North Fork: Whitesburg Tributaries Watershed Plan, Letcher County, KY

Kentucky Water Resources Research Institute

Kentucky Energy & Environment Cabinet

Headwaters
Big Sandy - Upper Cumberland - North Fork of the Kentucky River

Title: North Fork: Whitesburg Tributaries Watershed Plan, Letcher County, KY

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- Michaela Lambert and Alyson Gallagher, Kentucky Division of Water – review and editing.
- Emily Madden, Headwaters, Inc. - review and editing.
- Dr. Alice Jones, Eastern Kentucky University – severe erosion assessment.
- Mac Jones, Colton Pugh, and Cole Crankshaw, student interns at Kentucky Water Resources Research Institute – data processing for chapters 3 and 4.

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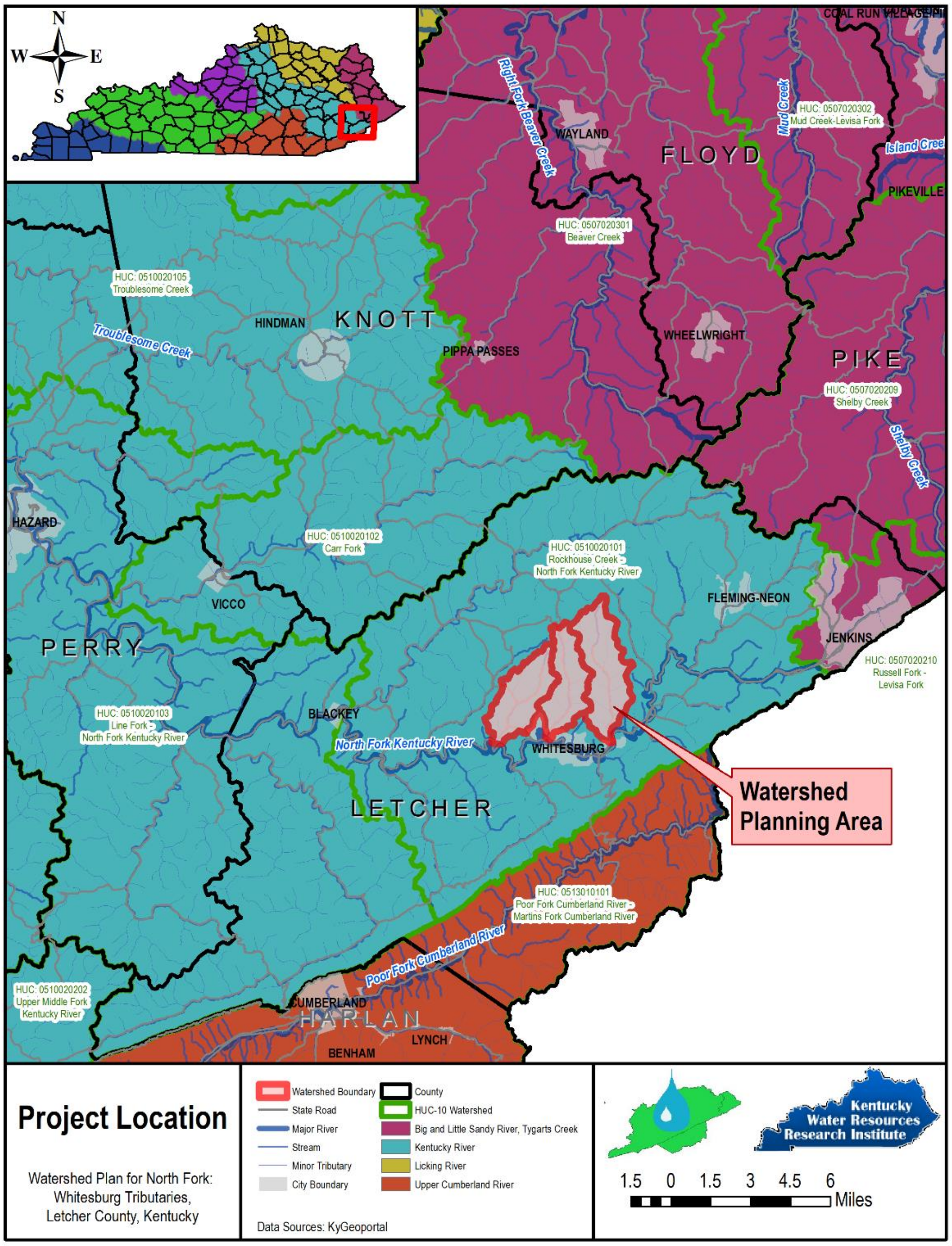
I. Introduction

A. The Watershed

Crafts Colly, Sandlick, and Dry Fork are tributaries to the North Fork of the Kentucky River. The three tributaries are located immediately north of the North Fork of the Kentucky and flow southward into the river within or near the City of Whitesburg in Letcher County, Kentucky as shown in Figure 1.1. Letcher County is found in the Appalachian coalfields of southeastern Kentucky.

FIGURE 1.1 – WATERSHED LOCATION



To improve water quality in the Kentucky River, water quality impairments in the upper reaches of the watershed must be addressed. In focusing efforts in Crafts Colly, Sandlick, and Dry Fork, three headwater tributaries of the North Fork Kentucky River, pollution loading may be reduced downstream. Aside from improving the overall water quality of the North Fork of the Kentucky drainage basin, the watershed of focus offers an ideal project area in terms of scope and feasibility. The watershed is a manageable size and is close to the City of Whitesburg.

Crafts Colly, Sandlick, and Dry Fork are distinct communities located close to one another with housing and rural development oriented along each stream. Other factors contributing to the selection of the watershed include suspected water quality impairments, population of the sub-watersheds, historical data, and local support for water quality improvement efforts. Planning efforts are being sought for this watershed based on community buy-in and the desire for improve water quality for environmental well-being, recreation, and economic development.

Local water quality concerns include flooding, eroding stream banks causing land loss and crumbling roadways, high bacteria stemming largely from straight pipes and failing septic systems, and acid mine drainage contributing to stream impairments. With most development, including roadways and housing, existing in the flats lands very near to streams, there is a lack of adequate riparian buffer zones throughout Crafts Colly, Sandlick, and Dry Fork. Community members also raise questions and concerns related to unknown watershed impacts of oil and gas production.

Water sampling conducted by Kentucky River Watershed Watch volunteers has been carried out throughout Crafts Colly, Sandlick, and Dry Fork for many years. The results of the sampling consistently show high *E.coli* levels (>1,000 CFU/100ml), high metals (aluminum, beryllium, iron, lead, nickel, zinc), high sulfates (>250 mg/l), high conductivity readings (>500 µs/cm) and low pH levels (<6).

Crafts Colly, Sandlick, and Dry Fork flow into a stretch of the North Fork of the Kentucky River that is listed on the 303(d) List as non-supporting primary contact recreation and aquatic life (KDOW, 2016). The primary contact listing is based on *E. coli* levels and is due to sanitary sewer discharges, straight pipes, and residential onsite sewage treatment systems in need of repair or maintenance. The aquatic life listing is due to bank erosion, sedimentation and high conductivity levels. Suspected sedimentation sources include farming activities, logging, abandoned mine lands and stormwater runoff.

Moving forward with watershed planning, close attention should be paid to the local names and spelling of rivers, streams, and points of interest. Local spelling often differs from official or documented titles. This is true of the streams that are the focus of this watershed plan; “Crafts Colly” is sometimes spelled “Crafts Colley”, “Sandlick” is also spelled “Sand Lick”, and “Dry Fork” is colloquially known as “Little Dry Fork”.

B. Partners and Stakeholders

In collaboration with various partners, Headwaters is leading local watershed planning efforts. Headwaters is a non-profit community watershed organization that formed in 2005 to promote water resource management and water quality improvement in Letcher County, Kentucky. Headwaters is led by an operating board of professionals from communities throughout the county. Together the board and staff promote partnerships among volunteers of the Kentucky River Watershed Watch, local high school students, community members and leaders, nonprofits, local organizations, and government officials of Letcher County. Headwaters leads efforts and facilitates collaborations that reflect the mission of improving watersheds of Letcher County thorough community education, access to accurate and timely water quality information, and encouragement of stewardship of local waterways.

Project partners involved in watershed plan development include:

City of Whitesburg
38 E. Main St., Whitesburg, KY 41858
James W. Craft, Mayor
(606) 633-3700
mayor@cityofwhitesburg.com
Role/Contribution: Promotion and support of the watershed plan and its development as an initiative that will benefit the local community. The partnership will extend to collaboration on events and assistance with information gathering.

Whitesburg Water & Sewer
240 CS-118, Whitesburg, KY 41858
Chris Caudill, Director
(606) 633-3710
chroscaudill@gmail.com
Role/Contribution: Staff time is authorized to go towards watershed advisory meetings, assistance with information gathering, and involvement in community engagement activity surrounding watershed improvement efforts.

Sierra Club, Cumberland Chapter
PO Box 1368, Lexington, KY 40588
Tom Sexton, Eastern Kentucky Organizer
(606) 548-1113
tom.sexton@kentucky.sierraclub.org
Role/Contribution: Assistance in writing the watershed plan as it pertains to community information and planning for community engagement efforts. This partnership will also include collaboration in planning community meetings and community engagement efforts.

Appalachian Citizens' Law Center
317 Main St., Whitesburg, KY 41858
Stephen A. Sanders, Director
(606) 633-3929
aclc@appalachianlawcenter.org
Role/Contribution: Legal assistance to ensure that the project is carried out in accordance with state and federal law and that necessary contracts are effective, and property ownership issues are understood.

Letcher County Public Schools
224 Parks St., Whitesburg, KY 41858
Jennifer Honeycutt, Youth Service Center Coordinator
(606) 331-1103
jennifer.honeycutt@letcher.kyschools.us
Role/Contribution: Facilitation of watershed education programming and volunteer opportunities among high school students.

Eastern Kentucky University Environmental Research Institute
521 Lancaster Ave., Richmond, KY 40475
Dr. Alice Jones, Professor
(859) 622-6914
alice.jones@eku.edu
Role/Contribution: Assistance with quality control, technical needs, and volunteer support and management.

Kentucky Water Resources Research Institute (KWRRI)
504 Rose Street, 233 Mining and Mineral Resources Building, University of Kentucky
Lexington, KY 40506
Steve Evans, Associate Director
(859) 257-1299
steve.evans@uky.edu
Role/Contribution: Advisory role and technical assistance in watershed plan development and project management.

Kentucky River Watershed Watch (KRWW)
PO Box 1248, Frankfort, KY 40602
Malissa McAlister, Kentucky River Basin Coordinator
(859) 324-0845
mmcalister@uky.edu
Role/Contribution: Advisory role in project management and assistance with use of historical data.

Letcher County Conservation District
125 Industrial Park Rd, Whitesburg, KY 41858
Ron Brunty, Chairman
(606) 633-4448
letcherconservation@tvscable.com
Role/Contribution: Advisory role and technical support with project activities and community engagement.

The following community and regional organizations are potential project partners and organizations that may offer information, resources, or assistance related to watershed improvement efforts. Partnerships and collaboration with organizations such as these will serve to expand project activities and improve community engagement efforts. In building relationships and collaborating with these organizations, project efforts can be expanded and awareness of and participation in project activities among community members can be increased and made more meaningful.

Appalshop
91 Madison Ave., Whitesburg, KY 41858
Marley Green, Community Development Worker
marley@appalshop.org
(276) 639-6169

Cowan Community Center

81 Sturgill Branch, Whitesburg, KY 41858
Nell Fields, Board President
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(606) 633-3187

Letcher County Health Department
115 East Main St., Whitesburg, KY 41858
Keven Nichols, Environmentalist
kevenh.nichols@ky.gov
(606) 633-2945

Whitesburg/Letcher County Farmers Market
198 Main St., Whitesburg, KY 41858
Valerie Ison-Horn
valerieisonhorn@gmail.com
(606) 634-9468

Letcher County Tourism
30 Childers Rd., Suite A, Whitesburg, KY 41858
Jessica Howard
letchertourism@gmail.com
(606) 634-8110

Kentucky Waterways Alliance
120 Webster St., 217 Louisville, KY 40206
Ward Wilson, Executive Director
ward@kwalliance.org
(502) 589-8008

Community Farm Alliance/University of Kentucky AppalTree Project
238 Main St., Whitesburg, KY 41858
Debi Sexton, Appal-TREE Field Director
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(859) 756-6378

CANE Community Agricultural and Nutritional Enterprises
38 College Hill, Whitesburg, KY 41858
Valerie Ison Horn, Community Leader
Valerieisonhorn@gmail.com
(606) 634-9468

C. USEPA's Nine Elements

This plan presents the collaborative culmination of an extensive data collection and analysis effort, recruitment of partners and stakeholders in watershed interests, and BMP implementation strategy development. This document is intended to address the nine minimum elements required in the USEPA's *Handbook for Developing Watershed Plans to Restore and Protect Our Waters* (USEPA 2008). These nine elements are as follows:

1. An **identification of the causes and sources** or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed based plan), as discussed in item (2) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (*e.g.*, X numbers of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded stream bank needing remediation).
2. An **estimate of the load reductions expected for the management measures** described under paragraph (3) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (1) above (*e.g.,* the total load reduction expected for dairy cattle feedlots; row crops; or eroded stream banks).
3. A **description of the nonpoint source management measures that will need to be implemented** to achieve the load reductions estimated under paragraph (2) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.
4. An **estimate of the amounts of technical and financial assistance needed**, associated costs, and/or the sources and authorities that will be relied upon to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, US Department of Agriculture's (USDA) EQIP and Conservation Reserve Program, and other relevant federal, state, local, and private funds that may be available to assist in implementing this plan.
5. An **information/education component** that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.
6. A **schedule for implementing the nonpoint source management measures** identified in this plan that is reasonably expeditious.
7. A **description of interim, measurable milestones** for determining whether nonpoint source management measures or other control actions are being implemented.
8. A **set of criteria that can be used to determine whether loading reductions are being achieved over time** and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a nonpoint source TMDL has been established, whether the nonpoint source TMDL needs to be revised.
9. A **monitoring component to evaluate the effectiveness of the implementation efforts over time**, measured against the criteria established under item (8) immediately above.

The goal of this watershed plan is to express community water quality concerns, raise awareness of these concerns, evaluate current water quality conditions, develop a BMP implementation strategy, and outline action steps to protect the watershed. This watershed plan will create greater opportunity for community members to become involved in watershed-improvement efforts and solutions and, ultimately, improve water quality in Crafts Colly, Sandlick, Dry Fork, and the North Fork of the Kentucky River in Whitesburg.

References

Kentucky Division of Water. 2008. *Kentucky 2008 Integrated Report to Congress*. Retrieved from http://www.water.ky.gov/sw/swmonitor/305b/default.htm.

