



Banklick Creek Watershed Characterization Report

Prepared for: Sanitation District No. 1 of Northern Kentucky



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1. WATERSHED SUMMARY

Watershed characterization reports are being developed for sixteen watersheds located in Northern Kentucky that lie within Sanitation District No. 1's (SD1's) service area. The purpose of the watershed characterization reports is to describe the physical and natural features, land cover, infrastructure, waterbody conditions, potential pollutant sources and other features in each watershed. This information will allow SD1 and other interested parties to develop an understanding of important features, pollutant sources and water quality in the watersheds. This information will also assist SD1 and others in goal-setting, prioritization of improvement projects, and assessment of the effectiveness of these projects. The watershed characterization reports meet the system characterization element for the receiving water that is required for a combined sewer overflow (CSO) Long-Term Control Plan (LTCP). Additionally, the Consent Decree requires that the Watershed Plans include elements of a LTCP.

The 58.2-square mile Banklick Creek watershed is located in Kenton and Boone Counties, in the Central Study Basin (Figure 1). Development is found throughout most of this watershed, although the headwaters are currently much less developed. The topography is fairly steep and flooding has been a recurring issue in this watershed. Doe Run Lake, a 51-acre reservoir (normal pool), is located on Bullock Pen Creek. This reservoir was constructed between 1978 and 1982 to help control flooding, but flooding problems persist.

Banklick Creek and its tributaries are designated for warm water aquatic habitat, primary contact recreation, secondary contact recreation and domestic water supply, at applicable points of withdrawal. Doe Run Lake and the entire length of Banklick Creek appear on the 303(d) list of impaired waterbodies (KDOW, 2008). A comparison of recent water quality data to applicable water quality criteria revealed elevated levels of bacteria. Violations of dissolved oxygen, temperature and pH have historically been observed at the USGS continuous monitoring station between 2001 and 2005, but the more recent data from this location are still being reviewed and are not yet included in this assessment.

Potential pollutant sources in this watershed include combined sewer overflows (CSOs), sanitary sewer overflows (SSOs), septic systems, KPDES-permitted discharges, livestock, storm water and streambank erosion. Backwater from the Licking River is a potential source in the downstream end of the creek. The potential for these sources (except backwater) to generate fecal coliform loads has been assessed using a Watershed Assessment Tool (WAT!)¹. The WAT! identifies the potential sources within a watershed and estimates their possible impact. It also allows SD1 to compare and rank the 16 different Northern Kentucky watersheds.

The WAT! calculated an approximately average fecal coliform loading potential for the Banklick Creek watershed for year-round conditions. Overland runoff is predicted to be the dominant source under year-round conditions. Under base flow conditions, septic

¹ The WAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

systems and non-CSO KPDES-permitted discharges are predicted to be the primary sources of bacteria.

The WAT! ranking is one of several factors that should be considered when prioritizing watersheds for improvement projects. Other factors include high public interest, the presence of one aquatic-dependent threatened and endangered species, the location of a drinking water intake just upstream of the Banklick confluence with the Licking River, and the location of portions of this watershed in a source water assessment and protection zone (SWAPP zone 1) for this intake.

Since improvement projects are planned to reduce collection system overflows in this watershed, next steps might include the application of the Banklick Creek model, the Ohio River model and WAT!, to better understand the appropriate level of control for the watershed. No additional monitoring, beyond what is currently planned, is recommended for this watershed.

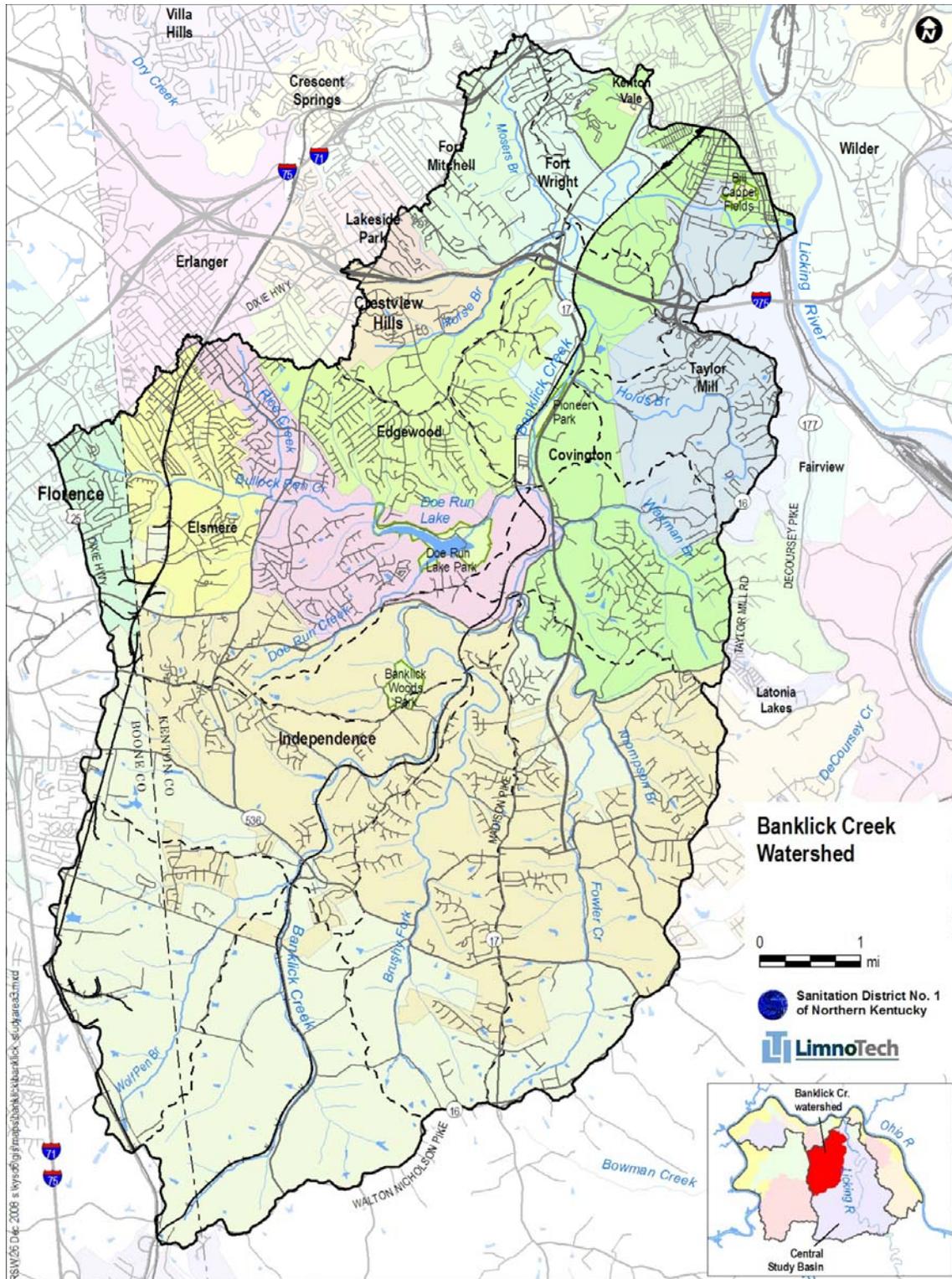


Figure 1. Banklick Creek Watershed

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2. WATERSHED FEATURES

Banklick Creek originates in Boone County and flows northward through Kenton County to the Licking River. The watershed area for this creek is 58.2 square miles.

2.1 PHYSICAL AND NATURAL FEATURES

The following sections describe key features of the watershed and creek, including hydrology, geology, topography, soils, climate, and habitat. These features are important because they affect land uses, and shape the chemical, biological, and hydrological characteristics of Banklick Creek.

2.1.1 Hydrology

Banklick Creek is a 19.2-mile long perennial stream and has six major tributaries. These tributaries are, in order from downstream to upstream: Horse Branch, Holds Branch, Bullock Pen Creek, Fowler Creek, Brushy Fork, and Wolf Pen Branch. The creek is shallow through most of its length and has been observed to go dry upstream of river mile (RM) 8.1. The stream gradient is highest near the upstream and middle reaches of the creek. Near the confluence with the Licking River (approximately 0.75 miles upstream from the mouth), the gradient is much lower and the channel widens. Near the mouth, flow is hydraulically influenced by the Licking River and backwater effects are thought to extend upstream to approximately RM 3.8. The spatial extent of backwater effects depends on Ohio River stage levels.

Banklick Creek flows are measured at an active USGS continuous monitoring station (03254550) located on Banklick Creek at Richardson Road near Erlanger, KY, which is at approximately RM 8.1 (see Figure 1). The watershed area draining to the station is 30 square miles, comprising approximately 58% of the Banklick Creek watershed. Daily discharge measurements are available at the station from April 1999 to the present². The average flow is 38 cfs (4/1/1999 - 9/30/2007), and 95% of flows are less than 138 cfs. Base flows at this location have been measured at less than 2 cfs, with flows increasing by up to three orders of magnitude during a storm event. The maximum flow recorded at the USGS station is 2,130 cfs. The periods of high flow tend to be very brief and only last one to two days. In contrast, during extended periods of dry weather, flows at the station become intermittent. Between April 1999 and September 2007 there were 49 days with zero flow.

Flooding has been a recurring problem in the Banklick Creek watershed, particularly in the Pioneer Park area. The United States Army Corps of Engineers (USACE) – Louisville District, has identified five primary flood damage areas along Banklick Creek that are located between RM 0.0 and RM 10.3. Previous major floods have been documented (USACE, 2000) as occurring in 1937, 1962, 1967, 1979, 1991, 1992, 1995 and 1996 with flooding occurring not only on Banklick Creek, but also Fowler Creek. The USACE (2000) study identifies three primary factors that have contributed to flood damages in the watershed. These are: 1) the concentration of early development along

² This analysis only uses approved data from USGS, and at the time of the analysis data was approved through 9/30/2007.

stream channels; 2) the extremely steep slopes of Banklick Creek and its tributaries; and 3) extraordinary recent development in the watershed along ridgelines and hillsides.

Agencies investigating flooding in this watershed have included the United States Department of Agriculture (USDA), Federal Emergency Management Agency (FEMA), and the Louisville District of the Corps of Engineers. Several reports have also been developed by residents. As a result of these studies, several projects have been implemented to reduce flooding impacts. These are:

- 1982 – completion of a 51-acre reservoir (normal pool), Doe Run Lake, on Bullock Pen Creek to help control flooding.
- 1980s - Removal of 36 trailer homes from the floodplain near I-275
- 1980s – Some channel realignment
- Elevation of mobile homes above most major flood levels (USACE, 2000).

Additional detail on other more recent ongoing projects is found in Sections 2.3 and 2.5.

2.1.2 Geology

The Banklick Creek watershed is located in the Outer Bluegrass Physiographic³ Region which is underlain primarily by Ordovician-age interbedded limestone and shale (Ray et al., 1994). Although most of this watershed is underlain by bedrock with a moderate potential for karst development (Paylor and Currens, 2002), rocks in this region generally contain higher percentages of shale layers and do not develop extensive karst features (Ray et al., 1994)⁴.

The headwaters of this creek traverse the rolling hills of the Grant Lake Limestone/Fairview formation, which produces broad stream valleys. The middle portion of the creek, as well as some tributaries (Fowler Creek, Bullock Pen Creek) cut through the erodible shale found in the Kope formation. Downstream of Bullock Pen Creek, Banklick Creek traverses alluvium comprised of unconsolidated sediments.

Groundwater yield varies depending on geological formation. Except near the headwaters, groundwater is generally unavailable on ridgetops and hillsides. In contrast, wells in the valley bottoms may yield 100-500 gallons per day. This water is hard and may contain salt and hydrogen sulfide. Water obtained from the alluvium may also be high in iron (Carey and Stickney, 2004, Carey and Stickney, 2005).

2.1.3 Topography

The Banklick Creek watershed is characterized by rolling hills with more gentle slopes in the headwaters. In the downstream half of the watershed, the ground tends to slope steeply toward the creek. The adjoining hillsides and tributaries also have steep slopes; slopes in excess of 100 feet per mile are not uncommon for many of these tributaries (USACE, 2000).

³ Physiographic regions are based on differences in geology, topography and hydrologic regime. The State of Kentucky is divided into five physiographic regions.

⁴ In areas with karst, an almost immediate connection between groundwater and surface water can exist, short-circuiting any attenuation of pollutant loads that might otherwise occur.

The highest elevations in the watershed (966 feet) are found near the intersection of Walton-Nicholson Pike and Dixie Highway at the southernmost part of the watershed, and near the intersection of Mt. Zion Road and Dixie Highway on the western edge of the watershed. The lowest elevation in the watershed (453.6 feet at normal Ohio River pool) occurs at the confluence of Banklick Creek with the Licking River.

2.1.4 Soils

The nature of soils and topography in a watershed play an important role in both the amount of runoff generated and the amount of soil erosion that can occur. Most (93%) of the soils in the Banklick Creek watershed are classified as hydrologic soil group C (NRCS, 2006), meaning they have slow infiltration rates when thoroughly wetted. Roughly 60% of the soils in the watershed are ranked “highly erodible”, and the remaining 40% of the watershed soils are ranked “fairly erodible” as indicated by an index for erodibility (NRCS, 2006). The erodibility of soils is important when soils are disturbed through activities such as land clearing for new development. Portions of the watershed, especially within the City of Independence and near the Banklick Creek headwaters, are undergoing significant development, as discussed in Section 2.2.2, and areas of severe erosion have been observed in this watershed (Figure 2).



Figure 2. Banklick Creek at RM 5.5

2.1.5 Climate

The temperatures in this area are generally lowest in January and highest in July. Precipitation averages 41.2 inches annually, with the wettest months observed between March and July. Minimum precipitation is recorded in the fall and late winter as shown in Figure 3 (NCDC, 2008).

