

STATE OF THE STREAMS

2016 WATER QUALITY SYNTHESIS REPORT



TO OUR COMMUNITY



This 2016 State of the Streams Report represents the culmination of efforts to assess the water quality of waterways in our area from the 1990s through 2015. MSD collects data from streams at 27 sites throughout Louisville Metro. We can tell if the streams are improving or getting worse by comparing recent results to data from past years.

The monitoring results show:

- Better quality aquatic communities were found in watersheds with the higher quality stream habitats, generally in less urban watersheds like Harrods Creek, Floyds Fork, and Cedar Creek in Bullitt County.
- Muddy Fork and South Fork of Beargrass Creek, Mill Creek, and Mill Creek Cutoff had poor quality stream habitat and poor aquatic communities.
- Trends in fish, aquatic insects and stream habitat health indicate that conditions at about half of the 27 monitoring sites were improving.
- Dissolved oxygen and water temperature were within acceptable ranges at most sites, as were nutrients (nitrogen and phosphorus) and suspended solids (sediment in water), which is good for aquatic communities and overall water quality.
- During lower flow conditions, most sites met bacteria water quality standards for boating and wading. Levels were during and immediately after storms.
- Bacteria is the pollutant of major concern, especially during and immediately after storms, but the sources are not just from sewers. Pets, birds, and wild animals also contribute bacteria.

The 1972 Clean Water Act includes national water quality goals for waterways that are fishable, swimmable and safe for use as drinking water supplies. The Act includes strict standards to measure the quality of waterways. This report highlights that together we have made tremendous progress toward Clean Water Act goals and standards, but we have not fully reached them yet.

MSD has made great progress by eliminating many older, smaller wastewater treatment facilities, improving wastewater collection systems and decreasing sewer overflows into our waterways. We are a leader in working with community businesses and industries to improve stormwater quality. In addition to traditional stormwater controls, green infrastructure uses native plants and soil infiltration as a cost effective way to clean stormwater and to keep it from entering the sewer systems to protect our waterways.

Ultimately in an urban watershed what we do on our land affects water quality and the health of our streams. We can all make a positive impact by planting a tree, limiting the use of dishwashers and washing machines during rain events, and picking up pet waste.

MSD is committed to safe, clean waterways. To meet this commitment, we are delivering exceptional wastewater collection and treatment, stormwater management, and flood protection services. We look forward to working with businesses, industries and citizens to create a cleaner and greener Louisville.

Sincerely,

James A. Parrott
Executive Director



The 2016 State of the Streams Report tells the story of how streams in our community are doing and whether they are improving or not. The monitoring data highlights the importance of wastewater projects, stormwater management and green infrastructure. These investments have helped to improve and protect our waterways.

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WHAT IMPACTS OUR WATERWAYS



EXECUTIVE SUMMARY

The Louisville and Jefferson County Metropolitan Sewer District (MSD), in cooperation with the United States Geological Survey (USGS), operates a Long-Term Monitoring Network (LTMN) to collect physical, chemical and biological data about streams in the Louisville Metro area. This State of the Streams Report is focused on the conditions of fish, aquatic insects, algae, stream habitat, bacteria, nutrients (nitrogen and phosphorus), total suspended solids (sediment in water), trace metals, stream flow, dissolved oxygen, and water temperature of the streams in our community, and whether or not these are improving. We've been collecting data at 27 Long Term Monitoring Network sites since 1999. This information will help us make decisions about where to focus our efforts, and tell us how we're doing in our mission to improve water quality of streams in the region.

The health of aquatic communities (fish, insects and algae) in streams can be compromised by one or more factors associated with urban streams:

- Overflows from sewer systems
- Significant and rapid runoff from impervious (hard surfaced) areas
- Stream bank erosion due to increases in runoff
- Sediment that covers habitat needed by fish and aquatic insects
- Channel modifications such as straightening and shoring up with concrete or stones can contribute to erosion elsewhere in the stream
- Lack of rocks and boulders in the stream bed that create cascades and ponding areas where fish and aquatic insects can live
- Insufficient vegetation along the banks that provide shade, food, and stability
- Periods of very low flow, high temperatures, or low dissolved oxygen which is harmful to fish

We can't control some of these factors, like low flows due to dry spells or high temperatures. Making improvements related to other factors will require numerous projects over several years, and we're committed to a program that should help. There are also things that individuals can do on private property, like minimizing the use of lawn chemicals, leaving a buffer along the banks of streams and planting trees along some streams where needed. We'll review these things throughout this report, and we'll look at how our major watersheds are doing with detailed sections in this report.

The charts on the next page reflect analyses of data as far back as 1999. They tell us that:

- In 2015, algae and stream habitat conditions at more than half the sites were good to excellent, whereas fish and aquatic insect conditions at most sites were classified poor to fair.
- Trends in fish, aquatic insects and stream habitat health indicate that about half of the sites were improving.
- Condition of the algal communities at most sites either had no trend or were declining over time.

We're also looking at other things like bacteria, nutrients and trace metals that can affect water quality, and physical measures of water quality, like stream temperature and dissolved oxygen. We also found that:

- Bacterial conditions at most sites are a concern. The vast majority of bacteria in streams are "good" bacteria, necessary for healthy ecosystems to function properly. However, fecal coliform bacteria which is found in human and warm blooded animal waste can cause illness and disease if it enters the body through the mouth, nose, ears or cuts in the skin. This is more likely to happen during the recreational season (May 1 through October 31) when people spend time in streams, lakes, and rivers. 21 of the 27 Long-Term Monitoring Network sites had recreational season levels of fecal coliform bacteria larger than the primary contact/swimming standard of 200 colonies per 100 milliliters, but only four sites had recreational season averages larger than the boating/wading standard of 1,000 colonies per 100 milliliters. From 2004 to 2015, 12 sites were shown to be improving and seven sites were declining.
- Trace metals (cadmium, copper, lead, and zinc) rarely (about five percent of over 4,000 analyses) exceed the criteria for aquatic life, and they are not a large issue of concern.
- Oxygen is a necessary element for all forms of life, including fish and other aquatic life forms. Two sites had a poor status for dissolved oxygen, six were fair, 15 were good and four sites do not have data. An analysis of trends in dissolved oxygen conditions (2005-2007 to 2013-2015) indicates that two sites were declining (Northern Ditch at Preston Highway and South Fork of Beargrass Creek at Schiller Avenue Ramp), nine had no trend, and 12 sites were improving.
- 22 sites met water temperature standards of being no more than 31.7 °C (89.1 °F) over 90 percent of the time, nine sites met the criteria 100 percent of the time.

In general, we've found that streams within urban sections of our community have poorer results, especially in the lower sections of the watersheds. A variety of things contribute to the poorer water quality, but bacteria is the pollutant of major concern. As we continue to address sewer overflows, we expect this to improve. Our challenge will be to implement projects and programs, along with cooperative agreements with others that will show tangible improvements.

MSD HAS BEEN COLLECTING STREAM DATA AT 27 LONG-TERM MONITORING SITES SINCE 1999.

The bacteria that are sampled, fecal coliform and *E. coli*, are derived from warm blooded animals and are not all from human sources. MSD is sampling additional sites during wet and dry weather conditions in order to track bacteria to more specific sources. During and shortly after rainfall events, bacteria concentrations tend to be much higher and from a broader range of sources, including wild animals, pets, and birds as well as collection system issues that have not yet been addressed. To track these down, MSD is conducting additional sampling in the Beargrass Creek watershed to try to pinpoint bacteria hotspots during wet and dry weather. It will be a challenge to both identify and rectify sources of bacteria other than sewers. Bacterial conditions at most sites during higher flows are especially a concern.

For additional details on individual watersheds, please refer to the appropriate chapters in this report.

Long-Term Monitoring Network Summary

2015 Status Category	Fish ⁴	Aquatic Insects	Algae	Stream Habitat	Fecal Coliform ²	Dissolved Oxygen ¹	Water Temp ¹	Nitrate ³	Total Kjeldahl Nitrogen ³	Total Phosphorus ³	Total Suspended Solids ³
Excellent	2 sites	1 site	6 sites								
Good	6 sites	2 site	13 sites	14 sites	6 sites	15 sites	22 sites	14 sites	16 sites	20 sites	15 sites
Fair	12 sites	15 sites	3 sites	5 sites	17 sites	6 sites	1 site	7 sites	9 sites	4 sites	8 sites
Poor	6 sites	9 sites	5 sites	8 sites	4 sites	2 sites	—	6 sites	2 sites	3 sites	4 sites

¹ Four of the sites have no data for these parameters.

² Green color indicates that the average bacteria concentration during the recreation season is low (less than the swimming criterion), red indicates that average is high (greater than the boating/wading criterion), and orange is moderate or in between.

³ Percent of a site's samples that are high compared to all samples (green is low, orange is moderate, red is high).

⁴ One site has no data for 2015.

Trend Category	Fish ^{2,4}	Aquatic Insects ²	Algae ²	Stream Habitat ²	Fecal Coliform ³	Dissolved Oxygen ^{1,5}	Water Temp ¹	Nitrate	Total Kjeldahl Nitrogen	Total Phosphorus	Total Suspended Solids
Improving	17 sites	13 site	6 sites	13 sites	12 sites	12 sites					
No Trend	3 sites	6 sites	11 sites	10 sites	8 sites	9 sites					
Declining	7 sites	8 sites	10 sites	4 sites	7 sites	2 sites					
Not applicable for trend											

¹ Four sites have no data for these parameters.

² Trend measured from the oldest sampling to 2015.

³ Trend measured from 2004-06 average to 2013-15.

⁴ One site has no data for 2015.

⁵ Trend measured from 2005-07 conditions to 2013-15.

INTRODUCTION

ABOUT THE METROPOLITAN SEWER DISTRICT (MSD)

MSD's mission to provide safe, clean waterways is accomplished through three core responsibilities:

- 1 Wastewater collection and treatment**
- 2 Stormwater drainage and management**
- 3 Ohio River flood protection**

Revenue comes almost entirely from MSD's customers. Grant funding provides an occasional supplement, but it is less than one percent of MSD's total annual revenue.

An eight-member citizen Board, which is appointed by the Louisville Metro Mayor, governs MSD's budget, rates, policies and initiatives. These members—who serve three-year overlapping terms—are eligible for reappointment. Each member represents a different state senatorial district in Louisville Metro. The Board holds one regular meeting on the fourth Monday of each month, and committees meet as necessary.

Wastewater Collection and Treatment

When MSD was created in 1946, there was no wastewater treatment in the community. Sewers carried both wastewater and stormwater, and the pipes emptied directly into area streams and the Ohio River. In the late 1950s, the Morris Forman Water Quality Treatment Center (WQTC) was constructed, along with several large diameter sewers that intercepted the flow on dry days and conveyed it to the WQTC for treatment and discharge to the Ohio River. During rain events, diluted flow from the combined sewers would sometimes be more than the new interceptor sewers could handle and this resulted in overflows to the streams and river. Known as combined sewer overflows (CSOs), these still occur today, though less frequently, and MSD is constructing a number of projects to significantly reduce the overflows.

Most of Louisville Metro is now served by separate sanitary and stormwater systems. Sanitary sewers are intended to carry only wastewater, with no stormwater or groundwater, but these systems deteriorate as they age and may allow clear water to enter the pipes. In some areas, downspouts and sump pumps are connected to the system. During rain events, these lines can become overwhelmed, resulting in sanitary sewer overflows (SSOs). MSD has initiated a plan to eliminate SSOs by the end of 2024.

After World War II a development boom took place resulting in thousands of new homes in subdivisions that were too far away from public sewers to be economically connected to MSD's sanitary system. The majority of these new homes were served by either on-site systems (usually a septic tank and lateral field) or sanitary sewers connected to a privately owned neighborhood package treatment plant. Both options were intended to be temporary solutions until public sewers became available. As these systems aged, many fell into disrepair and contributed to water quality problems when they failed to fully meet their original purpose. Over the past 30-plus years, MSD has extended service to most of these areas, eliminating the need for more than 40,000 on-site systems and more than 300 package treatment plants. Today the majority of Louisville Metro is served by five regional wastewater treatment facilities.

OVER THE PAST 30 YEARS, MSD HAS ELIMINATED MORE THAN 300 SMALL PACKAGE TREATMENT PLANTS. THE LAST REMAINING FACILITY (THE MCNEELY LAKE WQTC) WAS TAKEN OFFLINE IN 2016.

Stormwater Drainage and Management

In 1986, MSD took over responsibility for stormwater management in Jefferson County except in some of the fourth-class cities. Today, the cities of Anchorage, Jeffersontown, Shively and St. Matthews provide most of those services within their borders, and the cities partner with MSD on other aspects including review of new development plans and water quality reporting.

Stormwater facilities are typically designed to handle rain storms that have a 10 percent chance of occurring in any given year (also called a 10-year storm, this is defined as 4.5 inches of rainfall in 24 hours). Recent studies have shown that larger storms are occurring more frequently and MSD will consider changing the criteria for designing future facilities. In some areas of Louisville Metro, it might be necessary to upgrade existing facilities to meet the revised criteria.



Wet weather stream sampling

Management of stormwater in our community outside the combined sewer area is regulated through a Municipal Separate Storm Sewer System (MS4) permit, which requires periodic reporting on water quality in area streams. This State of the Streams Report meets that requirement by analyzing data from 27 stream monitoring sites and determining trends for several parameters. Collectively, the 27 sites are known as the Long Term Monitoring Network (LTMN) and MSD has been collecting data at these locations for more than 17 years. A more detailed description of the LTMN is found later in this section.

Capturing and treating stormwater before it reaches streams and sewers reduces pollution in waterways. In combined sewer areas, it helps to lessen sewer overflows by keeping rainwater from entering the system. MSD has initiated a program that allows partnerships with commercial, industrial and institutional property owners and businesses that are willing to install green infrastructure projects.

There are several engineered systems that act as natural landscapes to capture, cleanse and reduce the amount of stormwater entering sewers, creeks and waterways. These systems include:

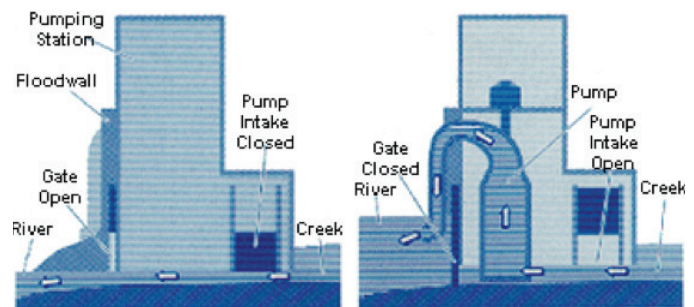
- **Rain Gardens and Bio-swales:** shallow areas with soil that can absorb rainwater.
- **Pervious Pavement:** porous materials that allow stormwater to soak through the pavement.
- **Green Roofs:** vegetation and other devices that capture stormwater.
- **Rain Barrels and Cisterns:** containers that collect stormwater for re-use during dry periods.

Additional information on MSD’s green infrastructure efforts can be found at msdgreen.org.

Ohio River Flood Protection

Louisville Metro is protected from flooding from the Ohio River by a system that consists of almost 29 miles of earthen levee and concrete floodwall and 16 flood pumping stations that stretch from Butchertown to the southwestern part of Jefferson County near West Point, Kentucky. When the Ohio River is high, these pumping stations are necessary to convey rainfall over the levee/floodwall and prevent flooding on the land side of the system. Most of the pumping stations are more than 60 years old, and significant upgrades will be needed to keep the system functioning properly.

How a flood pumping station works:



River Normal

When the river (left) is at its normal level, the gate in the river side of the pumping station is open and the pump intake closed. The creek flows through into the river.

River at Flood Stage

When the river (right) is at flood stage, the river side gate is closed. The pump intake is opened and the pumps raise the water from the creek into the river.

INTRODUCTION

THE LONG-TERM MONITORING NETWORK

In 1988, MSD and the United States Geological Survey (USGS) began monitoring water quality and stream flow throughout the Jefferson County area. This program, called the Long-Term Monitoring Network (LTMN), has changed over the years and currently includes 27 LTMN sites selected to represent streams in the Metro area (see map on page 14).

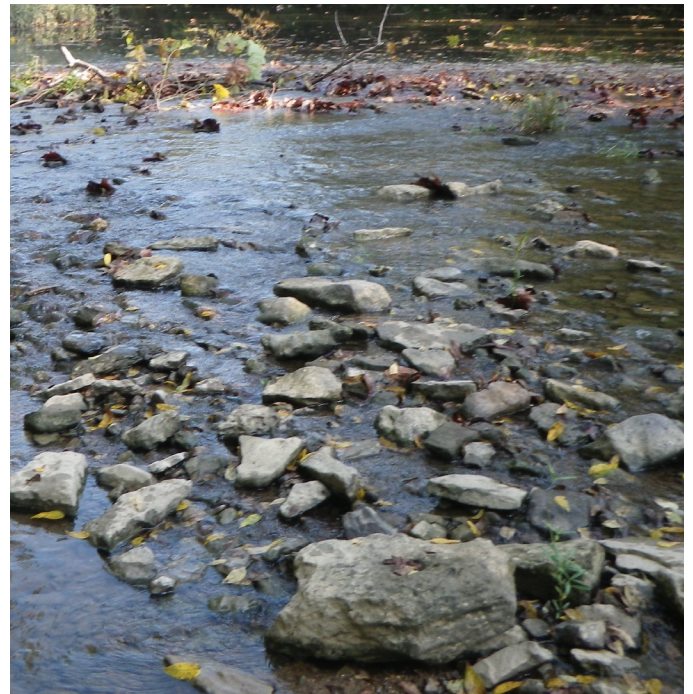
THE LONG-TERM MONITORING NETWORK INCLUDES 27 SITES IN THE METRO AREA.