II. WATERSHED INFORMATION

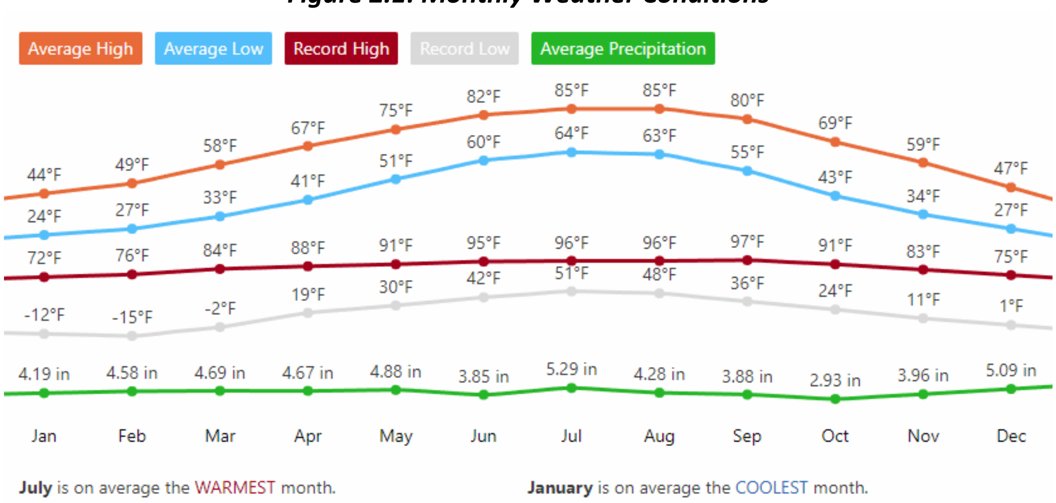
A. Watershed Location

Crafts Colly, Sand Lick, and Dry Fork are tributaries to the North Fork of the Kentucky River (NFKR). Each tributary flows southward into the NFKR within or near the City of Whitesburg, in Letcher County, which is found in the coalfields of southeastern Kentucky. Crafts Colly, Hydrologic Unit Code (HUC) number 051002010103, has a drainage area of 7.6 square miles. Sandlick Creek, HUC 051002010103, has a drainage area of 4.9 square miles and Dry Fork, HUC 051002010104, is a 5.3 square mile drainage basin. Together, the three watersheds encompass a drainage area of 17.8 square miles. The location of the watersheds is shown in Figure 1.1.

B. Climate

On average, in Whitesburg, Kentucky, July is the warmest month of the year and January is the coolest month. The average high is 85 degrees Fahrenheit in July and the average low is 24 degrees Fahrenheit in January. The highest average precipitation occurs in July with 5.29 inches of rainfall (weather.com). A summary of the average monthly weather conditions is shown in Figure 2.1.

Figure 2.1: Monthly Weather Conditions



SOURCE: www.weather.com

C. Hydrology and Geomorphology

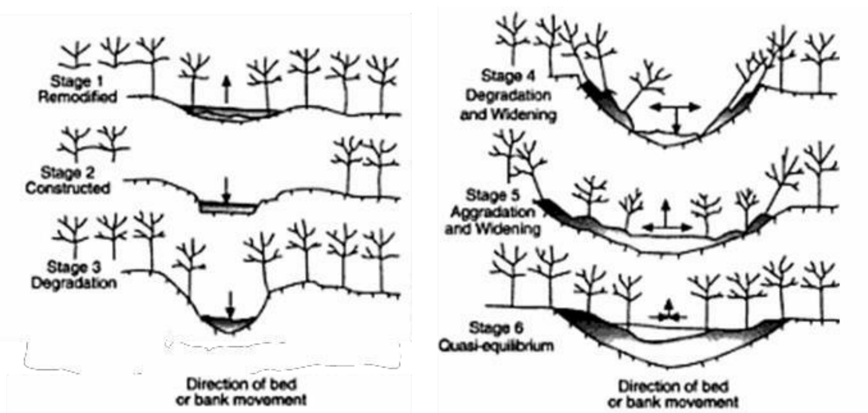
Crafts Colly Creek, Sandlick Creek, and Dry Fork are three tributaries to the North Fork of the Kentucky River. A total of about of about 30 miles of stream are in these three watersheds, including about 13 miles in Crafts Colly Creek, 9 miles in Sandlick Creek, and 8 miles in Dry Fork. The watershed of Crafts Colly includes the following named streams: Combs Branch, Thicket Branch, Copperhead, Allen Branch, Franklin Branch, Licking Rock Branch, Company Branch, and Magnolia. The Sandlick Creek watershed includes the following named streams: Thompson Branch, Persimmon Branch, Long Branch, Fairchild Branch, Hurricane Branch, and Tan Yard. Dry Fork watershed includes Raymonds Branch, Little Dry Fork, and Loggy Hollow.

According to the USGS StreamStats estimates for these watersheds, Crafts Colly Creek has a mean annual flow of 9.92 cubic feet per second (cfs) with a 7-day, 10-year low flow of 0.05 cfs and a 100-year peak flood flow of 2070 cfs. Sandlick Creek and Dry Fork are similar with mean annual flows near 7 cfs, 7-day, 10-year low flows of 0.04 cfs, and a 100-year peak flood flows of around 1650 cfs. Due to the mountainous terrain, there is rapid surface runoff, so streams are primarily ephemeral in nature. The main tributaries are supplied by shallow groundwater flow. Mine drainage also contributes to stream flows in the area.

These tributaries to the North Fork Kentucky River are found in the Eastern Kentucky Coalfield physiographic region of Kentucky. Although Parola et al (2005) assessed the geomorphic characteristics of streams in the Upper Cumberland River Basin instead of the Kentucky River basin, the assessments are applicable to Crafts Colly, Sandlick, and Dry Fork because they apply to the same physiographic region. The streams were characterized as meandering, entrenched, and highly incised in alluvial valleys and as high gradient, less entrenched channels found in valleys where the platform is confined by the valley sides. Channel incision and stream widening have occurred because of human activity (i.e. mining, logging, ATV riding in streams) in the watersheds. They found that mining, logging and removal of timber, and agriculture have directly impacted streams throughout the region. Homes built in the floodplains, mined lands, and the industrial development along the North Fork tributaries cause channel instability and greatly hamper ecological functions of the stream system.

Figure 2.2 shows an example model of this process. When stream channels become channelized (Stage 2) they change over time to re-stabilize through a process that involves incision (Stage 3), mass erosion and bank failures (Stage 4), and widening and sedimentation (Stage 5) before reaching a new equilibrium (Stage 6). Most streams in the North Fork Whitesburg tributaries are in Stage 4.

Figure 2.2: Channel Evolution Model



(Image from Simon and Hupp, 1986)

D. Groundwater-Surface Water Interaction

Due to the mountainous terrain, there is rapid surface runoff and moderate groundwater drainage. Shallow groundwater flow is available through fractures in the underlying sandstone, siltstone, shale, coal and limestone. While this groundwater flow is low, it does support the use of wells and springs for individual home use. According to Carey and Stickney (2005), the watershed is geologically located in the Breathitt Group, which "yields more than 500 gal/day of groundwater to more than three-quarters of the wells drilled in valley bottoms…. and hillsides and more than 100 gal/day to nearly all wells on ridges…. Waters are highly variable in chemical character in wells in this region."

Ray et al. (1994), identify the area as moderately sensitive to pollution as based on the KDOW hydrologic sensitivity index. The number rating is three, with one being the lowest and five being the highest. This classification is based on groundwater recharge, flow, and dispersion rates.

According to *Karst Occurrence in Kentucky* by Paylor and Currens (2001), the watershed area is "underlain by bedrock with limited or no potential for karst development."

E. Flooding

Floodplains are lands adjacent to streams that flood during intense wet weather events. The ability of a stream to access the floodplain is a critical component of a stream's health. When streams have access to natural floodplains, the number and severity of floods is reduced, nonpoint source pollutants are reduced, water slows down, sediments settle out over the large floodplain area, and groundwater can be recharged. A stream that cannot access its floodplain (*e.g.,* by channelization, channel incision, or construction of a flood wall) will carry more energy, causing bank erosion and channel down-cutting. It will also carry a higher pollutant load downstream during storm events and may have reduced base flow.

To identify a community's flood risk, the Federal Emergency Management Agency (FEMA) conducts a Flood Insurance Study. The study includes statistical data for river flow, storm tides, hydrologic / hydraulic analyses, and rainfall and topographic surveys. FEMA uses this data to create Flood Insurance Rate Maps (FIRMS) that indicate the risk in a specific area. These digital flood hazard maps provide an official depiction of flood hazards for each community and for properties located within it. Figure 2.3 (page 2.4) shows the 100-year and 500-year flood zones for the three tributaries located near the confluence with NFKR. The 100-year flood is a flood event that has a 1% probability to occur in a given year and is defined as the Special Flood Hazard Area (SFHA). More details can be found at the Kentucky Flood Risk Portal via the interactive map.

The FEMA Hazard Mitigation Grant Program (HMGP) provides grants to states, and states provide sub-grants to eligible applicants, to implement long-term hazard mitigation measures after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. Project funding is available for acquisition and demolition of substantially damaged buildings located in the Special Flood Hazard Area through this program for eligible applicants.

Due to the steep terrain of the mountainous area and the incised valleys, the floodplain is restricted to the valley bottoms. The valley bottoms are often the only flat lands, creating a situation where housing, roads, agricultural operations, and any human development is in the immediate floodplain of waterways. Due to this pattern of development along waterways, the ecological functions of waterways are compromised. The mountainous terrain also heightens the risk of flash flooding during heavy and intense precipitation events. This creates conditions that lead to destruction of infrastructure such as road deterioration.

F. Geology

Sandlick, Crafts Colly, and Dry Fork are in the Mayking and Whitesburg 7.5-minute geologic quadrangles. As shown in Figure 2.4 (page 2.5), there are four major formations in the watershed area: alluvium near the streams and floodplains, Pikeville formation and Hyden formation along the hillslopes, and Four Corners formation along some ridgetops.

According to Rice (1976), the Pikeville and Hyden formations are part of the lower Breathitt Group, which is comprised of sandstone, siltstone, shale and coal, including the Fire Clay, Fire Clay rider, Upper Elkhorn #3,and Whitesburg coal beds as well as the Kendrick Shale of Jillson. The Four Corners formation is part of the middle Breathitt Group, which is comprised of sandstone, siltstone, and coal. The alluvium consists of silt, sand, clay, and sandy gravel.

Figure 2.3: Floodplain

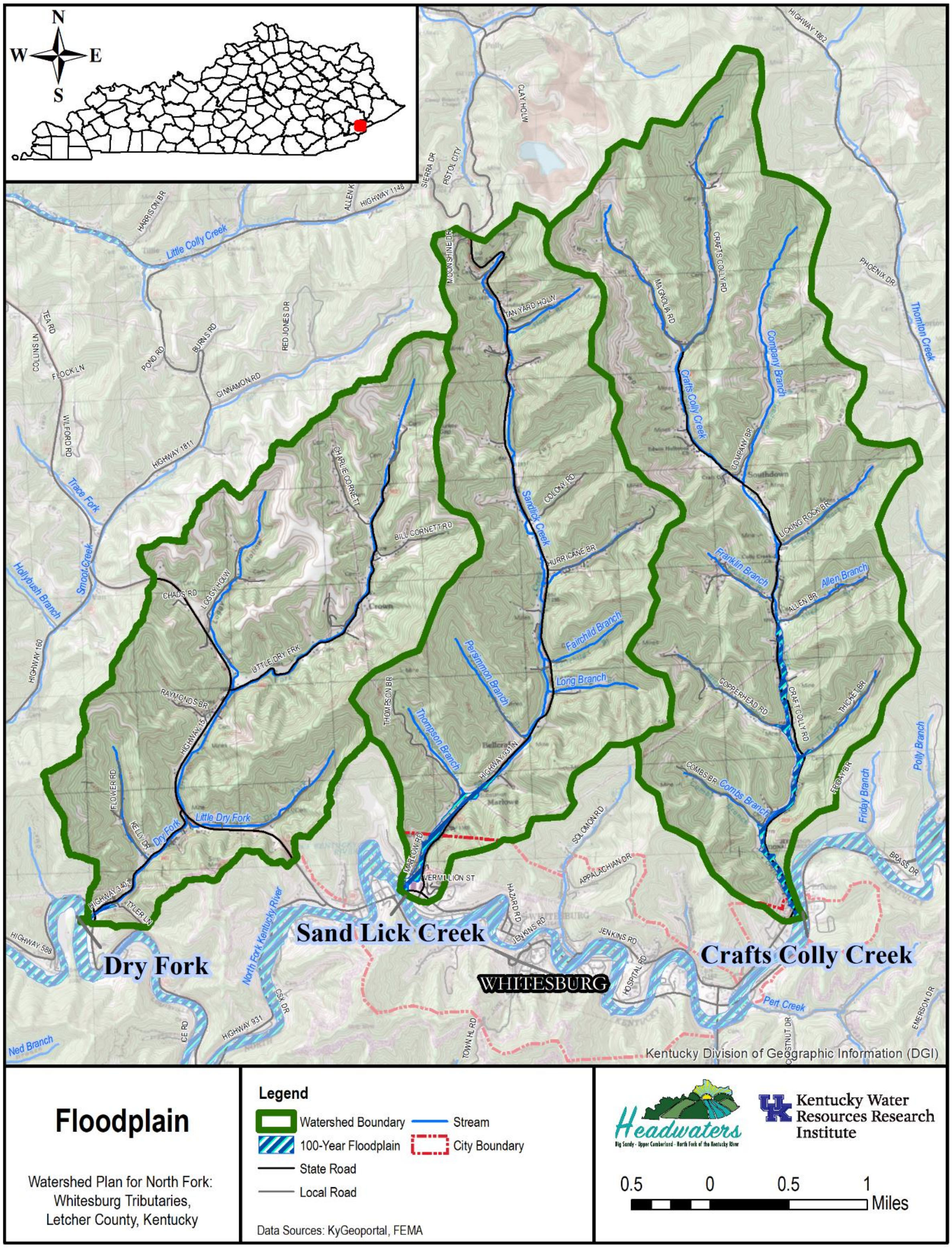
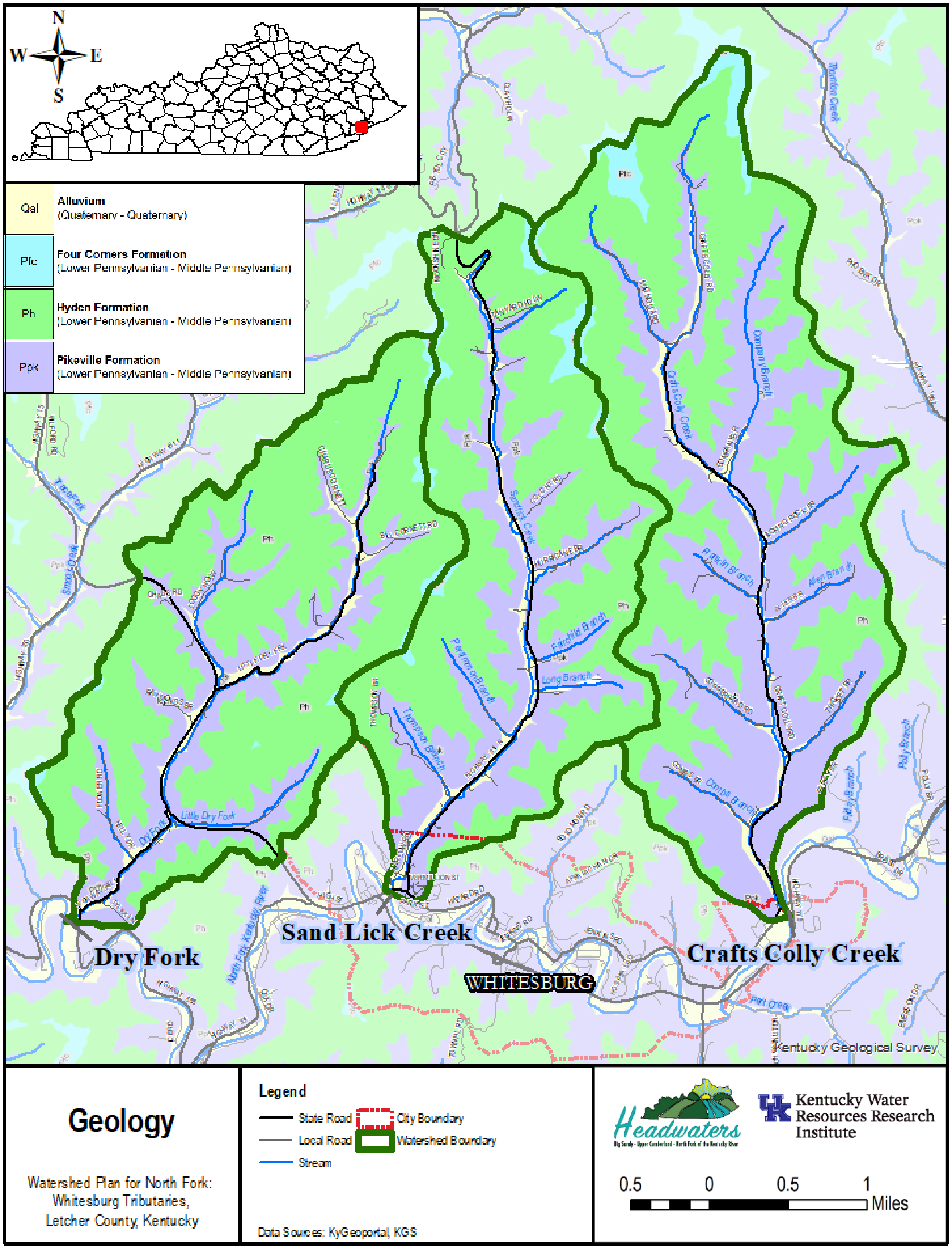


Figure 2.4: Geology



Ten coal beds in the area have been commercially mined with the lowermost Upper Elkhorn #3, Fire Clay, and upper bed of Whitesburg being the most productive. Strip mines, contour strips, augur mines, and underground mines have all been utilized in the area (Rice 1976).