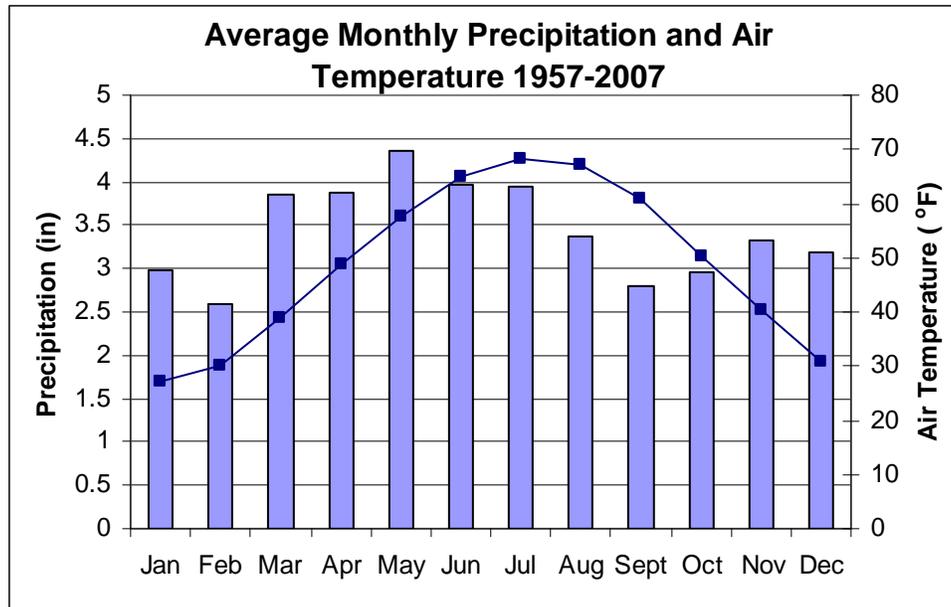


Figure 3. Average Monthly Precipitation and Air Temperature at the Cincinnati Northern Kentucky Airport (1957-2007)

2.1.6 Habitat

The Banklick Creek watershed lies within the Outer Bluegrass ecoregion⁵, which is characterized by sinkholes, springs, entrenched rivers and intermittent and perennial streams (Woods et al., 2002). Wetlands are not common in this ecoregion and comprise less than 1% of this watershed. Streams typically have relatively high levels of suspended sediment and nutrients. Glacial outwash, which tends to be highly erodible, exists in a few areas.

Pre-settlement conditions in this ecoregion consisted of open woodlands with barren openings, and vegetation was mostly oak-hickory, with some white oak, maple-oak-ash and American beech-sugar maple forests (Woods et al., 2002). As described in Section 2.2.1, natural habitats have been altered from pre-settlement conditions.

Habitat assessments have been conducted at many sites within the watershed. Habitat rankings reflect variable conditions (Table 1) and range from not supporting to partially supporting as calculated using EPA-established protocols, and from fair to good using the QHEI⁶. A habitat assessment of ten sites in 2001 found the site at RM 0.4 consistently had the poorest habitat, followed by the site at RM 3.9, due to the lower stream gradient, sedimentation, stream modifications and backwater flows. The lower habitat scores at

⁵ Ecoregions denote areas of general similarity in ecosystems and in the type, quality, and quantity of environmental resources (Woods et al., 2002).

⁶ These assessments were generally conducted using EPA-established protocols. KDOW rated several components of physical habitat within the stream such as epifaunal substrate, embeddedness, sediment deposition, channel flow status, bank stability and riparian vegetation zone width, among others. In 1996, some sites were assessed using a different protocol, Qualitative Habitat Evaluation Index (QHEI).

RM 15 and 18.2 were directly related to the fact that they are low order streams (Strand and Associates, 2003).

Table 1. Aquatic Habitat and Biological Sampling

Stream	River Mile	Monitoring ^a							
		Habitat		Macroinvertebrates		Diatoms		Fish	
		Year	Ranking	Year(s)	Ranking ^b	Year	Result	Year	Result ^b
Banklick Creek	0.3	1996	Fair ^c	1996	N/A ^d				
Banklick Creek	0.4	2001	Not supporting	2001, 2002, 2002, 2003	N/A ^d	2001	N/A ^e	2001 2002, 2002, 2003	Very poor Fair, Fair, Poor
Banklick Creek	1.2	1996, 1999	Good ^c , Not supporting	1996, 1999	N/A ^d Poor	1999	Poor	1999	Fair
Banklick Creek	2.5	2001	Partially supporting	2001, 2002, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2002, 2003	Fair, Poor, Excellent, Fair
Banklick Creek	3.9	1996, 2001	Good ^c , Not supporting	1996, 2001, 2002, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2002, 2003	Fair, Poor, Fair, Fair
Banklick Creek	5.4	2001	Partially supporting	2001, 2002, 2002 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2002, 2003	Fair, Fair, Excellent, Fair
Banklick Creek	8.1	2001	Partially supporting	2001, 2002, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2002, 2003	Fair
Banklick Creek	10.1	2001	Partially supporting	2001, 2002, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2002, 2003	Fair
Banklick Creek	13.5	2001	Not supporting	2001, 2002, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2002, 2003	Good, Fair, Good, Fair
Banklick Creek	15	2001	Not supporting	2001, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2003	Good, Excellent, Excellent

Table 1. Aquatic Habitat and Biological Sampling - Continued

Stream	River Mile	Monitoring ^a							
		Habitat		Macroinvertebrates		Diatoms		Fish	
		Year	Ranking	Year(s)	Ranking ^b	Year	Result	Year	Result ^b
Banklick Creek	18.2	2001	Not supporting	2001, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2003	Excellent
Bullock Pen Creek	0.1	2001	Partially supporting	2001, 2002, 2002, 2003	N/A ^d	2001	N/A ^e	2001, 2002, 2002, 2003	Excellent, Fair, Excellent, Good
Unnamed tributary to Bullock Pen Ck. at RM 3.2	0.8					1993	Poor		
Unnamed tributary to Bullock Pen Ck. at RM 3.2	2.1					1993	Poor		
Unnamed tributary to Bullock Pen Ck. at RM 3.2	2.2					1993	Poor		

^a SD1 completed sampling in 2008. These data were not available at the time of this report, but will be included in future updates.

^b When results for all sampling periods were the same, the value is only shown once.

^c At these sites, habitat was assessed using the Qualitative Habitat Evaluation Index (QHEI) and have a slightly different scale.

^d Results are not available because some parameters needed to calculate the MBI were not measured.

^e Results are not available because some parameters needed to calculate the DBI were not measured.

2.2 LAND COVER CHARACTERISTICS

Land cover and land use play an important role in the quantity and quality of runoff into receiving waters. Current and future land cover is described below.

2.2.1 Current Land Cover

The Kentucky Division of Geographic Information, Commonwealth Office of Technology provided a GIS dataset showing 2005 Kentucky land cover. This dataset was updated and improved to approximate 2007 land cover conditions (Figure 4) using a variety of other datasets that represent current impervious conditions (roads, parking lots, buildings), open space lands (including parks), and surface waters.

47% of this watershed is developed, with development concentrated in the central and northern (downstream) portions of the watershed. Developed areas include the communities of Independence, Covington, Erlanger, Taylor Mill, Edgewood, Elsmere, Fort Wright, Fort Mitchell, Florence, Crestview Hills, and very small portions of Lakeside Park, Kenton Vale, Latonia Lakes, Walton and Wilder. Roughly 11% of the watershed is impervious.

The headwaters of Banklick Creek are still primarily undeveloped and agricultural in nature. Forest and pasture/hay comprise the majority of the undeveloped land in the watershed. The larger parks in this watershed are shown in Figure 1 and include Doe Run Lake Park, and several community parks such as Banklick Woods Park, Pioneer Park and Bill Cappel Fields. There are also many smaller neighborhood parks and ball fields associated with schools.

2.2.1.a Animal operations

There are no concentrated animal feeding operations (CAFOs) in this watershed (Kentucky Geographic Network, 2008). There are two animal feeding operations (AFOs) in the watershed (Kentucky Geographic Network, 2008a). These are dairy operations with 40-45 animals and are located in the Bullock Pen Creek watershed.

Other livestock present, but not prevalent in the watershed include cattle and horses (Kenton County Conservation District, 2007), which are primarily found in the upstream portions of the watershed. Most manure spreading occurs on hayfields on average every few months and some cows are thought to have access to Banklick Creek and its tributaries.

2.2.1.b Septic Systems

SD1 estimates that approximately 5% of all parcels in the Banklick Creek watershed are potentially serviced by septic systems. Properties potentially served by septic systems are found throughout the watershed, but are more concentrated in the southern (headwater) portion, both inside and outside SD1's sanitary sewer service area.

Estimates of septic system failure rates are not available for Kenton and Boone Counties; however anecdotal reports from Health Department inspectors suggest that 10% of the septic systems may be operating improperly due to incorrect installation, lack of maintenance or age of the system (NKHD, 2008).

In addition, one septic area (hot spot area) was identified as having problems in the Fowler Creek subwatershed. This is an area in an older subdivision that either has very small lots that have unrepairable failing systems, or has systems that have been repaired to the extent practicable on the site, but are not fully functional (NKHD, 2008a).

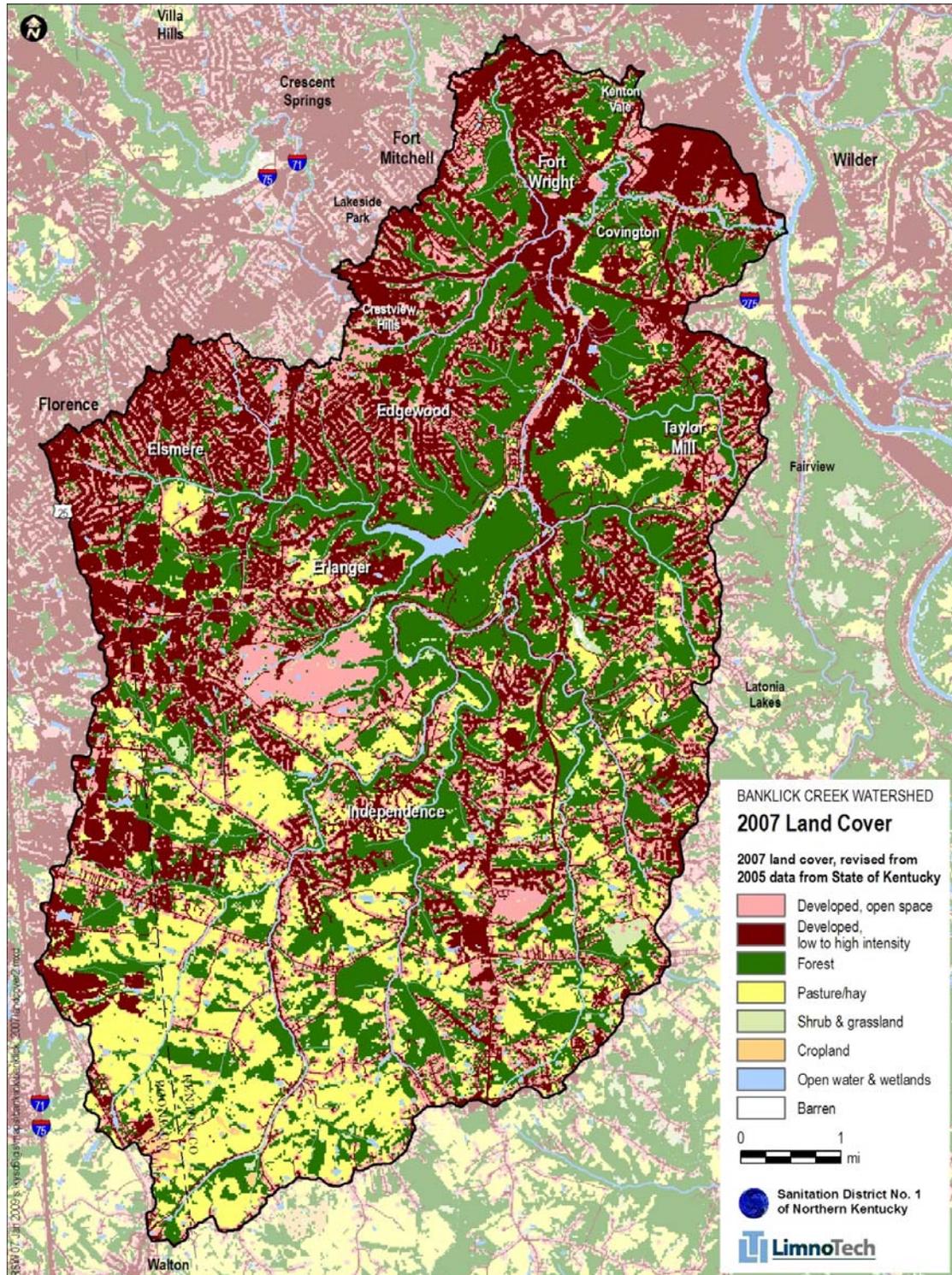


Figure 4. 2007 Land Cover

2.2.2 Future Conditions

Portions of the Banklick Creek watershed are developing at a fairly rapid pace, with urban-suburban developments replacing rural areas. In recent years (2000-2005), population growth in the watershed has been focused in the City of Independence (NKAPC, 2006), although Erlanger, Taylor Mill and Crestview Hills have also seen growth due to new home construction. In the unincorporated portions of the watershed, growth has expanded towards Walton. Between 2005 and 2010, it is anticipated that most of the new residential development will continue to occur in the City of Independence and in areas north of Walton, since urban areas will be nearing saturation. These areas correspond to the less developed headwater areas (NKAPC, 2006).

Several road construction, relocation or improvement projects are planned within the watershed. In the vicinity of Independence, KY 17 is being widened and relocated to the east of the city, essentially bypassing the downtown area, and additional road reconstruction is planned for route 536. Other planned road projects in the watershed includes portions of Turkeyfoot Road, KY 16, and I-275 (KYTC, 2006).

2.2.2.a Future land cover

Future land cover was developed by modifying 2007 land cover to reflect potential future conditions (roughly 2030) obtained from SD1 and the Northern Kentucky Area Planning Commission (NKAPC). It is predicted that development will comprise 70% of this watershed, with most development replacing forest and pasture/hay (Figure 5). Imperviousness is predicted to increase from 11% to 17%. Because flat land is becoming scarce, this development is expected to occur more frequently in areas with steep slopes (NKAPC, 2006).

