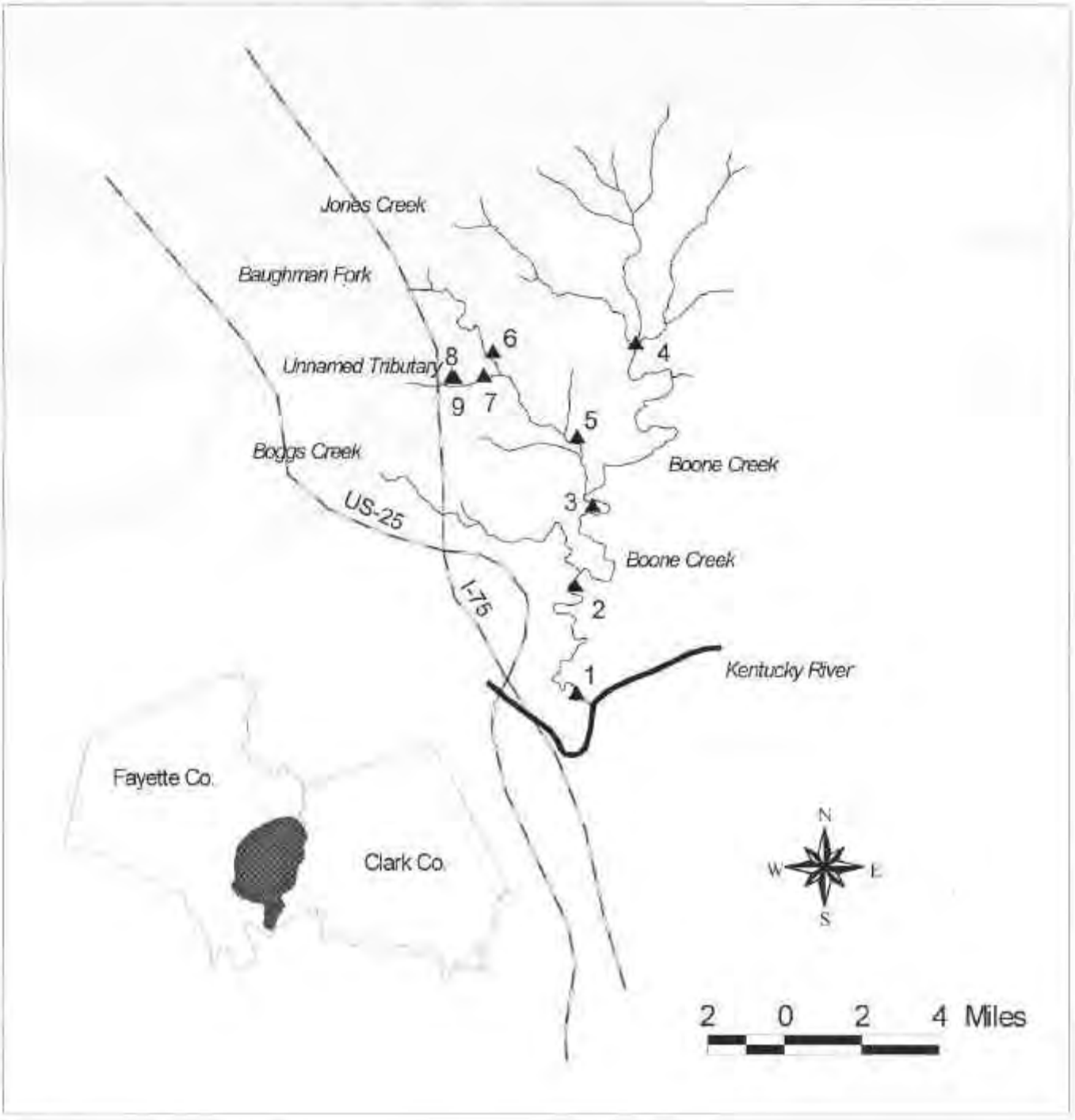

Table 1. List of Sampling Stations

Map #	Description
1	Boone Creek at mile 0.3, near the confluence with the Kentucky River
2	Boone Creek at mile 3.3, Grimes Mill Road Bridge
3	Boone Creek at mile 6.5, 0.4 miles above the Hwy 418 Bridge
4	Boone Creek at mile 12.6, above Baughman Fork, at Sulphur Well Road Bridge
5	Baughman Fork at mile 0.9, 1.7 miles below the Unnamed trib., at Gentry Road Bridge
6	Baughman Fork at mile 3.0, 0.3 miles above the Unnamed trib., at Cleveland Road Bridge
7	Unnamed tributary to Baughman Fork at mile 0.4, 0.3 miles upstream of Cleveland Road Bridge
8	Unnamed tributary to Baughman Fork at mile 1.55, above Blue Sky WWTP
9	Blue Sky WWTP Effluent, into mile 1.5 of Unnamed tributary

The Kentucky Rivers Assessment (KDOW 1992) considers Boone Creek an important stream in six categories: undeveloped corridor characteristics, botanical resources, fish resources, scenic features, whitewater recreational boating, and water quality.

Water Quality and Biological Data

Water quality and biological data were collected in the Boone Creek basin in 1949 and 1950. Neel (1951) reported, “though no industrial wastes empty into its drainage, it cannot technically be considered unpolluted as it receives domestic sewage and farm wastes from the villages and farms in the area.” He later noted that “Boone Creek received an insignificant amount of human wastes, but was enriched by livestock manure from pastures, and received carbonic acid erosion of calcium diphosphate rock in superficial soil layers.” He found that algal growth was extensive in places and attributed this to agricultural runoff carrying nutrients to the stream from pasture land, cattle with direct access to the streams, and the normal weathering of the calcium diphosphate rock found in the area. He described various springs in the area and also noted that the streams stop flowing during periods of little or no rainfall. Overall land use in the basin has changed little since that period, and as seen in the following sections, water quality is essentially the same except in areas of urban growth.

In the spring of 1992, the KDOW conducted a biological and water quality investigation of the Boone Creek drainage to determine the baseline water quality and any impacts from point and nonpoint source pollution (KDOW, 1998). Eight stream stations were sampled for a variety of chemical parameters, as was the effluent from the Blue Sky WWTP, which is the primary source of wastewater discharge in the basin (Figure 1, Table 1). Biological data were also collected at the stream sites, and metrics were calculated for algae, macroinvertebrates, and fish communities.