Acid mine drainage (AMD) is the outflow of acidic water from mines. Due to exposure to pyrite, an iron sulfide, high concentrations of iron and sulfuric acid are generated in addition to other heavy metals such as copper, lead, and mercury. The iron will typically come out of solution as an orange sediment, which is apparent along reaches of Sandlick Creek and Dry Fork. AMD can also lower the pH of the waters, but not all mine drainage is acidic. Mine drainage may be neutral or even basic but still contain high concentrations of metals. Sometimes, AMD refers to mine drainage irrespective of the acidity. The implications of mine drainage include contamination of drinking water and disruption in the growth and reproduction of aquatic species. Along with the environmental health implications of mine drainage, outdoor recreation and tourism are also hampered as fish species decline, groundwater supplies are at increased risk of contamination, and waterways are made aesthetically unappealing.

Mine drainage into Sandlick Creek downstream of the Fire Department.

G. Ecoregion and Topography

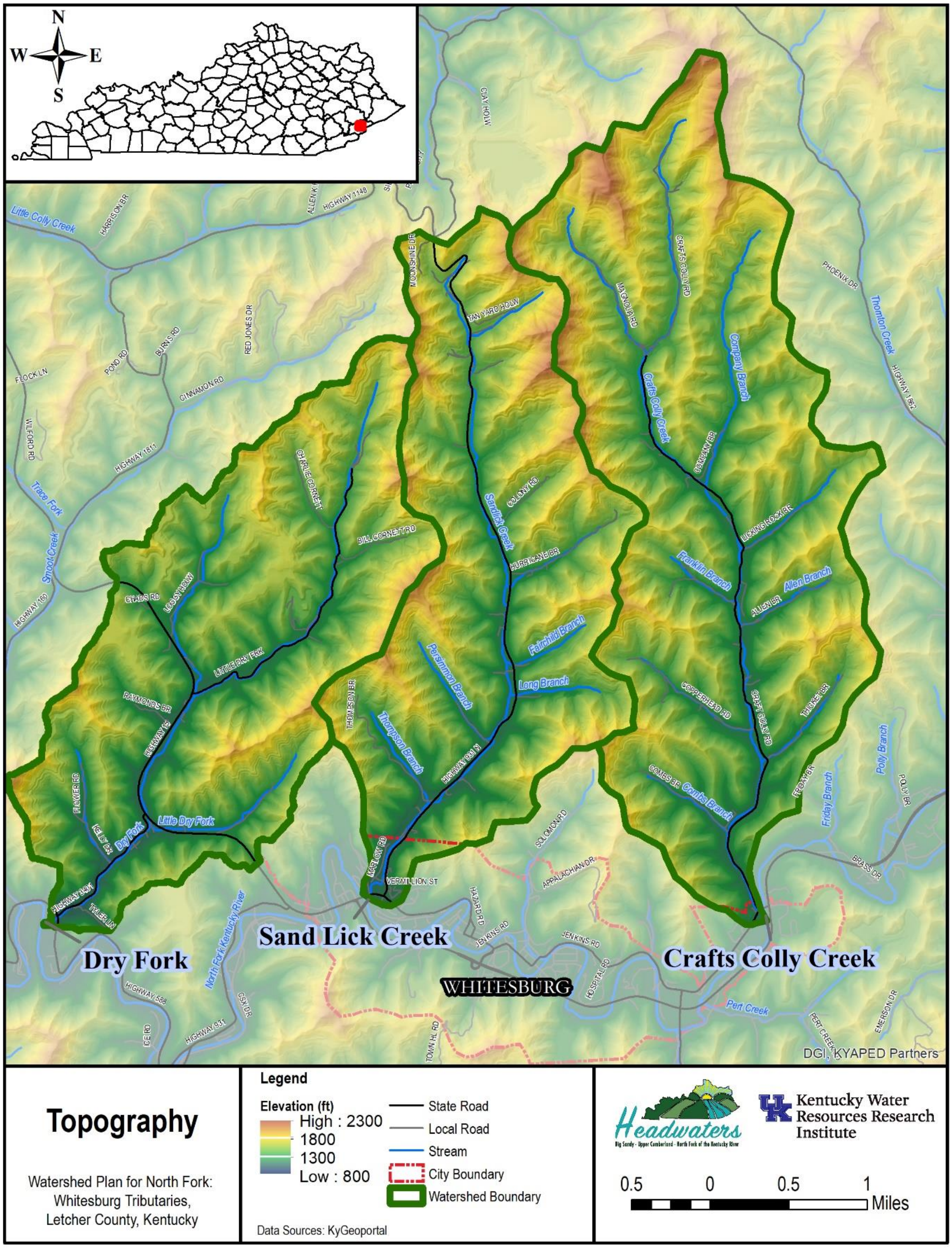
The Whitesburg Tributaries to the NFKR are in the Dissected Appalachian Plateau, level 4 ecoregion. This region is described as "unglaciated, highly dissected, hilly and mountainous plateau with steep ridges, very narrow ridge tops, narrow valleys, and deep coves. Cool, high gradient streams with cobble or boulder substrates and extensive riffle sections are common" (Woods et al. 2002). Soils in this ecoregion are well-drained, acidic, and low in fertility. The vegetation is described as mixed mesophytic forest dominated by mixed oaks, beech, yellow-poplar, and sugar maple with diverse understories locally dominated by mountain laurel or rhododendron (Woods et al. 2002).

In the Eastern Kentucky Coal Field there are wooded mountain crests, narrow valley bottoms and steep hills. This mountainous topography has some of the highest elevations in the state (Carey et al. 2008). The only Kentucky county with higher elevation is Harlan, on the southwestern border of Letcher County.

Crafts Colly, Sandlick, and Dry Fork are near Pine Mountain, a 125-mile ridgeline that extends from Jellico, Tennessee to Elkhorn City, Kentucky. Pine Mountain is a result of the Pine Mountain Thrust Fault and has an elevation of 3,200 feet (KGS 2012). Along the crest of Pine Mountain, the elevations range from 2,900 feet on the west to about 2,600 feet on the east. The highest elevation on Pine Mountain is 3,273 feet. This peak is found five miles east of Whitesburg. The topography of the area is shown in Figure 2.5 (page 2.7).

The highest elevation in Letcher County is 3,720 feet, in the southeastern corner. The lowest elevation is 940 feet, where the North Fork of the Kentucky River flows from Letcher County into Perry County (McGrain 1978). According to the 5-foot Kentucky Digital Elevation Model of Kentucky, the highest elevation in the watershed is 2,243 feet between Sandlick Creek and Crafts Colly Creek. The lowest elevation is 1,079 feet on Dry Fork.

Figure 2.5: Topography



H. Soils

Most soils in Letcher County formed from colluvium, residuum, or alluvium derived from sandstone, siltstone, or shale of the Pennsylvanian system. Level-bedded dominantly acid bedrock of the Pennsylvanian-aged lower and middle members of the Breathitt Formation underlie most soils in the County. Deeply weathered soils are uncommon and occur on isolated high terraces (Carey et al. 2008).

Based on the "Soil Survey of Knott and Letcher Counties, Kentucky" (USDA 2004), there are 32 major soil types in the Letcher County area. The soils range in texture, natural drainage, and other characteristics. The steep mountains are made up of mostly moderately deep, deep, and very deep soils that contain varying amounts of rock fragment. Soils in the floodplains and terraces are mostly loamy. In the upper reaches, the soils are largely gravelly.

According to the NRCS SSURGO Soil Database, floodplain soils have been converted to urban development space in much of Dry Fork, Sandlick Creek and Crafts Colly Creek. In these more urban sections of the floodplain, the soils are typically Udorthents - Urban Land complexes made up of unconsolidated rock and soil materials that have been used to raise the elevation. Hillslopes are primarily composed of Cloverlick-Kimper- Highsplint complex and Selocta-Highsplint-Gilpin complex soils. These are deep to very deep and well drained. The soils are formed in mixed colluvium weathered from acid shale siltstone, sandstone, and shale. Ridgetops are primarily Dekalb-Gilpin-Rayne complex soils with Matewan-Gilp-Marrobone complexes and Kaymine, Fairpoint, and Fiveblock soils in the highest elevations. All soils in the area are considered "very limited" for septic tank absorption suitability. None of the area is considered prime farmland, and most soils are considered rocky or stony soils with a high runoff rate. No hydric soils, or soils that support wetlands and remain completely saturated by water from flooding or ponding, are in the watershed area.

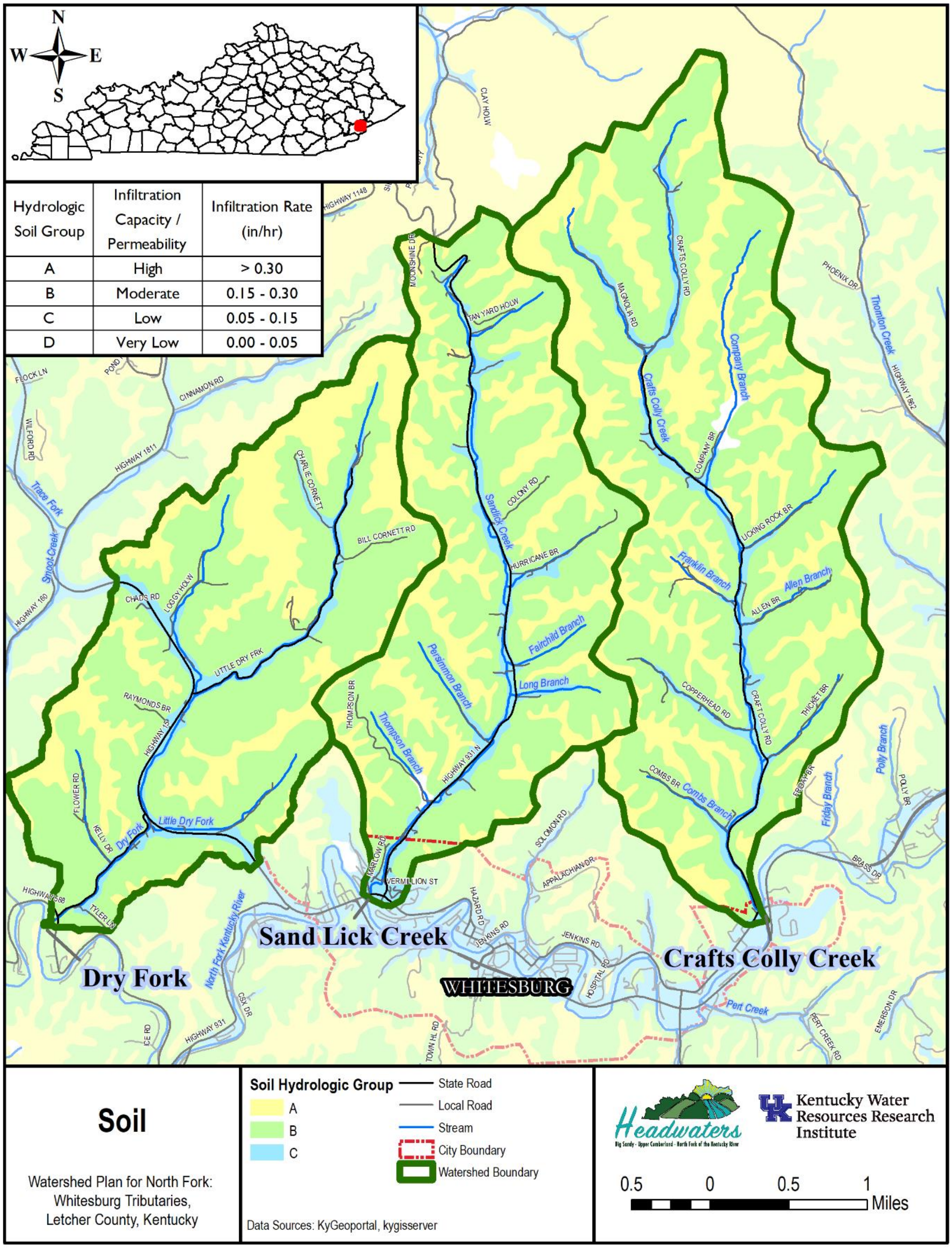
Soils are classified by the Natural Resource Conservation Service into four Hydrologic Soil Groups based on the soil's runoff potential (NRCS 1986). The locations of the soils are shown in Figure 2.6 (page 2.9). The four Hydrologic Soils Groups are A, B, C and D, with "A" having high infiltration capacity (little runoff) and "D" very low infiltration capacity (high runoff). Table 2.1 (page 2.10) shows the infiltration rates associated with each soil and the relative abundance at which these soils are present in the watershed. Most streams and floodplains are "C" group (7.6%) with low infiltration capacity, hillslopes are "B" group (61.4%) with moderate capacity, and ridgetops are "A" group (30.7%) with high capacity.

Table 2.1: Relative Abundance of Soils by Hydrologic Soil Group

Hydrologic Soil Group	Type	Infiltration Capacity / Permeability	Infiltration Rate (in/hr)	Relative Abundance (%)
A	Sand, loamy sand, or sandy loam	High	> 0.30	30.7%
B	Silt or loam	Moderate	0.15 - 0.30	61.4%
C	Sandy clam loam	Low	0.05 - 0.15	7.6%
D	Clay loam, silty clay loam, sandy clay, silty clay, or clay	Very Low	0.00 - 0.05	0.0%
Not Available	Unknown	Unknown	Unknown	0.3%

Source: Urban Hydrology for Small Watersheds TR-55 (USDA NRCS, 1986)

Figure 2.6: Soil



Hydrologic Soil Group	Infiltration Capacity / Permeability	Infiltration Rate (in/hr)
A	High	> 0.30
B	Moderate	0.15 - 0.30
C	Low	0.05 - 0.15
D	Very Low	0.00 - 0.05

I. Riparian Ecosystem

The riparian zone or riparian area is the vegetated area adjacent to the stream. This area forms a protective buffer for the stream water quality and is often called a riparian buffer zone.