The Kenton County Comprehensive Plan (NKAPC, 2006) outlines measures to reduce the impact of development. These include, but are not limited to, land use recommendations (e.g., conservation subdivisions, concentration of new developments in areas where urban services can be extended in a timely fashion, encouragement of mixed land use development) and protection of sensitive areas (e.g., greenways, riparian areas and hillsides).

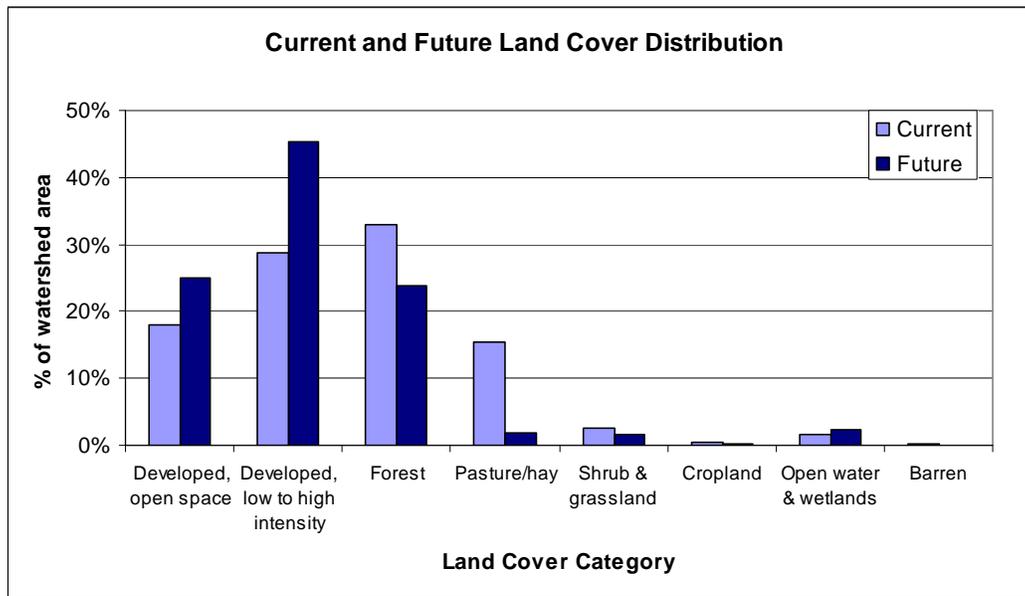


Figure 5. Current and Predicted Future Land Cover

2.3 INFRASTRUCTURE FEATURES

This section summarizes infrastructure features for the Banklick Creek watershed⁷.

Approximately 2% of the Banklick Creek watershed is serviced by SD1's combined sanitary sewer area. In addition, approximately 83% of the watershed is serviced by SD1's 48.05 square mile separate sanitary sewer (Figure 6). Of that area, the City of Walton owns approximately 0.03 square miles of the separate sanitary sewer area in this watershed, but contracts with SD1 for operation and maintenance. In total, there are approximately 386.2 miles of separate sanitary sewer lines and approximately 19.2 miles of combined sanitary sewer lines that are operated and maintained by SD1.

Approximately 2% of the Banklick Creek watershed is located within the City of Florence's sanitary sewer service area, which contains approximately 13.4 miles of separate sanitary sewer lines.

Approximately 98% of the Banklick Creek watershed lies within SD1's storm water service area. Within the service area, the storm water system is comprised of approximately 607 miles of streams and channels and approximately 188.9 miles of pipes. Approximately 2% of the Banklick Creek watershed is located within the City of Florence's storm water service area. The Florence storm water system is comprised of approximately 9.7 miles of streams and channels; the extent of the piped storm water system has not been mapped.

The extent of the sanitary sewer, combined sewer and storm water service areas in this watershed is shown in Figure 6.

⁷ SD1 is undertaking a characterization and assessment of the sewer system, and overflows identified herein are subject to change. Information on the sanitary and storm water system in Section 2.3 was queried from SD1's geodatabase accessed on November 21, 2008.

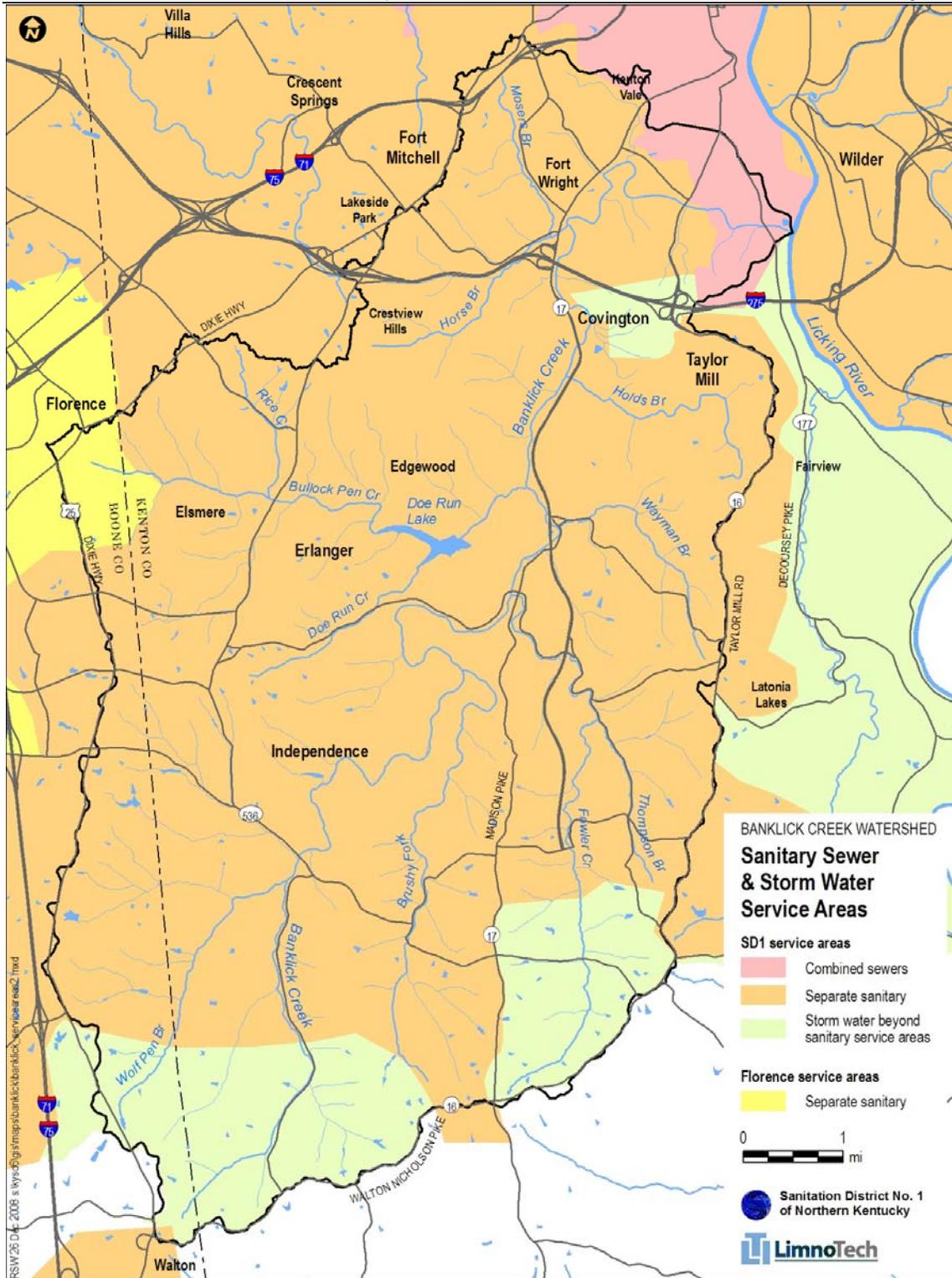


Figure 6. Sanitary Sewer, Combined Sewer and Storm Water Service Areas

2.3.1 Point Sources and Infrastructure

The occurrence of KPDES dischargers, sewer overflows and storm water discharges are described below.

2.3.1.a KPDES dischargers

There are 21 KPDES-permitted dischargers in the Banklick Creek watershed with a total of 32 currently-permitted outfalls. Fifteen of these outfalls are for sanitary wastewater, seven of which are covered under general permits for residences. The remaining outfalls are for storm water runoff, cooling water, a sedimentation basin drain, and concrete mixer truck washout water. Permitted CSOs are not included in this tally and are discussed separately. Permitted dischargers, excluding CSOs, are presented in Table 2.

Based on a review of recent effluent monitoring data (January 2007 to June 2008), it was observed that 18 of the permitted dischargers in the Banklick Creek watershed have violated their permit limits for at least one of the following parameters: total chlorine, total ammonia, fecal coliform, oil and grease, total zinc, total suspended solids (TSS), pH, total phenolics, and 5-day carbonaceous biochemical oxygen demand (CBOD₅). KDOW requires effluent monitoring for residential general permits (monitoring is required twice per year); however, data were not available for four of these facilities in this watershed. KDOW estimates that residential dischargers fail at a rate that is believed to be higher than 10% (KDOW, 2007).

Table 2. Permitted Dischargers

Receiving Water	KPDES ID	Facility Name	Outfall	Permit Type	Outfall Description	Currently Permitted? ^a	Permit Violations
Wolf Pen Branch	KY0033057	Eaton Asphalt Frogtown Plant	0011	Minor	New sanitary wastewater plant	N	NA
Wolf Pen Branch	KY0101591	Bp Oil Co Richwood Bulk Plant	0012	Minor	Storm water runoff	Y	NA
Wolf Pen Branch	KYG400896	Residence	0011	Minor	Sanitary wastewater Type B	Y	NA
Fowler Creek	KY0034207	Colony House Apts	0012	Minor	Sanitary wastewater	Y	Total chlorine, total ammonia
Fowler Creek	KY0040631	Whites Tower Elem School	0011	Minor	Sanitary wastewater	Y	NA
Fowler Creek	KY0040690	Old Twenhofel Middle School	0011	Minor	Sanitary wastewater	Y	Total chlorine
Fowler Creek	KY0075833	Nixutil Sanitation Assoc Inc	0012	Minor	Sanitary wastewater	Y	Fecal coliform, total ammonia
Fowler Creek	KY0080802	Regency Manor Inc	0012	Minor	Sanitary wastewater	Y	Total ammonia
Fowler Creek	KY0101672	Kenton Co Bd of Ed	0012	Minor	Whites Tower Elem School	Y	Total ammonia
			0022	Minor	Simon Kenton High School	N	Total ammonia
			0062	Minor	Twenhofel Jr High School	Y	CBOD ₅ , fecal coliform, total ammonia, TSS
Fowler Creek	KYG400090	Residence	0011	Minor	Sanitary wastewater Type B	Y	Fecal coliform
Fowler Creek	KYG400482	Residence	0011	Minor	Sanitary wastewater Type B	Y	NA
Fowler Creek	KYG400719	Residence	0011	Minor	Sanitary wastewater Type B	Y	NA
Bullock Pen Creek	KY0075485	Graham Packaging Plastic Prods	0011	Minor	Cooling water and sanitary	Y	Fecal coliform
Bullock Pen Creek	KY0090191	Camco Chemical Co Inc	0011	Minor	Storm water runoff	Y	pH
			0021	Minor	Storm water runoff	Y	pH
			0031	Minor	Storm water runoff	Y	pH
Bullock Pen Creek	KYG400111	Residence	0011	Minor	Sanitary wastewater Type B	Y	None
Thompson Branch	KYG400625	Residence	0011	Minor	Sanitary wastewater Type B	Y	NA

Table 2. Permitted Dischargers - Continued

Receiving Water	KPDES ID	Facility Name	Outfall	Permit Type	Outfall Description	Currently Permitted? ^a	Permit Violations
Banklick Creek	KY0089524	Interplastic Corp Thermoset	0011	Minor	Storm water runoff - plant grds	Y	Oil and grease, total zinc, TSS
			0012	Minor	Storm water runoff - plant grds	Y	None
			0021	Minor	Storm water runoff - west side	N	Total zinc, TSS
			0022	Minor	Storm water runoff - west side	N	NA
			0041	Minor	Storm water runoff - east side	Y	Total zinc, TSS
			0042	Minor	Storm water runoff - east side	Y	None
Banklick Creek	KY0101052	Moraine Materials Co Plt #29	0011	Minor	Concrete mixer trk washout wtr	Y	Oil and grease, TSS
Banklick Creek	KY0101222	BP Amoco Sohio Refinery	0011	Minor	Groundwater remediation	N	Naphthalene
			0021	Minor	Groundwater remediation	N	Total iron
			0031	Minor	Storm water runoff	Y	NA
			0032	Minor	Storm water runoff	Y	NA
			0041	Minor	Storm water runoff	Y	Total phenolics
			0042	Minor	Storm water runoff	Y	NA
Banklick Creek	KYG400514	Residence	0011	Minor	Sanitary wastewater Type B	Y	Total ammonia
Banklick Creek	KYG500131	KTC Kenton Co Maint Garage	SW10	Minor	Storm water runoff	Y	None
			SW20	Minor	Storm water runoff	Y	Oil and grease
			SW30	Minor	Storm water runoff	Y	NA
Banklick Creek	KYG640158	Taylor Mill WTP	0011	Minor	Sedimentation basin drain	Y	TSS

^a Discharge is permitted as of June 2008.

NA – Monitoring data were not available.

2.3.1.b Sewer overflows

There are five current combined sewer overflows (both permitted and “to be permitted”) in the Banklick Creek watershed. These overflows are listed in Table 3. All of these CSOs are located in the watershed draining the lower 2.3 miles of Banklick Creek.

There are twenty-seven sanitary sewer overflows (SSOs) in this watershed (Table 4). Two of these are located at pump stations that have historically been shown to have a lack of wet weather capacity. The Lakeview pump station is located along the Banklick Creek mainstem within the City of Fort Wright, and the Meadow Hill pump station is located in the southern portion of the City of Covington.