Physicochemical Data: Water samples were collected from each station on April 15, 1992, and results of selected parameters are shown in Table 2. Stream flow was low to moderate and had been falling steadily for about a week, as demonstrated by data from the U.S. Geological Survey gaging station on the South Fork Elkhorn Creek, near Fort Spring (USGS, 1993). This is within the same general region as Boone Creek. Mass balance equations of Blue Sky WWTP effluent with stream water also verify low- to moderate- flow conditions existed at the time of sampling. Water chemistry within the main stem of Boone Creek was considered excellent, while Baughman Fork was considered good, the UT above the Blue Sky WWTP was good, and the UT below Blue Sky was considered fair. Water quality at this site was degraded by the Blue Sky WWTP, as noted particularly by the elevated ammonia and phosphorus concentrations. During periods of lower stream flows, the effluent would have an even greater impact, and ammonia in particular would be at levels toxic to aquatic life. The ammonia effluent value of 22.8 milligrams per liter (mg/L) at Station 9 was a severe violation of the permit limit of 4 mg/L in effect at that time.

Phosphorus concentrations are somewhat elevated throughout the Boone Creek basin, ranging from 0.22 to 0.26 mg/L at the stations not impacted by wastewater effluents. The U.S. EPA recommends a value of 0.1 mg/L or less for flowing streams. The sources, as first described by Neel in 1951, are agricultural runoff, cattle with direct access to streams, and weathering of the calcium phosphate rock in this region. The UT above the Blue Sky WWTP shows this somewhat elevated background condition; however, below the facility it is significantly elevated and remains high down to station 5 on Baughman Fork. These stream concentrations below the WWTP will be higher during lower flow conditions. Both the EPA and the KDOW have begun to address the need for phosphorus removal from wastewater treatment plants, and effluent limits for phosphorus are being applied where needed. This will be further discussed in a following section of this report.