Although riparian zones produce many water quality benefits, these benefits are dependent on the width of the riparian area, the size of the stream that it borders, vegetative composition, and density. The water quality functions provided by the riparian zone vary by stream size. Riparian areas on smaller, headwater streams provide the maximum nutrient removal, shading, and bank stabilization benefits (Palone et al. 1997). Fish habitat and aquatic ecosystem benefits are typically greatest for larger, main-stem streams while flood mitigation benefits of riparian buffers increase as the stream size increases. Sediment control benefits remain relatively constant for all stream sizes.

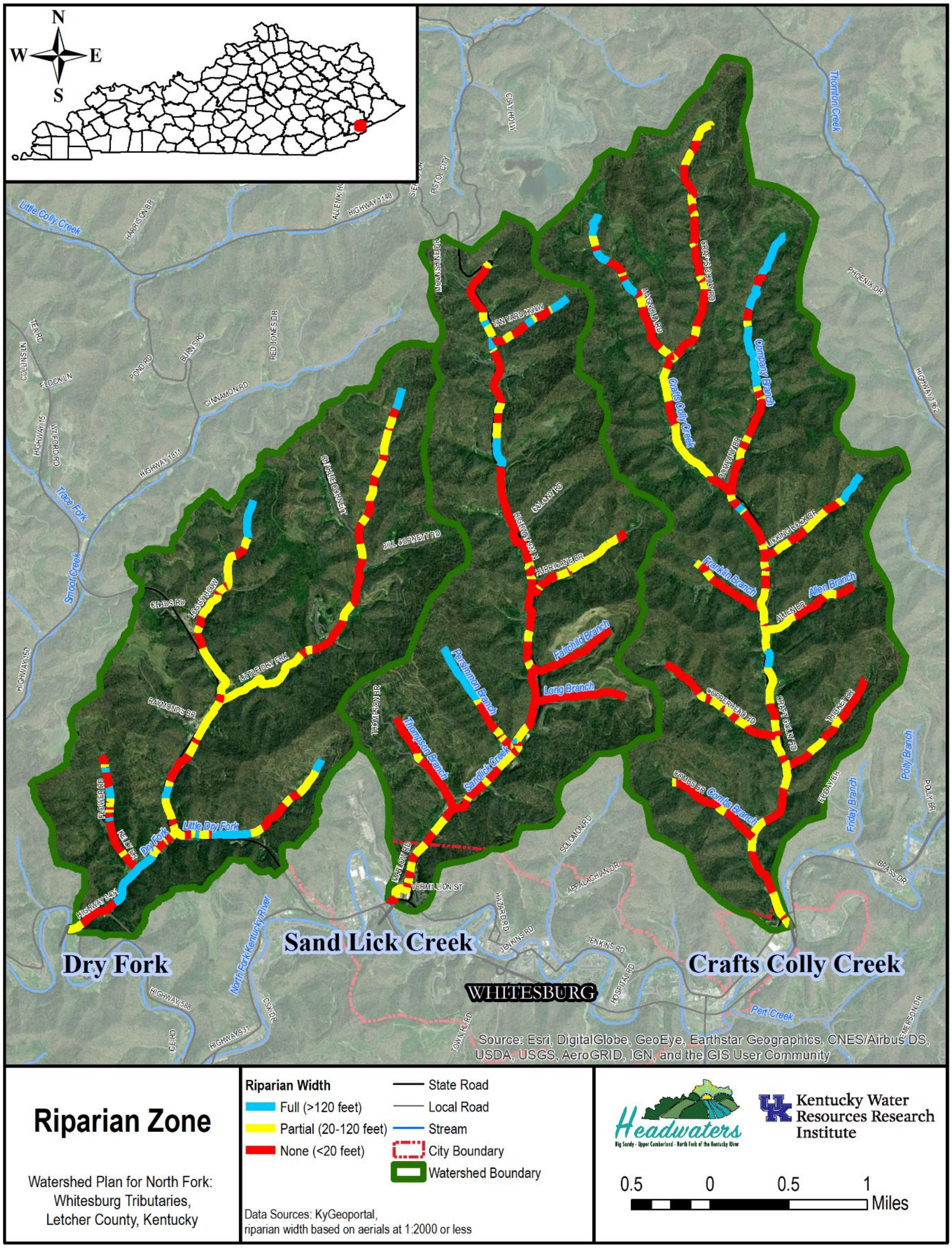
The width of the riparian zone necessary to achieve these benefits varies depending on the function. The US Army Corps of Engineers (Fischer and Fischenich 2000) recommends the following riparian buffer widths for various functions: 5 to 30 meters (16 to 100 feet) for water quality protection, 30 to over 500 meters (100 to over 1,600 feet) for riparian zone habitat, 10 to 20 meters (30 to 65 feet) for stream stabilization, 20 to 150 meters (65 to 500 feet) for flood attenuation, and 3 to 10 meters (10 to 30 feet) for detrital input.

An analysis of the actual riparian widths of the streams in the watersheds of the three tributaries to North Fork of the Kentucky, was compared against the minimum recommended buffer width for each function. Streams with riparian width of greater than 120 feet are labeled as "non-impacted," riparian widths of 20 to 120 feet are "moderately impacted", and riparian widths less than 20 feet are "heavily impacted." The riparian width and edge of water for each bank was delineated from aerial photographs. Areas with forested canopy or overgrown vegetation were included in the riparian buffer zone. Table 2.2 summarizes these results, and Figure 2.7 (page 2.11) shows the locations of riparian zones and widths.

Table 2.2: Riparian Zone Width Impact Summary

Riparian Zone Width	Length (miles)	Percent
Non-impacted (>120 ft)	3.9	13%
Moderately Impacted (20-120 ft)	10.4	35%
Heavily Impacted (<20 ft)	15.4	52%
Total	29.7	

Figure 2.7: Riparian Zone



Due to the topography and development taking place on the flatlands near the streams, full un-impacted riparian buffer zones are limited. In the three watersheds of focus and throughout the region, roads, homes, and industrial development have taken place in extremely close to streams. In many parts of the watersheds, buffer zones are nonexistent as roads are crumbling into streams. The majority of stream reaches, 87%, have been impacted to some level by development. This creates a major challenge as restoring riparian buffer zones would, in many areas, require removal or relocation of roads, homes, municipal development, and some industry. Moderate riparian zones often occur when a roadway was setback from one side of the stream with a large forested riparian zone on the far side of the banks.

In segments of the watersheds where riparian buffer zone restoration is feasible, plantings may be used to increase the widths of these zones. In areas where feasible, stream restoration could be explored to re-route streams away from roads and infrastructure to more natural settings.

J. Fauna and Flora

The region in which the watersheds are located is characterized by Appalachian mixed mesophytic forest. Jones (2005) describes the mixed mesophytic forest region as “characterized by a rich overstory dominated by a mixture of deciduous tree species including American beech, cucumber magnolia, oaks (northern red, white), sugar maple, tuliptree, and white ash, as well as eastern hemlock, an evergreen species…. The sub canopy and herbaceous layers are astoundingly rich in species richness, especially in flowering shrubs and spring wildflowers.” Due to past resource extraction, there are no old growth forests in Crafts Colly, Sandlick, or Dry Fork. Currently, forests in the region are predominantly second and third growth oak-hickory (Barbour and Wharton, 1973).

Secondary mixed mesophytic forests are less mixed than original growth forests and are restricted to north slopes, ravines, and coves. These forests grow in deep and well drained soils. Today's forests are more adapted to dry conditions than previous growth forests. This is a result of logging as extensive logging leaves behind thinner soils which are unable to retain the moisture needed to support healthy mesophytic forests (Barbour and Wharton, 1973).

Invasive and exotic species also threaten the biodiversity of the local ecosystem and hinder the health of waterways. The following invasive species present major concerns to the region: kudzu (*Pueraria lobata*), Japanese knotweed (*Polygonum cuspidatum*), bush honeysuckle (*Lonicera* sp.), Japanese honeysuckle (*Lonicera japonica*), and hemlock woolly adelgid (*Adelges tsugae*) (Kentucky Division of Forestry, et al. 2010). Invasive and exotic species must be addressed and controlled for the preservation of endangered and native species and watersheds.

The Kentucky Department of Fish and Wildlife Resources lists 370 animal species, including 164 birds, 64 fish, 21 reptiles, 44 amphibians, 43 mammals, 27 crustaceans, and two mussels, for the Mayking and Whitesburg quadrangles in which Dry Fork, Sandlick, and Crafts Colly are located. This indicates a large and diverse community of wildlife in the area. Other surveys have found that animal numbers in the area are large.

While the National Audubon Society did not perform an Annual Christmas Count in Letcher County, an estimation of songbirds, ducks, and geese populations can be based on the 2017 Wayne County bird count which included over 13,000 songbirds, 225 ducks, and 369 geese. Migratory birds found in the Crafts Colly, Sandlick, and Dry Fork watersheds include the bald eagle, cerulean warbler, Kentucky warbler, prairie warbler, wood thrush, and the yellow-bellied sap sucker (US Fish and Wildlife Service, 2018).

The Kentucky Department of Fish and Wildlife Telecheck Results for 2017 identify that harvested game in Letcher County included: 219 deer, 152 turkeys, 41 bobcats, 18 elk, and 6 bears (Kentucky Department of Fish and Wildlife Resources). As these are harvest numbers, the living populations of these species are much larger. Based on the American Veterinary Medical Association Pet Ownership Calculator (2018), there are an estimated 383 dogs and 878 cats in the Crafts Colly, Sandlick, and Dry Fork watersheds.

Threatened, endangered, and special concern species potentially located within the watersheds are summarized in Table 2.3 (page 2.14). There are five state-threatened and five state-endangered species listed by the Kentucky Department of Fish and Wildlife Resources for the Whitesburg and Mayking quadrangles (KDFWR, 2018). The US Fish and Wildlife Service lists two endangered species, gray bat (*Myotis grisescens*) and Indiana bat (*M. sodalis*) as well as two threated species and one special concern specie. Based on the US Fish and Wildlife Service IPaC Report, there are no critical habitats within the Crafts Colly, Sandlick, and Dry Fork watersheds. Critical habitats are areas with physical and biological features that are necessary for the conservation of threatened and endangered species (US Fish and Wildlife Service, 2018). While there are no critical habitats designated, habitat destruction and changes to native plant communities have altered species distribution and the ecosystems of wildlife communities.

K. Point Sources and Municipal Utilities

1. Water Supply

Drinking water utilities provide water for indoor purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and outdoor purposes such as watering lawns and gardens. Raw water is withdrawn from surface or groundwater sources, treated for public consumption, and then distributed to area residents.

Two different water supply systems are in the watershed area: the Letcher County Water and Sewer district and the Whitesburg Water System as shown in Figure 2.8 (page 2.15). The Letcher County Water and Sewer District serves most of the watershed area with supply lines along Dry Fork, Sandlick Creek, and Crafts Colly Creek. The Whitesburg District serves a few customers near the mouth of Sandlick Creek.

According to the Kentucky Infrastructure Authority Water Resource Information System, in 2017, Letcher County Water and Sewer District directly serviced 4,771 households and indirectly serviced 1,627 households. This district does not produce its own water but purchases water primarily from Knott County Water and Sewer District with its withdrawal from Carr Fork Lake. Whitesburg Water and Sewer District is located inside of the Whitesburg city limits. It directly serviced 1,480 households and indirectly serviced 4,771 households in 2017, including the Letcher County Water and Sewer District. The North Fork of the Kentucky River is the primary raw water source for the Whitesburg water utility, with an intake located just upstream of Whitesburg at river mile 406.3, above the confluence of Sandlick Creek and below Crafts Colly.

The Source Water Assessment and Protection Program (SWAPP) is designed to provide for a proactive planning and protection for public drinking water supplies. The SWAPP data set provide a three-tiered polygon delineation of the protection areas for the purposes of inventorying potential contaminant sources in each of Zones I, II, and III. The lower portion of Crafts Colly Creek is in Zone III, Zone of Potential Impact, for the Whitesburg District.

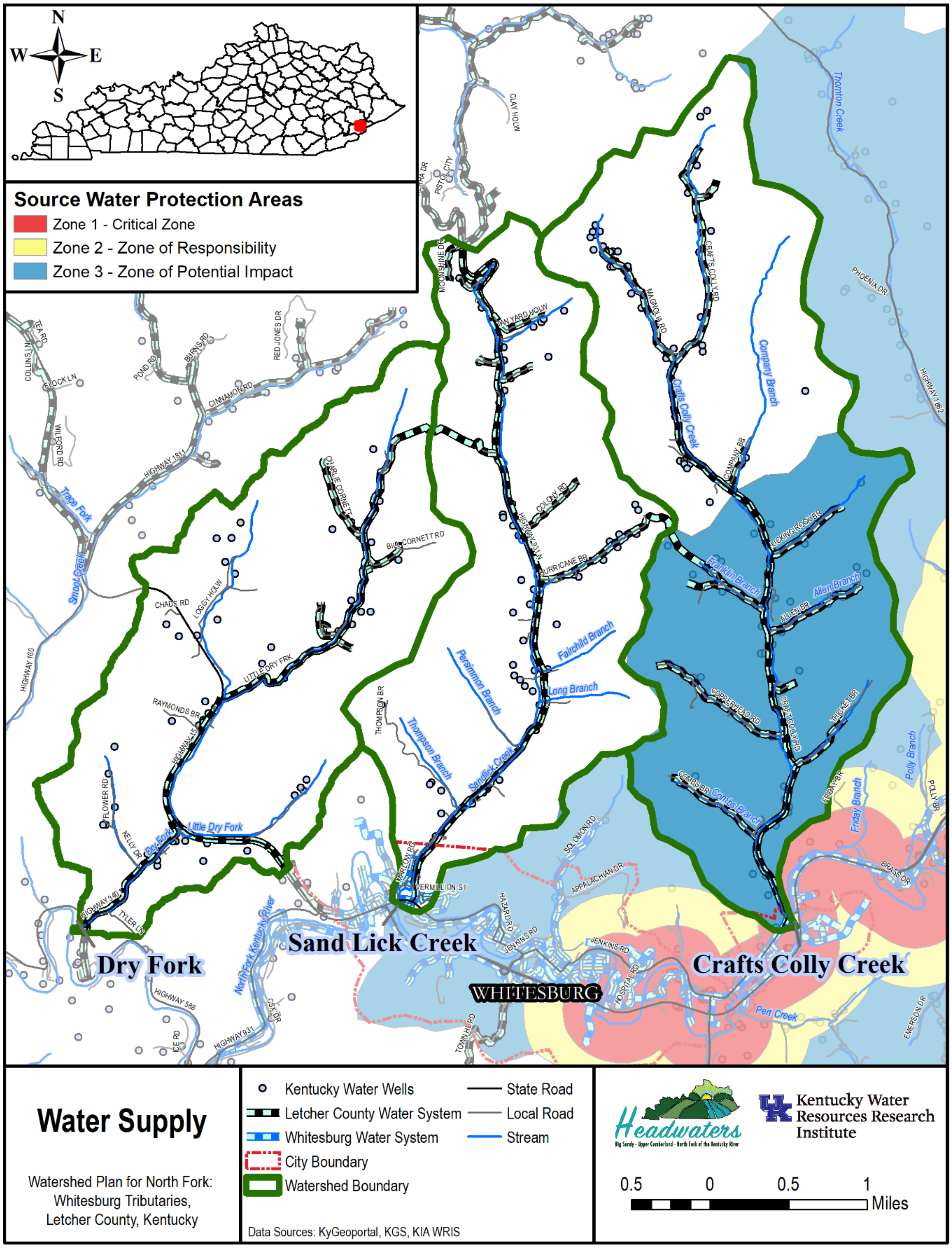
According to the KGS Water Wells database, there are 248 wells located in the watershed area. Most of these wells are used for domestic supply although some are monitoring wells or wells with other uses. Despite the presence of public water supplies in the area, many of these wells are still actively used. Wells can be