Streams are constantly changing. They are affected by rainfall, temperature, land use, geology, man-made pollutants, and other factors. Because many factors affect streams, understanding their water quality requires several different tools. These tools include stream samples, water quality and flow meters, biological samples and stream habitat assessments. MSD collects these data at each LTMN site to evaluate overall health of a stream. MSD collects and analyzes the information in accordance with standards set by the United States Environmental Protection Agency and the Kentucky Division of Water. A Quality Assurance Project Plan has been implemented to ensure high quality data for all these collection and analysis methods.

Tools to Measure Stream Health		
Biological Communities and Habitat Assessments	Stream Samples	Water Quality and Flow Meters
Sample every 2 years	Sample at least quarterly	Meter reading every 15 minutes
<ul style="list-style-type: none"> • Fish • Aquatic • Insects • Algae • Habitat 	<ul style="list-style-type: none"> • Bacteria • Nutrients • Suspended solids • Ammonia • Metals 	<ul style="list-style-type: none"> • Dissolved Oxygen • Water Temperature • Stream Flow

Trend Status	Getting Better	Stable (No change)	Getting Worse
Excellent or Good	Awesome news	Great news	Caution - could go either way
Fair	Great news	Caution - could go either way	Bad news
Poor	Good news	Bad news	Very bad news

Each of these datasets were used to assess current stream health (status), and by looking at data collected over time, we can tell whether streams are getting better, staying the same or getting worse (trend). Together, status and trends tells us where streams are doing well and where they are not. This information could be used to focus on better understanding the factors that are affecting the streams and identifying measures that can be undertaken by MSD and all of us to better protect and improve our streams.



Streams that have a variety of habitats, with shallow and deep areas, fast and slow water, and places with plenty of rocks and shade, are characteristics of good habitats for healthy aquatic communities.



Fish are collected using a common scientific survey method known as electro-fishing. Electricity is used to stun fish before they are caught. This method is used to sample fish populations and normally the fish are returned to the stream unharmed in as little as ten minutes after being stunned. One person operates the equipment that stuns the fish while others catch the stunned fish with a net and place them in a bucket of stream water. The fish are identified and then returned to the stream.

Biological Samples and Habitat Assessments

MSD has been collecting biological samples since 1999, but it is not enough just knowing whether some of these organisms live in the waters. We need to know about their biological communities - what kinds (species) are there, how many of each, and if they are healthy. These biological communities help us to understand overall stream health because they live in the water for weeks (algae) to months (insects) to years (fish). Over that time, they are affected by water quality, stream flow, and habitat quality. Some species require clean water and good habitat to thrive and reproduce, while other species are tolerant of less ideal conditions. By knowing what kinds and how many fish, aquatic insects, and algae are there, we can tell whether a stream is healthy or not.

The Kentucky Division of Water developed metrics to evaluate fish, aquatic insect, and algal communities in Kentucky. The US Environmental Protection Agency developed habitat assessment metrics. Individual metrics are combined into a score for each community and habitat assessment. The scores are used to assign narrative ratings of excellent, good, fair, or poor biological condition. Habitat is rated as good, fair, or poor. The ratings are scaled based on the region of Kentucky in which the stream is located and whether the stream is a small headwater or larger wadeable stream.

FISH ARE USED AS BIOLOGICAL INDICATORS IN STREAMS BECAUSE OF THEIR STABLE POPULATIONS.

Fish: Fish are used as biological indicators in streams because of their stable populations. They are the most mobile of the three communities, moving to areas most suitable for their growth and survival as needed. MSD collects fish community samples every two years using methods developed by the Kentucky Division of Water. Biologists use electro-fishing equipment to stun the fish, collect them in nets, identify them and return them to the streams. Some of the fish found in Louisville Metro streams are shown on the next pages.

Aquatic Insects: Many insects spend the early parts of their lives in water, including dragonflies, mayflies, damselflies and others. MSD collects aquatic insect community samples every two years using methods developed by the Kentucky Division of Water. Biologists use D-frame dip nets to collect the immature (larval) forms of insects that live in the gravel and other habitats in the bottoms of streams. The aquatic insects are sent to a laboratory and identified by biologists looking through a microscope.



Biologist using a D-frame dip net to sample aquatic insects in a stream riffle.



Placing ceramic tiles for collecting algae in the Middle Fork of Beargrass Creek.

Algae: Benthic (bottom dwelling) algae are a natural part of our streams and are a food source for some aquatic insects and fish. Algal communities change in response to changes in stream nutrient concentrations, sunlight, and the amount of sediment. MSD collects algal community samples every two years using methods developed by the Kentucky Division of Water. Biologists attach ceramic tiles to the stream bottom and leave them in place for at least 15 days. During this time, algae grow on the tiles. The tiles are frozen and sent to a laboratory where biologists identify and count the algae from the tiles using microscopes.

BENTHIC ALGAE ARE A NATURAL PART OF OUR STREAMS AND ARE FOOD SOURCE FOR SOME AQUATIC INSECTS AND FISH.

Stream Habitat: Stream habitat is a way of describing the “neighborhood” in which the fish, aquatic insect and algal communities live. Fish, aquatic insects, and algae must rely on their local environment for food and shelter. These creatures thrive in streams that have shallow and deep areas, fast and slow water, and places with plenty of rocks and shade. Streams with eroding banks, large deposits of silt and sediment, straightened stream channels and limited shade tend to be populated with biological communities that can tolerate poorer habitats.

Biological Community and Habitat Assessment Metrics*

Assessment	Metrics	
Fish Community	<ul style="list-style-type: none"> • Number of native species. Non-native species are used as indicators of impairment • Number of darters, madtom and sculpin species (require good water and habitat quality) • Number of intolerant species (species that require good water and habitat quality) • Number of species that require relatively clean gravel for spawning (good habitat quality) 	<ul style="list-style-type: none"> • Percent of individuals that feed on aquatic insects, excluding tolerant species • Percent of pollution tolerant species that increase due to poor water quality and poor habitat • Percent of species that are not typically found in small headwater streams
Aquatic Insect Community	<ul style="list-style-type: none"> • Measure of pollution tolerant and intolerant aquatic insects (Modified Hilsenhoff Biotic Index) • Number of all classifications found, also known as taxa richness (more is better) • Percent of organisms that require hard, silt-free surfaces on which to “cling” (good habitat quality) • Percent of midges and freshwater worms, which are generally pollution tolerant 	<ul style="list-style-type: none"> • Number of mayfly, stonefly and caddisfly classifications (species that require good water and habitat quality) • Percent of mayfly, stonefly and caddisfly classifications excluding the relatively tolerant caddisfly genus Cheumatopschye (species that require good water and habitat quality) • Percent of mayfly larvae (only in small headwater streams) (species that require good water and habitat quality)
Algal Community	<ul style="list-style-type: none"> • Number of species that are not tolerant of silt and sediment (good habitat quality) • Number of different species and how evenly distributed they are (Shannon Diversity Index) • Number of diatom taxa (also known as taxa richness) (more is better) 	<ul style="list-style-type: none"> • Percent of pollution tolerant species that increase due to poor water quality (Pollution Tolerance Index) • Percent of individuals that are in the Fragilaria group (species that require good water and habitat quality) • Percent of individuals that are in the Cymbella group (species that require good water and habitat quality)
Habitat Assessment	<ul style="list-style-type: none"> • Amount and variety of stable habitat, such as gravels, logs, and undercut banks, that provide habitat, food, and spawning sites (more is better) • Extent that gravels, logs and other habitats are covered or sunken into the silt, sand, mud (less covered in sediment is better) • Presence of 1) slow-deep, 2) slow-shallow, 3) fast-deep and 4) fast-shallow habitats (presence of all four is ideal) • Amount of sediment accumulated in pools and changes to the stream bottom due to sediment deposits (less is better) • Degree to which the channel is filled with water (average flow is better) 	<ul style="list-style-type: none"> • Extent of changes to the stream channel such as straightening, artificial bank stabilization, dams, and bridges, dredging, etc. (less is better) • Distance between riffles (rocky places) in a stream. Riffles provide food, shelter, and add dissolved oxygen to water (more riffles are better) • Extent of actual or potential bank erosion on each stream bank (less is better) • Amount of native trees, shrubs and other vegetation that helps protect banks from erosion (more is better) • Width of natural vegetation from the edge of the stream bank. At least 54 feet is an ideal condition.

* The Kentucky Division of Water developed metrics to evaluate fish, aquatic insect, and algal communities in Kentucky. The US Environmental Protection Agency developed habitat assessment metrics. Individual metrics are combined into a score for each community and habitat assessment. The scores are used to assign narrative ratings of excellent, good, fair, or poor biological condition and good, fair or poor habitat quality. Ratings are scaled based on the region of the Kentucky in which the stream is located and whether the stream is a small headwater or larger wadeable stream.



Creek chub is a species of minnow that can grow to 10 inches and is tolerant to a wide variety of water conditions.



The diet of the colorful longear sunfish generally includes aquatic insects and small fish.



Top to bottom: greenside, banded, and rainbow darters are very sensitive to pollution and silt.

Stream Samples

Water samples are collected from LTMN sites at least quarterly and analyzed in MSD's laboratory for bacteria, nutrients such as nitrogen, phosphorus and ammonia, total suspended solids (sediment in the water), and metals. Each of these water quality measures is described below.

Bacteria: Bacteria and viruses that live in the water and on the bottom of streams are natural and have an important role in breaking down natural wastes such as leaves, in healthy streams. However, some types of bacteria and viruses from human and animal wastes can lead to unhealthy conditions. Fecal coliform bacteria indicate the presence of fecal material from human and animal wastes. Fecal material can get into streams from sewer overflows or leaks in the sewer collection system pipes, failing septic systems and wastes from pets, wildlife, and livestock.

The Kentucky Division of Water has established water quality criteria for fecal coliform bacteria to reduce the risk of infection for people using the water. The criteria require collection of at least five stream samples each month during the May 1 through October 31 recreation season, when people are more likely to be in the water. The Kentucky criteria requires the geometric mean (a special type of average) of five bacteria samples for each month to be less than:

- 200 bacteria colonies for swimming
- 1,000 bacteria colonies for wading, boating or fishing

MSD collected fecal coliform samples five times per month at each LTMN site during the recreation between 2004 and 2015. The geometric mean of the recreation season samples was compared to the Kentucky criteria. LTMN sites were rated as follows using geometric mean results:

- **Good:** Geometric mean *below* 200 colonies
- **Fair:** Geometric mean *between* 200 and 1,000 colonies
- **Poor:** Geometric mean *above* 1,000 colonies

Because bacteria concentrations can change a lot in streams, the average of the first three years (2004 to 2006) and last three years (2013-2015) of data was used to evaluate trends. Trends were classified as follows:

- **Getting Better:** bacteria concentrations *decreased* by ten percent or more
- **Stable:** bacteria concentrations changed by less than ten percent
- **Getting Worse:** bacteria concentrations *increased* by ten percent or more

Nutrients: Algae depend on nutrients such as nitrogen and phosphorus for growth. The algae, in turn, are a food source for some aquatic insects and fish. But too much nutrients can cause nuisance algal blooms that reduce habitat quality and the amount dissolved oxygen in the stream. Nutrients can get into streams when rainwater carries fertilizers from lawns, golf courses and farms from the land to the water. MSD's Water Quality Treatment Centers are required to limit the amount of phosphorus in treated wastewater discharges, so these facilities are no longer a major source of phosphorus.



The yellow bullhead is a voracious scavenger that will eat almost anything.



Green sunfish are able to tolerate poorer water quality conditions.



Striped shiner minnows eat zooplankton, insects, plants, and algae, and are themselves food for all types of larger fish.

Suspended Solids: Streams that run clear when flows are normal can look muddy during and after storms. The mud can settle out on stream bottoms and cover algae and gravels used by aquatic insects and fish. Measuring the amount of suspended solids gives us information about how much soil and sediment is suspended in the water. Streams can become muddy if the banks are eroding or if bare soil is washed from land to streams during storms. MSD's Stormwater Program requires developers to minimize the amount of bare soil on construction sites and to put controls in place to keep it from washing off site during construction.

MSD monitored concentrations of nutrients (total nitrogen, nitrate, phosphorus) and suspended solids in streams periodically from 2000 to 2005 and quarterly from 2006 to 2011. From 2012 to 2015, samples were collected five times per month between May and October and quarterly between November and April. For this report, 2006 to 2015 data for each site were compared to the range of concentrations from all sites. This approach was used because Kentucky, like many other states, does not have numeric criteria for nutrients or suspended solids. The following thresholds were used:

- **Total Nitrogen:** 0.9 milligrams per liter
- **Nitrate:** 1.32 milligrams per liter (parts per million)
- **Phosphorus:** 1.35 milligrams per liter
- **Suspended Solids:** 12 milligrams per liter

Sites were classified as good, fair, or poor for nutrients and suspended solids based on the percent of samples above the thresholds:

- **Good:** Less than 29% above the threshold
- **Fair:** Between 29% and 48% above the threshold
- **Poor:** More than 48% of samples above the threshold

Ammonia: Ammonia is a form of nitrogen that can be toxic to fish in certain forms. The un-ionized form of ammonia is the same chemical that is used as a household cleaner. Sources of un-ionized ammonia in streams include commercial fertilizers, breakdown of waste, gas exchange with the atmosphere, forest fires, animal and human waste.

Un-ionized ammonia cannot be measured directly in water. Instead, it is calculated using total ammonia, pH and temperature data with an equation in the Kentucky water quality standards. The concentration of un-ionized ammonia at LTMN sites was calculated and compared to Kentucky's water quality criteria for un-ionized ammonia, which is 0.05 milligrams per liter.

Trace Metals: Very small (trace) amounts of metals are necessary for the healthy growth of algae, aquatic insects, and algae. However, if the concentrations are too high, metals can cause "chronic" effects such as shortened lifespans and reproductive problems and "acute" effects by killing these organisms. MSD's LTMN monitoring is focused on four metals that may affect urban streams: cadmium, copper, lead and zinc. These metals may be found in streams affected by historical industrial pollution, and they can wash off industrial facilities and urban areas. Copper is also used to treat excess algae in ponds.

MSD monitored concentrations of the four metals in streams periodically from 2000 to 2004 and on a quarterly basis since 2005. Concentrations of total metals at each site were compared to the Kentucky acute and chronic Aquatic Life Criteria which were calculated with equations using total hardness concentrations.

Water Quality and Flow Meters

MSD and the USGS use permanent water quality meters to measure dissolved oxygen and stream temperature every 15 minutes at 24 of the 27 LTMN sites since 2000. Flow gages measure the stream flow every 15 minutes at 25 of the LTMN sites. The raw (draft) water quality and flow measurements are relayed to the USGS National Water Information System (NWIS) website in real time, and are available to the public. The USGS reviews and finalizes the data, then posts final data to the NWIS website. This level of effort highlights MSD's commitment to effectively monitor the quality and condition of streams in Jefferson County.

The data are collected using protocols developed by the USGS. It is important to note that collection of continuous dissolved oxygen data requires diligent attention to cleaning and calibrating the meters that are used to collect the readings. In some streams, the meters can become dirty or covered by silt, resulting in missing or incorrect readings. MSD has developed a Quality Assurance Project Plan with USGS to improve the maintenance of these meters. Dissolved oxygen and water temperature data collected by MSD and USGS between 2005 and 2015 were assessed for this report. Stream flow data collected by USGS between 2004 and 2013 were assessed for this report, along with rainfall data from the MSD network for the same time period.



MSD Laboratory personnel perform analyses of water samples.

Dissolved Oxygen: Both fish and aquatic insects rely on oxygen that is dissolved in water to “breathe”. When dissolved oxygen levels are too low, it causes stress on all aquatic organisms. Kentucky’s water quality criteria for dissolved oxygen specify:

- No readings less than four parts per million
- 24-hour average reading must be above five parts per million

Factors that can reduce dissolved oxygen include low streamflow, hot water temperature, lack of shade, excessive algae, and organic pollution.

FISH AND AQUATIC INSECTS RELY ON DISSOLVED OXYGEN TO “BREATHE”. WHEN OXYGEN LEVELS ARE TOO LOW, IT CAUSES STRESS ON ALL AQUATIC ORGANISMS.

For this report, the average daily dissolved oxygen concentration was calculated from readings collected at 15 minute intervals. Days with more than half of the data available were included in the analysis. Results for the most recent three years of data (2013 to 2015) were grouped into rating categories based on the percent of days when average dissolved oxygen concentrations were above five parts per million.

- **Good:** 100 percent of days above five parts per million
- **Fair:** 90 percent of days above five parts per million
- **Poor:** Less than 90 percent of days above five parts per million

Because dissolved oxygen concentrations can change a lot in streams, trends were based a comparison of the first three years (2005 to 2007) and last three years (2013-2015) of data. The percent change in number of days with dissolved oxygen above five parts per million was used to evaluate trends. Trends were classified as follows:

- **Getting Better:** the percent of days that dissolved oxygen was above five parts per million *increased* by ten percent or more over time
- **Stable:** the percent of days that dissolved oxygen was above five parts per million changed by less than ten percent
- **Getting Worse:** the percent of days that dissolved oxygen was above five parts per million *decreased* by ten percent or more

Water Temperature: High water temperatures can stress the aquatic communities by increasing metabolism and respiration, and by lowering the capacity of water to hold dissolved oxygen. The Kentucky water quality criteria for a maximum water temperatures in a day is 31.7 °C (89.1 °F).