Table 2. Water Quality Data in the Boone Creek Basin

(sampled 4-15-1992)

Map #	BOD-5 (mg/L)	Ammonia (mg/L)	pH (Units)	Total Phosphorus (mg/L)	Chloride (mg/L)	Specific Cond. (umho/cm)	Total Suspended Solids (mg/L)	Total Dissolved Solids (mg/L)	BAI Rank*
1	1.2	<.05	8.3	0.22	4.7	405	3	228	good
2	1.4	<.05	8.4	0.22	4.9	397	7	236	good
3	1.6	<.05	8.2	0.23	<.1	400	8	234	good
4	3.2	<.05	8.2	0.26	<.1	385	5	231	good
5	3.5	0.14	8.1	0.34	9.2	461	2	280	good
6 **	5.8	0.31	8.1	0.25	7.4	373	9	212	poor
7	4.3	2.3	8	0.91	20.5	630	2	366	poor
8	3.6	<.05	8	0.26	12.5	617	3	360	NA
9	6.1	22.8	7.7	5.9	81	870	7	388	NA

* BAI - Biotic Assessment Index

** Site was impacted by a toxic spill of unknown material and origin, causing a fish kill and other problems.

NA – Not available

Biological Data: Algae, macroinvertebrates, and fish were collected from seven locations in the drainage basin, while only algae were collected from the UT above the Blue Sky WWTP. A Biotic Assessment Index (BAI) was calculated for each stream station. The BAI is a summary compilation of the algae, macroinvertebrate, and fish data to assess the ecological health of a waterbody. Each data set is analyzed and scored independently, and the individual scores are averaged. Each BAI score is given a descriptive classification of either excellent (fully supports the warm water aquatic habitat [WAH] use designation), good (fully supports but is threatened), fair (partially supports), or poor (fails to support). The BAI scores for this study, listed in Table 2, show that all the Boone Creek stations and the lowest Baughman Fork station fully support the WAH use designation but are considered threatened by nonpoint source pollution, primarily from agricultural practices. Station 8, on the UT above the Blue Sky WWTP, was considered to be partially supporting uses based on the algae data. Station 6, on Baughman Fork above the UT, and station 7, on the UT below the Blue Sky WWTP, failed to support uses. Station 6 had recently received a spill of some unknown toxic substance. Chemical analysis taken during this study was not able to detect the substance, which resulted in numerous dead leeches, crayfish, and fish. It is believed the substance was released into a sinkhole which discharged from a spring just upstream of station 6. Effluent from the Blue Sky WWTP has degraded the UT at station 7. Algae and macroinvertebrates found at this site were typical of streams impacted by poorly treated wastewater effluent.

More recent data indicate that stations 2 and 5 have been downgraded to partial support, with agricultural practices as the primary cause and possibly the high phosphorus concentrations and toxicity from the Blue Sky WWTP as a secondary source. Station 4, on Boone Creek above Baughman Fork, retained its full support status for the WAH use designation.

Wastewater Treatment Plants

Two wastewater treatment plants exist in the basin, and both are located on the UT that is impaired. The first facility, Boonesboro Manor, serves a small commercial area along the UT on the western side of I-75. The facility, built in the early 1970s, discharges at mile 1.7 of the UT and has a design flow of 70,000 gallons per day (gpd). The commercial area did not grow as originally anticipated, and currently the facility discharges only about 8000 gpd. The discharge is about 0.2 miles upstream of sampling station 8. It is interesting to note that the water quality and biological data collected in 1992 at station 8 did not show significant problems. It is likely that the very small flows from the facility were sufficiently diluted by natural streamflow which resulted in little impact to stream quality. The Boonesboro Manor WWTP has experienced significant permit violations in the past, and on January 25, 1999, the KDOW placed the facility on the sewer sanction list, meaning that no new connections could be allowed until the facility was brought into compliance with permit conditions. In addition, the KDOW issued a Notice of Violation to the facility on April 12, 1999, after a Compliance Evaluation Inspection found the facility operations to be unsatisfactory. Because of the enforcement actions taken, the owners of the facility hired a new operations firm and contracted with a local engineering firm to evaluate the facility and recommend solutions. Significant repairs were made. Satisfied that the facility is in compliance with permit conditions and that this situation will continue, the KDOW removed the facility from the sewer sanction list on March 3, 2000.