Table 2.3: Threatened, Endangered, and Special Concern Animal and Plant Species

Scientific Name	Common Name	US Status* (USFWS)	KY Status* (KDFWR)
Mammals			
Myotis grisescens	Gray Bat	E	T
Myotis sodalis	Indiana Bat	E	E
Myotis leibii	Eastern Small Footed Bat		T
Nycticeius humeralis	Evening Bat		S
Myotis septentrionalis	Northern Long Eared Bat	T	E
Sorex dispar blitchi	Long Tailed or Rock Shrew		E
Ursus americanus	American Black Bear		S
Sorex cinereus	Cinereus Shrew		S
Spilogale putorius	Eastern Spotted Skunk		S
Clethrionomys gapperi maurus	Kentucky Red-backed Vole		S
Insects			
Stylurus notatus	Elusive Clubtail		E
Litobrancha recurvata	Burrowing Mayfly		S
Crustaceans			
Cambarus buntingi	Longclaw Crayfish		S
Cambarus parvoculus	Mountain Midget Crayfish		T
Birds			
Falco peregrinus	Peregrine Falcon		E
Haliaeetus leucocephalus	Bald Eagle		T
Corvus corax	Common Raven		T
Junco hyemalis	Dark-Eyed Junco		S
Phalacrocorax auritus	Double-crested Cormorant		T
Pandion haliaetus	Osprey		S
Accipiter striatus	Sharp-shinned Hawk		S
Amphibians			
Cryptobranchus alleganiensis	Eastern Hellbender		E
Plethodon wehrlei	Wehrle's salamander		E
Reptiles			
Pituophis melanoleucus	Northern Pine Snake		E
Fish			
Chrosomus cumberlandensis	Blackside Dace	T	T
Etheostoma sagitta	Cumberland Arrow Darter	C	S

*Status abbreviations are as follows: SOMC=Species of Management Concern, E = Endangered, T = Threatened, S = Special Concern, X = Extirpated, C = Candidate
KDFWR records are from http://app.fw.ky.gov/speciesinfo/QuadListSpecies.asp.
USFWS records are from https://ecos.fws.gov/ecp0/reports/species-by-current-range-county?fips=21133.

Figure 2.8: Water Supply



contaminated from surface uses and should be regularly disinfected and maintained. Annual testing should be conducted for the presence of bacteria, which could indicate a problem with the water supply. Other causes of poor well water quality in the area could include contamination from stream infiltration, inactive mining sites, abandoned wells, or poor water quality due to the aquifer's surrounding geology.

2. Permitted Dischargers and Other Point Sources

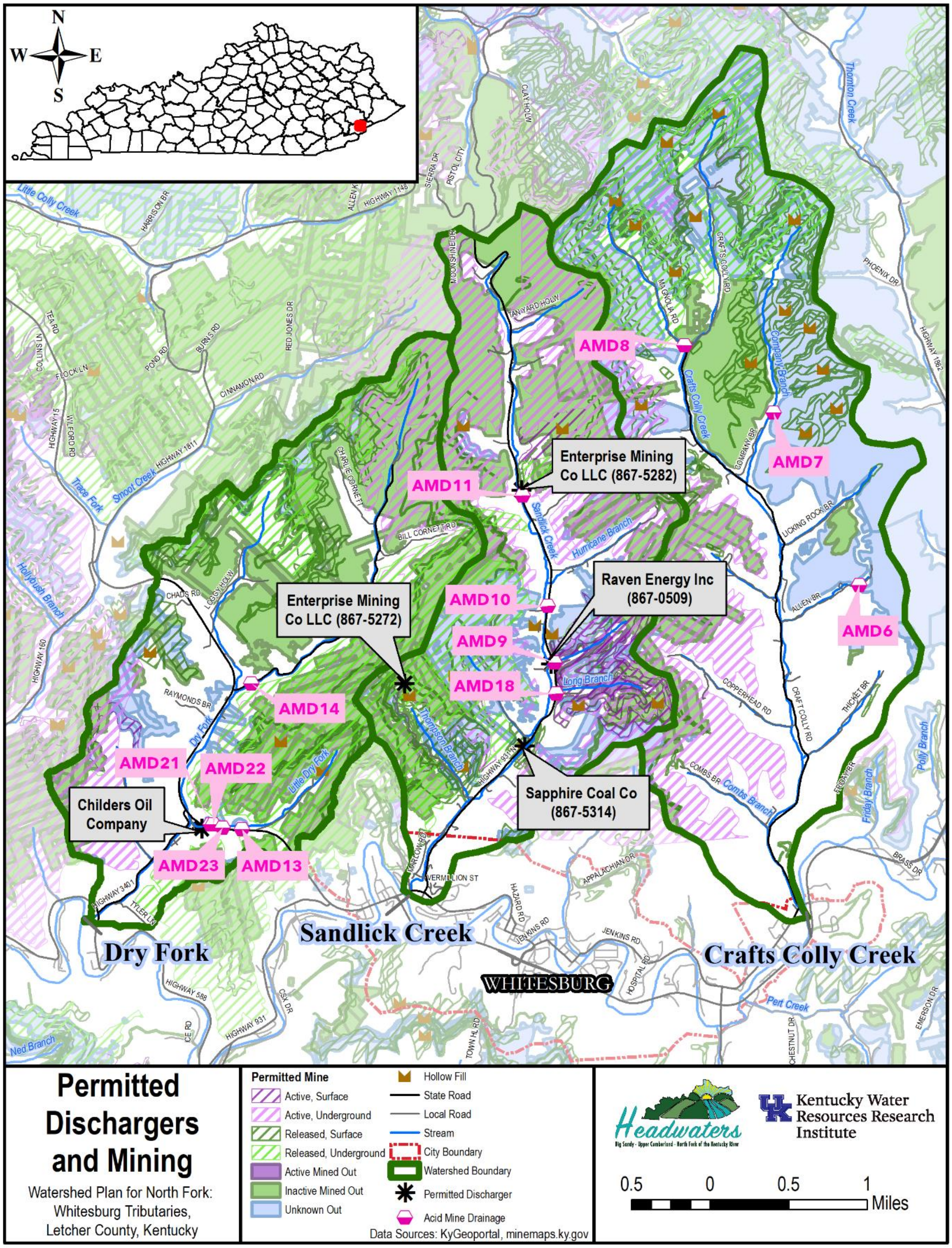
All dischargers to waters of Kentucky are required to obtain a Kentucky Pollutant Discharge Elimination System (KPDES) permit including concentrated animal feeding operations (CAFOs), combined sewer overflows (CSOs), individual residences, Kentucky Inter-Municipal Operating Permits (KIMOPs), mining, municipal, industrial, oil, and gas. Table 2.4 summarizes the permitted dischargers in the watershed in 2017. These discharges are shown in Figure 2.9 (page 2.17).

Table 2.4: Permitted Dischargers

KPDES Permit ID	Facility Name	Facility Type	Parameters	Exceedances
KY0097870	Childers Oil Company Inc	Merchant Wholesalers, Nondurable Goods	pH, suspended solids, oil and grease, benzene, toluene, ethylbenzene, xylene, naphthalene	None from 1/2015 to 4/2018
KYGE40321 KYGE40334	Enterprise Mining Company, LLC (867-5272) (867-5282)	Bituminous Coal and Lignite Surface Mining	specific conductance, pH, suspended solids, settleable solids, iron, selenium, manganese, chronic toxicity	None from 1/2015 to 4/2018
KYGE40478	Sapphire Coal Company (867-5314)	Bituminous Coal and Lignite Surface Mining	specific conductance, pH, suspended solids, settleable solids, iron, selenium, manganese, acute toxicity, sulfate	Acute toxicity, 1 quarter from 1/2015 to 4/2018
KYGE40565 KYG045529	Raven Energy Inc (867-0509)	Bituminous Coal and Lignite Surface Mining	specific conductance, pH, suspended solids, settleable solids, iron, selenium, manganese, chronic toxicity, sulfate	Manganese, Iron, pH, 2 qtrs. exceeded from 1/2015 to 4/2018. 4 informal enforcement actions and 2 formal enforcement actions with total penalty of $2,000 in past 5 years.

Three coal companies and one auto repair shop are permitted to discharge and are all located in the Sandlick Creek watershed. Of these facilities, two have exceeded their permit limits in the past three years, Sapphire Coal Company and Raven Energy Inc.

Figure 2.9: Permitted Dischargers



Sapphire Coal Company exceeded its permit for acute toxicity-limit in the fourth quarter of 2015 and received a notice of violation in June 2016 from the Kentucky Division of Water. Raven Energy Inc, had violations for manganese, iron, and pH during two quarters from January 2015 to April 2018. Four informal enforcement actions from 2014 to 2017 and two formal enforcement actions in 2018 with total penalty of $2,000 had been issued to the facility.

Several mine drainage sites are discharging polluted water into the Crafts Colly, Sandlick, and Dry Fork watersheds. A series of brownfield studies entitled, "Phase II Environmental Site Assessments for Dry Fork, Sandlick Creek, and Crafts Colly Creek" (AMEC 2011) identified 13 AMD sites along these tributaries, shown in Figure 2.8. These are described as follows:

Dry Fork

- AMD 13 flows from an old pipe that discharges into Little Dry Fork. The site is at the bottom of a small ravine on the north side of Highway 15, about 2 miles west northwest of Whitesburg.
- AMD 14 originates from an abandoned mine opening in a rock outcrop on the side of a hill and runs for several hundred feet into Dry Fork. Orange-stained sediment is present along the entirety of the drainage and for a short distance downstream of the stream junction.
- AMD 23 has a high flow rate and has been referred to as the "blow out." It is located on the north side of Highway 15, about 2 to 2.5 miles northwest of Whitesburg. There are two major discharges in the same vicinity that both enter Little Dry Fork just downstream of AMD 13, near Body Shop Lane. Little Dry Fork enters Dry Fork several hundred feet downstream of AMD 23.
- AMD 21 and 22 are located just downstream of AMD 23.

Sandlick Creek

- AMD 9 and 11 are known but were not sampled under the Brownfields Study.
- AMD 10 occurs in a small drainage and on a dirt road on a steep hillside east of Sandlick Creek, about 3 miles north of Whitesburg.
- AMD 11A does not have a known point source, but it is indicated by orange sediment along a short stretch of Sandlick Creek on the west side of Highway 931, just north of the fire station.
- AMD 18 originates above a sedimentation pond along Long Branch, about 2 miles north of Whitesburg.

Crafts Colly

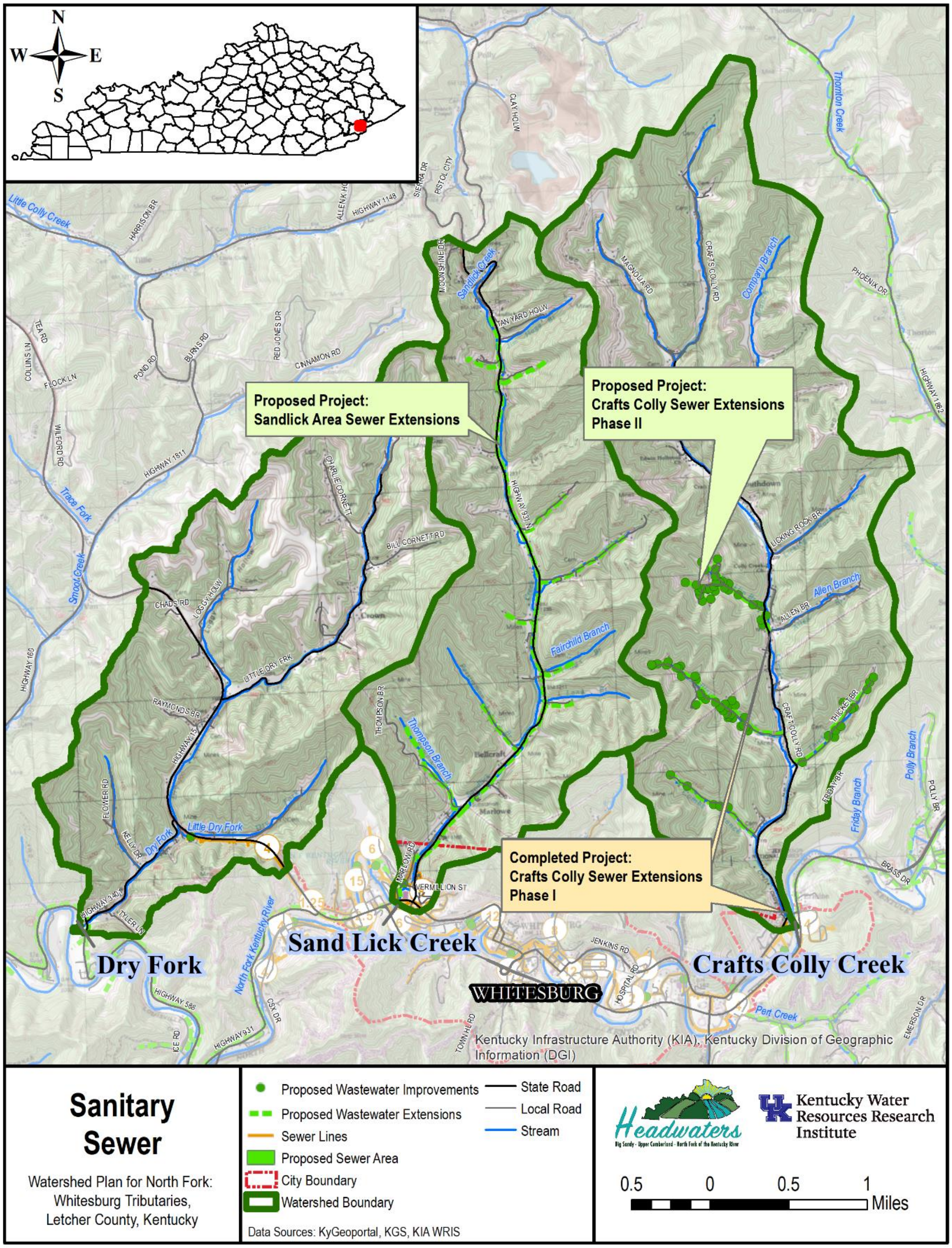
- AMD 6 is 3 to 4 miles northeast of Whitesburg, flowing down a hill from the base of a sandstone outcrop into Allen Branch.
- AMD 7 seeps from a steep hillside along Company Branch.
- AMD 8 does not have an identified point source but has deposited about a 100-foot stretch of orange sediment in a ditch along Magnolia Road, near the Left Fork of Crafts Colly Creek.

3. Waste water

Wastewater drainage systems collect and transport water from toilet flushing, laundry, showers or hand washing, dish washers, or other similar uses in buildings and residential properties. Wastewater may be properly addressed by two types of systems: public sanitary sewer systems or private onsite septic systems.