Days with more than half of the data available were included in the analysis. The maximum daily temperature was identified for each day using the 15-minute water temperature readings. The average number of days for 2005 to 2015 with water temperature above the 31.7 °C criteria was calculated and used to classify LTMN sites as follows:

- **Good:** 100 percent of days below 31.7 °C
- **Fair:** 90 percent of days below 31.7 °C
- **Poor:** Less than 90 percent of days below 31.7 °C

Stream Flow: Stream flow has a major influence on fish and aquatic insects. Stream flow varies naturally in response to rain, and seasonally tends to be higher in the winter and spring, lower in summer and fall. Streams may flow very little or not at all during drought. Periodic low flows can stress aquatic organisms by reducing the amount of stream habitat available to them, and if concurrent with hot air temperatures, can lead to high stream temperature and low dissolved oxygen. Very high flow can reduce habitat quality critical to organisms by eroding stream banks and beds, by moving or covering stream bed habitat like gravel and woody debris, and by washing fish and aquatic insects downstream. The frequency and volume of stream flow can increase significantly both in areas where impervious (hard) surfaces, such as roofs and roads, prevent water from filtering into the soil.



This USGS streamflow gage (gray box in photo) is located on Cedar Creek at Thixton Lane. This type of gage is used to continuously monitor stream temperature, dissolved oxygen, and stream flow. The antenna to the right of the box transmits data to a satellite for real time monitoring results via the web at <http://waterwatch.usgs.gov>

The analysis of stream flow for this report focused on a comparison of the average annual runoff in inches to the average annual rainfall in inches at each LTMN site for the 10-year period 2004-2013. Expressed as a percentage, the values revealed differences between sites due to extent of urban development, presence of karst bedrock features and other drainage features, and inflows from wastewater treatment facilities.

BE PART OF THE SOLUTION

Help us reduce sewer overflows and keep our waterways clean!



Keep storm drains clear of leaves and yard waste. Clogged drains create

standing water in neighborhoods and in streets.



Plant a rain garden. They capture water runoff before it can reach storm drains, filter the runoff before it reaches waterways, support biodiversity — and look great!



Scoop the poop! Pet waste left on the ground is carried to our waterways — contaminating the very same streams that kids and pets play in.



Using the washing machine or dishwasher during a hard rain can overload the sewer system.



Use rain barrels to collect and store rain water from your roof top. You can use it later on your garden or lawn and help diminish sewer overloads during heavy rain.

WATERSHED REPORTS

There are eleven primary watersheds in Jefferson County, Kentucky (see the map on the facing page). Two of the streams (Harrods Creek and Floyds Fork) have their headwaters in other counties and flow into Jefferson County. About a quarter of the Pond Creek watershed lies in Bullitt County, and that water enters the main stem of the creek near the southwestern tip of Jefferson County.

MSD has been collecting stream samples from these watersheds for decades, along with a watershed that lies entirely in Bullitt County. Cedar Creek in Bullitt County was included in MSD's sampling program to provide a basis for comparison from this relatively rural watershed to the more urbanized watersheds in Louisville Metro.

In order to understand the current conditions and trends in water quality, samples are collected from streams and those samples are analyzed for a number of parameters, including bacteria, suspended solids, oxygen demand, nutrients, trace metals and more. This report utilizes stream samples that were collected from as early as 1999 through December 2015. We also evaluate habitats and health of the streams using a variety of organisms like fish, algae and aquatic insects. This information is compared to previous samples, summarized for status and trends, and compiled into simple graphics for each watershed chapter on the following pages in this section.

An example of the results for the Middle Fork of Beargrass Creek at Lexington Road is presented here to explain how to interpret the information presented in each graphic. The color coding in each parameter box refers to its status for 2015. Blue for algae indicates that the stream is in excellent condition for that parameter, green is good, orange is fair, and red indicates the fish community is in poor condition. The trend is based on a comparison of the initial, baseline conditions to the 2015 conditions. For example, habitat is in fair condition (orange) based on the assessment in 2015, but the 2015 numerical score is more than 10 percent lower than the initial assessment that was obtained in 2005 and so, stream habitat conditions are declining over time.

For bacteria, an improving trend is where conditions for in-stream activities are getting better because concentrations are getting lower over time, and a declining trend means that conditions are getting worse.

Watershed Area	Stream Name and Location								Dominant Land Use
	Middle Fork of Beargrass Cr at Lexington Rd (24.8 square miles and 73 percent urban)								
2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Colliform	Nutrients	
Trend	↑	—	—	↓	↑	—	↑	~	

↑ Improving
 ↓ Declining
 — Stable
 ~ Variable

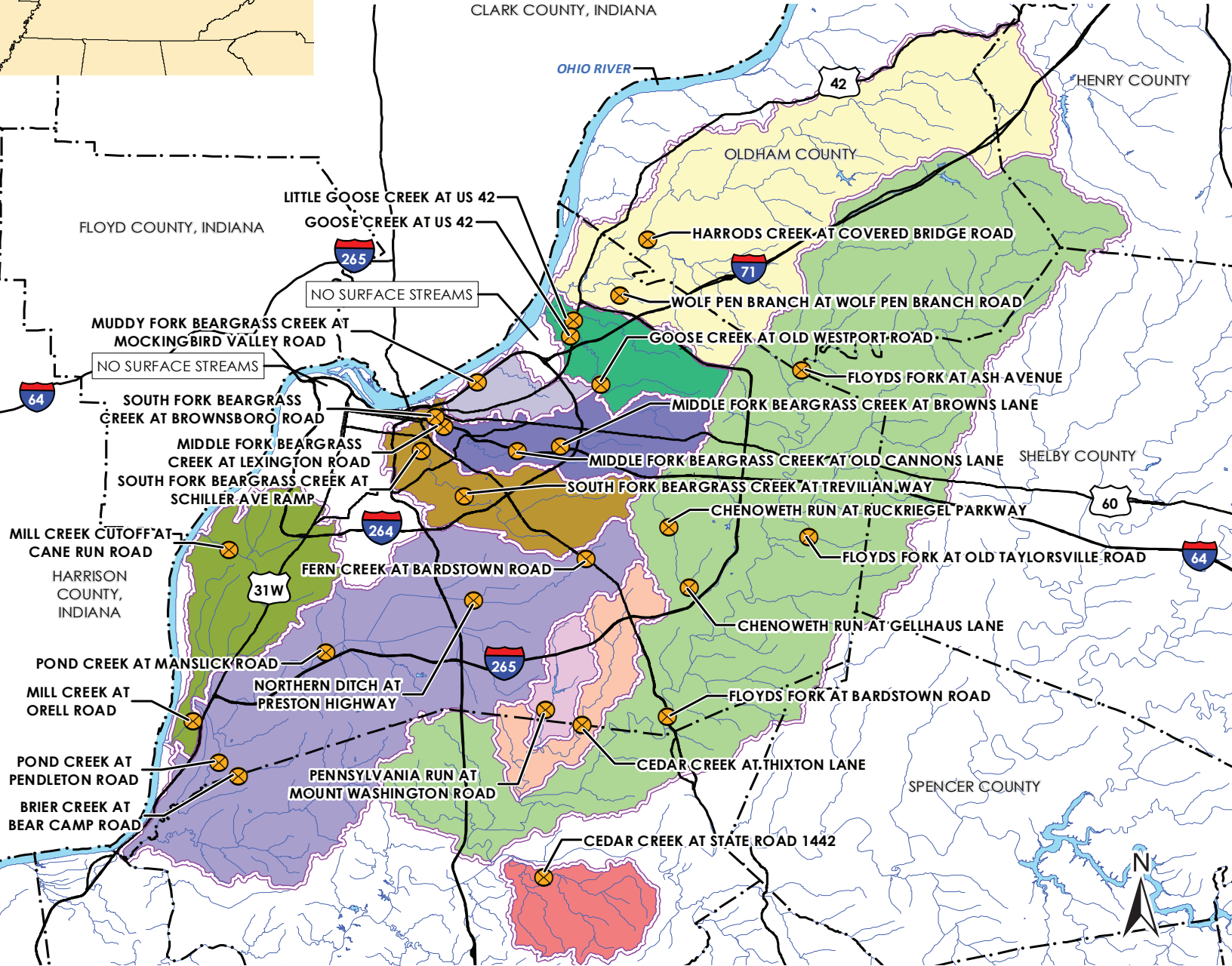


Waterfall on Big Run, along the Glenmary golf course in Southeastern Jefferson County



JEFFERSON COUNTY, KENTUCKY

LONG TERM MONITORING NETWORK SITES



Legend

- Monitoring Site
- Stream
- Road
- County Boundary
- Watershed Boundary
- Lake

Watersheds

- | | | |
|--------------------------------|------------------|------------------------------|
| Harrods Creek | Floyds Fork | Pond Creek |
| Goose Creek | Cedar Creek | Mill Creek |
| Muddy Fork of Beargrass Creek | Pennsylvania Run | Cedar Creek (Bullitt County) |
| Middle Fork of Beargrass Creek | | |
| South Fork of Beargrass Creek | | |

HARRODS CREEK WATERSHED

The small streams that eventually form Harrods Creek originate in Henry County. Harrods Creek flows southwest through Oldham County and drains into the Ohio River in northern Jefferson County near Prospect. The Harrods Creek watershed drains approximately 92 square miles. Commercial and residential development has been expanding in the area.

Watershed Assessment

MSD has monitored water quality and flow in Harrods Creek at Covered Bridge Road since 1999. There are 70.3 square miles of land draining to the Covered Bridge site. This land is mostly agricultural and forest, with 8.5 percent of the land developed for urban and suburban uses. About 1.3 percent of the land is covered by impervious surfaces, such as roads, parking lots, rooftops and driveways.

MSD has monitored water quality, but not stream flow, in Wolf Pen Branch at Wolf Pen Branch Road since 2002. There are two square miles of land draining to the Wolf Pen Branch site. This land is a mix of agricultural, forest, urban and suburban uses. About seven percent of the land is covered by impervious surfaces.

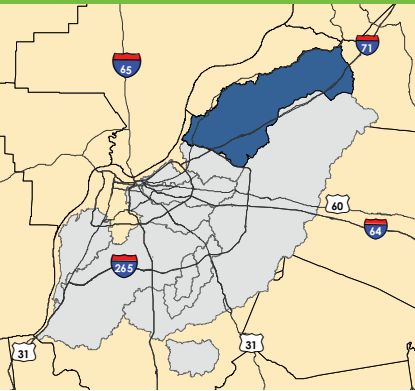
MSD ELIMINATED FIVE NEIGHBORHOOD TREATMENT CENTERS IN THE PROSPECT AREA IN 2015, AND NOW TREATS THIS FLOW AT THE HITE CREEK WATER QUALITY TREATMENT CENTER

A Harrods Creek: Fish communities were in fair condition and declining and aquatic insect communities were in good condition and declining. Algal communities and stream habitat were in good condition and stable. Nutrients, ammonia, suspended solids and trace metals concentrations were low. Dissolved oxygen was good and stable, and temperature was good. Fecal coliform bacteria concentrations were low but getting worse, with concentrations generally higher during wet weather events.

B Wolf Pen Branch: Fish communities were in fair condition and declining and aquatic insect communities were in poor condition and declining. Algal communities were in good condition and stable. Stream habitat was in good condition and improving. Nutrients, ammonia, suspended solids and trace metal concentrations were low. Flow, dissolved oxygen and temperature are not monitored continuously at this location. Fecal coliform bacteria concentrations were moderate and getting worse, with concentrations generally higher during wet weather events.



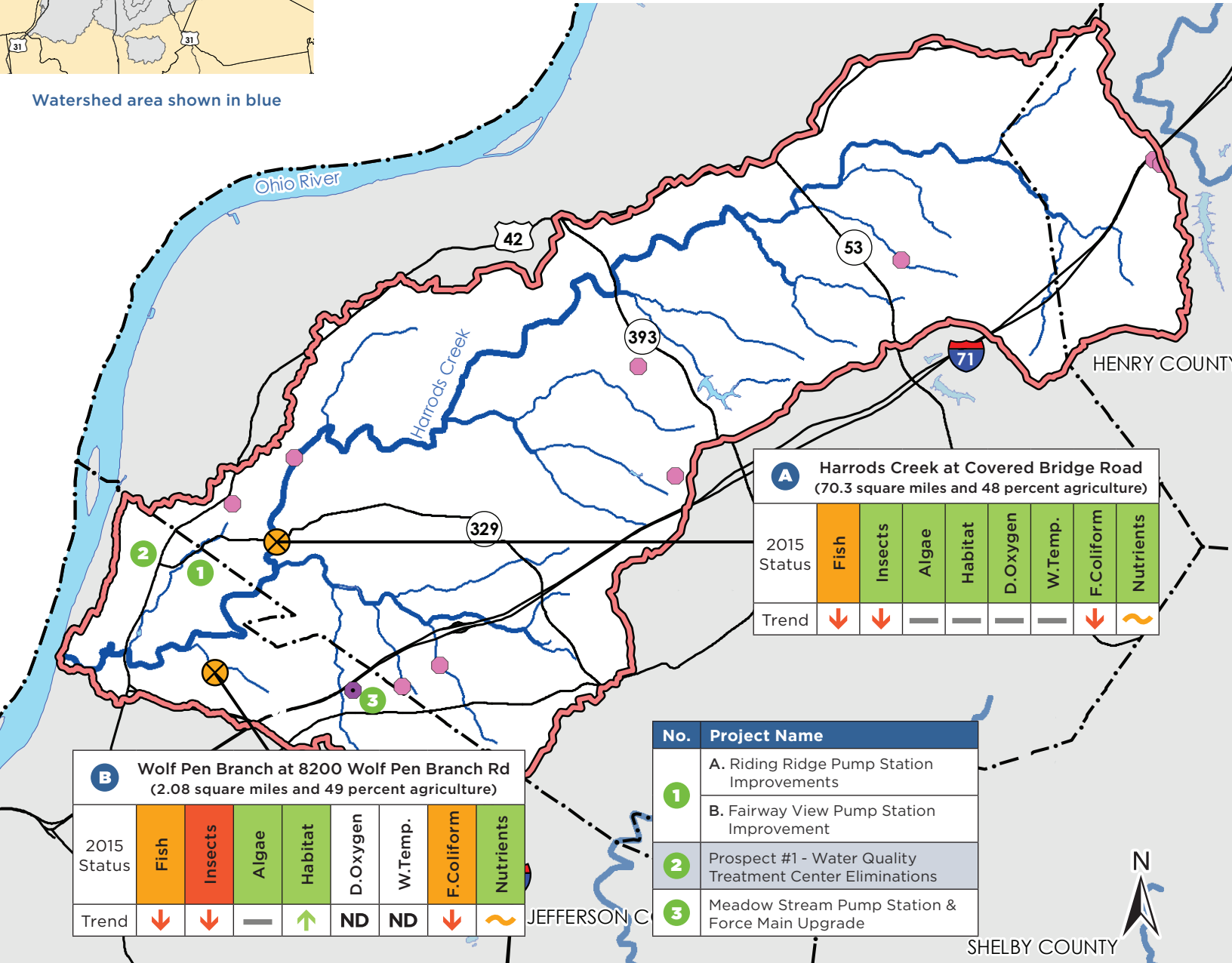
Harrods Creek near Covered Bridge Road.



Watershed area shown in blue

WATER QUALITY STATUS AND TRENDS

HARRODS CREEK WATERSHED



A Harrods Creek at Covered Bridge Road
(70.3 square miles and 48 percent agriculture)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↓	↓	—	—	—	—	↓	~

B Wolf Pen Branch at 8200 Wolf Pen Branch Rd
(2.08 square miles and 49 percent agriculture)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↓	↓	—	↑	ND	ND	↓	~

No.	Project Name
1	A. Riding Ridge Pump Station Improvements B. Fairway View Pump Station Improvement
2	Prospect #1 - Water Quality Treatment Center Eliminations
3	Meadow Stream Pump Station & Force Main Upgrade

Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | TREND | STATUS |
|--|--|
| ↑ Improving | ■ Excellent |
| ↓ Declining | ■ Good |
| ~ Varies | ■ Fair |
| — No Change | ■ Poor |
| ND No Data | |

GOOSE CREEK WATERSHED

The two streams that form the Goose Creek watershed, Little Goose Creek and Goose Creek, flow northwest from Anchorage to Glenview Acres. Goose Creek enters into the Ohio River near Lime Kiln Lane and River Road.

Watershed Assessment

MSD has monitored water quality and flow since 1999 at three stream sites in the watershed: Goose Creek at Old Westport Road, Goose Creek at US 42 and Little Goose Creek at US 42.

The Goose Creek watershed drains 19 square miles of land. The land use associated with the Goose Creek sites, like the entire watershed, is a mix of about 50 percent urban, about 40 percent forest and about 10 percent agriculture. Of the six square miles draining to Goose Creek at Old Westport Road, almost ten percent is impervious surfaces, such as roads, rooftops, parking lots and driveways. Of the ten square miles draining to Goose Creek at US 42, almost 11 percent is impervious surfaces. Of the 5.82 square miles draining to Little Goose Creek at US 42, about 18 percent is impervious surfaces. Of the three sites, the watershed draining to the Little Goose Creek site is the most developed (almost 66 percent) and has less agriculture and forest.



Little Goose Creek

A **Goose Creek at Old Westport Road:** Fish communities and aquatic habitat were in good condition and improving. Algal communities were in good condition and stable. In contrast, aquatic insect communities were in fair condition and declining. Nutrients, ammonia, suspended solids and trace metals were relatively low so they were not likely a contributor to the declining condition of the aquatic insect community. Dissolved oxygen was good and stable, and temperature was good. Fecal coliform bacteria concentrations were elevated and getting worse, with concentrations generally higher during wet weather events.