Table 3. Combined Sewer Overflow Points

Manhole ID	Common Name	Direct Discharge to Waterbody	Typical Year Spill Frequency (# spills) ^a	Typical Year Volume (Million gallons) ^a
1870194 (outfall 79)	47 th Street	Banklick Cr.	4	0.13
1850158 (outfall 76)	Church Street	Banklick Cr.	74	56.26
1870193 (outfall 78)	Decoursey Ave.	Banklick Cr.	24	1.29
1840130 ^b	Latonia	Banklick Cr. trib.	25	1.12
1510245 ^b	Henry Clay	Banklick Cr. trib.	0	0

^a The results presented were generated by models based on SD1’s current (2008) understanding of the collection system infrastructure. These models are predictive tools and are based on numerous variables and assumptions on the characteristics of the collection system, and may differ from actual field conditions. These models are subject to change based on improved knowledge of the system, improvements to the system, and changes in land use and development. These results are subject to change and should therefore not be relied on or considered definitive.

^b These are “to be permitted” CSOs, i.e., SD1 has (or will) identified these locations for KPDES permitting.

Table 4. Sanitary Sewer Overflow Points

Manhole ID	Direct Discharge to Waterbody	Typical Year Spill Frequency (# spills) ^{a,b}	Typical Year Volume (Million Gallons) ^{a,b}
1040060	Tributary to Bullock Pen Creek	3	0.1
1090069	Tributary to Bullock Pen Creek	0	0.0
1110025	Tributary to Bullock Pen Creek	4	0.2
1110067	Tributary to Bullock Pen Creek	5	0.4
1110161	Tributary to Bullock Pen Creek	2	0.1
1110294	Tributary to Bullock Pen Creek	5	0.1
1570100	Tributary to Horse Branch	7	0.2
1760047	Tributary to Bullock Pen Creek	0	0.0
1760048	Tributary to Bullock Pen Creek	0	0.0
1860108	Banklick Creek	0	0.0
1870013	Banklick Creek	0	0.0
1950199	Tributary to Banklick Creek	0	0.0
1960012	Horse Branch	0	0.0
2030097	Tributary to Bullock Pen Creek	0	0.0
2090001	Bullock Pen Creek	0	0.0
2090026	Bullock Pen Creek	0	0.0
2110002	Tributary to Bullock Pen Creek	10	1.0
2120001	Tributary to Bullock Pen Creek	5	0.2
2120002	Tributary to Bullock Pen Creek	0	0.0
2120041	Tributary to Bullock Pen Creek	4	0.1
2160036	Tributary to Horse Branch	NA	NA
2280010	Wolf Pen Branch	0	0
2280011	Wolf Pen Branch	10	0.4
2280012	Wolf Pen Branch	0	0.0
2300123	Banklick Creek	27	6.1
1950PS1 (Lakeview PS)	Banklick Creek	17	10.6
2020PS2 (Meadow Hill PS)	Tributary to Banklick Creek	NA	NA

^a The results presented were generated by models based on SD1's current (2008) understanding of the collection system infrastructure. These models are predictive tools and are based on numerous variables and assumptions on the characteristics of the collection system, and may differ from actual field conditions. These models are subject to change based on improved knowledge of the system, improvements to the system, and changes in land use and development. These results are subject to change and should therefore not be relied on or considered definitive.

^b NA means no model data are available.

2.3.1.c Storm water discharges

Storm water pipe outlets are located throughout most of the Banklick Creek watershed with the highest concentration in north and west portions of the watershed where development is denser. In addition to storm water outfalls, there are approximately 162

suspected illicit activity (SIA) points which are located throughout the Banklick Creek watershed, with the greatest concentrations to the north and west. SIAs are locations where there was possible evidence of illicit discharges during SD1's storm water mapping project (2001-2002). These locations are being further investigated to determine if they are recurring.

A small portion of this watershed is located outside of SD1's storm water service area, so outfalls and other illicit discharges may be located in these areas, but were not inventoried by SD1. Storm water outfalls covered by individual KPDES permits are discussed in Section 2.3.1.a.

2.3.2 Recently Completed Infrastructure Projects

SD1 has completed numerous projects, including the following:

- Lakeview Pump Station Capacity Upgrade, completed in 2005, involved the repair and rehabilitation of the existing pump station and increased the capacity of the Lakeview Pump Station to approximately 22 MGD, reducing overflows at the pump station bypass and upstream as well.
- Banklick Pump Station Screening Facility project, completed in 2006, installed a new bar screen to remove solids and floatables that were clogging the pumps and preventing the pump station from running properly during wet weather. The pump station can now run continuously without clogging reducing the frequency and volume of CSOs upstream.
- The Wilson Road Sewer Assessment project was completed in 2005 and involved extending sewer lines, giving 6 properties the opportunity to connect to sewer service.
- The Taylor Mill Sewer Assessment project was completed in 2005 and involved extending sewer lines, giving 15 properties the opportunity to connect to sewer service.
- The Pleasure Isle Sewer Assessment project was completed in 2005 and involved extending sewer lines, giving 10 properties the opportunity to connect to sewer service.
- The Cadillac Drive Sewer Assessment project was completed in 1999 and involved extending sewer lines, giving 73 properties the opportunity to connect to sewer service.
- Brookwood Subdivision SSES Study, completed in 2006, evaluated the sanitary sewer and storm sewers in the Brookwood subdivision to identify locations of storm water inflow and infiltration (I/I) into the separate sanitary sewer system in order to identify projects to be performed to remove this identified I/I. Flows from this area are tributary to the Lakeview pump station service area.
- Stevenson Road Relief Sewer Project Phase II project, completed in 2006, was constructed to increase the wet weather capacity in the Lakeview pump station service area collection system to reduce the frequency and volume of known SSOs.

- McMillan Pump Station Removal project, completed in 2006, provided increased dry and wet weather sewer capacity by constructing a new sewer to eliminate an existing maintenance intensive pump station.
- Apple Drive Sewer Outfall project, completed in 2006, extended sanitary sewer service to remove a package treatment plant.
- KY Transportation Cabinet - KY17 / Pelly to Nicholson project, completed in 2006, relocated and upsized existing sewers to provide additional dry and wet weather capacity in an area upstream of Lakeview pump station.
- Fort Wright Sanitary Sewer Rehabilitation project, completed in 2006, was a result of the Fort Wright Illicit Discharge Removal Project and installed new sanitary and storm sewers to separate sanitary and storm flows in this area. This project resulted in eliminating sewage from getting into existing storm sewers and the local creeks and reduced wet weather flow tributary to the Lakeview pump station service area, thereby reducing overflows downstream.
- Fort Wright Outfall Sewer Phase II, completed in 2006, constructed a new sanitary sewer to remove the existing sanitary sewer from the creek, thereby reducing inflow and infiltration from storm and creek water into the sanitary sewer.
- South Hills Outfall, completed in 2007, included the construction of a new 24-inch sewer via horizontal directional drilling on grade (first in the country of this size and slope) to eliminate a CSO at a street intersection. This new sewer has been successful in diverting combined sewer flows from the Lakeview pump station service area, and into the Bromley pump station combined sewer service area, thereby consolidating flows within the combined system and reducing overflow volume at the Lakeview pump station. This project also eliminated a failing sewer located within a landslide area that has resulted in past sanitary sewer overflows.
- Latonia Combined Sewer Separation project, first phase completed in 2007, provided sewer separation through the construction of a new storm sewer to separate and intercept storm water flow to keep it out of the combined sewers in Latonia. This project has helped to reduce basement backups in this area and reduce the overflow volume from downstream CSOs. Additional phases of this work could be completed in the future if monitoring proves that it would be beneficial.
- Bluegrass Swim Club Sewer Separation, completed in 2007, removed existing storm water connections to the sanitary sewers in Fort Wright, thereby reducing wet weather flows in SD1's sanitary sewer system.

2.3.3 Ongoing or Planned Infrastructure Improvement Projects

SD1 has several ongoing and planned projects for the Banklick Creek watershed including:

- Western Regional - Narrows Road Diversion Pump Station and Industrial Road Force Main. This project will divert flow from the Lakeview pump station

service area, which experiences overflows at the pump station and from manholes upstream. This project will: (1) free up capacity at the Dry Creek Treatment Plant; and (2) increase capacity in the conveyance system tributary to Lakeview, decreasing overflows in this system.

- Western Regional – KY Transportation Cabinet - Turkeyfoot Road Force Main, partially completed, is the first construction piece of the new Diversion Pump Station system that will eventually divert flow from the Lakeview Pump Station service area.
- Three locations where the sewerline crosses Banklick Creek are being fixed using stream stabilization techniques such as J hooks and riffles, to stop headcutting. These are located along the mainstem of Banklick Creek, just upstream of Banklick Woods Park. Another manhole and exposed pipe are being surveyed to determine the best solution for that site, which is also along the mainstem of Banklick Creek, near River mile 9.5.

Project information is presented in Table 5.

Table 5. Ongoing or Planned Infrastructure Improvement Projects

Capital Improvement Project Title	Goals	Anticipated Start Date	Anticipated Completion Date	Project Total
Western Regional - Narrows Road Diversion Pump Station	Decrease overflows in the Lakeview service area	2010	2013	\$11,565,000
Western Regional - Turkeyfoot Industrial Road Force Main	Decrease overflows in the Lakeview service area	2010	2013	\$3,045,000
Stream crossing projects and problem manhole	Decrease potential for stream inflow into District sanitary sewers	To be determined	To be determined	To be determined

2.4 SENSITIVE AREAS

The federal CSO Control Policy (USEPA, 1994) states EPA's expectation that a permittee's Long-Term Control Plan (LTCP) give the highest priority to controlling CSOs in sensitive areas. The CSO Control Policy indicates that sensitive areas include:

- Waters designated as Outstanding National Resource Waters (ONRW);
- Waters with threatened or endangered species and their habitat;
- Waters with primary contact recreation, such as bathing beaches;
- Public drinking water intakes and their designated protected areas;
- National Marine Sanctuaries; and
- Shellfish beds.

These six criteria were evaluated individually. None of the waters in the Banklick Creek watershed have been designated by the State of Kentucky as ONRW (401 KAR 10:030) and no National Marine Sanctuaries have been designated (NOAA, 2008). There are no known commercial shellfish beds within the Banklick Creek watershed, nor is shellfish harvest for consumption by private individuals known to occur. The remaining three criteria are discussed below.

2.4.1 Threatened and Endangered Species or Their Designated Critical Habitat

Threatened and endangered species, species of concern and their designated critical habitat within the Banklick Creek watershed were identified by contacting the Kentucky State Nature Preserves Commission (KSNPC). KSNPC identified five species (Table 6), one of which (Running buffalo clover) is an threatened and endangered species. There is no critical habitat designated for any of the five species.

Table 6. Endangered Species, Threatened Species and Species of Concern

Taxonomic Group	Scientific name	Common name	Status ^a	Last Observed	Habitat(s)	Identified Threats
Vascular Plants	<i>Trifolium stoloniferum</i>	Running buffalo clover	Federal - Endangered State - Threatened	2003	Riparian areas, upland areas	Habitat loss, non-native species, bison decline,
Breeding Birds	<i>Ammodramus henslowii</i>	Henslow's sparrow	Federal - SOMC State-Special Concern	1950	Grasslands, savannahs	Habitat loss
Breeding Birds	<i>Tyto alba</i>	Barn owl	State - Special Concern	1987	Farms and farm structures	Habitat loss
Amphibians	<i>Plethodon cinereus</i>	Redback salamander	State - Special Concern	1998	Woodlands	Habitat loss, habitat degradation
Amphibians	<i>Rana pipiens</i>	Northern leopard frog	State - Special Concern	1934	Ponds, wetlands, grasslands	Habitat loss, non-native species, commercial overexploitation

Source: KSNPC, 2006; KSNPC, 2007

^aSpecies of Management Concern (SOMC) is a Federal/ESA Designation

Running buffalo clover is a small herbaceous plant (Figure 7) that inhabits streambanks and upland areas, and erosion is noted as the biggest threat (KSNPC, 2006). Other factors contributing to population declines are loss of bison populations, non-native plants, and overall habitat loss (USFWS, 2003).

The northern leopard frog is an aquatic-dependent species, which is a state species of special concern. The northern leopard frog inhabits various habitats including slowly flowing areas in creeks and rivers, springs, the nearshore area of lakes, bogs, fens, herbaceous wetlands, riparian areas and grasslands (NatureServe, 2007). Threats to the northern leopard frog include habitat loss, commercial overexploitation, and competition with introduced species (NatureServe, 2007).



Source: US Fish & Wildlife Service; Sarena Sabo

Figure 7. Running Buffalo Clover, *Trifolium stoloniferum*

Three of the species identified by KSNPC are neither aquatic nor dependent on riparian habitats. These are Henslow's sparrow, the barn owl and the redback salamander. Henslow's sparrow inhabits grassland and savannah habitats and the greatest threat to the species is loss of habitat (Reinking, 2002). The barn owl inhabits farms and farm structures, and loss of farmland to commercial development, changes in farming practices (e.g., reduction in dairy and sheep farming) and a general decline in the number of farms have been cited as contributing to population declines (NatureServe, 2007). The redback salamander, a woodland species, is sensitive to localized habitat loss, mainly due timber removal and habitat degradation (NatureServe, 2007).

2.4.2 Primary contact recreation waters

Kentucky does not have a tiered approach for primary contact recreation (PCR). This means that the State has designated that all PCR waters should be suitable for full body contact recreation during the recreation season of May 1 through October 31 (401 KAR 10:001E). The State water quality standards do not define full body contact recreation, so the bacteria criteria developed are based on the presumption that people will ingest water and could become ill if the water was sufficiently contaminated with bacteria.

Banklick Creek and its tributaries are designated for PCR. It is not clear whether or not swimming occurs in the creek, as public surveys regarding that information are unavailable. No public swimming beaches were identified in the watershed. Wading has been observed in Banklick Creek. Additional data will be gathered about uses of the creek.