The Blue Sky WWTP, originally issued a construction permit in 1968 and expanded to 150,000 gpd in 1979, is located on the UT at about mile 1.5. The facility was originally designed and built to treat domestic-type wastewater; however, the area the facility serves developed into an industrial park. The facility accepted wastewater from industrial customers that contribute high-strength and/or incompatible wastes that either pass through the WWTP untreated or that interfere with the biological processes. As a result, the WWTP has had significant permit compliance problems for more than 10 years. Its effluent is highly toxic, as evidenced by continued failure to pass biomonitoring tests and its very high ammonia

concentrations. The KDOW continues to undertake efforts to bring this facility into compliance. These actions include Notices of Violation issued to the facility, an Agreed Order issued in 1995 demanding remedial measures, adding the facility to the sewer sanction list in January 1999, and most recently a formal legal complaint filed with the Division of Administrative Hearings dated March 27, 2000. The complaint specifically lists violations of carbonaceous biochemical oxygen demand (CBOD), ammonia nitrogen (NH3-N), dissolved oxygen (DO), total suspended solids (TSS), fecal coliform bacteria, total residual chlorine (TRC), toxicity, and failure to monitor for a variety of metals. The owners have responded over the years with a number of proposed measures and reasons for noncompliance, but little has actually been accomplished. The WWTP continues to be in significant noncompliance, and the receiving streams remain impaired.

Target Identification and TMDL Development

The endpoint or goal of the TMDL is to achieve water constituent concentrations (and associated loads in lbs/day) that allow for the sustainability and full support of aquatic life use in these stream reaches. The critical flow condition is the 7-day, 10-year low flow (7Q10) because it is during low-flow periods that the stream is most susceptible to wastewater effluents. As demonstrated in the previous sections of this report, wastewater effluent from the Blue Sky WWTP is the primary source of stream impairment. The natural 7Q10 of this small stream is zero cubic feet per second (cfs) as evidenced by U.S. Geological Survey published data (Ruhl and Martin, 1991) from gaging stations on much larger streams in the same geographic area.

A TMDL for low-flow conditions is the sum of three basic components: the natural background load, the wasteload allocation (WLA) for point source discharges, and a margin of safety. In this case, the background load is zero because the critical low-flow condition occurs when there is no natural flow in the stream. The WLA establishes effluent limits for CBOD and NH3-N from a wastewater discharger. These are calculated using well-documented, EPA-approved procedures. These employ the use of a computer model, and Kentucky uses EPA’s QUAL2E model for this purpose (Brown and Barnwell, 1987). Maximum values of the pollutants CBOD and NH3-N are set. These and

their corresponding loads are shown on Table 3. The loadings are based on a simple conversion of the QUAL2E model concentration inputs (mg/L) multiplied by the WWTP plant size (gpd). Thus, if WWTPs are in need of expansion, the model runs will be revisited and an increase in loading (lbs/day) could be approved. The margins of safety for these parameters are implicit because the model itself employs conservative assumptions, including the assumptions that the streamflow is zero (no dilution is available) and water temperatures are warm (77 degrees Farenheit). Wastewater effluent has a greater impact upon aquatic life at warm temperatures.