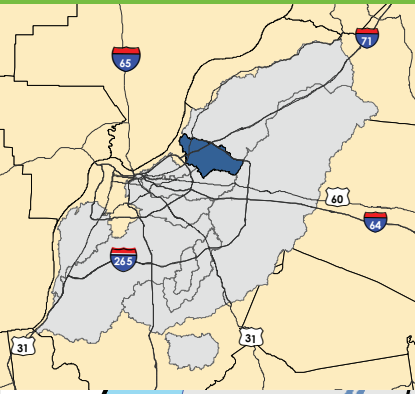
THE BANCROFT WATER QUALITY TREATMENT CENTER, WHICH DISCHARGED TREATED WASTEWATER INTO GOOSE CREEK, WAS ELIMINATED ON MARCH 31, 2016.

B **Goose Creek at US 42:** Fish communities and aquatic habitat were in good condition and improving. Algal communities were in good condition and declining. Aquatic insect communities were in fair condition and improving. Nitrate concentrations were moderate, while other nutrients, ammonia, suspended solids and trace metals were relatively low. Dissolved oxygen was good and improving, and temperature was good. Fecal coliform bacteria concentrations were elevated but improving, with concentrations generally higher during wet weather events.

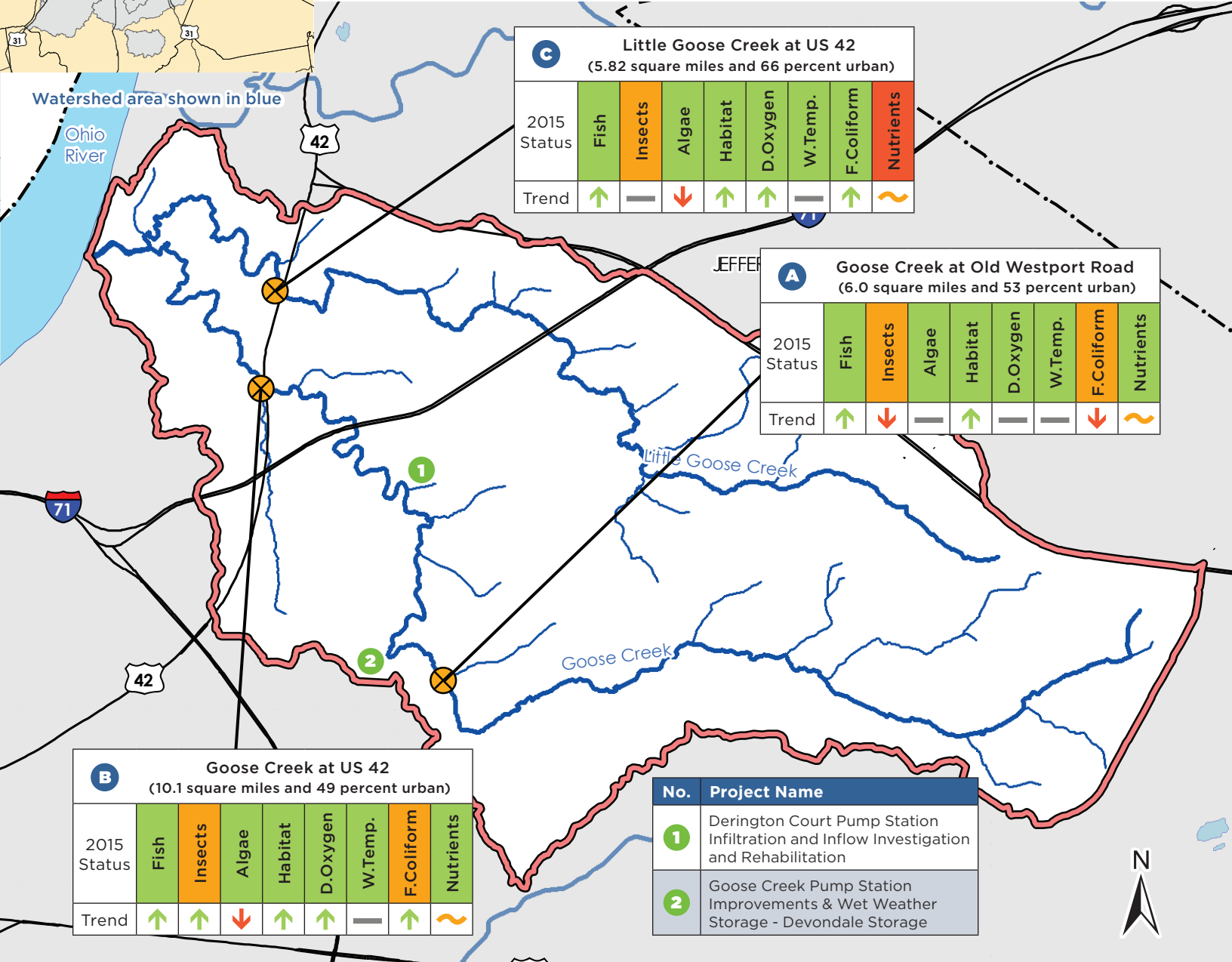
C **Little Goose Creek at US 42:** Fish communities and aquatic habitat were in good condition and improving. Algal communities were in good condition and declining. Aquatic insect communities were in fair condition and stable. Nitrate, total nitrogen and suspended solids concentrations were elevated, while phosphorus, ammonia and trace metals concentrations were relatively low. Dissolved oxygen was good and improving, and temperature was good. Fecal coliform bacteria concentrations were low and improving, with concentrations generally higher during wet weather events.

WATER QUALITY STATUS AND TRENDS

GOOSE CREEK WATERSHED



Watershed area shown in blue



C Little Goose Creek at US 42
(5.82 square miles and 66 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	—	↓	↑	↑	—	↑	~

A Goose Creek at Old Westport Road
(6.0 square miles and 53 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↓	—	↑	—	—	↓	~

B Goose Creek at US 42
(10.1 square miles and 49 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↑	↓	↑	↑	—	↑	~

No.	Project Name
1	Derington Court Pump Station Infiltration and Inflow Investigation and Rehabilitation
2	Goose Creek Pump Station Improvements & Wet Weather Storage - Devondale Storage

Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | | |
|--------------|---------------|
| TREND | STATUS |
| ↑ Improving | Excellent |
| ↓ Declining | Good |
| ~ Varies | Fair |
| — No Change | Poor |
| ND No Data | |

MUDDY FORK OF BEARGRASS CREEK WATERSHED

The Muddy Fork of Beargrass Creek is one of the three streams that join to form the larger Beargrass Creek watershed. The Muddy Fork flows west from Windy Hills toward the Ohio River, then southwest along Interstate 71 before joining with the South Fork to become Beargrass Creek near Mellwood and Story Avenues. Historically, major segments of Muddy Fork were straightened along Interstate 71 and along Mockingbird Valley Road.

Watershed Assessment

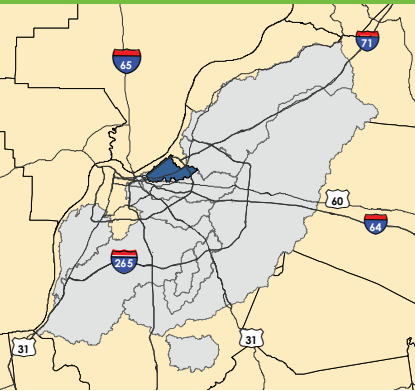
There are about 9 square miles of land in the Muddy Fork watershed and 6.2 square miles of land draining to the sampling site at Mockingbird Valley Road, which MSD has monitored since 2002. Land use draining in the watershed is a mix of forest and urban and suburban uses. Although about half of the watershed is classified as forest, many of the areas classified as forest are actually tree covered developed areas. There is a small area of agricultural land in the very upper part of the watershed. Impervious surfaces such as roads, rooftops, parking lots and driveways cover about 9 percent of this watershed.

THE MELLWOOD AVENUE PUMPING STATION AT MOCKINGBIRD VALLEY ROAD HAS ELIMINATED AN OVERFLOW FROM THE EXISTING SEWER SYSTEM.



Mellwood Avenue Pumping Station

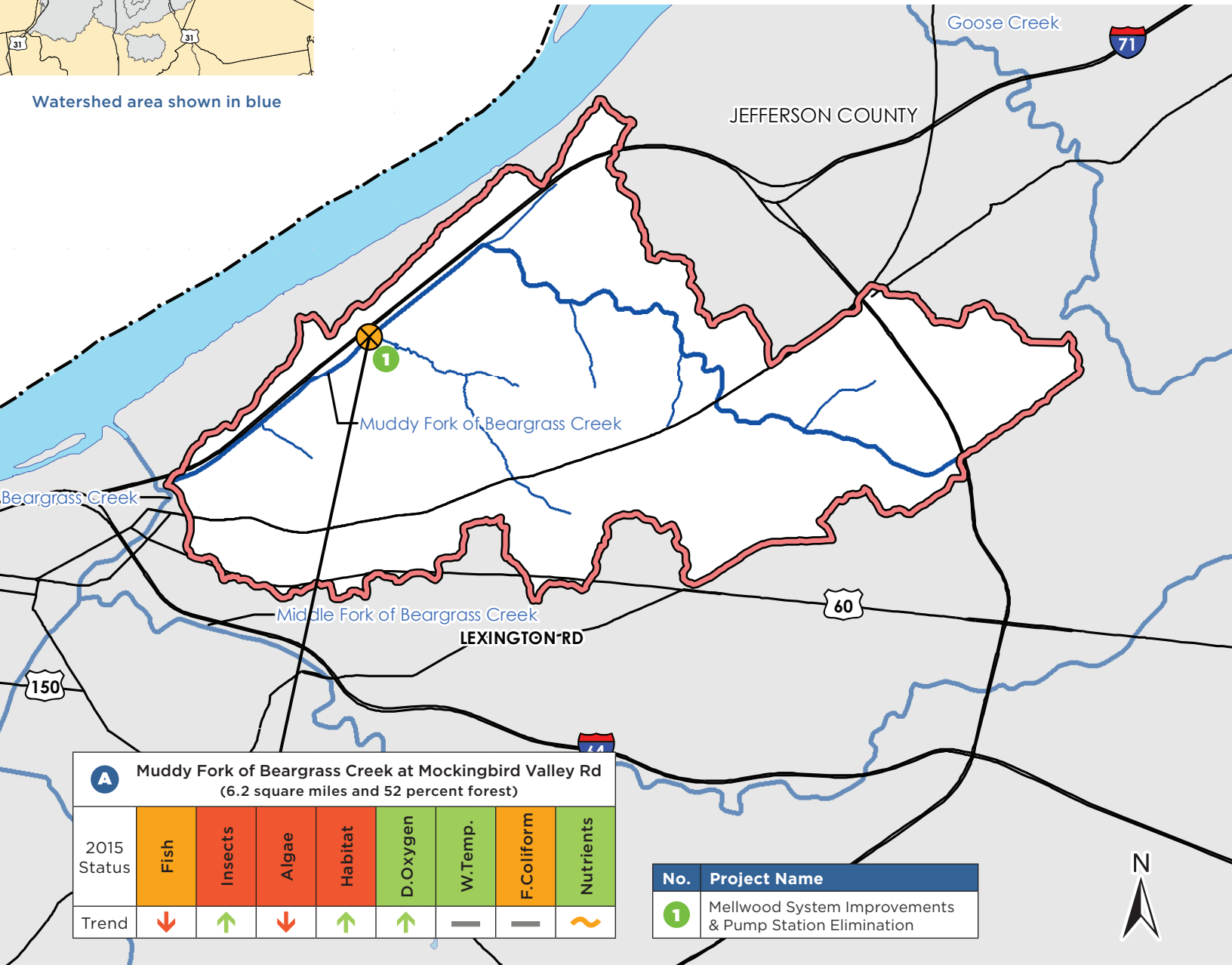
- A Mockingbird Valley Road:** The health of the fish communities was fair in 2015, highly variable from year to year, and declining. The aquatic insect communities were poor in 2015 but improving over time. Algal communities were poor and declining over time. Stream habitat was consistently poor but improving. Stream habitat was diminished by straightening of the channel, lack of trees and other protective vegetation along the stream banks, eroding banks, and a silt covered stream bottom, all contributing to a less than ideal habitat for aquatic organisms. Nitrogen, phosphorus, ammonia, suspended solids and trace metal concentrations were low. Dissolved oxygen was good and improving, and temperature was good. Fecal coliform concentrations were elevated and stable.



Watershed area shown in blue

WATER QUALITY STATUS AND TRENDS

MUDDY FORK OF BEARGRASS CREEK WATERSHED



A Muddy Fork of Beargrass Creek at Mockingbird Valley Rd
(6.2 square miles and 52 percent forest)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Colliform	Nutrients
Trend	↓	↑	↓	↑	↑	—	—	~

No.	Project Name
1	Mellwood System Improvements & Pump Station Elimination



Legend

- Completed Project
- Stream
- ⊗ Monitoring Site
- Road
- Water Quality Treatment Center (Operated by MSD)
- - - County Boundary
- Sewage Treatment Plant (Operated by Other Agency)
- Watershed Boundary
- Lake

Ratings Key

- | TREND | STATUS |
|-------------|-------------|
| ↑ Improving | ■ Excellent |
| ↓ Declining | ■ Good |
| ~ Varies | ■ Fair |
| — No Change | ■ Poor |
| ND No Data | |

MIDDLE FORK OF BEARGRASS CREEK WATERSHED

The Middle Fork of Beargrass Creek is one of three streams that join to form the larger Beargrass Creek watershed. The small streams that eventually form the Middle Fork of Beargrass Creek originate in Middletown and Douglass Hills, and flow west across St. Matthews then join the South Fork of Beargrass Creek near Irish Hill. The South Fork then joins with the Muddy Fork to become Beargrass Creek near the intersection of Interstates 71 and 64. Prominent features of this watershed include Cherokee Park, Seneca Park and Cave Hill Cemetery. The downstream part of this watershed is currently served by combined sewers.

Watershed Assessment

There are just over 25 square miles of land in the Middle Fork of Beargrass Creek Watershed. MSD has monitored water quality and flow since 1999 at three stream sites in the watershed: at Browns Lane, which drains 15.2 square miles, Old Cannons Lane, which drains 18.9 square miles, and at Lexington Road, which drains 24.8 square miles.

The land use associated with each monitoring site, like the entire watershed, is mostly developed for urban and suburban uses. Portions of the watershed classified as forest include Cherokee Park and Seneca Park. However, this area of Louisville is densely developed, and some of the areas classified as forest in the western part of the watershed are actually tree covered developed areas. There is a small area of agricultural land in the middle part of the watershed. Impervious surfaces such as roads, rooftops and driveways cover about 23 percent of this watershed.

A Browns Lane: The health of fish communities was fair and improving, aquatic insect communities were consistently fair and algal communities were good but declining. Aquatic habitat was fair and improving. Total nitrogen, phosphorus, ammonia, suspended solids and trace metals concentrations were low, however nitrate concentrations were elevated. Fecal coliform bacteria concentrations were some of the highest in the Louisville Metro, and were getting worse.

B Old Cannons Lane: The health of fish communities was fair and declining, aquatic insect communities were fair and improving and algal communities were good but declining. Aquatic habitat was consistently good. Total nitrogen, ammonia, phosphorus and suspended solids concentrations were low, however nitrate concentrations were elevated. Trace metal concentrations exceeded aquatic life criteria more often than most other monitoring sites. Dissolved oxygen was good and improving; water temperature was good. Fecal coliform bacteria concentrations were consistently elevated.

C Lexington Road: The health of fish communities was poor and improving, aquatic insect communities were consistently fair and algal communities were consistently excellent. Aquatic habitat was fair and declining. Nitrate, ammonia, and total nitrogen concentrations were low, however phosphorus and suspended solids concentrations were elevated. Metals concentrations exceeded aquatic life criteria more often than other monitoring sites. Dissolved oxygen was fair and improving; water temperature was good. Fecal coliform bacteria concentrations were elevated but improving.

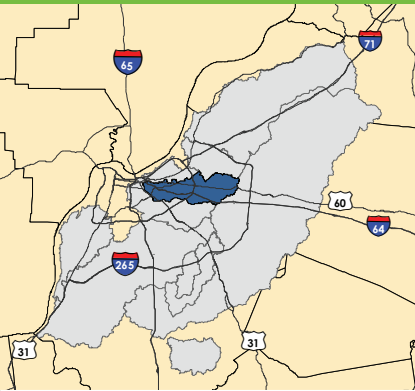
**MSD COMPLETED
REPLACING THE ENTIRE
SEWER SYSTEM
(PUBLIC AND PRIVATE)
IN THE BEECHWOOD
VILLAGE AREA IN 2010.**



Beargrass Creek

WATER QUALITY STATUS AND TRENDS

MIDDLE FORK OF BEARGRASS CREEK WATERSHED



Watershed area shown in blue

C Middle Fork of Beargrass Cr at Lexington Rd
(24.8 square miles and 73 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Colliform	Nutrients
Trend	↑	—	—	↓	↑	—	↑	~

No.	Project Name
1	CSO 140 Inline Storage & Green Infrastructure Controls
2	A. CSO 206 Sewer Separation
	B. CSO 123 Downspout Disconnection
3	Sinking Fork Relief Sewer
4	Beechwood Village Sanitary Sewer Replacement
5	Middle Fork Relief Interceptor, Wet Weather Storage, and Upper Middle Fork Lift Station Diversion
6	Hurstbourne Infiltration and Inflow Investigation and Rehabilitation
7	Anchor Estates Pump Station Elimination 1 - Vannah Pump Station Elimination

B Middle Fork of Beargrass Cr at Old Cannons Ln
(18.9 square miles and 76 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Colliform	Nutrients
Trend	↓	↑	↓	—	↑	—	—	~

A Middle Fork of Beargrass Creek at Browns Ln
(15.2 square miles and 73 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Colliform	Nutrients
Trend	↑	—	↓	↑	ND	ND	↓	~

Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | TREND | STATUS |
|-------------|-----------|
| ↑ Improving | Excellent |
| ↓ Declining | Good |
| ~ Varies | Fair |
| — No Change | Poor |
| ND No Data | |

SOUTH FORK OF BEARGRASS CREEK WATERSHED

The South Fork of Beargrass Creek is one of the three streams that join to form the larger Beargrass Creek Watershed. The small streams that eventually form the South Fork of Beargrass Creek originate in Jeffersontown and Hurstbourne Acres and flow west across Buechel and Audubon Park before joining the Middle Fork of Beargrass Creek near Irish Hill. The South Fork then joins with the Muddy Fork to become Beargrass Creek near the intersection of Interstates 71 and 64. In the past, streams in this watershed were straightened and several miles have been enclosed in concrete channels to reduce flooding. The downstream part of this watershed is currently served by combined sewers.