According to Chris Caudill, City of Whitesburg Water and Sewer Director (pers. comm. 2018), the Whitesburg wastewater treatment facility is utilized by the Letcher County Water and Sewer District. This system services Crafts Colley (to Allen Branch), Dry Fork (to Boatwright Drive), and none of Sandlick to date. The location of the sanitary sewer system and future proposed projects are shown in Figure 2.10 (page 2.19). Whitesburg

Figure 2.10: Sanitary Sewer



wastewater is treated through an aeration ditch facility. Wastewater aeration is the process of adding air into wastewater to allow aerobic bio-degeneration of the pollutant components. It is the standard treatment method of most wastewater treatment systems today. This facility makes use of a process of extended aeration to treat waste.

The $1.1 million "Crafts Colly Sanitary Sewer Project – Phase 1" was completed in 2016. The project removed one package treatment system at the Dry Fork Market and addressed about 125 households along the lower half of Crafts Colly Creek (C. Caudill, 2018). Additional projects have been proposed by the sewer districts, but have not been funded in the watershed area, including the following:

- *Crafts Colly Sewer Extensions Phase II*: Low pressure sewer line extensions with grinder stations for each household. Project will serve approximately 79 households in the area along Combs Branch, Thicket Branch, Blair Branch, and Franklin Branch. The project would not address the homes on Crafts Colly located north of Franklin Branch. Total project cost is $1.2 million.
- *Sandlick Area Sewer Extensions*: Project will provide sewer service to 105 customers along Sandlick Creek and its tributaries. Estimated budget is $2.1 million.

No projects have been proposed to extend sanitary sewer to residents along Dry Fork or the upper portions of Crafts Colly.

In areas without adequate wastewater infrastructure like Sandlick and the un-serviced areas of Crafts Colly and Dry Fork, homeowners utilize private septic systems serviced by waste management companies. When private onsite septic systems are not routinely cared for, groundwater can become contaminated. Aside from proper waste disposal protocol, there are straight pipes that discharge waste directly into the streams contributing to elevated *E. coli* levels. While recent sewer extension projects in the Crafts Colly and the Dry Fork watersheds have helped with this issue, straight pipes remain a problem. This improper wastewater management by homeowners presents health concerns for the watershed, particularly during recreation in the stream.

4. Stormwater Utilities

Stormwater is water from rain or melting snow that does not soak into the ground. Instead, it flows from rooftops, across paved areas, and through sloped lawns. As stormwater moves across these surfaces, it can pick up and carry along pollutants such as yard and pet waste, sediment, chemicals, oil, grease, and other possible contaminants.

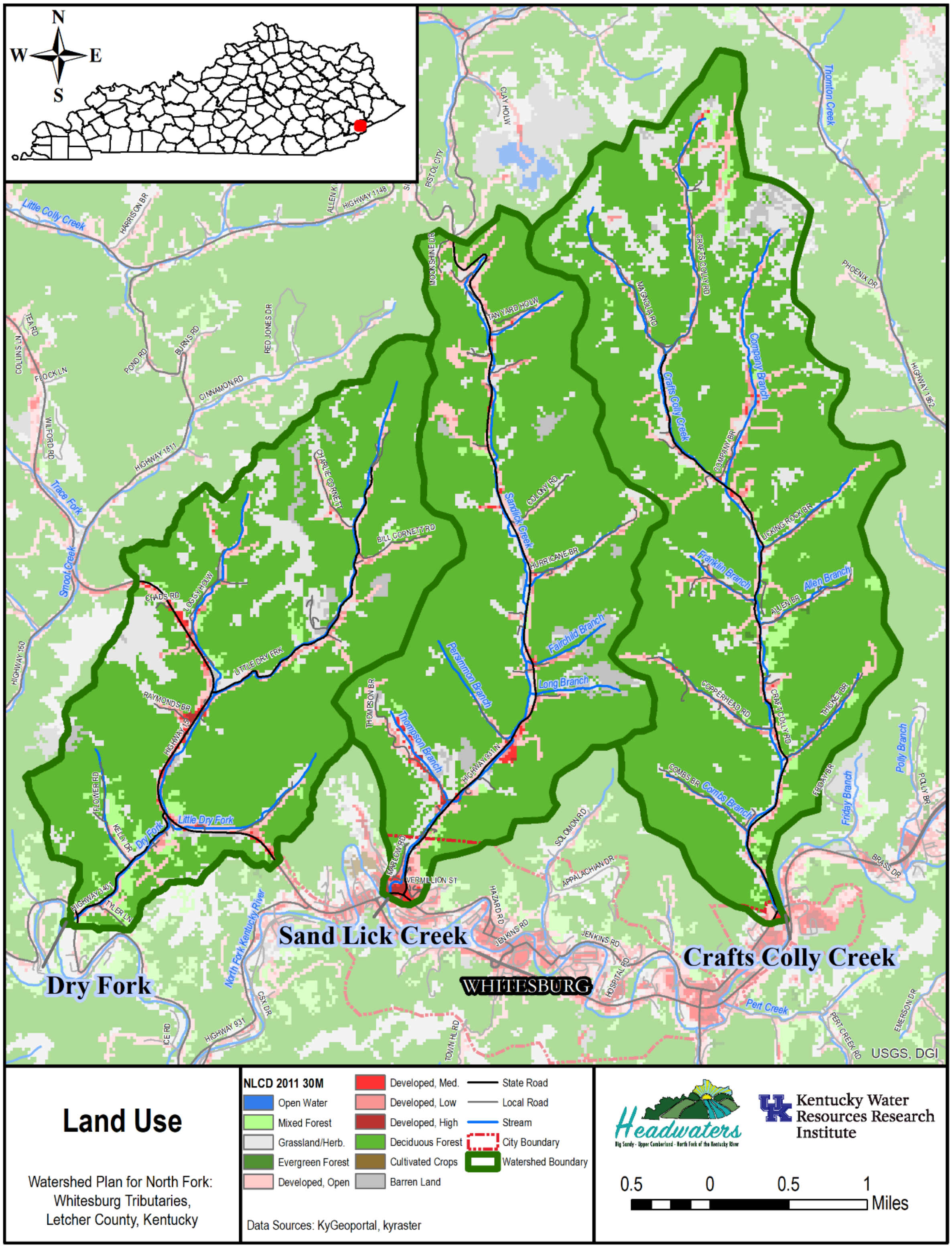
There are no permitted stormwater utilities in the watersheds of focus or Letcher County.

L. Non-Point Sources and Land Use

1. Land Use

The land cover distribution for Crafts Colly and Sandlick (HUC 051002010103) is about 74% deciduous forest, 9% grassland, 6% developed open space, and 11% developed land, barren land, evergreen and mixed forests, pasture land, and cultivated crops (wikiwatershed, 2018). The land cover distribution for Dry Fork (HUC 051002010103) is 76% deciduous forest, 9% grassland, 7% mixed forest, 5% developed open space, with the remainder being developed land, barren land, and shrubs (wikiwatershed, 2018). The land use is shown in Figure 2.11 (page 2.21).

Figure 2.11: Land Use



a. Mining

At the end of the nineteenth century the character and culture of Letcher County and eastern Kentucky were transformed by the coal industry. Coal speculation began in 1885 throughout most of Letcher County. Most mineral wealth became deeded to a few coal operators and by 1905 coal companies had purchased mineral rights to much of the county. Completion of the Lexington and Eastern Railroad in 1912 connected the region to the larger national economy and the population of communities like Whitesburg and Mayking rapidly expanded.

With mechanization and dramatic changes in the industry, coal mining continued to be the mainstay of Letcher County's economy into the 1990s, but with dramatic changes in the industry. Modern mechanized coal mining techniques require far fewer employees than were needed in the early twentieth century (Kleber, 1992).

More recently, the industry has been challenged by competition from natural gas. Despite the significant downturn in the production of coal and the local economy, coal has continued to be commercially mined. Coal tonnage statistics are demonstrative of the decline in production. In the ten years from 2008-2018, a total of 31,136,103 tons have been extracted from Letcher County coal mines, with 9,476,603 tons (30%) coming from surface mining permits and 21,659,500 tons (70%) coming from underground permits (KGS 2018a). During the previous ten years (1997-2007) total coal production was 104,037,935 tons, with 38,666,553 tons (37%) coming from surface mining and 65,371,382 tons (63%) coming from underground mining. Thus, only 30% of the coal volume was produced in the last decade as compare to the previous decade (KGS 2018b).

b. Logging

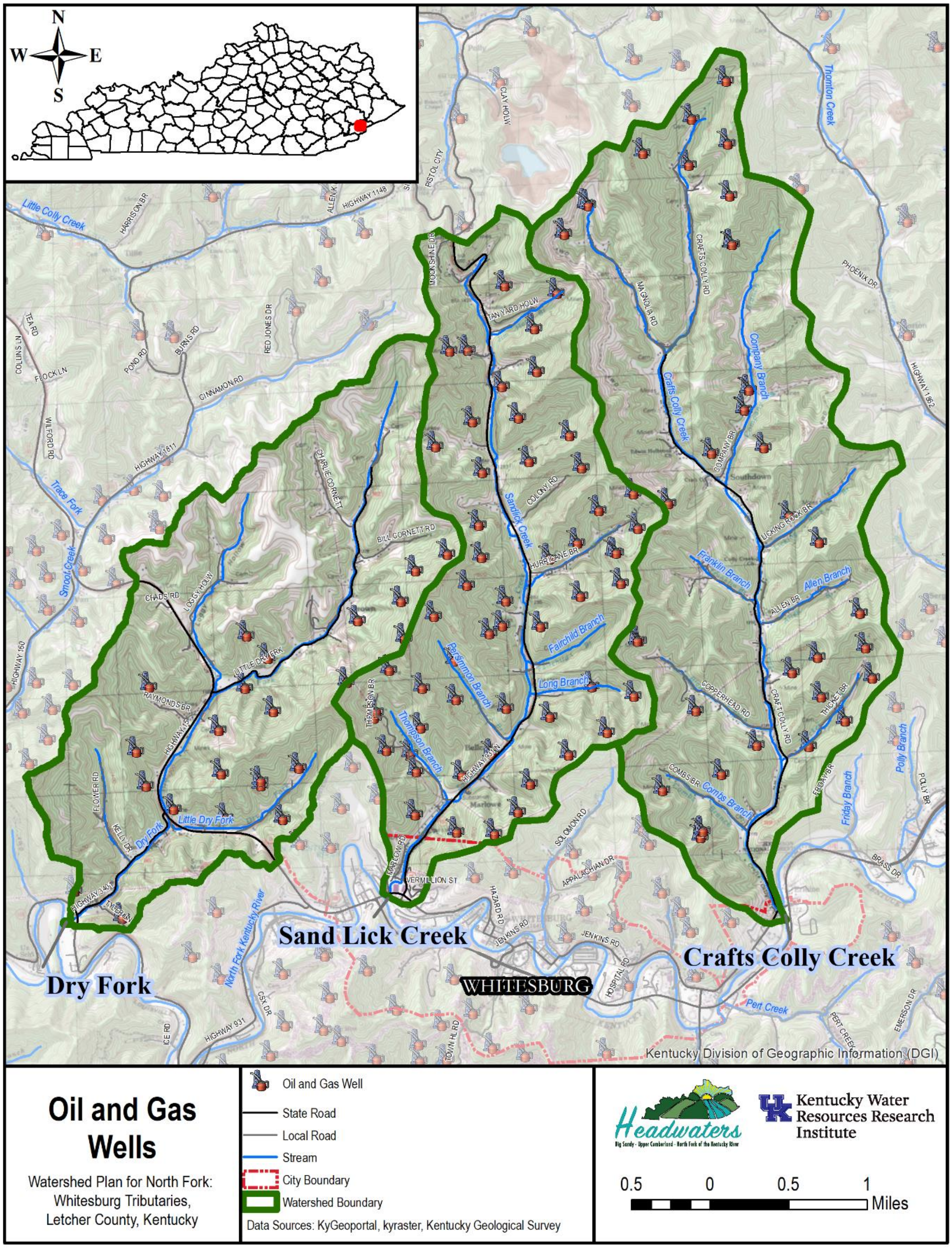
During the last century, most forests in the area were cleared. Valuable timber was sold, and what remained was burned to make farming and pasture lands. These practices have contributed to flooding and sedimentation of the Kentucky River. Logging increases water runoff rates and subsequently, the risk of flash floods. Deforestation also decreases water filtration and accelerates sedimentation. With increased sedimentation, riverbeds are elevated, and floodplain capacity is reduced.

According to Letcher County Forest Ranger, James Madden, logging operations have taken place in the Crafts Colly and Dry Fork watersheds in recent years, but there are no notable logging sites in the Sandlick watershed. While there has been active logging, there has not been significant sedimentation stemming from the recent logging sites. Water control structures have been utilized and care has been taken to remove any associated debris from streams. All logging operations are subject to the Kentucky Forest Conservation Act (J. Madden, pers. comm. on August 1, 2018).

c. Oil and Gas

In eastern Kentucky, oil production is from Pennsylvanian sands, Mississippian limestones, and sandstones. Natural gas is produced from the Devonian black shale (Weisenfluh, 2016). The Kentucky Geological Survey identifies 572 permits associated with oil and gas wells in the Whitesburg and Mayking quadrangles. One hundred and twenty-three (123) oil and gas wells are scattered throughout each of the three focus watersheds with the greatest density located in the Sandlick Creek watershed as shown in Figure 2.12 (page 2.23). To further locate and identify oil and gas wells throughout Crafts Colly, Sandlick, and Dry Fork, the Kentucky Geocode Oil and Gas Wells Search (KGS 2018c) is a useful resource.

Figure 2.12: Oil and Gas Wells



As of 2015, Letcher County was Kentucky's number one producer of oil, and number 14 producer of natural gas; making Letcher County number one overall in the state for oil and gas production and number 33 overall in the country for oil and gas production. According to the same 2015 data, Equitable Production Company (EQT) was the largest individual holder of oil and gas properties in Letcher County, holding 19 of Letcher County's 108 oil and gas properties (ShaleXP 2018).

Per Letcher County Judge Jim Ward (pers. comm.), as of April 2017, Letcher was the producer of nearly 10% of Kentucky's oil and gas. That same month, the county government weighed a measure that would place a tax on all new oil and gas extraction. After a public meeting, the measure was defeated after a 3-3 vote (Estep, 2017). It would have been the first tax of its kind in the state, and tax revenues from the nearly 1,500 oil and gas wells were estimated to be around $3.7 million annually, enough to cover some 95% of the county's budget (Farley, 2017).

Some potential water concerns related to oil and natural gas drilling include contamination from chemicals used in drilling the well, processing the oil or gas, or disposing of waste. It is possible for methane or other gases to leak into water supplies when wells have been improperly cased. Groundwater contamination can be caused by natural or man-made fractures that allow gas to move between oil and gas formations. Surface water concerns stem from on-site equipment and diesel leaks or spills. Surface water concerns are mostly related to land management and site management (Union of concerned scientists, 2018).

With oil and gas wells there are access roads with traffic from heavy equipment and machinery. Given the steep terrain of the watershed, the access roads often have significant hillslopes which make erosion control difficult. To help with erosion control, ditches and culverts can be utilized. If possible, access roads should not be constructed when there is a hillslope greater than 10% (West Virginia surface owners' rights organization, 2010).

Other than access roads, other on-site issues include abandoned or decaying infrastructure. In the case of abandoned oil and gas wells, the Kentucky Division of Oil and Gas prioritizes wells based on environmental or safety hazards. Prioritized wells are plugged (Kentucky Division of Oil and Gas, 2016).

d. Agriculture

Subsistence farming was once extremely important to the livelihood of families in Letcher County, however by the 21st century, the number of producing farms drastically declined. Currently, there are about 4,000 acres of "prime farmland" in Letcher County. These lands are valley floors that are occasionally flooded (USDA et al, 2004).