2.4.3 Public drinking water intakes or their designated protection areas

There are no public drinking water intakes from surface waters or public groundwater wells in this watershed. The nearest intake is located on the Licking River just upstream

of the Banklick Creek confluence. Northern Kentucky Water District (NKWD) is responsible for the drinking water intake on the Licking River.

Source Water Assessment and Protection Areas (SWAPPs) for the water intake on the Licking River have been delineated to identify potential contaminants upstream of the water intake. The SWAPP zones are not used in a regulatory sense but are used to support identification of sources potentially impacting the intakes. Due to the location of the NKWD intake, portions of this watershed lie within SWAPP Zone 1, which extends 5 miles upstream on Banklick Creek from the mouth. The remainder of the watershed lies within SWAPP Zones 2 and 3, because they are farther from the intake.

Drinking water supply features are shown in Figure 8.

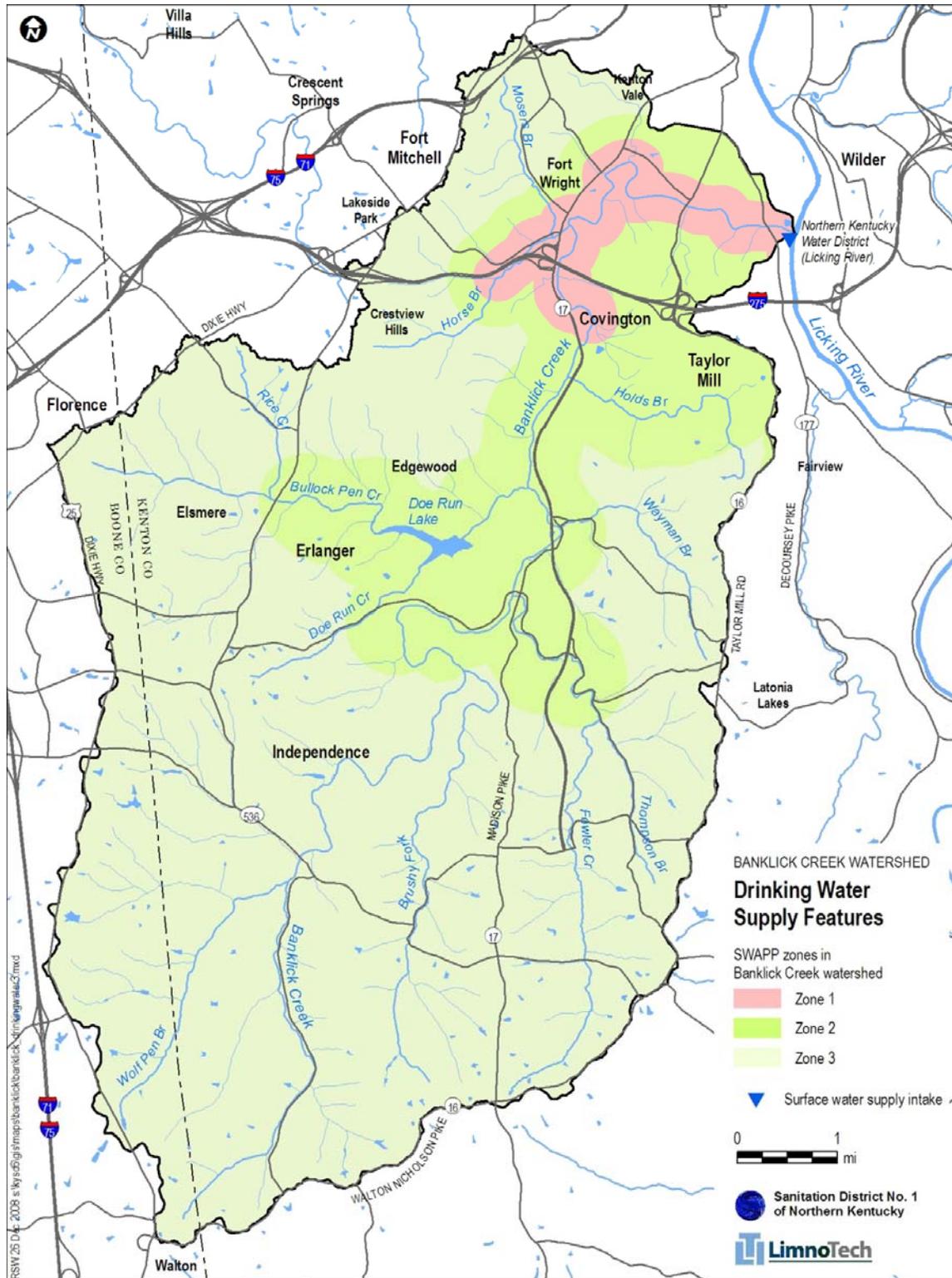


Figure 8. Drinking Water Supply Features

2.5 PUBLIC INTEREST/WATERSHED GROUP ACTIVITIES

Interest in this watershed is considered high, and is gauged through an active watershed council, past studies and improvement projects, and past sampling.

The Banklick Watershed Council was formed in 2002 “to make Banklick Creek once again “swimmable and fishable” and a safe, public amenity without dangerous flooding and pollution” (<http://www.banklick.org/index.htm>). A watershed action plan was developed in 2005 using 104(b)(3) funds (Banklick Watershed Council, 2005), and more recently, the watershed council was awarded 319(h) grant funding to revise the existing watershed plan and continue restoration activities.

Many organizations have been active in this watershed, including SD1, the Banklick Creek Watershed Council, the U.S. Army Corps of Engineers, the Northern Kentucky Health Department, the Local Alliance for Nature and Development, Kenton County Conservation District, Licking River Watershed Watch, the Area Development District and the Licking Region Basin Team. Some studies and projects in this watershed are briefly described below. Projects more directly related to infrastructure improvements are discussed in Sections 2.3.2 and 2.3.3.

- SD1 has been conducting monitoring and modeling studies in this watershed since 1995 and has been responsible for funding or conducting numerous investigations, reports and projects aimed at improving the health of the watershed.
- The USDA, FEMA and the USACE have been involved in projects to investigate and reduce flooding in the watershed (See Section 2.1.1).
- A 2006 small area study (NKAPC, 2006a) examined potential future land uses in the headwaters of Banklick Creek, and identified key natural features for preservation. The study provides recommendations for greenways, riparian buffers along perennial and intermittent streams, hillside protection, stream restoration.
- A \$1 million 319(h) project is underway to modify the existing watershed plan and conduct restoration activities in this watershed over the next 6.5 years (Kentucky Energy and Environment Cabinet, 2008).
- A preliminary scope has been developed to conduct stream and wetland restoration along Banklick Creek, in the 38-acre Wolsing Preserve. This work will involve removal of a low water bridge, sewer crossing restoration, Cody Road crossing removal, restoration of a 100 foot riparian buffer, and wetlands enhancement. This project is proposed by the Northern Kentucky University Center for Applied Ecology through the Northern Kentucky Stream and Wetland Restoration Fund, with some funding also being provided by Kenton County Conservation District. The Kenton and Boone County Conservation Districts, and the USDA Natural Resources Conservation Service also continue to promote riparian buffers (Banklick Watershed Council, 2005).
- A master plan has been developed for Doe Run Lake to protect and enhance the lake, link adjacent areas using trails, greenways, stream or wildlife corridors, and

- provide opportunities for education and increasing awareness of this resource (Human Nature, 2003).
- The Madison Pike (KY 17) Corridor Study was developed to guide development of the area adjacent to Banklick Creek. Among other things, this plan includes objectives to maximize Banklick Creek as an asset to the surrounding area and provide recreational opportunities in the corridor. Riparian protection/buffers and hillside protection areas are discussed (City of Fort Wright, Kentucky, 2004).

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3. WATERBODY USES

This section describes designated and current uses for Banklick Creek and its tributaries.

3.1 DESIGNATED USES

Banklick Creek and its tributaries are designated for warm water aquatic habitat, primary contact recreation, secondary contact recreation and domestic water supply, applicable at existing points of public water supply withdrawal (401 KAR 10:026). These are defined below.

- **Warm water aquatic habitat** means any surface water and associated substrate capable of supporting indigenous warm water aquatic life.
- **Primary contact recreation** waters means those waters suitable for full body contact recreation during the recreation season of May 1 through October 31.
- **Secondary contact recreation** waters means those waters that are suitable for partial body contact recreation, with minimal threat to public health due to water quality.
- **Domestic water supply** means surface waters that with conventional domestic water supply treatment are suitable for human consumption through a public water system as defined in 401 KAR 8:010, culinary purposes, or for use in any food or beverage processing industry; and meet state and federal regulations under the Safe Drinking Water Act, as amended, 42 U.S.C. 300f - 300j.

3.2 CURRENT USES

An assessment of available information found the following:

- Fish IBI scores for Banklick Creek ranged from poor to excellent. Benthic algal surveys revealed high levels of eutrophication throughout the creek. The most diverse aquatic macroinvertebrate communities were found in the upper watershed and outside of urban areas (Strand Associates, 2003).
- There is a swimming advisory for the entire length of Banklick Creek, based on bacteria measurements in the creek (KDOW, 2007b).
- Wading in the creek has been observed along the mainstem of the Banklick Creek in the Pioneer Park area.
- There are no boat launches or marinas on the creek, however recreational boating may occur on Banklick Creek. Banklick Creek is listed on the American Whitewater website and a description of the creek between Independence Station Road and the Doe Run confluence is provided, which provides the class of the creek, the gradient and the length of this reach (<http://www.americanwhitewater.org/rivers/id/3132>).
- A boat launch ramp for Doe Run Lake is located within Doe Run Lake Park.
- A statewide fish consumption advisory was issued on April 11, 2000 due to low levels of organic mercury found in fish taken from Kentucky waters (KDOW, 2007a).

- Fishing is permitted at Doe Run Lake Park and Banklick Woods Park. Fishing has also been observed along the mainstem of the Banklick in the areas of Pioneer Park and SD1's Public Service Park.
- There are no water supply intakes from surface waters in the Banklick Creek watershed.
- There are no active public water supply groundwater wells in this watershed (KDOW, 2008a; KDOW, 2007c).

4. WATERBODY CONDITIONS

This section describes monitoring programs and observed water quality and biological conditions in this watershed.

4.1 303(d) STATUS AND POLLUTANTS OF CONCERN

The entire length of Banklick Creek and one lake appear on Kentucky's 2008 303(d) list of impaired waters (Table 7; KDOW, 2008).

Table 7. 303(d)-listed Waterbodies

Waterbody Segment	Designated Uses (use support)	Pollutants	Suspected Sources
Banklick Creek RM 0.0 – 3.5	Primary contact recreation (Not supporting) Warm water aquatic habitat (Partially supporting)	Fecal coliform Nutrient/eutrophication biological indicators; Organic enrichment (sewage) biological indicators; Sedimentation/siltation	Highways, Roads, Bridges, Infrastructure (New construction), municipal point source discharges, unspecified urban storm water, urban runoff/storm sewers
Banklick Creek RM 3.5 – 8.2	Primary contact recreation (Not supporting) Warm water aquatic habitat (Not supporting)	Fecal coliform Nutrient/eutrophication biological indicators; Organic enrichment (sewage) biological indicators; Sedimentation/siltation	Agriculture, on-site treatment systems (septic systems and similar decentralized systems)
Banklick Creek RM 8.2 – 19.2	Primary contact recreation (Partially supporting) Warm water aquatic habitat (Partially supporting)	Fecal coliform Nutrient/eutrophication biological indicators; Organic enrichment (sewage) biological indicators	Agriculture, on-site treatment systems (septic systems and similar decentralized systems)
Doe Run Lake 51 acres	Warm water aquatic habitat (Partially supporting)	Dissolved oxygen; Nutrient/eutrophication biological indicators; Dissolved gas supersaturation	Source unknown, upstream source

TMDL development is planned for Banklick Creek. KDOW may collect additional sediment data if needed and once data collection is complete, KDOW will develop the sediment TMDLs. KDOW will pursue development of nutrient and organic enrichment TMDLs when nutrient targets are available (KDOW, 2008).

4.2 MONITORING PROGRAMS

Water quality data have been collected in this watershed by KDOW, Northern Kentucky University (NKU), Licking River Watershed Watch (LRWW), USGS and SD1. Data currently compiled by SD1 from known monitoring programs are presented in Table 8,

however, only data which have been fully analyzed are discussed in Section 4.3 Water Quality Data Analysis. Available data exists for the main stem of Banklick Creek, Bullock Pen Creek, Fowler Creek, Mosers Branch as well as Doe Run Lake.

Data not included in this report will be reviewed and included in subsequent updates.