Watershed Assessment

There are about 26.7 square miles of land in the South Fork of Beargrass Creek Watershed not including the Middle Fork. MSD has monitored water quality and flow since 1999 at three stream sites in the watershed: at Trevilian Way, which drains 17.2 square miles, Schiller Avenue, which drains 22.8 square miles, and at Brownsboro Road, which drains 51.5 square miles including the Middle Fork. MSD moved the Schiller Avenue site downstream to Breckinridge Street in 2015 because the Schiller Avenue site was not accessible during construction of a nearby wet weather basin. Data from the two sites was integrated for this assessment.

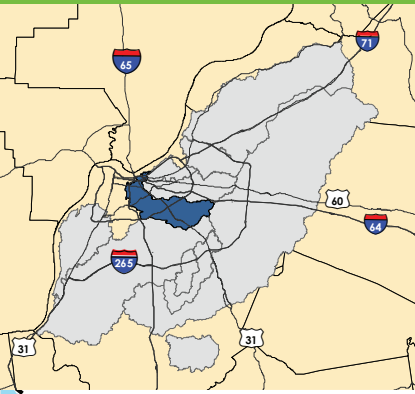
The land use associated with each site, like the entire watershed, is mostly developed for urban and suburban uses. Impervious areas, including roadways, rooftops and driveways cover 32 percent of the land draining to the Trevilian Way site. At the Brownsboro Road site, impervious surfaces cover 28 percent of the land area upstream. A modest percentage of land is intermixed forest.

- A Trevilian Way:** In 2015, the health of fish communities was fair and improving, aquatic insect communities were poor and improving and algal communities were good but declining. Stream habitat was poor and improving. Nitrate, ammonia, phosphorus, and trace metal concentrations were low, however total nitrogen and suspended solids were moderate. Dissolved oxygen was fair and stable; water temperature was good. Fecal coliform bacteria concentrations were some of the highest in the Louisville Metro, and were getting worse.
- B Schiller Avenue:** The health of fish communities was not assessed in 2015 due to construction but has been declining, aquatic insect communities were very poor and declining, and algal communities were fair and stable. Stream habitat was poor and stable. Nitrogen, ammonia, and phosphorus concentrations were low, however suspended solids were moderate. Cadmium and lead exceeded aquatic life criteria more often than other sites. Dissolved oxygen was poor and declining; water temperature was good. Fecal coliform bacteria concentrations were some of the highest in the Louisville Metro, and were getting worse.
- C Brownsboro Road:** In 2015, the health of fish communities was poor and improving, aquatic insect communities were very poor and declining and algal communities were excellent and stable. Stream habitat was good and improving. Total nitrogen, ammonia, phosphorus and suspended solids were low, however nitrate concentrations were moderate. Cadmium and lead exceeded aquatic life criteria more often than other sites. Fecal coliform bacteria concentrations were some of the highest in the Louisville Metro, but were improving.

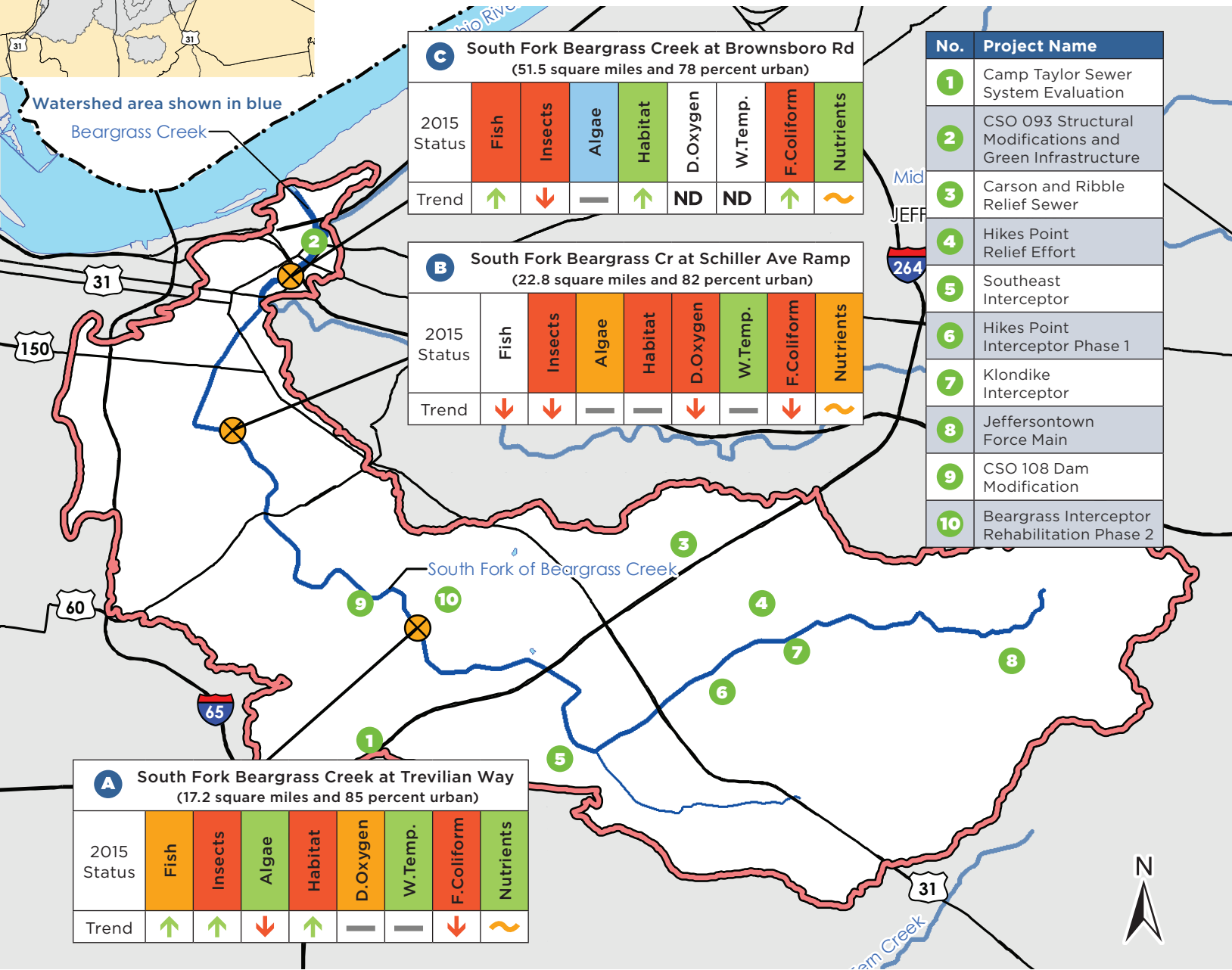
MSD IS CONSTRUCTING A LARGE COVERED BASIN AT LOGAN STREET NEXT TO THE SOUTH FORK OF BEARGRASS CREEK. WHEN COMPLETED IN 2017, IT WILL STORE ALMOST 17 MILLION GALLONS OF COMBINED SEWAGE AND STORM WATER FOR LATER TREATMENT.

WATER QUALITY STATUS AND TRENDS

SOUTH FORK OF BEARGRASS CREEK WATERSHED



Watershed area shown in blue
Beargrass Creek



Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | TREND | STATUS |
|--|--|
| ↑ Improving | ■ Excellent |
| ↓ Declining | ■ Good |
| ~ Varies | ■ Fair |
| — No Change | ■ Poor |
| ND No Data | |

FLOYDS FORK WATERSHED

The small streams that form Floyds Fork originate in Henry, Oldham, Shelby, and Spencer Counties. Floyds Fork flows south through Oldham, eastern Jefferson, and northern Bullitt Counties where it drains into the Salt River near Shepherdsville.

Watershed Assessment

There are about 284 square miles of land in the Floyds Fork watershed, about 40 percent of which is in Jefferson County. MSD monitors water quality and flow at two stream sites on Chenoweth Run, which is a tributary draining Jeffersontown that enters Floyds Fork from the west and upstream of the Bardstown Road site. There are 5.5 and 11.6 square miles of land draining to Chenoweth Run at the Ruckriegel Parkway and Gellhaus Lane sites, respectively. MSD monitors three sites on Floyds Fork: the Ash Avenue site drains 80 square miles north of Jefferson County, the Old Taylorsville Road site, which drains 138 square miles and the Bardstown Road site, which drains 213 square miles.

The Chenoweth Run watershed is mostly developed for urban and suburban uses. The area draining to the Ruckriegel Parkway site is over 33 percent impervious (75 percent urban and suburban), and the area draining to Gellhaus Lane is 21 percent impervious (52 percent urban and suburban). The land draining the three sites on Floyds Fork is mostly forest and agricultural. Extensive tracts of land along Floyds Fork have been preserved to develop a premier park system, The Parklands of Floyds Fork. Less than 15 percent of land in Floyds Fork has been developed for urban and suburban uses, mostly in the portions of the watersheds nearer to Louisville. Impervious area, including roadways, rooftops and driveways, is less than 4 percent in Floyds Fork.

A Ruckriegel Parkway: In 2015, the health of fish and aquatic insect communities was fair and improving, algal communities were good but declining. Stream habitat was good and improving. Nutrients, ammonia, suspended solids and trace metal concentrations were low. Dissolved oxygen was fair but improving, water temperature was good. Fecal coliform bacteria concentrations were elevated and decreasing.

B Gellhaus Lane: In 2015, the health of fish and aquatic insect communities was fair and stable, algal communities were excellent and improving. Stream habitat was good and

improving. Suspended solids, ammonia, and trace metal concentrations were low, but nitrogen and phosphorus were elevated. Dissolved oxygen was good and stable, water temperature was good. Fecal coliform bacteria concentrations were moderate and improving.

C Ash Avenue: In 2015, the health of fish communities was fair and stable, aquatic insect communities were fair and improving and algal communities were poor and declining. Stream habitat was good and stable. Ammonia and trace metal concentrations were low, but nitrogen, and suspended solids were moderate and phosphorus concentrations were elevated. Dissolved oxygen was good and improving, water temperature was good. Fecal coliform bacteria concentrations were moderate and stable.

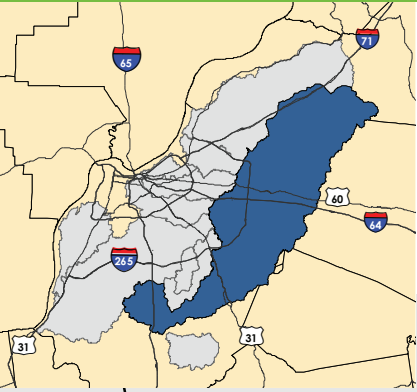
MSD ELIMINATED THE DISCHARGE FROM THE JEFFERSON TOWN WATER QUALITY TREATMENT CENTER INTO CHENOWETH RUN IN 2015, AND NOW TREATS THE FLOW AT THE MORRIS FORMAN WQTC.

D Old Taylorsville Road: In 2015, the health of fish communities was good and improving, aquatic insect and algal communities were excellent and improving. Stream habitat was good and stable. Ammonia and trace metal concentrations were low, however nitrogen, phosphorus and suspended solids concentrations were elevated. Dissolved oxygen was good and stable, water temperature was good. Fecal coliform bacteria concentrations were moderate and improving.

E Bardstown Road: In 2015, the health of fish communities was fair and improving, aquatic insect communities were good and improving and algal communities were fair and stable. Stream habitat was good and stable. Ammonia and trace metal concentrations were low, however nitrogen, phosphorus and suspended solids concentrations were elevated. Dissolved oxygen was good and stable, water temperature was good. Fecal coliform bacteria concentrations were moderate and stable.

WATER QUALITY STATUS AND TRENDS

FLOYDS FORK WATERSHED



Watershed area shown in blue

C **Floyds Fork at Ash Avenue**
(80 square miles and 48 percent agriculture)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	—	↑	↓	—	↑	—	—	~

A **Chenoweth Run at Ruckriegel Parkway**
(5.47 square miles and 75 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↑	↓	↑	↑	—	↑	~

B **Chenoweth Run at Gellhaus Lane**
(11.6 square miles and 52 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	—	—	↑	↑	—	—	↑	~

No.	Project Name
1	Floydsburg Rd Sewer System Evaluation Survey Rehabilitation and Pump Station Upgrade
2	Lake Forest Pump Station Sanitary Sewer Overflow Investigation
3	Woodland Hills Pump Station Diversion
4	Ashburton Pump Station Improvements & Diversion
5	A. Chenoweth Hills Wastewater Treatment Plant Elimination & Pump Station Improvements
	B. St. Rene Rd Pump Station In-line Storage
6	Jeffersontown Wastewater Treatment Plant Elimination
7	A. Fairmount Rd Pump Station Off-line Storage Basin
	B. Fairmount Rd Pump Station Improvements

D **Floyds Fork at Old Taylorsville Road**
(138 square miles and 44 percent forest)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↑	↑	—	—	—	↑	~

E **Floyds Fork at Bardstown Road**
(213 square miles and 49 percent forest)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↑	—	—	—	—	—	~

Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | TREND | STATUS |
|--|--|
| ↑ Improving | ■ Excellent |
| ↓ Declining | ■ Good |
| ~ Varies | ■ Fair |
| — No Change | ■ Poor |
| ND No Data | |



CEDAR CREEK / PENNSYLVANIA RUN WATERSHEDS

The small streams that eventually form Cedar Creek in Jefferson County originate in the Fern Creek area, flow south and empty into Floyds Fork east of Shepherdsville. Pennsylvania Run originates in the Highview area, flows south through McNeely Lake and empties into Cedar Creek east of Zoneton. Cedar Creek in Bullitt County originates in the Cedar Grove area, flows north and empties into the Salt River east of Shepherdsville.

Watershed Assessment

There are about 11.1 square miles of land that drain to the site on Cedar Creek at Thixton Lane. There are about 6.4 square miles of land that drain to the Pennsylvania Run site, which includes the 46 acre McNeely Lake. MSD monitored these sites since 1999. The land includes urban, agriculture, forest and some grassland. About 10 and 9 percent, respectively, of these watersheds is covered by impervious surfaces such as roads, rooftops and driveways.

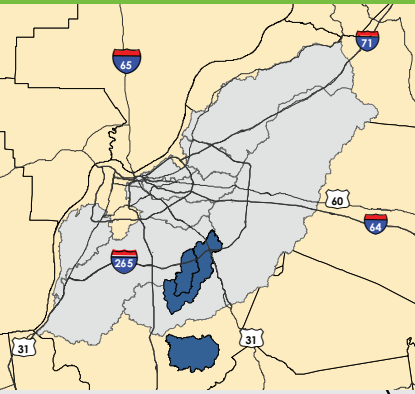
There are about 12.1 square miles of land that drain to the Cedar Creek (Bullitt County) site on State Road 1442. This land is mostly forested, with significant amounts of agriculture and grasslands. Less than six percent has been developed for urban and suburban uses. Impervious area covers only 0.2 percent of this watershed. MSD began monitoring this site in 2002 because it is located outside of the urban influences of Louisville and provides a basis for comparing water quality in a rural watershed to the more urbanized streams in the Louisville Metro area.

CEDAR CREEK IN BULLITT COUNTY IS ALMOST 70% FORESTED LAND. IT PROVIDES A BASIS FOR COMPARING WATER QUALITY TO THE MORE URBANIZED STREAMS IN LOUISVILLE METRO.



Cedar Creek at Thixton Lane

- A Thixton Lane:** In 2015, the health of fish communities was excellent and improving, aquatic insect communities were fair and stable, and algal communities were poor and stable. Stream habitat was good and improving. Phosphorus, ammonia, suspended solids and trace metal concentrations were low, however, concentrations of nitrate were high and total nitrogen was moderate. Dissolved oxygen was good and stable; water temperature was good. Fecal coliform bacteria concentrations were moderate and were improving.
- B Mt. Washington Road:** In 2015, the health of fish communities was good and improving, aquatic insect communities were fair and improving, and algal communities were good and stable. Stream habitat was fair and improving. Ammonia and trace metal concentrations were low; however, nitrate and phosphorus concentrations were high and total nitrogen and suspended solids concentrations were moderate. Dissolved oxygen was fair and stable; water temperature was good. Fecal coliform bacteria concentrations were moderate and stable.
- C State Road 1442:** In 2015, the health of fish communities was excellent and stable, aquatic insect communities were fair and stable, and algal communities were excellent and improving. Stream habitat was good and stable. Concentrations of nitrogen, ammonia, phosphorus, suspended solids and trace metals were low. Dissolved oxygen was good and stable; water temperature was good. Fecal coliform bacteria concentrations were moderate and improving.