In the watersheds of Crafts Colly, Sandlick, and Dry Fork, there are not large-scale agriculture operations, however small farming operations and garden plots are commonplace. While family gardens have a mainstay over larger farming activity, agriculture can still present watershed impairments, especially when Best Management Practices are not being implemented. While not extensively used, there is certainly some nitrogen and phosphorus runoff associated with the small-scale farming and gardening that takes place throughout Crafts Colly, Sandlick, and Dry Fork.

Along with small farm and garden plots, there is a presence of some livestock. Chickens are fairly common, and horses, goats, and cattle are present at a few homes. Livestock, particularly when not properly fenced, can contribute to the bacteria loads of waterways. When free to roam close to streams, livestock may also impact riparian zones.

Based on the USDA National Agricultural Statistics Service Cattle County Estimates released on May 14, 2018, the overall number of cattle in Letcher County is 100. In all other categories including: tobacco, alfalfa hay, other hay, corn, soybeans, winter wheat, and cash rents, Letcher County is not reported. Based on Agricultural Statistics, Wikiwatershed (2018), calculates the livestock in the watersheds to include 6 chickens, 6 horses, and 14 sheep.

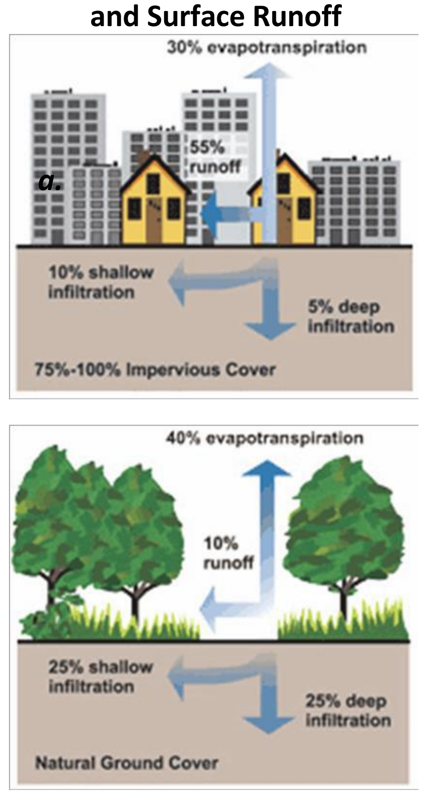
Recently, family gardens and subsistence farming has been encouraged to stimulate the local economy and promote healthy eating throughout Letcher County and the Appalachian coalfields. Through the Whitesburg/Letcher County Farmers Market and programs like Grow Appalachia, residents are encouraged to farm as a cost saving measure, for supplementary income, and for greater community access to fresh fruits and vegetables.

Based on this recent promotion of small-scale farming, attention and community engagement efforts should be focused on Best Management Practices for small agricultural operations. Targeted community engagement efforts should place further emphasis on the importance of water quality for farming.

e. Urban / Suburban Development

One of the greatest sources of pollution in developed areas is runoff from impervious surfaces. Impervious surfaces, such as roadways and rooftops, are surfaces which water cannot penetrate. As these surfaces are unable to infiltrate water, they subject streams to extraordinarily high flows during storm events, leading to erosion and further pollution. This relationship is illustrated in Figure 2.13. The average percentage of impervious area determined from NLDC 2011 impervious dataset within the watershed is 1.5% (USGS 2018).

Figure 2.13: Relationship Between Impervious Cover and Surface Runoff



Source: US EPA

Impervious cover in a watershed results in increased surface runoff. As little as 10% impervious cover can cause stream degradation.

On impervious roadways, vehicles introduce numerous pollutants including oils, grease, rubber, and heavy metals (e.g., lead, zinc, copper). Some of these pollutants also accumulate when the vehicles are idle on parking lots, driveways, and other parking areas. Most heavy metals tend to accumulate and remain within vegetated ditches adjacent to the surface. Other roadway pollutants tend to be more mobile. Research indicates that the amount of pollutants in surface waters is proportional to the amount of average daily traffic. Also, in winter months, deicing salt transported through runoff can be a significant pollutant to surface waters. Roof runoff can also be high in certain metals and solids.

In residential areas, lawn fertilization and pesticide applications, carried to streams through the storm sewer system, can also contribute to nonpoint source pollution. Lawn fertilizers (typically high in nitrogen and phosphorus), herbicides, and pesticides are commonly applied in these zones to keep grass green. However, fertilizer that is not absorbed into the soil may be carried into streams in runoff resulting in nutrient pollution problems and algal blooms. Often, household pets are associated with residential areas and can contribute to bacteria and nutrient pollution.

In addition to floodplain accessibility, the frequency and magnitude of flooding is affected by the percent of impervious surface in a watershed. Under natural conditions, most rainwater is absorbed into the soil or evapotranspired by trees. With increased impervious surfaces such as rooftops or pavement, water cannot infiltrate into the soil and therefore quickly flows into the stream. This can lead to frequent and/or severe flooding events of higher magnitudes.

Most development within Crafts Colly, Sandlick, and Dry Fork is single-family residences or mobile homes. While this is the case, there is commercial development within the southern portion of Sandlick which is near to the urbanized area of Whitesburg.

In some of the residential portions of the watershed, littering and waste disposal remains a problem. When appliance, vehicle, and trash disposal go unmanaged, it contributes to debris and litter along the streams. Litter is aesthetically unappealing, hinders stream ecosystems and aquatic life, and presents a pollution concern as substrates of abandoned heavy machinery, vehicles, appliances, and other litter can leach into surface and groundwater.

M. People and Communities

The quality of the water in the river, streams, and tributaries of the watershed is impacted by the people and communities that live and work in its drainage area. Understanding community dynamics will aid in the education and stakeholder engagement that is necessary to ensure that a watershed plan is implemented successfully. Best management practices and solutions for water quality impairments should be appealing and doable for community members.

1. Culture and History

Historically, the Iroquois, Chickasaw, and Shawnee inhabited Letcher County and the surrounding area. Scotch- Irish immigrants settled the region around 200 years ago. Since the beginning of human settlement in the region, people and homesteads have survived by way of hunting, gathering, foraging, farming, and self- sufficiency. Coal speculation began in 1875 and soon after came and the expansion of railroad, the establishment of coal camps, and demand for workers in the mines.

Periods of economic boom in the coal industry were met with an influx of immigrants from different parts of the country and world. For example, Black Americans immigrated from the South to work on the railroads and in the mines. The coalfields also attracted European immigrants; between 1910 and 1920, there was significant Italian and Eastern European immigration to Letcher County and Eastern Kentucky (Taylor-Caudill & Hays, 2014).

Music, food, religion, and most traditions have formed around local industry and the land and waterways. With the cultural significance of land and water, knowledge of and familiarity with streams and rivers is pervasive among community members. People use local waterways for everyday and practical purposes like directions or referencing areas of the county. Waterways also represent cultural and historical significance as people use creeks to identify their homeplace and ancestral lands. Outdoor recreation like hiking, fishing, and kayaking is also common among residents.

2. Community Characteristics

Human settlement and development is in the floodplains and low terraces. With limited flat lands, less than 20% of the state's population lives in the Eastern Kentucky Coal Field which makes up 28% of the state's land. As of 2008, there were roughly 65 people per square mile throughout the region (Carey & Hounshell, 2008). Recently, the downturn in the local coal economy has contributed even further population decline.

The 2017 Annual Estimates of the Resident Population by the United States Census Bureau found that the population of Letcher County included 22,339 individuals. Whitesburg, the county seat, is the largest population center in the county. Crafts Colly, Sandlick, and Dry Fork are near Whitesburg, which is located adjacent to the North Fork of the Kentucky River.

Figure 2.14 (page 2.28) shows Census Tract 9504.02, which includes most of the three watersheds in question. The watersheds take up approximately half of the census tract area, so the data associated with this census tract are representative of the watersheds' residents. Table 2.5 includes demographic, educational, economic, and housing data for Census Tract 9504.02 and compares it to data for Letcher County, Kentucky, as well as the entire state of Kentucky.

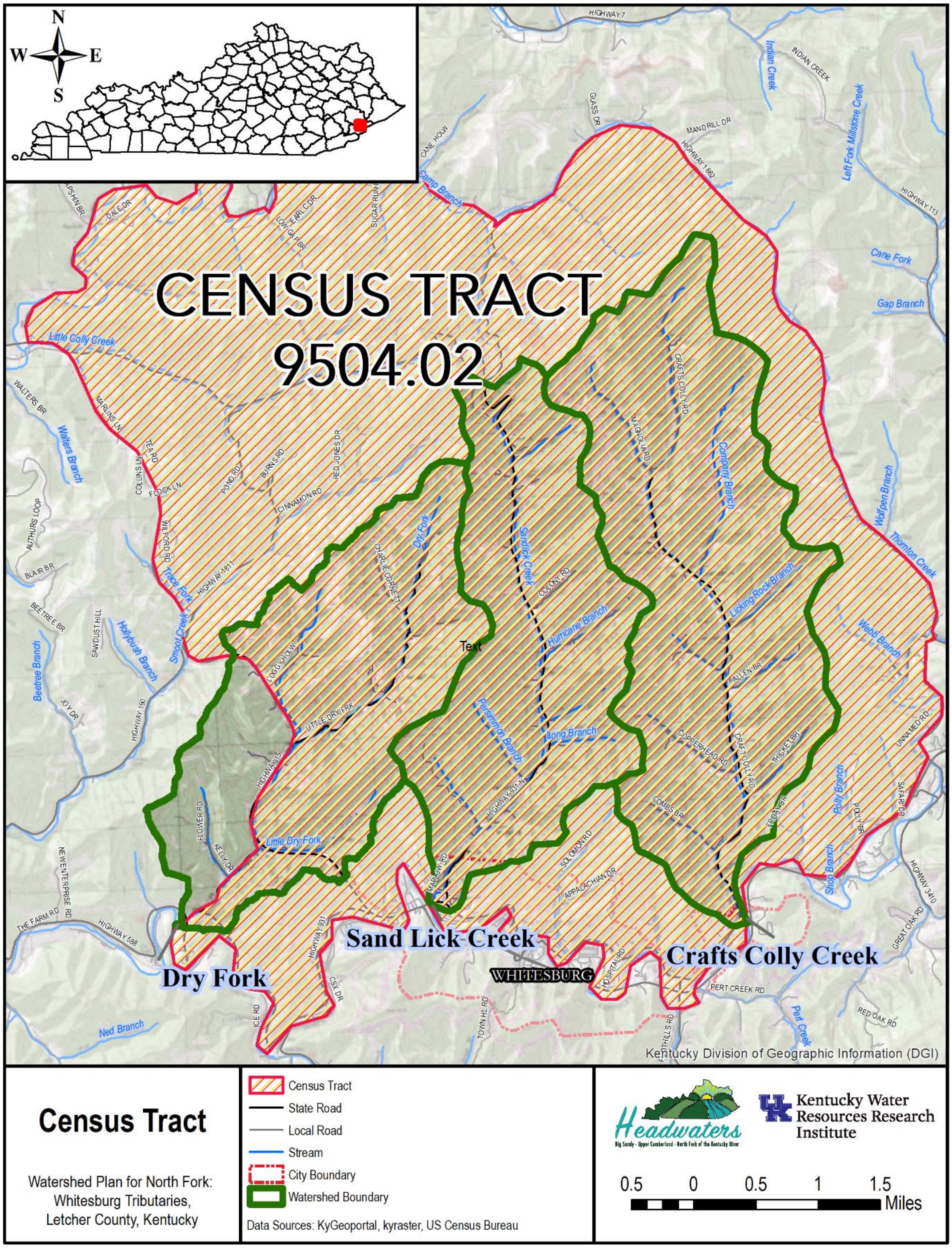
Table 2.5: 2012-2016 American Community Survey Census Data

Census Data		Census Tract 9504.02	Letcher County	Kentucky
Population	# People	4,981	22,339	4,339,367
	Density (#/Acre)	0.226	0.103	0.168
Age	% <18 Years	25	22	23
Income	Per Capita ($)	18,470	17,181	24,802
	% Below Poverty	35	30	19
Education (≥25 years old)	% High School Graduate	76	75.1	85
	% College Degree or Above	13	11	23
Housing	% Built Pre-1950	14	22	15
	% Mobile Homes	39	28	12

Data were obtained from the American Fact Finder 2012-2016 American Community Survey 5-Year Estimates.

The most significant characteristics to note include per capita income, poverty, educational attainment, and housing type. The census tract and county have similar income levels, but they are both about 25% lower than the average statewide income. The percentage of people living in poverty in the community is higher than Letcher County's poverty level, and nearly twice the statewide level. Kentucky's poverty rate of 18.8% is the fifth highest among states in the U.S. (U.S. Census Bureau, 2016), which underscores the extent of poverty in the Whitesburg community. Educational attainment in the watersheds is representative of Letcher County, which has lower educational attainment than statewide levels. 85% of Kentuckians have a minimum of a high school diploma, compared with about 75% of Letcher County residents. 23% of Kentucky residents have a bachelor's degree or higher, compared with 11% of Letcher County residents and 13% of individuals living in the watersheds. Letcher County is 98% white. Other ethnicities include Black, American Indian, Asian, Hispanic or Latino, and mixed peoples make up the remainder of the population.

Figure 2.14: Census Tracts



When carrying out community engagement efforts and helping residents employ Best Management Practices, it is important to ensure that activities are accessible for all people, regardless of income or education level. In many cases, this may mean providing services and materials at very little or no cost to participants. For example, installing septic systems in similar communities has been challenging in the past as residents cannot afford the cost of installation and hookup or the addition of a new monthly bill. Recent sewer infrastructure projects in Crafts Colly and Dry Fork have been largely federally funded and utilized payment plans to assist customers with the cost of sewer line connection.

Houses built before 1950 are more likely to have inadequate septic systems, which is important to consider since straight pipes are a known issue in the watersheds. The percentage of homes in the watersheds that were built before 1950 is nearly the same as the percentage statewide. A total of 368 houses in the census tract were built before 1950.

Mobile homes make up nearly 40% of housing in the watersheds. Letcher County's housing is about 28% mobile, indicating that mobile homes are particularly concentrated in the Whitesburg area. Because of the terrain, most development in the watersheds has occurred in the streams' floodplains, often adjacent to the streambank. This is challenging because stable streams require floodplain access, which is where many of the roads and homes are located. Depending upon their locations, there is potential to move some mobile homes away from the streambanks.

Crafts Colly, Sandlick, and Dry Fork are rural communities. The dynamics of rural communities should be taken into consideration with engagement efforts surrounding watershed planning and implementation. Residents and community members are often located far from one another, schools, workplaces, community centers, municipal services, and stores other locations of interest. Like much of Letcher County, Crafts Colly, Sandlick, and Dry Fork lack walkability and roads are in extreme disrepair. During inclement weather conditions, roads become dangerous, making it hard for residents to travel to school and work. In consideration, these areas are sometimes hard to reach, and, at times, it may be difficult for residents to travel for events, programming, and other activities.

When planning and performing community engagement in rural areas, *Toolkit for Working with Rural Volunteer*s is a useful resource put together by Office of Surface Mining and AmeriCorps VISTA teams. Tactics for recruitment and engagement need to be specific to rural locations as community structure does lend to the same recruitment and engagement activities that may be useful in areas with greater population concentrations. For instance, due to the lack of walkability, door knocking is not the most effective recruiting measure.