Table 8. Summary of Water Quality Monitoring Data

Entity	Dates	Parameters Sampled	Sampling Locations ^b	Number of Samples
KDOW	1985	Fecal coliform, Fecal strep	Banklick Cr. RM 5.9, 0.3, 1.2	1/month March & July
KDOW	1989, 1994, 1995,	Alkalinity, chloride, chlorophyll-a, DO, DO % Sat, 1% light compensation point, pH, conductivity, TSS, VSS, TOC, DOC, transparency (secchi disc), temperature, nutrients	Doe Run Lake (Bullock Pen Cr. RM 0.9)	3/yr May-October
KDOW	1991-2005	Fecal coliform, Fecal strep or entero, E. coli, alkalinity, chloride, chlorophyll-a, DO, DO % Sat, 1% light compensation point, pH, conductivity, TSS, transparency (secchi disc), temperature, nutrients	Banklick Cr. RM 0.2, 0.3, 1.2, 2.4, 3.3, 3.6, 4.0, 8.1	Numerous sampling dates between Apr & Nov
KDOW	1996	DO, pH, conductivity, transparency (secchi disc), turbidity, temperature	Banklick Cr. RM 0.3	13 days in June, July, Aug, & Sept.
KDOW	1999	Fecal coliform	Bullock Pen Cr. RM 0.1	2/month May, Aug, Sept
KDOW	1999	DO, DO % Sat, pH, conductivity, temperature	Banklick Cr. RM 1.2	1 sample (8/19/1999)
KDOW	1999-2000	Fecal coliform, biochemical oxygen demand (5 Day), TSS, nutrients	Banklick Cr. RM 0.3, 1.2, 3.9, 8.2, 8.1, 11.6, 17.7; Fowler Cr. RM 0.1	10 samples from Apr 1999 to Mar 2000 (no sample in June, Oct, & Jan, but two samples for Feb)
LRWW	1999	Fecal coliform	Banklick Cr. RM 0.2, 5.7	1 sample (7/16/1999)
LRWW	2002	Fecal coliform	Banklick Cr. RM 0.1, 0.2, 5.7; Fowler Cr. RM 0.1, 1.7; Mosers Br. RM 0.7	1 sample (7/12/2002)
LRWW	2003	Fecal coliform	Banklick Cr. RM 7.7	2 samples (5/14/2003 & 7/10/2003)
LRWW	2004	Fecal coliform, <i>E. coli</i>	Banklick Cr. RM 0.1, 0.2, 0.8, 5.7; ; Bullock Pen Cr. RM 0.1, 1.8; Mosers Br. RM 0.7	3 samples (May, July, Sept)
NKU	1998	Alkalinity, bromide, chloride, fluoride, hardness, conductivity, sulfate, TOC, TSS, nutrients, metals	Banklick Cr. RM 0.2, 5.7	1 sample (10/11/1998)
NKU	1998	Fecal coliform	Banklick Cr. RM 0.2, 5.7	1 sample (7/14/1998)
NKU	1998	Alachlor, atrazine, chlorpyrifos-methyl, metolachlor, 2,4-D, Dichlorophenoxyacetic acid	Banklick Cr. RM 0.2, 5.7	1 sample (5/17/1998)
NKU	1999	Atrazine, chlorpyrifos-methyl, 2,4-D, Dichlorophenoxyacetic acid	Banklick Cr. RM 0.2, 5.7	1 sample (5/23/1999)
NKU	1999	Alkalinity, chloride, hardness, conductivity, sulfate, TOC, TSS, nutrients	Banklick Cr. RM 0.2, 5.7	1 sample (9/13/1999)
NKU	2000	Alkalinity, chloride, hardness, conductivity, DO, pH, sulfate, TOC, TSS, temperature, nutrients	Banklick Cr. RM 0.2, 5.7	1 sample (Sept.)
NKU	2000	Fecal coliform, Fecal Streptococci	Banklick Cr. RM 0.2, 5.7	1 sample (7/15/2000)
NKU	2000	Atrazine, metolachlor	Banklick Cr. RM 0.2, 5.7	1 sample (5/21/2000)
NKU	2001	Atrazine, metolachlor	Banklick Cr. RM 0.1, 0.2, 5.7	1 sample (June)

Table 8. Summary of Water Quality Monitoring Data - Continued

Entity	Dates	Parameters Sampled	Sampling Locations ^b	Number of Samples
NKU	2001	Fecal coliform, Fecal Streptococci	Banklick Cr. RM 0.1, 0.2, 5.7	1 sample (7/14/2000)
NKU	2001	Fecal coliform, E. coli, DO, pH, temperature	Banklick Cr. RM 15.6; Bullock Pen Cr. RM 0.4, 2.7; Fowler Cr. RM 1.7; Mosers Br. RM 0.7	1 sample (8/25/2001)
NKU	2002	Atrazine, DO, pH, temperature	Banklick Cr. RM 15.6; Bullock Pen Cr. RM 0.4, 2.7; Fowler Cr. RM 0.1, 1.7; Mosers Br. RM 0.7	1 sample (May)
NKU	2003	Fecal coliform, DO, pH, conductivity, temperature	Banklick Cr. RM 0.1, 0.2, 0.8, 5.7; Mosers Br. RM 0.7	1 sample (5/17/2003)
NKU	2003	Fecal coliform, alkalinity, boron, chloride, DO, hardness, pH, conductivity, silicon, sulfur, sulfate, TSS, temperature, nutrients, metals	Banklick Cr. RM 0.2, 5.7; Mosers Br. RM 0.7	1 sample (Sept.)
NKU	2003	Fecal coliform	Banklick Cr. RM 0.1, 0.2, 5.7; Mosers Br. RM 0.7	1 sample (7/10/2003)
SD1	1995-1996	Fecal coliform, E. coli, biochemical oxygen demand (5 Day), carbonaceous biochemical oxygen demand (5-day), chlorophyll a, cyanide, DO, hardness, oil and grease, pH, settleable solids, conductivity, TOC, total solids, TSS, transparency (secchi disc), turbidity, VSS, temperature, nutrients, metals	Banklick Cr. RM 0.3, 1.2, 3.9	12 wet/dry weather events (33 samples from each station for all of the events)
SD1	1996	DO, pH, conductivity, transparency (secchi disc), temperature	Banklick Cr. RM 0.3, 1.2, 3.9	1/month June, Aug, & Sept
SD1	1996	WQ: DO, pH, conductivity, turbidity, temperature, transparency (secchi disc) Sediment: chemical oxygen demand, oil and grease, total solids, total volatile solids, toluene, nutrients, metals	Banklick Cr. RM 0.3	1 sample (8/8/1996)
SD1	2001-2003	DO, pH, conductivity, transparency (secchi disc), turbidity, TSS, temperature, nutrients	Banklick Cr. RM 0.4, 2.5, 3.8, 5.4, 8, 10.1, 13.5, 15, 18.2; Bullock Pen Cr. RM 0.1	Four sampling events (Sept & Oct of 2001, May & June of 2002, Sept of 2002, & April & May of 2003) -- parameters and sampled stations vary from each event
SD1	2002-2003	Fecal coliform, E. coli, carbonaceous biochemical oxygen demand (5-day), DO, hardness, pH, conductivity, TSS, VSS, temperature, nutrients, metals	Banklick Cr. RM 0.3, 3.9, 8.1, 11.6, 15.6; Bullock Pen Cr. RM 0.1; Fowler Cr. RM 0.1	3 wet and 3 dry weather events (21 samples from each station for all of the events)

Table 8. Summary of Water Quality Monitoring Data - Continued

Entity	Dates	Parameters Sampled	Sampling Locations ^b	Number of Samples
SD1	2002-2003	Gage height, discharge, DO, pH, conductivity, temperature	Banklick Cr. RM 0.3, 1.2	5- & 15-minute intervals
SD1	2007	Fecal coliform, E. coli, carbonaceous biological oxygen demand (5-day), DO, pH, conductivity, TSS, temperature, turbidity, nutrients	Banklick Cr. RM 0.3, 1.2, 3.9, 8.1, 11.6, 15.6; Bullock Pen Cr. RM 0.1; Fowler Cr. RM 0.1	1 sample (6/26/2007)
SD1	2008	Fecal coliform, E. coli, carbonaceous biological oxygen demand (5-day), DO, pH, conductivity, TSS, temperature, turbidity, nutrients	Banklick Cr. RM 0.3, 1.2, 3.9, 8.1, 11.6, 15.6; Bullock Pen Cr. RM 0.1; Fowler Cr. RM 0.1	1 Wet Weather Event in May (Eight samples from each station for the event)
SD1	2008 ^a	Fecal coliform, E. coli, carbonaceous biological oxygen demand (5-day), DO, pH, conductivity, TSS, temperature, turbidity, nutrients	Banklick Cr. RM 0.3, 1.2, 3.9, 8.1, 11.6, 15.6; Bullock Pen Cr. RM 0.1; Fowler Cr. RM 0.1	1 sample (6/25/2008)
University of Kentucky	1993	Fecal coliform, Fecal strep, biochemical oxygen demand (5 Day), DO, TSS	Banklick Cr. RM 1.2, 2.4, 3.6, 4.0	10 samples for Aug, 5 samples for Sept, & 2 samples for Nov
USGS	1999-present ^a	Gage height, discharge, precipitation, DO, DO % sat, DO equilibrium, pH, conductivity, turbidity, temperature	USGS Station No. 03254550; Banklick Cr. RM 8.1	15-minute intervals

^aData not analyzed in Section 4.3, including USGS data collected after WY 2005

^b RM = River mile

4.2.1 Future Sampling

Both instream and outfall sampling are currently planned.

SD1 plans to continue monitoring this watershed during base flow conditions with at least one survey per year. The eight sampling locations are: Banklick Cr. RM 0.3, 1.2, 3.9, 8.1, 11.6, 15.6; Bullock Pen Cr. RM 0.1; and Fowler Cr. RM 0.1. Typical analyses will include bacteria, nutrients, solids, oxygen-demanding constituents and physical parameters.

SD1 is planning to collect wet weather data at four locations in this watershed in 2009. The four locations are: Banklick Creek RM 0.3, 1.2, 3.9 and 8.1. Attempts will be made to sample three events of varying characteristics (total rainfall, maximum intensity). Samples may be analyzed for bacteria, nutrients, solids, oxygen-demanding constituents and physical parameters. Within each event, samples will be collected near hour 0, 2, 4, 6, 12, 24, 36, and 48 hours of the start of the storm, though these intervals are dependent on the storm characteristics and may be changed if necessary. Additionally, surveys to assess the degree of stream hydromodification are currently underway by SD1.

The USGS will continue to operate the stage gage, measure flow, and water quality (physical parameters) at RM 8.1 (station 03254550). This station is operated and funded via a cooperative agreement between USGS and SD1.

Outfall sampling was initiated in 2007 to better characterize water quality and loadings from CSOs, SSOs and storm water runoff. Six outfalls are being sampled in the Banklick Creek watershed and analyzed for bacteria, nutrients, solids, metals and oxygen-demanding constituents. The outfalls being sampled include the Lakeview pump station, the Church Street CSO and four storm water outfall locations. This sampling program plan is anticipated to continue until ten events are monitored.

4.3 WATER QUALITY DATA ANALYSIS

Water quality data have been collected in the Banklick Creek watershed since 1985. Historical water quality data (1985-2005) have been analyzed to identify past water quality problems in this watershed. Historical exceedances of bacteria, dissolved oxygen, metals, temperature, pH and alkalinity (Doe Run Lake only) have been observed. Temperature and pH violations were only observed at the USGS continuous monitoring station.

Recent data (2006-present) have been analyzed in more detail to describe current stream conditions, because these data better reflect the effect of existing sources on instream water quality. Analysis of recent data collections indicate elevated bacteria levels. It should be noted that the data collected at the USGS station are not included in this assessment of recent data. These data are being reviewed and will be included in the next update of this report.

4.3.1 Historical Data

Both discrete measurements and the continuous water quality data were analyzed to identify historical water quality problems. The 15-minute data collected at the USGS

continuous monitoring station through water year 2005 have been previously analyzed and documented in report by Cumberland Environmental Group (2007). This report is used to as the basis for the continuous data analysis.

Historical sampling data, as well as the 15-minute USGS data, reveal numerous exceedances of water quality criteria (Tables 9-12). Locations and parameters not discussed met their applicable water quality standards.

Table 9. Historical Bacteria Exceedances

Stream	River Mile	Parameters exceeding criteria				
		Season	Fecal coliform		<i>E. coli</i>	
			# samples	% of samples exceeding criteria ^a	# samples	% of samples exceeding criteria ^a
Banklick Creek	0.1	May-Oct	6	83%	1	100%
Banklick Creek	0.2	May-Oct Nov-Apr	101 6	61% 17%	3 ---	67% n/a
Banklick Creek	0.3	May-Oct Nov-Apr	58 7	86% 100%	50 ---	90% n/a
Banklick Creek	0.4	May-Oct	3	67%	3	67%
Banklick Creek	0.8	May-Oct	2	100%	---	n/a
Banklick Creek	1.2	May-Oct Nov-Apr	125 13	75% 23%	27 ---	93% n/a
Banklick Creek	2.4	May-Oct Nov-Apr	68 8	54% 38%	---	n/a
Banklick Creek	3.3	May-Oct	12	58%	---	n/a
Banklick Creek	3.6	May-Oct Nov-Apr	93 8	68% 38%	---	n/a
Banklick Creek	3.9	May-Oct Nov-Apr	51 5	82% 40%	47 ---	85% n/a
Banklick Creek	4.0	May-Oct Nov-Apr	112 8	72% 13%	---	n/a
Banklick Creek	5.7	May-Oct	10	80%	---	n/a
Banklick Creek	7.7	May-Oct	2	100%	---	n/a
Banklick Creek	8.1	May-Oct Nov-Apr	60 7	68% 14%	21 ---	81% n/a
Banklick Creek	11.6	May-Oct	24	75%	21	81%
Banklick Creek	15.6	May-Oct	22	77%	21	81%
Banklick Creek	17.7	May-Oct	1	100%	---	n/a
Bullock Pen Creek	0.1	May-Oct	26	65%	23	78%
Fowler Creek	0.1	May-Oct Nov-Apr	24 1	88% 100%	21 ---	81% n/a
Mosers Branch	0.7	May-Oct	8	50%	3	67%

^a There are no instances where 5 samples were collected from a single location within a 30-day period. Therefore the comparison to the geometric mean portion of the fecal coliform and *E. coli* criteria, which requires a minimum of 5 samples taken during a 30-day period, is not possible. Comparisons were, however, made to the part of the criteria that reads, "Content shall not exceed 400 colonies/100 ml in 20 percent or more of all samples taken during a 30-day period for fecal coliform or 240 colonies/100ml for *E. coli*." Even this comparison is conservative as the criterion is meant to be applied to a dataset of 5 or more samples collected over a 30-day period.

--- is used to indicate no data; n/a indicated not applicable

Table 10. Historical Dissolved Oxygen Violations

Stream	River Mile	Parameters violating criteria	
		Dissolved oxygen ^a	
		# measurements	% of measurements in violation
Banklick Creek	0.2	67	7%
Banklick Creek	0.3	76	7%
Banklick Creek	1.2	114	11%
Banklick Creek	2.4	70	9%
Banklick Creek	3.6	81	20%
Banklick Creek	4.0	82	1%
Banklick Creek	8.1	60	2%
Bullock Pen Creek	0.9	186	66%

^a The dissolved oxygen criterion is 4 mg/l.