Watershed area shown in blue

WATER QUALITY STATUS AND TRENDS

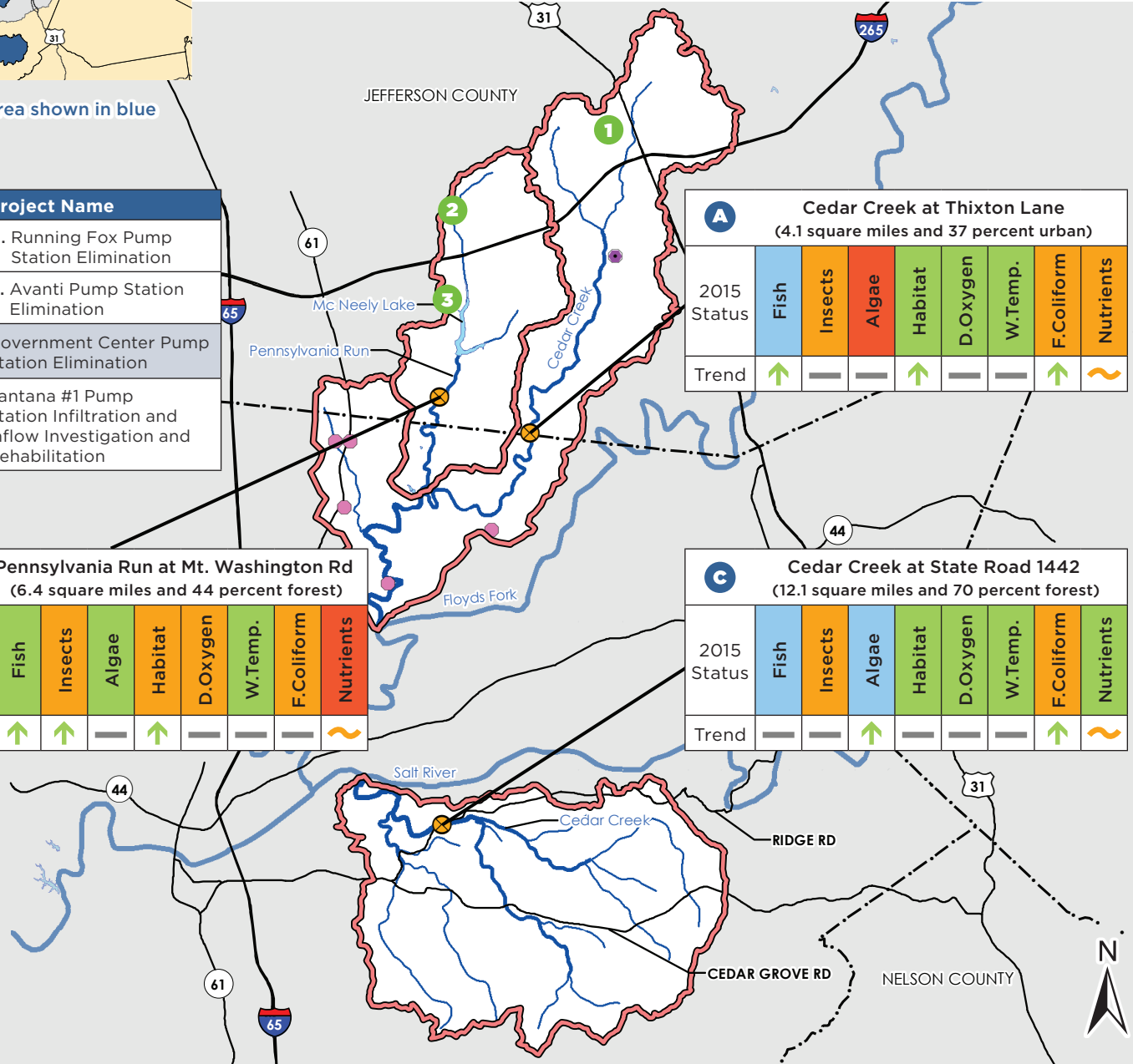
CEDAR CREEK / PENNSYLVANIA RUN WATERSHEDS

No.	Project Name
1	A. Running Fox Pump Station Elimination B. Avanti Pump Station Elimination
2	Government Center Pump Station Elimination
3	Lantana #1 Pump Station Infiltration and Inflow Investigation and Rehabilitation

B Pennsylvania Run at Mt. Washington Rd (6.4 square miles and 44 percent forest)	
2015 Status	Fish: Good, Insects: Fair, Algae: Good, Habitat: Fair, D.Oxygen: Good, W.Temp.: Good, F.Coliiform: Fair, Nutrients: Poor
Trend	Fish: ↑, Insects: ↑, Algae: —, Habitat: ↑, D.Oxygen: —, W.Temp.: —, F.Coliiform: —, Nutrients: ~

A Cedar Creek at Thixton Lane (4.1 square miles and 37 percent urban)	
2015 Status	Fish: Excellent, Insects: Fair, Algae: Poor, Habitat: Good, D.Oxygen: Good, W.Temp.: Good, F.Coliiform: Fair, Nutrients: Poor
Trend	Fish: ↑, Insects: —, Algae: —, Habitat: ↑, D.Oxygen: —, W.Temp.: —, F.Coliiform: ↑, Nutrients: ~

C Cedar Creek at State Road 1442 (12.1 square miles and 70 percent forest)	
2015 Status	Fish: Excellent, Insects: Fair, Algae: Good, Habitat: Good, D.Oxygen: Good, W.Temp.: Good, F.Coliiform: Fair, Nutrients: Good
Trend	Fish: —, Insects: —, Algae: ↑, Habitat: —, D.Oxygen: —, W.Temp.: —, F.Coliiform: ↑, Nutrients: ~



Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | TREND | STATUS |
|--|--|
| ↑ Improving | ■ Excellent |
| ↓ Declining | ■ Good |
| ~ Varies | ■ Fair |
| — No Change | ■ Poor |
| ND No Data | |

POND CREEK WATERSHED

The Pond Creek watershed drains about 126 square miles in southern and southwestern Louisville Metro area. Approximately 89 square miles are located in Jefferson County and 37 square miles are in Bullitt County. The Louisville International Airport and its associated large industrial complex, and Jefferson Memorial Forest are prominent features in this watershed.

Watershed Assessment

The small streams which flow west out of the Jeffersontown and Fern Creek areas, join to form Fern Creek and then become Northern Ditch near Shepherdsville Road. Just to the south, small streams flow west out of Okolona and form Southern Ditch near Interstate-65. Southern joins Northern Ditch and forms Pond Creek near New Cut Road, where it flows west into the Salt River near West Point. Brier Creek is a small tributary draining into Pond Creek just south of Pendleton Road. MSD has been monitoring water quality and stream flow in this watershed since 1999 at five locations.

The sites on Fern Creek, Northern Ditch, and Pond Creek are similar in land use with most of the upstream area in urban and suburban uses. The amount of impervious surfaces such as roads, rooftops and driveways, ranges from 16 percent to 24 percent. Forest ranges from 28 to 34 percent and agriculture was less than ten percent. The land draining to Brier Creek is quite different from the other four sites. This small stream drains steep wooded areas southwest of Jefferson Memorial Forest. The watershed is largely undeveloped with mostly forest and some agriculture.

A Fern Creek: In 2015, the health of fish communities was fair and improving, aquatic insect communities were poor and declining, and algal communities were good and stable. Stream habitat was fair and improving. Total nitrogen, ammonia, suspended solids and trace metal concentrations were low, however, concentrations of nitrate and phosphorus were moderate. Dissolved oxygen was good and improving, water temperature was good. Fecal coliform bacteria concentrations were moderate and stable.

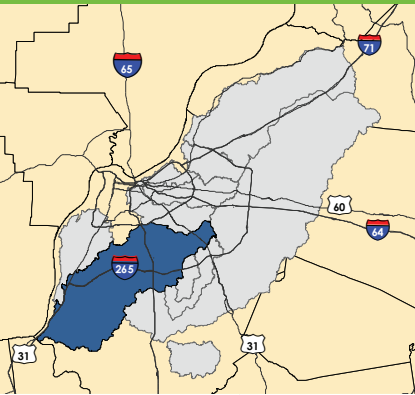
B Northern Ditch: In 2015, the health of fish communities was good and improving, aquatic insect communities were fair and improving, and algal communities were fair and stable. Stream habitat was poor and stable. Beaver activity has led to ponding conditions at this site, resulting in lowering of stream habitat and aquatic community measures in some years. Nutrients, ammonia, suspended solids and trace metal concentrations were low. Dissolved oxygen was poor and declining, water temperature was poor. Fecal coliform bacteria concentrations were low and improving.

C Manslick Road: In 2015, the health of fish communities was poor and improving, aquatic insect communities were fair and improving, and algal communities were good and improving. Stream habitat was poor and declining. Nitrate, ammonia, phosphorus, and trace metal concentrations were low, however, concentrations of total nitrogen were moderate and suspended solids were high. Dissolved oxygen was good and improving, and water temperature was good. Fecal coliform bacteria concentrations were moderate and stable.

MANY STREAMS IN THE POND CREEK WATERSHED WERE MAN-MADE OR CHANNELIZED IN THE PAST TO REDUCE FLOODING.

D Pendleton Road: In 2015, the health of fish communities was poor and improving and aquatic insect communities were fair and improving. Algal communities and stream habitat were poor and declining. Nutrients, ammonia, and trace metal concentrations were low; however, concentrations of suspended solids were moderate. Dissolved oxygen was good and improving, water temperature was good. Fecal coliform bacteria concentrations were low and improving.

E Brier Creek: In 2015, the health of fish communities was fair and improving, aquatic insect and algal communities were poor and declining. Stream habitat was fair and stable. Nutrients, ammonia, suspended solids and trace metal concentrations were low. Dissolved oxygen was fair and improving, water temperature was good. Fecal coliform bacteria concentrations were low and improving.



Watershed area shown in blue

WATER QUALITY STATUS AND TRENDS

POND CREEK WATERSHED

B Northern Ditch at Preston Highway
(11.1 square miles and 62 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↑	—	—	↓	—	↑	~

C Pond Creek at Manslick Road
(64 square miles and 58 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↑	↑	↓	↑	—	—	~

D Pond Creek at Pendleton Road
(80.3 square miles and 60 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↑	↓	↓	↑	—	↑	~

A Fern Creek at Old Bardstown Road
(3.5 square miles and 60 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↓	—	↑	↑	—	—	~

E Brier Creek at Bear Camp Road
(4.13 square miles and 84 percent forest)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Coliform	Nutrients
Trend	↑	↓	↓	—	↑	—	↑	~

No.	Project Name
1	Middle Fork Relief Interceptor, Wet Weather Storage, and Upper Middle Fork Lift Station Diversion 1 - Buechel Basin
2	Northern Ditch Diversion Interceptor
3	Lea Ann Way System Improvements
4	Parkview Estates Infiltration and Inflow Investigation & Rehabilitation
5	Edsel Pump Station Infiltration and Inflow Investigation and Rehabilitation
6	Charleswood Interceptor Extension

Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | | |
|--------------|---------------|
| TREND | STATUS |
| ↑ Improving | Excellent |
| ↓ Declining | Good |
| ~ Varies | Fair |
| — No Change | Poor |
| ND No Data | |

MILL CREEK WATERSHED

The Mill Creek watershed drains about 34 square miles in western Louisville, near the Ohio River. The northern part of the watershed includes streams that drain to the Mill Creek Cutoff, which flows directly into the Ohio River near Shively. The southern part of the watershed flows south through Pleasure Ridge Park and then into the Ohio River near Watson Lane. Many of the streams in this watershed were straightened or channelized in the past to reduce flooding.

Watershed Assessment

MSD has monitored water quality and flow in Mill Creek Cutoff at two sites in this watershed since 1999; on Mill Creek Cutoff at Old Cane Run Road and on Mill Creek at Orell Road. There are 24.4 square miles of land draining to the Mill Creek Cutoff site and 13.5 square miles of land draining to the Orell Road site. These watersheds are highly urbanized and industrial, with some forest and very little agriculture. Approximately 38 and 21 percent of the land draining to the Mill Creek Cutoff and Orell Road sites, respectively, is covered by impervious surfaces such as roads, rooftops and driveways.

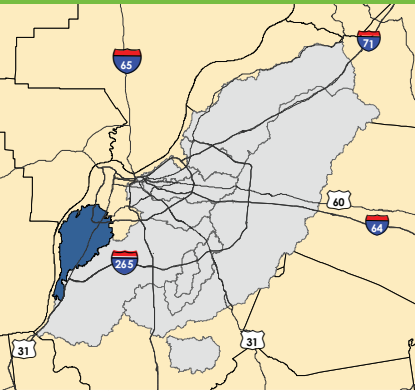


Derek R. Guthrie Water Quality Treatment Center

A Mill Creek Cutoff: Fish communities were in poor condition and declining and aquatic insect communities were in poor condition and improving. Algal communities were in excellent condition and improving and stream habitat was in poor condition and stable. Nitrate, ammonia and phosphorus were low, total nitrogen was moderate and suspended solids were elevated. Copper, lead and zinc exceeded aquatic life criteria more often than other monitoring sites. Fecal coliform bacteria concentrations were moderate and getting worse, with concentrations generally higher during wet weather events. MSD and USGS do not operate a water quality sonde at this site.

B Orell Road: Fish and aquatic insect communities were in poor condition and declining. Algal communities were in good condition and improving and stream habitat was in poor condition and declining. Nitrate, ammonia and phosphorus were low, total nitrogen and suspended solids were moderate. Dissolved oxygen concentrations were sometimes low, but were improving. The water temperature criterion was consistently met. Copper and lead sometimes exceeded aquatic life criteria. Fecal coliform bacteria concentrations were low and stable.

MILL CREEK HAS THE SECOND HIGHEST PERCENTAGE OF URBAN AND SUBURBAN LAND USES (BEHIND THE SOUTH FORK OF BEARGRASS CREEK).



Watershed area shown in blue

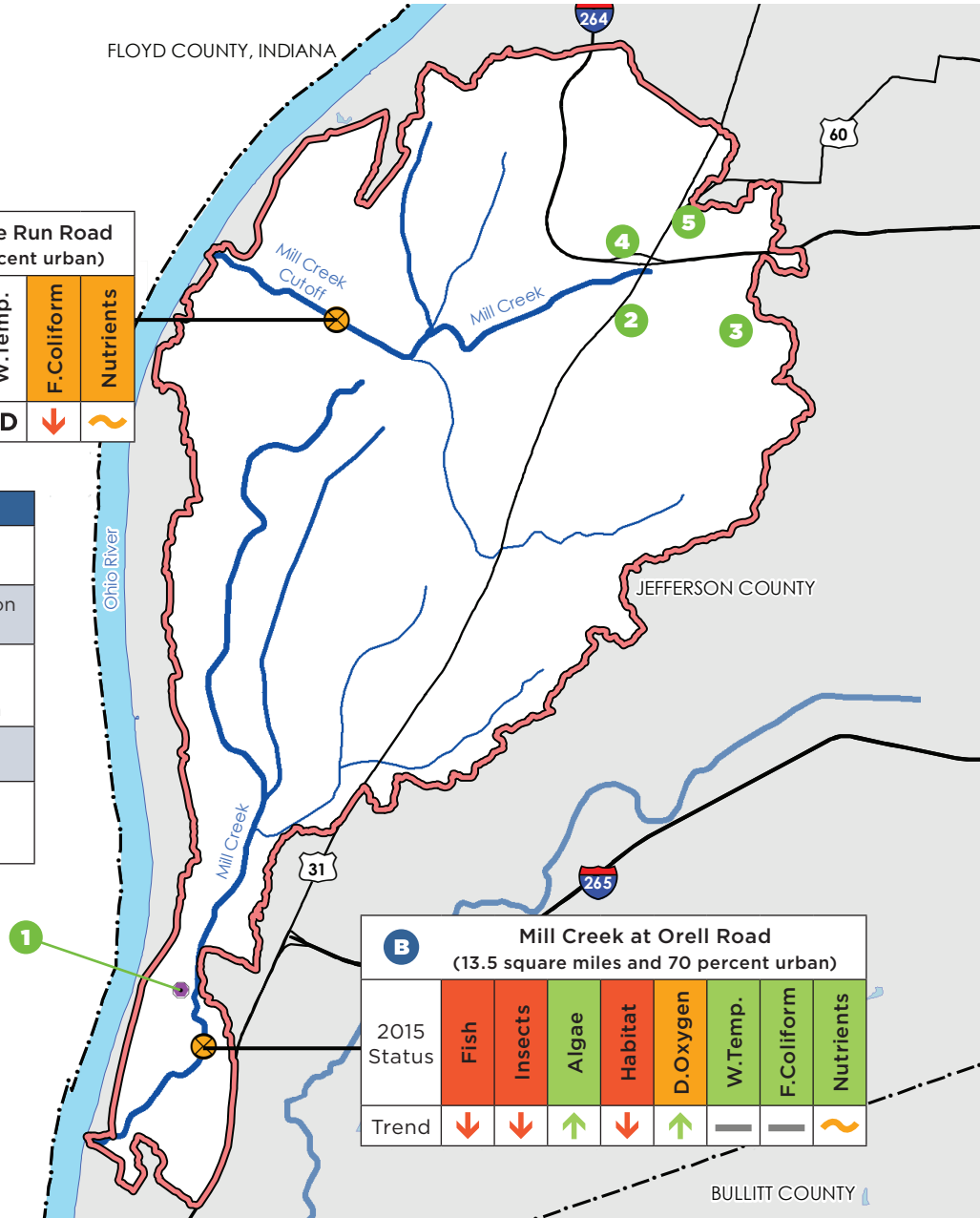
WATER QUALITY STATUS AND TRENDS

MILL CREEK WATERSHED

A Mill Creek Cutoff at Old Cane Run Road
(24.4 square miles and 86 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Colliform	Nutrients
Trend	↓	↑	↑	—	ND	ND	↓	~

No.	Project Name
1	Derek R. Guthrie Water Quality Treatment Center
2	East Rockford Lane Pump Station Relocation
3	Hazelwood Pump Station Infiltration and Inflow Investigation and Rehabilitation
4	Shively Interceptor
5	Sonne Pump Station Infiltration and Inflow Investigation and Rehabilitation



B Mill Creek at Orell Road
(13.5 square miles and 70 percent urban)

2015 Status	Fish	Insects	Algae	Habitat	D.Oxygen	W.Temp.	F.Colliform	Nutrients
Trend	↓	↓	↑	↓	↑	—	—	~

Legend

- Completed Project
- ⊗ Monitoring Site
- Water Quality Treatment Center (Operated by MSD)
- Sewage Treatment Plant (Operated by Other Agency)
- Stream
- Road
- - - County Boundary
- Watershed Boundary
- Lake

Ratings Key

- | | |
|--------------|---------------|
| TREND | STATUS |
| ↑ Improving | Excellent |
| ↓ Declining | Good |
| ~ Varies | Fair |
| — No Change | Poor |
| ND No Data | |

OHIO RIVER WATERSHED

The Ohio River is one of the nation's great natural resources. The river not only provides drinking water for over five million people, but serves as a warm water habitat for aquatic life, provides numerous recreational opportunities, is used as a major transportation route, and is a source of water for the manufacturing and power industries. The Ohio River begins in Pittsburgh, Pennsylvania at the confluence of the Allegheny and Monongahela Rivers and flows southwesterly for 981 miles, joining the Mississippi River near Cairo, Illinois. For the stretch of river near Louisville, it forms the state boundaries between Indiana to the north and Kentucky to the south.