As found from water quality sampling, phosphorus concentrations in effluent from the Blue Sky WWTP are high. The reported value of 5.9 mg/L (Table 2) is nearly twice as high as that from a number of municipal dischargers across Kentucky, which average 2.5 to 3.0 mg/L. An effluent limit of 1.0 mg/L should be applied to the Blue Sky WWTP at the next permit reissuance. This value is commonly being applied to facilities in Kentucky that discharge into nutrient impacted streams. The corresponding load is shown on Table 3.

Of equal importance to aquatic life are the toxicity components. The TRC limit is based upon water quality standards published in KDOW regulations (401 KAR 5:031) as that necessary to protect aquatic life, and since this has a concentration value, a load can be calculated (Table 3). Total toxicity is established through the use of a biomonitoring requirement on facilities with flow greater than one million gallons per day or those that have an industrial component to their discharge which is likely to contain toxic materials. This is established as a toxicity unit, and either acute or chronic limits are determined. Chronic limits are set for appropriate facilities on zero flow streams, meaning that the effluent must be nontoxic to aquatic life. Because these limits are in a measurement of “units,” a load cannot be calculated.

Table 3. Effluent Limits and Loadings

Facility	Design Flow (gpd)	CBOD Limit (mg/L)	NH3-N Limit (mg/L)	Total Phosphorus (mg/L)	TRC Limit (mg/L)	Chronic Toxicity Limit (Units)	CBOD Load (lbs/day)	NH3-N Load (lbs/day)	Total Phosphorus Load (lbs/day)	TRC Load (lbs/day)
Boonesboro Manor	*70,000	30	4	nr	nr	nr	17.5	2.34	nr	nr
Blue Sky	150,000	30	4	1.0	0.011	1.07	37.6	5.01	1.25	0.014
						Total	55.1	7.35	1.25	0.014

* Actual flow is about 8,000 gpd.
nr- not required on this permit. Will be considered if flows increase in the future.
TRC: Total Residual Chlorine
CBOD: Biochemical Oxygen Demand
NH3-N: Nitrogen Ammonia

As previously noted in this report, data collected from as early as the 1950s show some problems in the Boone Creek Basin associated with agricultural runoff. This is not, however, the cause of the UT's failure to support its designated use, which resulted in its listing as a 303(d) stream. A TMDL has not been calculated for runoff conditions when these nonpoint sources would have their greatest impact. Nevertheless, nonpoint source pollution needs to be addressed. In 1994, Kentucky passed the Agricultural Water Quality Act (KRS 224.71-100 through 224.71-140). All landowners with more than 10 acres conducting agriculture or silviculture production will be required to develop and implement a water quality plan based upon guidance from the Statewide Agriculture Water Quality Plan. Individuals have until October 23, 2001, to fully implement their plan. Technical assistance is available from a number of agencies dealing with these issues. It is anticipated that implementation of these plans will improve water quality statewide, and will include components for erosion control, farm animals with direct access to streams, nutrient management, and other issues as appropriate.

Recommendations

As shown in this report, effluent limits and loads that would be expected to protect water quality in the UT and Baughman Fork can be calculated. Considering the long history of non-compliance from the Blue Sky WWTP, however, it seems unlikely that these issues will be resolved quickly. The KDOW recognizes three possible options to bring these streams into compliance with water quality standards. The first would be the elimination of the discharge entirely. The area is within the Lexington Fayette Urban County Government (LFUCG) 201 planning area, and it is recommended that local government consider extending sewer lines to this area. Both the Blue Sky WWTP and the Boonesboro Manor WWTP could be eliminated by connection to the regional system. A second option would be for the KDOW to revoke the discharge permit of the Blue Sky WWTP. Another legal entity would need to take over the facility, preferably the LFUCG but possibly a local association of the businesses connected to the facility. A third option would be to allow the current owner to continue to operate this facility with increased oversight by the KDOW. The second and third options would require either the

construction of a new wastewater facility or significant upgrading of the existing facility because the WWTP cannot properly treat the wastewater it currently receives. Phosphorus removal would be an additional permit requirement for a new or upgraded facility. Legal action is underway, and until such time as one of these options, or perhaps another as yet unconsidered option, is implemented, the receiving streams will remain impaired.

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