Table 11. Historical Metals Violations

Stream	River Mile	Parameters violating criteria							
		Cadmium ^a		Copper ^a		Iron ^b		Zinc ^a	
		# samples	% of samples in violation	# samples	% of samples in violation	# samples	% of samples in violation	# samples	% of samples in violation
Banklick Creek	0.3	44	7%	54	2%	---	n/a	---	n/a
Banklick Creek	1.2	30	23%	---	n/a	---	n/a	---	n/a
Banklick Creek	3.9	29	17%	---	n/a	---	n/a	---	n/a
Banklick Creek	5.7	---	n/a	---	n/a	5	50%	---	n/a
Banklick Creek	8.1	---	n/a	20	5%	---	n/a	---	n/a
Banklick Creek	11.6	---	n/a	20	5%	---	n/a	---	n/a
Fowler Creek	0.1	---	n/a	20	10%	---	n/a	20	5%

^a Acute criteria to protect aquatic life are hardness-dependent. Individual criteria were calculated for each sampling event based on hardness at the time of sampling. Acute cadmium criteria ranged from 1.9 ug/l to 8.5 ug/l. Acute copper criteria ranged from 12.7 ug/l to 50.5 ug/l. Acute zinc criteria ranged from 110 ug/l to 380 ug/..

^b The acute water quality criterion for iron is 4,000 ug/l

--- is used to indicate no data; n/a indicated not applicable

Table 12. Historical Alkalinity Violations

Stream	River Mile	Parameters violating criteria	
		Alkalinity ^a	
		# samples	% of samples in violation
Bullock Pen Creek	0.9	3	100%

^a The alkalinity criterion is 20 mg/l CaCO₃

The dissolved oxygen, temperature and pH violations discussed below were all observed at the USGS station on Banklick Creek at RM 8.1.

Violations of the 4.0 mg/l dissolved oxygen criteria have been reported in 2001 (May and September), 2002 (June), and 2003 (July). In general, flows were very low on days where dissolved oxygen was less than 4 mg/l.

Infrequent violations of the temperature criteria (31.7°C) were observed in 2001, 2002 and 2005. These violations occurred during the summer months when flows were low.

Infrequent pH violations at the USGS gage were observed in 2002 and 2005, where the pH at RM 8.1 was observed to change more than 1 su in a 24-hour period. These violations occurred over a range of flow conditions. There were no observations of pH greater than 9.0 su or less than 6.0 su. The Synthesis Report suggests that the cause of most pH violations is algal growth and photosynthesis (CEG, 2007).

4.3.2 Recent Data

Recent water quality data were available for six locations along the mainstem of Banklick Creek (RM 0.3, 1.2, 3.9, 8.1, 11.6, and 15.6), as well as one location on Bullock Pen Creek (RM 0.1) and one location on Fowler Creek (RM 0.1). Eight fecal coliform samples and eight *E. coli* samples were available for each location.

Recent bacteria exceedances were observed (Table 13). Measurements for parameters not shown met water quality criteria. Recent data collected at the USGS station are being reviewed and will be included in the next update of this report.

Table 13. Recent (2006-2008) Bacteria Exceedances

Stream	River Mile	Parameters exceeding criteria			
		Fecal coliform ^a		<i>E. coli</i> ^b	
		# samples	% of samples exceeding criteria	# samples	% of samples exceeding criteria
Banklick Creek	0.3	8	75%	8	75%
Banklick Creek	1.2	8	63%	8	75%
Banklick Creek	3.9	8	50%	8	88%
Banklick Creek	8.1	8	50%	8	75%
Banklick Creek	11.6	8	50%	8	63%
Banklick Creek	15.6	8	50%	8	75%
Bullock Pen Creek	0.1	8	50%	8	50%
Fowler Creek	0.1	8	25%	8	63%

^aThere are no instances where 5 samples were collected from a single location within a 30-day period. Therefore the comparison to the geometric mean portion of the fecal coliform and *E. coli* criteria, which requires a minimum of 5 samples taken during a 30-day period, is not possible. Comparisons were, however, made to the part of the criteria that reads, "Content shall not exceed 400 colonies/100 ml in 20 percent or more of all samples taken during a 30-day period for fecal coliform or 240 colonies/100ml for *E. coli*." Even this comparison is conservative as the criterion is meant to be applied to a dataset of 5 or more samples collected over a 30-day period.

4.3.2.a Bacteria

Fecal coliform and *E. coli* data were available for both base flow and storm conditions. Storm flow results for bacteria are presented as an average over the storm event. As shown in Figure 9, fecal coliform concentrations exceeded the applicable criterion in Banklick Creek and Bullock Pen Creek. Four of the 16 base flow samples exceeded the fecal coliform criterion, and storm flow samples exceeded the criterion at every location except Fowler Creek at RM 0.1. The maximum base flow fecal coliform concentration, 1,530 cfu/100 ml, was observed at Bullock Pen Creek RM 0.1, while the maximum storm event concentration, 1,697 cfu/100 ml, was observed at Banklick Creek RM 0.3.

E. coli concentrations exhibited a similar pattern, as shown in Figure 10. Eight of the 16 base flow measurements exceeded the applicable criterion, with exceedances observed at all sampling locations. The maximum base flow *E. coli* concentration, 1,333 cfu/100 ml, was observed at Bullock Pen Creek RM 0.1. Storm flow measurements exceeded the criterion at all locations, with a maximum concentration of 1,972 cfu/100 ml observed at Banklick Creek RM 0.3.

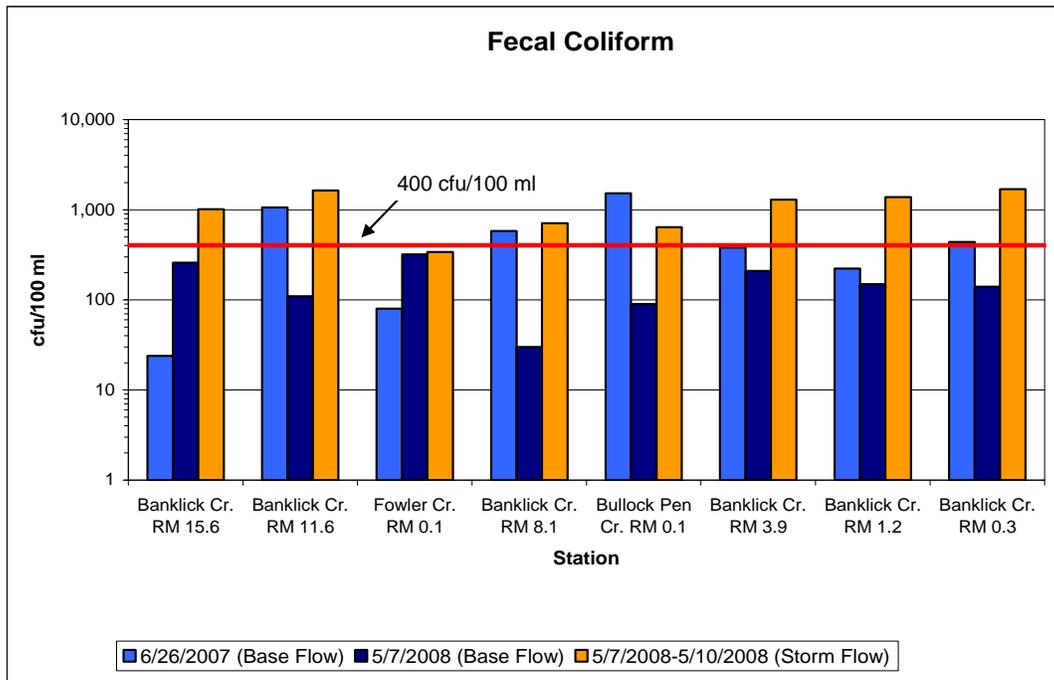


Figure 9. 2006-08 Base Flow and Average Storm Flow Fecal Coliform Concentrations Compared to 400 cfu/100 ml Criterion

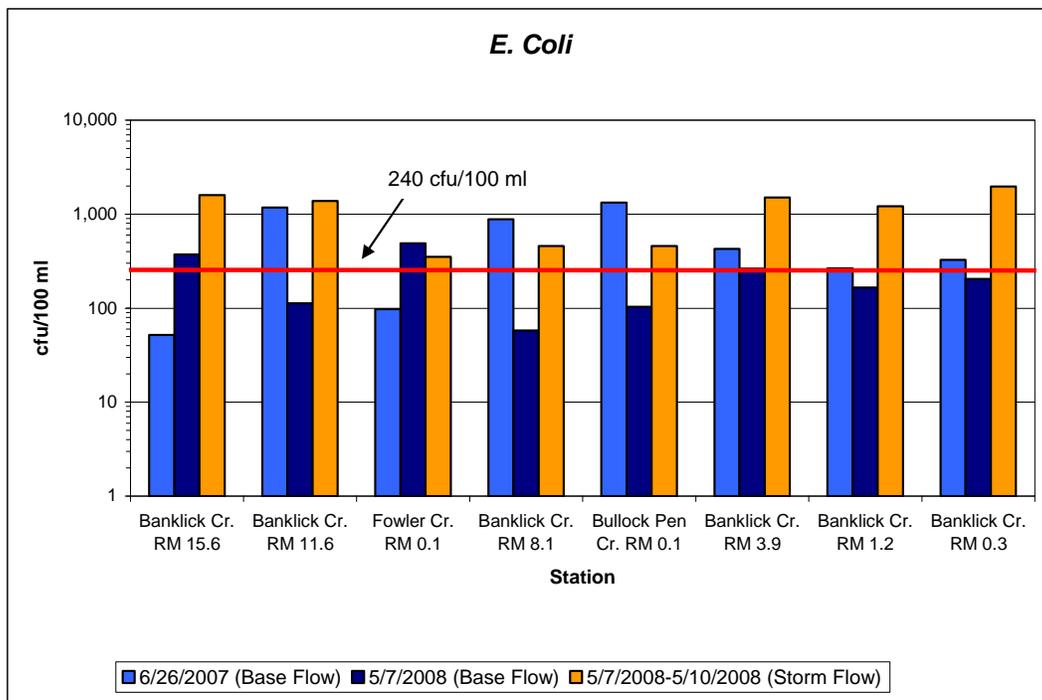


Figure 10. 2006-08 Base Flow and Average Storm Flow E. Coli Concentrations Compared to 240 cfu/100 ml Criterion

4.4 BIOLOGICAL CONDITIONS

Macroinvertebrate communities are susceptible to water quality and habitat degradation, and data from these communities are used as a tool to detect changes in habitat and water quality and assessing stream health (KDOW, 2008b).

KDOW sampled macroinvertebrates in 1999 at Banklick Creek RM 1.2, which yielded a MBI⁸ rank of “poor” (Table 1). KDOW and Strand Associates also collected macroinvertebrate samples in 1996 and 2001-2003, respectively, but these data are not compatible with calculating the MBI. The 2001-2003 data indicate, with a few exceptions in locations where the creek is ephemeral, that areas upstream in the watershed had higher percentages of desirable macroinvertebrate individuals (Strand Associates, 2003). This is likely due to the lower level of land use disturbance in the primarily agricultural area compared to the high level of disturbance farther down the watershed where urban development exists. The urbanized areas have altered aquatic habitats, reduced riparian zones and increased siltation. Desirable macroinvertebrates were also low at the Bullock Pen Creek site and at sites closest to the mouth of Banklick Creek (Strand Associates, 2003). The downstream sites in Banklick Creek are also subject to backwater flows from the Licking and Ohio Rivers that cause siltation and further reduce desirable macroinvertebrates.

Benthic algae are useful biological indicators of water quality because they are sensitive to changes in water quality and are primary producers within aquatic ecosystems. Diatoms are benthic algae that are useful indicators of biological integrity because at least a few can be found under almost any condition and they are identifiable to species (KDOW, 2008b). In 1993, an unnamed tributary to Bullock Pen Creek received a poor rating based on diatom measurements (Table 1). Benthic algae were also measured in total biomass by Strand Associates between 2001 and 2003 (Strand Associates, 2003). The results of this sampling showed that eutrophication is a problem in some sections of the creek during some seasons (Strand Associates, 2003). The Bullock Pen Creek site often had chlorophyll-a measurements exceeding 300 mg/m². High algal levels were also observed in the uppermost portion of the creek, which is surrounded by agricultural lands and subject to low flows, especially during the fall. In the most downstream portions of Banklick Creek, periphyton levels were high only during extended periods of low flow (Strand Associates, 2003).

KDOW and Strand Associates sampled several sites within the Banklick Creek watershed for fish. The calculated KIBI scores⁹ varied in ratings (Table 1).

⁸ The macroinvertebrate data collected by KDOW were used to calculate the macroinvertebrate biotic index (MBI). The MBI compiles attributes of the macroinvertebrate community such as taxa richness, pollution tolerant species and pollution intolerant species. Additional metrics are added depending on the stream size and/or ecoregion.

⁹ The data from this survey were used to calculate the Kentucky Index of Biotic Integrity (KIBI), a multimetric index using fish as an indicator of stream health. The KIBI compiles attributes of the fish community such as taxa richness and abundance, pollution tolerance/ intolerance, feeding and reproductive needs, and presence or absence of native species in order to provide a numerical value and corresponding narrative classification for streams.

4.5 STREAM METABOLISM

Stream metabolism can be used as a measure of ecosystem health because it responds to the complex interactions between instream conditions (physical, biological and chemical) and watershed conditions. It can be assessed by looking at the ratio of primary production (P), which is influenced by instream conditions (light and nutrient inputs), to respiration (R), which is influenced by watershed conditions (other nutrient and detritus inputs). This ratio can be calculated using continuous instream dissolved oxygen measurements, because dissolved oxygen responds to both instream and watershed inputs. Smaller ratios (e.g., P:R less than 1) suggest that stream system health is more strongly affected by watershed inputs than by instream and near stream processes.