The Ohio River Valley Water Sanitation Commission (ORSANCO) is an interstate agency charged with abating existing pollution in the Ohio River basin and preventing future degradation of its waters. ORSANCO was created in 1948 with the signing of the Ohio River Valley Water Sanitation Compact among the bordering states (orsanco.org).

ORSANCO's Bimonthly Monitoring Program, in existence since 1975, is comprised of 31 monitoring sites on the main stem of the Ohio River and near the mouth of major tributaries. The Bimonthly Sampling Program currently collects six samples per year, every other month. This was reduced from a monthly frequency in 1992.



Every two years, ORSANCO assesses water quality conditions of the Ohio River and the ability of the river to support each of its four designated uses; warm water aquatic life, public water supply, contact recreation, and fish consumption. ORSANCO's 2016 assessment (their 305b Report to Congress) summarizes 2010-2014 data. During this time period, ORSANCO reported full support of aquatic life and public water supply uses along the entirety of the Ohio River, including in the vicinity of Louisville. The entire 981 miles of the Ohio River is designated as impaired for the fish consumption use, caused by PCBs and dioxin. orsanco.org/biennial-assessment-of-ohio-river-water-quality-conditions-305b

**FOR 2010-2014,
ORSANCO REPORTED
FULL SUPPORT OF
AQUATIC LIFE AND
PUBLIC WATER SUPPLY
USES ALONG THE
ENTIRE OHIO RIVER.**

The Kentucky Division of Water's Water Health Portal (watermaps.ky.gov/waterhealthportal) shows that swimming designated uses were met in the Ohio River between Harrods Creek and the Kennedy Bridge (I-65) as of 2014. The reaches above and below this segment in Jefferson County partially support designated uses for swimming. A plan for reducing bacteria in the river is being developed by the US Environmental Protection Agency with participation from ORSANCO and member states. orsanco.org/programs/bacteria-tmdl

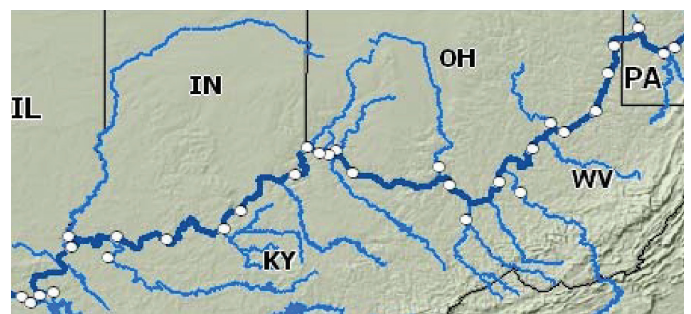
At times, elevated nutrients and warm, slow moving water conditions can contribute to blooms of potentially harmful blue-green algae in the river. The algae can cause skin irritation and affect breathing of children and sensitive individuals. In September 2015, Kentucky Division of Water issued a recreational advisory due to a harmful algal bloom affecting the entire Ohio River including Louisville. People were advised to avoid direct contact with water that had an unusual color. ORSANCO, Kentucky Division of Water and many other agencies are working to reduce the level of nutrients in the river. Over time, these efforts are anticipated to minimize harmful algal blooms.



Volunteers collect trash during the annual Ohio River Sweep.

ORSANCO has conducted fish surveys to evaluate the Ohio River since 1957, including surveys of the McAlpine Lock and Dam adjacent to and upriver of Louisville. Increases in various measures of the fish communities over time indicate an overall improvement in the fish community health. For example, the percentage of pollution tolerant fish species in the river has declined and pollution intolerant and native species have increased since 1957. In the 2014 McAlpine Lock and Dam pool survey, ORSANCO rated the overall biological condition of this area as very good. 216.68.102.178/data/pool/2014McAlpineAssessmentSummary.pdf

ORSANCO has analyzed the trends in various water quality measures at Ohio River sampling sites from 1990 to 2007. At three Ohio River sites near Louisville, concentrations of nitrogen compounds, total suspended solids, iron, and zinc in the river are declining or staying the same. Concentrations of total phosphorus and chloride, however, are increasing over time. orsanco.org/images/stories/files/publications/trendsreport/2008trendsanalysis.pdf



ORSANCO Bimonthly Sampling Program Sites

SUMMARY AND CONCLUSIONS

The Louisville and Jefferson County Metropolitan Sewer District (MSD) in cooperation with the United States Geological Survey (USGS) operates a Long-Term Monitoring Network (LTMN) to collect physical, chemical and biological data about streams in the Metro Area. MSD collects the water quality and biological data and USGS collects stream flow. This State of the Streams Report is focused on the conditions of fish, aquatic insects, benthic algae, stream habitat, bacteria, nutrients (nitrogen and phosphorus compounds), total suspended solids, trace metals, stream flow, dissolved oxygen and water temperature of the streams in our community, and whether or not measures of these components are improving. The data collected at the 27 LTMN sites since 1999 helps us make decisions about where to focus our attention and tells us how we're doing in our mission to improve water quality in the region. This report augments a previous MSD report: State of the Streams, 2014 Water Quality Synthesis Report (available in the Project WIN library section at msdprojectwin.org).

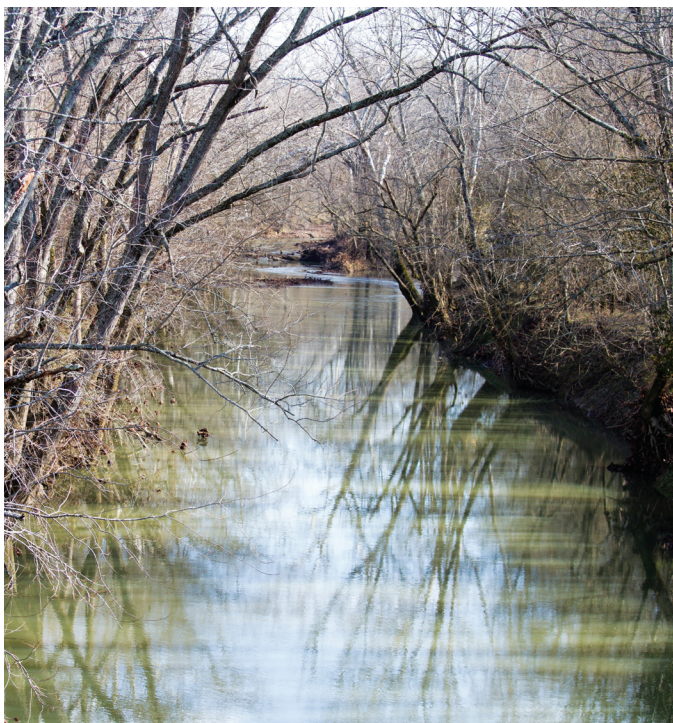
The health of aquatic communities in streams of the Louisville Metro area can be compromised by one or more factors that commonly affect urban and suburban streams. Significant and rapid runoff from impervious areas often leads to stream bank

erosion due to increases in the percentage of rainfall that becomes runoff (more frequent flushing). More rapid runoff can also cause scouring of stream beds and banks in higher velocity areas, with downstream deposition of some of that sediment often partially covering habitat needed by fish and other aquatic organisms. Channel modifications such as straightening and shoring up the stream bank with concrete or large stones leads to limited amounts of rock riffle habitat and usually insufficient protective tree cover along the banks, both of which are needed to support healthy aquatic communities. Occasional periods of very low flow, high temperatures, or low dissolved oxygen infrequently contribute to lower than desired observed health of aquatic communities.

In addition to the typical urban effects, a major impact on stream quality in the older urban areas of Louisville is related to the presence of combined sewer systems that release sewage and stormwater during larger rainfall events. The lower parts of the South and Middle Forks of Beargrass Creek are affected by combined and sanitary sewer overflows, and their aquatic communities are generally rated as in poor to very poor condition. Very high concentrations of bacteria also were observed in these watersheds. These are being mitigated by extensive projects to eliminate or reduce the frequency and volume of overflows.

The aquatic communities in watersheds with impervious area greater than 20 percent have shown variable responses to the effects of development depending, in part, on the presence of healthy stream habitat. Parts of the Beargrass Creek (Muddy, Middle, and South Forks) watershed have poor habitat and generally poor to very poor conditions of their aquatic communities. Some watersheds, like Pond Creek and Mill Creek, have considerable amounts of man-made channels without the healthy mix of rocky riffles and tree covered banks. As a result, the aquatic communities generally are in poor to fair condition and they are declining at some sites. Northern Ditch in the Pond Creek watershed is an exception in that the conditions of the aquatic communities are showing improvement, perhaps in part, due to channel stabilization projects.

Streams that run on bedrock, like Cedar Creek, Fern Creek, and Pennsylvania Run, to some extent lack the variety of in-stream habitat types such as deep pools and rocky riffles that provide good habitat for fish and aquatic insect communities. As a result, their aquatic communities are in poor to good condition but for other reasons they are still showing improvement.



Floyds Fork



Beargrass Creek

IN 2015, ALGAE AND STREAM HABITAT AT OVER HALF THE SITES WERE IN GOOD TO EXCELLENT CONDITION, BUT MOST SITES FOR FISH AND AQUATIC INSECTS WERE IN POOR TO FAIR STATUS.

The predominance of forested and agricultural land in less developed watersheds, like Harrods Creek, Floyds Fork, Brier Creek, and Cedar Creek (Bullitt County), helps slow down and absorb runoff during rain events. As such, healthier stream habitat conditions in these systems were found to be supporting healthier aquatic communities, even in Floyds Fork despite it having some of the highest nutrient levels in the county.

Measures of aquatic community health in 2015 indicate that for algae and stream habitat, over half of the sites were in good to excellent condition, whereas, for fish and aquatic insects most sites were in poor to fair status. Trends in fish, aquatic insect, and stream habitat health indicate that about half of the sites were improving. The algal communities at most sites had no trend or were declining. The fair to poor habitat conditions of about half of the streams can be attributed to historic stream channelization and straightening along with the loss of rock riffles, bends, vegetative bank protection, and the now less stable banks and narrow to nonexistent riparian corridors. Some consideration for using well-planned stream restoration techniques and riparian tree plantings might greatly improve conditions for fish and insects in streams with poorer habitat conditions.

Data in 2015 for fecal coliform bacteria indicate that 21 of the 27 Long-Term Monitoring Network sites had recreational season geometric means of fecal coliform bacteria larger than the primary contact/swimming standard of 200 colonies per 100 milliliters, but only four sites had recreational season geometric means larger than the boating/wading standard of 1,000 colonies per 100 milliliters. From 2004 to 2015, 12 sites were shown to be improving, seven sites were declining and eight were stable. The lower parts of the South and Middle Forks of Beargrass Creek had the highest concentrations of bacteria and most frequent exceedances of the recreational criteria. These impacts are being mitigated by extensive projects to eliminate or reduce the frequency and volume of sewer system overflows during larger rainfall events. Studies during higher flow periods also indicate that non-point sources of bacteria can still be high, even in the more rural streams.

The fecal coliform bacteria that are sampled are derived from warm blooded animals and are not all from human sources. MSD is working to identify and reduce sources of bacteria by sampling additional sites during wet and dry weather conditions. This work is designed to track sources of bacteria to more specific locations than just the 27 sites. Dry weather stream sampling has indicated that bacterial sources during low flow are not as wide spread as thought and can be used to identify some possible source areas. MSD then can scout the area for specific problems. In at least one case, a broken sewer line was found and repaired.

During and shortly after rainfall events, bacteria concentrations tend to be higher and likely are from a broader range of sources, including wild animals, pets, and birds as well as collection system issues that have not yet been addressed. Bacterial conditions at most sites, especially during higher flow conditions, will remain a concern.

Dissolved oxygen data in 2015 indicate that 15 sites were in good status, six were fair, and only two sites were in poor status (Northern Ditch at Preston Highway and South Fork of Beargrass Creek at Schiller Avenue Ramp). Trends in the historical data (2007-2015) indicate that dissolved oxygen conditions at the same two sites were declining, nine sites had no trend, and at 12 sites conditions were improving. Water temperature conditions in 2005-15 indicate that 22 of 23 sites met the criteria (not greater than 31.7 °C (89.1 °F)) at least 90 percent of the time. There were no measurable trends in water temperature data. Periodic hot days and low stream flows occasionally can cause an exceedance of dissolved oxygen or temperature criteria. The presence of significant tree cover at many sites and potential for groundwater influence at some sites probably helps buffer these measurements to some degree from otherwise significant urban influences.

The levels of nutrients in 2015 (nitrate, total Kjeldahl nitrogen, and total phosphorus) and total suspended solids at each site were compared to all samples at 27 LTMN sites collected since 2005. Using a natural break in the data, six sites (Little Goose Creek and five sites in Floyds Fork watershed) had the highest number of samples in the upper third of all LTMN samples for these nutrients. Those sites have more agricultural or suburban land use types, generally with higher use of fertilizers on crops and lawns. The sites that had the lowest number of samples in the upper third of all LTMN samples are mainly north (Harrods Creek and Goose Creek) or southwest of the city (Pond Creek, Mill Creek, and Cedar Creek-Bullitt). The mid-range sites were largely urban.

IN WETTER PERIODS, BACTERIA CONCENTRATIONS ARE HIGHER AND SOURCES INCLUDE WILD ANIMALS, PETS AND BIRDS, AS WELL AS COLLECTION SYSTEM ISSUES THAT HAVE NOT YET BEEN ADDRESSED.

In its un-ionized form, ammonia can be toxic to fish and other aquatic organisms. MSD collected total ammonia since 2000 (about 1,000 samples) at 27 LTMN sites. For a comparison to the Kentucky water quality criterion, the un-ionized form of ammonia was calculated using water temperature and pH data with equations from the State's water quality standards 401 KAR 10:031. Four samples from Chenoweth Run at Gellhaus Lane (in 2007, 2008, 2012, and 2013) and two at the Ruckriegel site (in 2007 and 2008) were above the criterion. One sample each at four other sites (Wolf Pen Branch and Fern Creek in 2013, Northern Ditch in 2012, and Middle Fork Beargrass at Lexington Road in 2007) also were above the criterion. The source of these higher ammonia concentrations is not known. Concentrations of un-ionized ammonia were below the criterion in all other samples at the 27 sites with available data since 2006, suggesting that un-ionized ammonia currently is not an issue at LTMN sites.



A group of students paddles by MSD's Beargrass Creek Flood Pumping Station on a tour of the stream.

The picture of total suspended solids is a little different. Pond Creek at Manslick Road is very dominant with 93 percent of its samples in the upper third of all LTMN total suspended solids samples. It is suspected that the banks and sediment-laden stream bed in this channelized system are highly erodible and that even small rises in flow can lead to higher suspended solids. Sites on Little Goose Creek, Mill Creek, and Floyds Fork follow next, but were well behind in percent of samples in the upper third of all samples. Otherwise, the rest of the sites do not have much of a problem with suspended solids.

Of more than 1,000 total samples collected for each trace metal at 27 sites since 2006, lead had the most exceedances with 109 and cadmium had 70 exceedances, both with at least one exceedance at each site. Copper had 41 exceedances at 16 sites and zinc had 22 exceedances at 9 sites. In summary, 38 percent of the metal exceedances were at sites in the Beargrass Creek watershed and 29 percent were in the Mill and Pond Creek watersheds. Of the 242 total number of exceedances, 90 percent were above the chronic criterion and 10 percent were above both criteria. For lead, cadmium, copper, and zinc, respectively, 100, 97, 71, and 50 percent of the exceedances were above the chronic criterion. The relatively few exceedances of the acute and chronic Aquatic Life Criteria (together about 5 percent of the total number of analyses) since 2006 would indicate that trace metals currently are not a large issue of concern in LTMN streams.

TRACE METALS ARE NOT A LARGE ISSUE OF CONCERN IN LTMN STREAMS DUE TO RELATIVELY FEW EXCEEDANCES OF THE ACUTE AND CHRONIC AQUATIC LIFE CRITERIA.

Biochemical oxygen demand (BOD) is a measure of the amount of oxygen that would be used up by bacteria and other organisms to break down organic compounds in a waterbody. Concentrations of BOD in the 1,071 samples collected between 2005 and 2015 ranged from 0.5 to 19 parts per million. About 95 percent of the samples were less than 5 parts per million, which is considered a low to moderate level of BOD. About 1.8 percent were above 8 parts per million which is considered an elevated concentration of BOD. The maximum BOD concentration of 19 parts per million occurred in Wolf Pen Branch in 2013.



Pond Creek

Chemical oxygen demand (COD) is a measure of the amount of oxygen required to break down organic compounds using acid and heat. Concentrations of COD are always higher than BOD. Concentrations of COD in the 1,056 samples collected between 2005 and 2015 ranged from 0.5 to 72 parts per million. About 66 percent of the samples were less than 15 parts per million. About 6.7 percent were above 30 parts per million. The maximum COD concentration of 72 parts per million occurred in Chenoweth Run at Ruckriegel Parkway in 2008.

The analysis of the historical LTMN data suggests that, in about half of the streams, bacteria continues to be an issue, and that fair to poor habitat quality significantly affected the observed health of fish and aquatic insect communities. The natural effects of drought conditions likely contributed to lower aquatic health status in some streams in some years as well. The effects of lower dissolved oxygen and higher temperature conditions are much more subtle and probably limited to a few sites for very short periods. For example, below normal stream flows prior to and during the 2005 and 2008 sampling events likely affected observed health in aquatic insect and fish communities, affecting the aquatic insects more than fish. The cooler than normal stream temperatures during sampling likely affected the observed health of the aquatic insect communities in 2013 and much lower flow conditions likely lowered many of the fish ratings in 2015. One of the additional values of a long-term network like the LTMN is the ability to identify these naturally induced fluctuations in water quality as well.

SUMMARY AND CONCLUSIONS

SUMMARY OF THE STATUS AND TRENDS IN STREAM WATER QUALITY

MSD Site Name	Characteristics of the Watershed			Stream Flow and Rainfall (2004-2013)			Fish KIBI Status and Trend		Aquatic Insect MBI Status and Trend		Algal DBI Status and Trend	
	Drainage Area (square miles)	Percent that is Urban	Percent that is Impervious	Mean Annual Stream Flow (inches)	Mean Annual Rainfall (inches)	Percent of Rainfall that Becomes Stream Flow	Fish Status (2015)	Trend as Percent Change (oldest to 2015)	Aquatic Insect Status (2015)	Trend as Percent Change (oldest to 2015)	Algal Status (2015)	Trend as Percent Change (oldest to 2015)
Harrods Creek at Covered Bridge Road	70.3	9%	1%	23.99	48.3	50%	Fair	↓ -23%	Good	↓ -14%	Good	0%
Wolf Pen Branch at 8200 Wolf Pen Branch Road	2.08	24%	7%	No Gage		--	Fair	↓ -48%	Poor	↓ -18%	Good	8%
Goose Creek at Old Westport Road	6.00	53%	11%	23.25	49.0	47%	Good	↑ 29%	Fair	↓ -16%	Good	2%
Goose Creek at US 42	10.1	49%	10%	18.76	49.0	38%	Good	↑ 10%	Fair	↑ 21%	Good	↓ -10%
Little Goose Creek at US 42	5.82	66%	18%	30.39	49.0	62%	Good	↑ 73%	Fair	3%	Good	↓ -17%
Muddy Fork of Beargrass Creek at Mockingbird Valley Road	6.20	46%	9%	20.83	47.7	44%	Fair	↓ -11%	Poor	↑ 36%	Poor	↓ -45%
Middle Fork of Beargrass Creek at Browns Lane	15.2	73%	24%	No Gage		--	Fair	↑ 24%	Fair	3%	Good	↓ -23%
Middle Fork of Beargrass Creek at Old Cannons Lane	18.9	76%	24%	22.17	49.0	45%	Fair	↓ -17%	Fair	↑ 11%	Good	↓ -16%
Middle Fork of Beargrass Creek at Lexington Road	24.8	73%	22%	20.61	49.0	42%	Poor	↑ 12%	Fair	-5%	Excellent	-4%
South Fork Beargrass Creek at Trevilian Way	17.2	85%	32%	22.49	49.0	46%	Fair	↑ 18%	Poor	↑ 40%	Good	↓ -21%
South Fork Beargrass Creek at Schiller Avenue Ramp	22.8	81%	30%	22.09	49.0	45%	No Data	↓ -148%	Very Poor	↓ -36%	Fair	-7%
South Fork Beargrass Creek at Brownsboro Road	51.5	78%	28%	No Gage		--	Poor	↑ 60%	Very Poor	↓ -30%	Excellent	-6%
Floyds Fork at Ash Avenue	80.0	9%	1%	23.35	48.3	48%	Fair	6%	Fair	↑ 36%	Poor	↓ -23%
Floyds Fork at Old Taylorsville Road	138	13%	3%	23.25	48.3	48%	Good	↑ 17%	Excellent	↑ 32%	Excellent	↑ 26%
Floyds Fork at Bardstown Road	213	14%	4%	23.95	50.4	48%	Fair	↑ 37%	Good	↑ 23%	Fair	-7%
Chenoweth Run at Ruckriegel Parkway	5.47	75%	33%	28.53	50.4	57%	Fair	↑ 43%	Fair	↑ 19%	Good	↓ -18%
Chenoweth Run at Gellhaus Lane	11.6	52%	21%	33.43	50.4	66%	Fair	9%	Fair	9%	Excellent	↑ 25%
Cedar Creek at Thixton Lane	11.1	37%	10%	27.65	52.5	53%	Excellent	↑ 44%	Fair	6%	Poor	-9%
Pennsylvania Run at Mount Washington Road	6.40	39%	9%	23.93	52.5	46%	Good	↑ 38%	Fair	↑ 94%	Good	2%
Cedar Creek at State Road 1442 Bullitt County	12.1	6%	0%	23.25	51.5	45%	Excellent	8%	Fair	-6%	Excellent	↑ 17%
Fern Creek at Old Bardstown Road	3.50	60%	17%	27.65	49.0	56%	Fair	↑ 29%	Poor	↓ -25%	Good	6%
Northern Ditch at Preston Highway	11.1	62%	17%	25.62	48.5	53%	Good	↑ 39%	Fair	↑ 30%	Fair	2%
Pond Creek at Manslick Road	64.0	58%	25%	22.31	48.1	46%	Poor	↑ 13%	Fair	↑ 27%	Good	↑ 20%
Pond Creek at Pendleton Road	80.3	60%	21%	24.53	49.9	49%	Poor	↑ 29%	Fair	↑ 16%	Poor	↓ -26%
Brier Creek at Bear Camp Road	4.13	1%	0%	19.56	49.9	39%	Fair	↑ 30%	Poor	↓ -12%	Poor	↓ -69%
Mill Creek Cutoff at Old Cane Run Road	24.4	86%	38%	9.32	47.6	20%	Poor	↓ -36%	Poor	↑ 39%	Excellent	↑ 24%
Mill Creek at Orell Road	13.5	69%	21%	18.46	49.9	37%	Poor	↓ -22%	Poor	↓ -41%	Good	↑ 18%

Stream Habitat Status and Trend		Fecal Coliform Status and Trend		Dissolved Oxygen Status and Trend		Water Temperature	Nutrients and Suspended Solids Status				Short Name	MSD Site Number
Habitat Status (2015)	Trend as Percent Change (2005 to 2015)	2015 Recreation Season Geomean (colonies/100 ml)	Trend as Percent Change in 3-year Averages (2004-06 to 2013-15)	Status as Percent of Days Met (2013-15)	Trend as Percent Change 2005-07 to 2013-15	Average Number of Days Criterion Exceeded Per Year (2005-14)	Nitrate > 1.32 mg/l	Total Kjeldahl Nitrogen > 0.9 mg/l	Total Phosphorus > 0.135 mg/l	Total Suspended Solids > 12 mg/l		
Good	4%	194	↓ 16%	98%	8%	1.5	9%	16%	8%	23%	Harrods Creek	EHCHC001
Good	↑ 19%	433	↓ 44%	No Data	No Data	No Data	25%	15%	2%	24%	Wolf Pen Branch	EHCWP002
Good	↑ 37%	655	↓ 44%	91%	8%	0	19%	15%	8%	15%	Old Westport Road	EGCGC001
Good	↑ 12%	429	↑ -24%	100%	↑ 20%	0	46%	16%	17%	26%	US 42	EGCGC002
Good	↑ 19%	162	↑ -61%	99%	↑ 12%	0	74%	53%	20%	60%	Little Goose Creek	EGCLG001
Poor	↑ 14%	689	-2%	99%	↑ 20%	0	40%	15%	26%	26%	Mockingbird Valley Road	EMUMU001
Fair	↑ 37%	1218	↓ 16%	No Data	No Data	No Data	43%	11%	8%	23%	Browns Lane	EMIMI009
Good	6%	522	-4%	98%	↑ 15%	0.1	32%	14%	6%	13%	Old Cannons Lane	EMIMI002
Fair	↓ -10%	518	↑ -34%	76%	↑ 10%	1.5	25%	20%	30%	37%	Lexington Road	EMIMI010
Poor	↑ 52%	1825	↓ 101%	85%	1%	0	17%	30%	7%	40%	Trevilian Way	ESFSF001
Poor	-4%	1806	↓ 79%	69%	↓ -16%	1	26%	27%	24%	39%	Schiller Avenue Ramp	ESFSF002
Good	↑ 31%	1098	↑ -40%	No Data	No Data	No Data	43%	26%	21%	19%	Brownsboro Road	ESFSF006
Good	0%	265	-6%	93%	↑ 19%	0.6	44%	39%	49%	42%	Ash Avenue	EFFFF001
Good	6%	230	↑ -27%	99%	9%	1.8	63%	45%	46%	55%	Old Taylorsville Rd	EFFFF003
Good	1%	356	-9%	91%	-1%	1.8	65%	39%	36%	45%	Bardstown Road	EFFFF002
Good	↑ 13%	534	↑ -27%	85%	↑ 15%	0	19%	21%	27%	20%	Ruckriegel Parkway	EFFCR002
Good	↑ 21%	348	↑ -26%	97%	3%	2.5	92%	49%	66%	24%	Gellhaus Lane	EFFCR001
Good	↑ 11%	342	↑ -40%	97%	2%	0.1	91%	36%	5%	18%	Thixton Lane	ECCCC001
Fair	↑ 20%	434	-3%	81%	9%	0	75%	39%	80%	29%	Mt. Washington Road	EPRPR001
Good	1%	218	↑ -36%	96%	2%	1.2	11%	17%	4%	20%	State Road 1442	ECBCB001
Fair	↑ 31%	541	1%	100%	↑ 11%	0	37%	17%	31%	25%	Fern Creek	EPCFC001
Poor	-4%	150	↑ -15%	69%	↓ -13%	20.7	9%	12%	10%	11%	Northern Ditch	EPCND001
Poor	↓ -34%	485	-3%	95%	↑ 15%	7.4	2%	30%	24%	93%	Manslick Road	EPCPC001
Poor	↓ -25%	187	↑ -26%	97%	↑ 26%	0.5	2%	16%	11%	32%	Pendleton Road	EPCPC002
Fair	5%	160	↑ -123%	80%	↑ 30%	0	3%	8%	1%	12%	Brier Creek	EPCBC001
Poor	1%	397	↓ 39%	No Data	No Data	No Data	3%	30%	27%	52%	Mill Creek Cutoff	EMCMX001
Poor	↓ -18%	160	9.7%	88%	↑ 32%	0	4%	25%	27%	39%	Orell Road	EMCMC001

IMPORTANT TERMS

Aquatic Insects: Aquatic insects, also known as benthic macroinvertebrates, are small animals (bugs) that can be seen with the naked eye, live on the bottom of streams and lakes, and don't have a backbone. They are often the immature aquatic forms of insects that live on land as adults, and they are an important food source for fish and other aquatic organisms.

Benthic Algae: The small green plant-like organisms that live on the rocks and other materials on the bottoms of streams are called benthic algae. Benthic algae have limited mobility, growing in areas suitable for their survival for weeks to months. They are particularly responsive to stream nutrient concentrations, sunlight, and the effects of sedimentation. Many algae types (especially diatoms, green algae, and blue-green algae) are an important food source for many fish and aquatic insects.

Biological Indices: Various methods used in this report to assess water quality by applying measures (metrics) of biological communities to derive a narrative rating of good, fair or poor condition of the aquatic communities in a stream. A number of metrics are used, including the total number and diversity of species, tolerance to pollution, and other assessments. This report used data on the fish, aquatic insect, algae, and stream habitat communities to rate each stream.

Dissolved oxygen: Dissolved oxygen is the oxygen that is freely available in water, and that is vital to fish and other aquatic life and for the prevention of odors. Dissolved oxygen levels are considered an important indicator of a water body's ability to support desirable aquatic life. Dissolved oxygen levels fluctuate seasonally and over a 24- hour period. They also vary with water temperature and altitude (elevation). Water at the same temperature holds less oxygen at higher altitudes and cold water holds more oxygen than warm water.

Erosion: Erosion is when soil, silt, sand, rock and other particles are removed from unprotected land surfaces or stream banks usually by flowing water (runoff and stream flow) and are deposited downstream as sediment (mud, silt, sand, and gravel). Sediment becomes problematic when it covers rocks and other stream habitat needed by fish and other aquatic life.

Floodplain: A floodplain, or flood plain, is the flat or nearly flat land adjacent to a stream or river that experiences occasional or periodic flooding. It includes the floodway, which consists of the stream channel and adjacent areas that carry flood flows, and the flood fringe, which are areas covered by the flood, but which do not experience a strong current.

Geomeans: the geometric mean (geomean) is a way of averaging a set of numbers by using the product of their values, as opposed to the arithmetic mean, which uses their sum. The geometric mean is defined as the nth root of the product of n numbers. It is used in this report to compute a value of multiple samples of bacteria for comparison with a standard value or criteria.

Impervious Surface: An impervious surface is any surface that is covered by materials that block the infiltration of water into the ground or soil. Impervious surfaces include roads, sidewalks, driveways, parking lots, and rooftops. Compacted soils (including some lawns) can also behave like impervious surfaces.

Indicator Bacteria: Bacteria and viruses that live in the water and on the bottom of streams are both natural and beneficial conditions in healthy streams. Bacteria and viruses in wastewater inflows and runoff from urban surfaces can lead to less healthy conditions, especially if they contain untreated animal or human waste. There are two types of bacteria that are used to indicate whether streams are clean or polluted, getting better or worse. Fecal coliform bacteria are one type more generally indicative of the presence of some kind of fecal material. The other type, *E. coli* bacteria, is more indicative of the presence of fecal material from the gut of warm blooded animals, including humans. Both types have established criteria mainly related to body contact recreation by humans.

Nutrients: The primary nutrients in streams are nitrogen and phosphorus compounds carried in runoff and other inflows. They are important for the growth and health of aquatic organisms. In excess, however, they can lead to nuisance growths of algae and low dissolved oxygen. Nitrate nitrogen is largely in a dissolved form, derived from fertilizers and wastewaters. The other compounds are both in dissolved and particulate forms. Total Kjeldahl is a measure of both ammonia and organic nitrogen carried with sediment runoff and wastewater inflows. Total phosphorus is particularly important for algal growth and also is delivered to the stream with sediment runoff and wastewater inflows.

Riffle: A riffle is a short, steeper, relatively shallow and coarse-bedded length of stream over which the stream flows at a faster velocity and higher turbulence than in a pooled reach of a stream. Riffles are usually caused by an increase in a stream bed's slope or an obstruction (rocks, logs, etc.) in the flow. Riffles typically increase dissolved oxygen and provide high quality aquatic habitat.

Riparian zone or area: A riparian zone is the area of land at and near the stream interface. Riparian zones, when well vegetated, have a significant role in stream bank stabilization, soil conservation, filtration of chemicals and sediment in runoff, and in providing shade and food (organic material).

Runoff: Runoff is the portion of rain, snow melt, or irrigation water that arrives in streams, rivers, lakes, ponds, drains or sewers.

Stream Flow: Stream flow is the volume of water flowing past a point in a fixed unit of time. Stream flow is often expressed in cubic feet per second (ft³/ sec).

Stream habitat: Stream habitat is the underwater environment that is used as a living space by fish, aquatic insects, other plants and animals. Vegetation near the channel also is important for quality habitat. Streams that have a variety of habitats, with shallow and deep areas, fast and slow water, and places with rocks, gravel, woody debris, tree covered banks, and shade are characteristics of good habitats.



Beargrass Creek at the Ohio River.

Total Suspended Solids: Total suspended solids in streams are indicative of the amount of sediment washing off watershed surfaces and from erosion of stream banks. Sediment carried in higher flows, when deposited downstream, can reduce the quality of aquatic habitat and negatively affect aquatic communities.

Trace Metals: Various metals carried in trace amounts in runoff and other inflows. They are both in dissolved and particulate forms and in higher concentrations can affect the health of aquatic organisms. Criteria exist for the more important metals.

Watershed: The area of land where all the water drains to a particular stream or location along a stream. The boundary of a watershed is formed by the highest elevations surrounding the stream. A rain drop of water falling outside the watershed boundary will drain to another watershed. Small watersheds join together to form larger watersheds. A major river, such as the Ohio River, will encompass many smaller watersheds.



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