Stream metabolism has been analyzed at eight USGS continuous monitoring stations which deploy multi-parameter sondes. These stations are located in watersheds that have varying levels of watershed impacts; however, none are located in an unimpacted or reference watershed. For the 2000-2005 period, all eight sites have ratios that indicate the health of these streams is more strongly affected by watershed inputs than instream and near stream inputs.

Instream and watershed inputs appear to be relatively well balanced in Banklick Creek at RM 8.1, because this site has a P:R ratio close to 1. Because there are no reference sites in this region that can be used for comparison, it is not known how this ratio compares to that for an unimpacted watershed. Longer-term monitoring of dissolved oxygen at the Banklick Creek site may prove useful in understanding how stream and watershed level changes affect the stream metabolism balance at this site.

5. SOURCE ANALYSIS

This section summarizes potential pollutant sources in the Banklick Creek watershed and some of its tributaries. Conclusions are based on the watershed characterization and recent water quality data.

5.1 WATERSHED SOURCES ANALYSIS

Potential sources of bacteria were identified within the Banklick Creek watershed, based on the watershed characterization information discussed previously. Bacteria exceedances have been observed during both base flow and storm flow conditions at all locations recently monitored. These sources are summarized in Table 14 and their location is shown in Figure 11.

Table 14. Summary of Potential Sources

	Banklick Creek Headwaters to RM 8.2 (excluding Fowler Ck)	Fowler Creek	Bullock Pen	Banklick Creek RM 8.2 - mouth (excluding Bullock Pen)
<i>Recent observed Impairments=></i>	Bacteria 303(d): Nutrients, organic enrichment ^c Flooding reported upstream to RM 10.3	Bacteria Flooding reported	Bacteria 303(d): Doe Run Lake DO, nutrients, dissolved gas supersaturation ^d	Bacteria ^b 303(d): Nutrients, organic enrichment, sedimentation/siltation ^e Flooding reported
CSO ^a				5
SSO ^a	4		15	6
SSO-pump station ^a				2
Septic	Numerous	Numerous 1 septic "hot spot"	Few	Few
KPDES-sanitary outfalls ^f	2	11	2	
KPDES-storm water/other outfalls ^g	2		4	12
Storm water runoff	Urban and rural	Urban and rural	Urban; Small portion in Florence	Urban
Livestock	Cattle, horses		2 AFOs (cattle)	
Licking River backwater				Affects lower reaches of Banklick Creek
<i>Watershed improvements</i>	<i>Planned stream and wetland restoration along Banklick Creek in Wolsing preserve. 3 projects planned on mainstem of Banklick Creek near RM 10.5, to address streambank erosion.</i>		<i>Doe Run Lake Master Plan developed to protect and enhance the lake and link the lake to adjacent areas using greenways, trails or stream corridors.</i>	<i>Several projects completed to increase capacity at, and divert flows from Lakeview PS to reduce overflows at PS and upstream. Latonia sewer separation project to reduce overflow from downstream CSOs. Bluegrass Swim Club sewer separation to reduce wet weather flows into sanitary system. Several improvement projects planned to divert flow from Lakeview PS to reduce overflows Madison Pike Corridor Study to maximize Banklick Creek as an asset.</i>

^a SD1 is undertaking a characterization and assessment of the sewer system, and sources are subject to change.

^b DO, pH and temperature violations have historically been observed at the USGS station, but recent data have not been reviewed.

^c Agriculture and on-site treatment systems are identified as potential sources contributing to the impaired primary contact recreation and warm water aquatic habitat uses (KDOW, 2008).

^d An upstream source and unknown source are identified as potential sources contributing to the impairment of the warm water aquatic habitat use (KDOW, 2008).

^e Highways, roads bridges, infrastructure (new construction), municipal point source discharges, unspecified urban storm water runoff, urban runoff/storm sewers, agriculture and on-site treatment systems are identified as potential sources contributing to impairment of the primary contact recreation and warm water aquatic habitat uses (KDOW, 2008).

^f Excludes CSOs. Includes currently permitted facilities only.

^g One outfall is included twice because it covers sanitary and cooling water. Includes currently permitted facilities only.

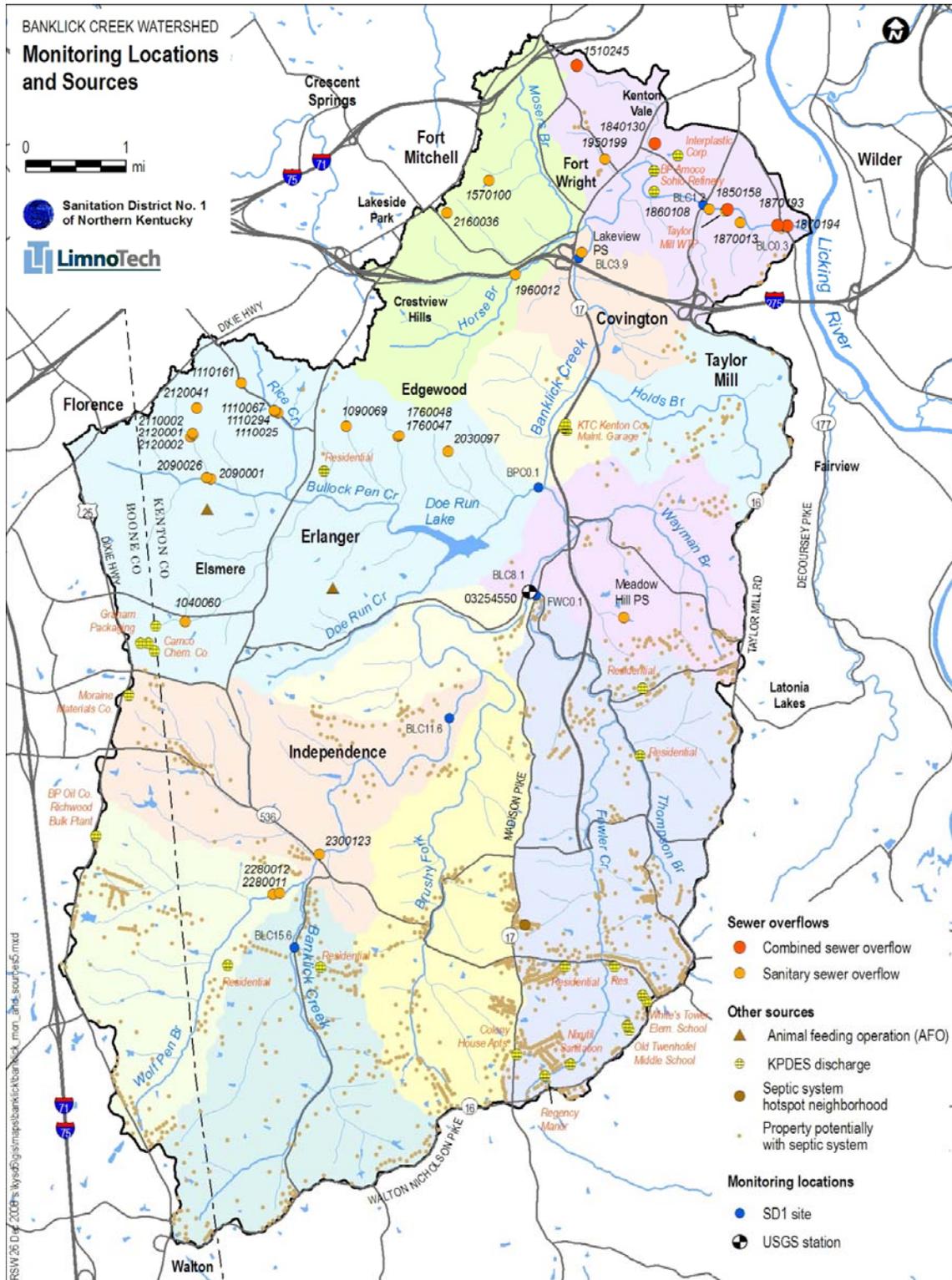


Figure 11. Monitoring Locations and Sources

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6. RANKING

6.1 SUMMARY OF RESULTS

The WAT! is a tool that assesses the potential for point and nonpoint sources to generate fecal coliform, total solids and total phosphorus pollutant loads. WAT! was developed for these three pollutants because data to support modeling were readily available and they are representative indicators of potential water quality conditions. Calibration of the WAT! tool for total solids and total phosphorus is planned, and results should be available in future reports. Results for fecal coliform are discussed below.

This analysis was conducted for each of the sixteen watersheds located within SD1's study area. In addition to assessing pollutant loading potential by source, the WAT! also assesses pollutant loading potential by watershed, which allows for ranking and comparisons among the sixteen watersheds.

WAT! results¹⁰ indicate that under year-round conditions, the Banklick Creek watershed has a roughly average ranking (analogous to load) for fecal coliform, relative to the sixteen identified watersheds in SD1's jurisdictional area.

In addition to WAT! results, other factors such as presence of public drinking water features, presence of aquatic-dependent threatened and endangered (T&E) species, special designations, and public interest may affect watershed prioritization. These and other ranking considerations are summarized in Table 15.

Table 15. Watershed Ranking Considerations

CSO (#)	SSO (#)	SWAPP Zone	Aquatic-dependent T&E Species ^a (#)	Special Designations	Public Interest	WAT! Rank, year-round conditions ^b
						Bacteria
5	27	Zone 1, 2 and 3 (due to Licking River intake)	1	None	High	7 of 16

^a There is also one aquatic-dependent and three terrestrial species of State special concern. One terrestrial species is also a federal species of management concern.

^b The WAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

T&E = Threatened and endangered species

6.2 SCREENING TO DETERMINE IF ADDITIONAL DATA ARE NEEDED

Sufficient data and information are currently available or planned to support a good understanding of current conditions in the Banklick Creek watershed. Additionally, watershed and water quality models have been developed which could be applied to examine the effects that future activities (e.g., development or improvement projects) will have on the watershed.

¹⁰ WAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

Elevated bacteria concentrations have been observed in the watershed during base flow conditions. Preliminary WAT! results indicate septic systems are the primary bacteria source during base flow conditions, but other potential sources, such as: livestock, KPDES-permitted facilities, pets, and wildlife may also be contributing.

6.2.1 Data Gap Analysis

A site visit to the watershed to investigate dry weather bacteria sources is recommended. Additionally, coordination with the health department and the KPDES-permitting agency may also be useful for identifying and addressing improperly operating systems and facilities.

No additional water quality or biological data collection is recommended beyond that already planned, to characterize current conditions in this watershed.

6.3 SOURCE PRIORITIZATION

The sources identified through the process of watershed characterization have been quantified using the WAT!. WAT! has been applied for a five-year period (1992-1996 climatological conditions), to quantify fecal coliform contributions by source. Together the characterization and WAT! results help inform source prioritization for improvement or elimination.

6.3.1 WAT! Results

The relative fecal coliform load generated by source is shown in Figure 12. These WAT! results incorporate predicted sewer overflow volumes from infrastructure model simulations for 1992-1996 climatological conditions¹¹. Flow estimates are available for four of the CSOs and thirteen of the SSOs in this watershed.

Under year-round conditions, the largest source of fecal coliform bacteria is storm water runoff. Septic systems are not a significant contributor to the total annual bacteria load; however, during base flow conditions they are estimated to contribute the majority of the fecal coliform load.

¹¹ The results presented were generated by models based on SD1's current understanding of the collection system infrastructure. These models are predictive tools and are based on numerous variables and assumptions on the characteristics of the collection system, and may differ from actual measured field conditions. These models are subject to change based on improved knowledge of the system, improvements to the system, and changes in land use and development. These results are subject to change and should therefore not be relied on or considered definitive.

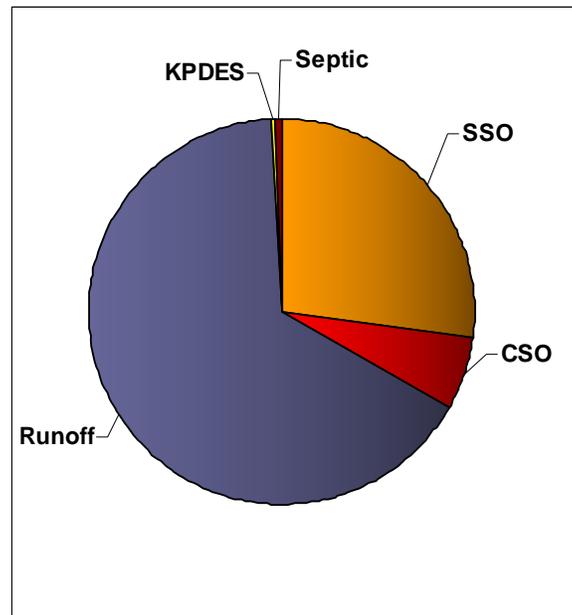


Figure 12. Initial Year-Round WAT! Results for Fecal Coliform

WAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

WAT! results should be considered preliminary as ongoing work may affect the WAT! source analysis and rankings. Work is currently ongoing to refine the bacteria contribution from septic systems.

6.4 WATSHED RANKING

The WAT! produced a ranking, by watershed for sixteen watersheds, based on their potential to generate fecal coliform loads over a 1-year period. The water quality impact score (analogous to load) for each of the sixteen watersheds was used as a ranking metric. Additional detail on the ranking is available in the WAT! documentation.

The WAT! produces rankings of the watersheds for both base flow and year-round conditions. By separating base flow conditions, the impacts of dry weather sources on stream conditions can be differentiated from the combined impact of dry and wet weather sources. The ranking of the Banklick Creek watershed during year-round and base flow conditions is provided in Table 16.

Table 16. WAT! Watershed Rankings

	Rank for Year-Round Conditions ^{a,b}	Rank for Base flow Conditions ^{a,b}
Fecal coliform	7	9

^aRank ranges from 1 to 16. A rank of 1 indicates a high water quality impact score which is analogous to load. The lowest possible rank is 16.

^bWAT! is still under development. All results presented here are for illustrative purposes only. The results are subject to change and should therefore not be relied on or considered definitive.

The WAT! analysis for both total solids and total phosphorus will be presented in future reports upon completion of the WAT! calibration. Future monitoring programs will further populate and refine modeling results, aiding in characterization of potential sources.

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