Partnerships and collaborations with local organizations, schools, and churches are a useful and effective method of reaching and engaging community members. Whitesburg has a very active and engaged network of community organizations that make ideal project partners. Local community organizations include: Appalshop, Letcher County Conservation District, Whitesburg/Letcher County Farmers Market including the Walking Program and Farmacy Program, Kentucky Farm Alliance, the AppalTree Project, Appalachian Citizens Law Center, Cowan Community Center, the Mountain Air Project, HOMES Inc., Letcher County Rotary Club, Senior Citizens Center and many others. Organizations with contact information are listed in Table 2.6.

Table 2.6: Local Community Organizations

Organization	Address	Phone Number
Appalshop	91 Madison Ave, Whitesburg, KY 41858	(606) 633-0108
Letcher County Conservation District	125 Industrial Park Rd., Whitesburg, KY 41858	(606) 633-4448
Whitesburg/Letcher Co. Farmers Market	298 E Main St., Whitesburg, KY 41858	(606) 312-2290
Community Farm Alliance	327 Chestnut St., Suite #1, Berea, KY 40403	(859) 756-6378
Appalachian Citizens' Law Center	317 Main St., Whitesburg, KY 41858	(606) 633-3929
Cowan Community Center	81 Sturgill's Branch, Whitesburg, KY 41858	(606) 633-3187
HOMES Inc.	65 Bentley Ave., Whitesburg, KY 41858	(606) 632-1717
Senior Citizens Center	2145 HWY 119 N, Whitesburg, KY 41858	(606) 633-0121

In terms of physical space for meetings and general community engagement, Crafts Colly, Sandlick, and Dry Fork are near to the city of Whitesburg and closely connected to Whitesburg in terms of livelihood for work, school, groceries, city and county offices, and recreation opportunities like the County Recreation Center, Tanglewood Walking Trail, Farmers Market, Riverside Walking Track, Appalshop, and businesses and restaurants. There are also various churches located throughout Crafts Colly, Sandlick, and Dry Fork.

The North Fork of the Kentucky River runs through the City of Whitesburg and many of the points of interests, meeting locations, and prime community engagement locations are along the North Fork. Crafts Colly, Sandlick, and Dry Fork flow into the North Fork near to the City and these various points of interest. The Letcher County Recreation Center, Tanglewood Trail, Farmers Market, Riverside Walking Track, Appalshop, churches (First Baptist, Presbyterian) and public schools (West Whitesburg Elementary, Whitesburg Middle School, Letcher County Central High School, and Kentucky Community and Technical College) are ideal locations for community engagement and watershed improvement programming.

Another point of interest is the Sandlick Fire Department which is located near the middle of the sub-watershed. The open field space next to the fire department is often mentioned as a potential location for sustainable development like an outdoor recreation area or display space for environmental education. While this area is impacted by AMD, it would be an ideal location for remediation and community-focused development.

3. Previous Watershed Planning

The completion of this watershed plan will mark the first watershed plan for Crafts Colly, Sandlick, and Dry Fork watersheds. While there has not been a previously established watershed plan, there are years of water-quality data from Kentucky River Watershed Watch sampling and Big Dip Redux sampling. In addition to this, the Letcher County Conservation District received a Brownfield Petroleum and Hazardous Substances Assessment Grant from the USEPA in 2008. Through this grant, AMEC Earth and Environmental Consultants conducted water sampling at mine drainage sites in 2010 and 2011. Some of the sampled sites were in the watershed of focus. In addition to previous water sampling, Headwaters has been carrying out watershed improvement efforts throughout Letcher County since its formation in 2005.

N. Regulatory Status of Waterways

Kentucky assigns designated uses to each of its waterways, such as recreation, aquatic habitat, and drinking water. For each use, certain chemical, biological, or descriptive ("narrative") criteria apply to protect the waterbody so that its uses can safely continue. The criteria are used to determine whether a waterbody is listed as "impaired" on the 303(d) list (KDOW 2015). For each waterbody on the 303(d) list, states are required to develop a Total Maximum Daily Load (TMDL) plan, which is a detailed analysis of the all sources of a pollutant and includes calculations and allocations of pollutant loads so that a waterbody can be brought back to meeting criteria. In some cases, an alternative type of plan can be developed that improves water quality to the point where the waterbody meets criteria and a TMDL does not need to be developed.

1. Designated Uses

The designated uses of Crafts Colly, Dry Fork, and Sandlick Creek include warm water aquatic habitat (WAH), primary contact recreation (PCR), fish consumption, and secondary contact recreation (SCR). The WAH criteria are in-place to protect aquatic life that inhabits streams. The PCR criteria are in-place to protect people recreating in a way that likely will result in full body immersion in the water body, such as swimming. The SCR designated use criteria are in place to protect those recreational activities that are likely to result in incidental contact with water, such as boating, fishing and wading. Fish consumption is not a designated use in Kentucky water quality standards, but the use is implied in 401 KAR 10:031 Section 2 and through human health criteria in Section 6.

2. Designated Uses Impairment Status

Section 305(b) of the Clean Water Act requires Kentucky and other states to assess and report water quality conditions to EPA every two years. Streams are assessed to determine whether they support their designated uses. Based on assessment results, each stream receives one of three classifications to denote relative level of designated use support: fully supporting (good to excellent water quality, meeting); partially supporting (fair water quality, impaired); and non-supporting (poor water quality, impaired).

Kentucky assigns surface waters to reporting categories based on the results of the assessment. Category 1 waters are fully supporting all applicable designated uses. Category 2 waters are fully supporting assessed designated uses, but not all uses have been assessed (2), the water is proposed to EPA for delisting but not yet approved (2B), or the waterbody is meeting water quality criteria and has a TMDL (2C). Category 3 waters have not yet been assessed because of no data or insufficient data. Category 4 waters are impaired but have an approved TMDL (4A), an approved alternative pollution control plan (4B), or the impairment is not attributable to a pollutant (4C). Category 5 waters are impaired, and the cause of impairment is a pollutant. These waters make up the 303(d) list and require a TMDL.

Currently, Sandlick, Dry Fork, and Crafts Colly watersheds assessments have not been completed, and therefore they not on either the 305(b) or 303(d). All streams are Category 3 because they are unassessed. However, it is anticipated that some streams will be listed as impaired because of stream sampling for this project.

O. Summary and Conclusions

Streams within the Dry Fork, Sandlick Creek, and Crafts Colly watersheds are expected to be listed as impaired for WAH and PCR due to sampling performed in support of this project. The assessments have not yet been completed. This watershed characterization indicates the following factors may be contributing to impairments:

- <u>Geomorphic stream conditions:</u> Streams in these watersheds tend to be incised, entrenched, and over-widened. These entrenched streams contribute to increased erosion and sedimentation. This also increases the frequency of dry streams and the severity of flood events.

- Houses along the floodplain: Much of the development in the watershed has occurred near the streams and waterways due to the steepness of the surrounding terrain. Almost all roadways crisscross along streams in the area. The location of these properties and infrastructure may make stream restoration efforts challenging.
- Riparian Buffers: Over half of the streams have a heavily impacted riparian buffer of less than 10 feet on either bank. These buffers are important for habitat, water quality protection, stabilization, and detrital input.
- Mine drainage: 13 mine drainage locations have been identified in the watershed area. AMD can contribute to impairments in waterbodies, so finding treatment solutions for these sources will be an important part of implementation planning.
- Septic Systems and Straight Pipes: Most of the watershed area is unsewered. A recent sewer project extended sanitary sewer service to part of Crafts Colly. However, another $3.3 million would be required to extend service to Crafts Colly tributaries in the lower half of the watershed and to residences in Sandlick Creek. Additional projects would be required to address Dry Fork and the headwaters of Crafts Colly and Company Branch. Soils are “very limited” for septic tank absorption suitability and straight pipes are known to occur throughout the area. Failing septic system and straight pipes are a source of bacterial contamination for waterways.
- Pet ownership and Wildlife: Large pet and wildlife populations may contribute to bacteria loadings in the watershed.
- Oil and gas wells: Potential pollution sources may be produced during oil and gas extraction from the 123 wells located in the watershed, primarily in Sandlick Creek.

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Chapter III: Monitoring

A. Historic Water Quality and Biological Monitoring Overview

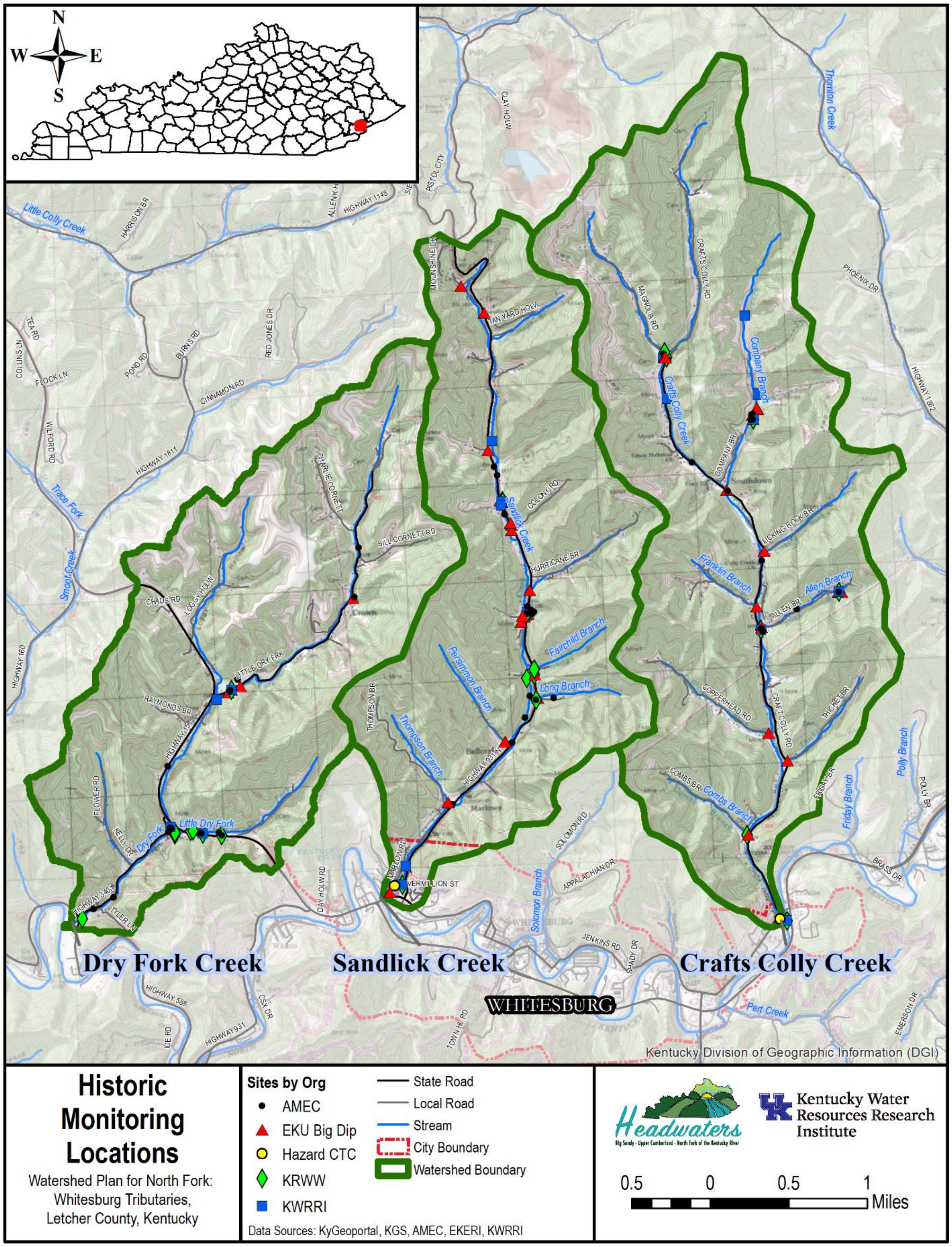
In order to evaluate the water quality within the North Fork Kentucky Watersheds, historic data was gathered from scientific research, government entities, and volunteer sources. There were eleven studies that were conducted in the North Fork Watersheds, with nine of the studies being quantitative water sampling projects, and two of the studies being qualitative sociopolitical projects. An overview of the quantitative studies is located in Table 3.1. A summary of the sampling locations is found in Figure 3.1. Eastern Kentucky University, Kentucky Water Resources Research Institute, Eastern Kentucky PRIDE, Kentucky River Watershed Watch, Hazard Community and Technical College, and AMEC, each conducted monitoring in the North Fork Watersheds from 2000 to the present. Each of the studies are summarized in the sections that follow.

Table 3.1: North Fork Kentucky River Watershed Monitoring Data Summary

Sampling Organization	Monitoring Type/Source	Stations Sampled	# of Sampling Events	Year(s) Sampled	Physicochemical	Bacteria	Nutrients	Metals
KRWW	Volunteer Routine Sampling	13	1 to 27	1998-2017	X	X	X	X
KWRRI / PRIDE	Volunteer Sampling	10	3 to 6	2001	X	X	X	X
KRWW	Volunteer Fecal Sampling	2	5	2003	X	X		
HCTC / PRIDE	Volunteer Sampling	2	10	2005	X	X		
EKU	"Big Dip" Sampling	41	1	2006	X		X	
KRWW	Volunteer Acid Mine Drainage Sampling	14	1 to 6	2006-2007	X		X	X
KWRRI	North Fork Watershed Heavy Metals Research	14	1	2011	X			X
AMEC	Phase II Environmental Assessment	40	2	2010-2011	X			X
EKU	"Big Dip Redux" Sampling	6	1	2016	X			

NOTE: AMEC = AMEC Engineering Consultants, EKU = Eastern Kentucky University, HCTC = Hazard Community and Technical College, KRWW = Kentucky River Watershed Watch, KWRRI = Kentucky Water Resources Research Institute, and PRIDE = Eastern Kentucky PRIDE

Figure 3.1: Historic Monitoring Locations



B. Sampling Project Summaries

1. Water-Related Public Surveys

Two reports focused on water quality, public health, public surveys, and civic action have been published by Eastern Kentucky University since 2000. These reports included feedback from surveys and interviews that were conducted with local residents in Letcher County to better understand water quality concerns in the area.

Banks, Jones, and Blakeney (2003 and 2005) of EKU's Center for Appalachian Studies began the Letcher County Headwaters Project with the objective "to expand and improve Letcher County's civic capacity by developing tools that will help citizens and community leaders better understand and monitor how land use decisions—from straight-piping household waste to large scale mining and timber activities—affect water quality, and subsequently the county's public health, natural environment, and stable economic future." The reports detail the historical roots of the current water quality problems, provide tools to communicate the water quality data to students, and include surveys of Letcher County health practitioners and interviews with residents about water quality issues.

Blakeney and Marshall (2009) sought to identify critical links between water quality and human occupations in the watershed by mapping the watershed, surveying Letcher County health professionals, and interviewing Letcher County adults regarding their lived experiences with water. They found that citizens experience occupational imbalance, deprivation, and alienation as a result of water pollution due to specific coal mining practices and a lack of infrastructure.

2. Kentucky River Watershed Watch, 1998 - 2017

Kentucky River Watershed Watch (KRWW) is a volunteer monitoring organization that has conducted numerous sampling events in the watersheds of the Whitesburg tributaries of the North Fork Kentucky River (NFKY River). Thirteen stream sites have been sampled in these watersheds since 1998, as summarized in Table 3.2 and shown in Figure 3.2. Each site was sampled between one and 27 times over this period. The results are summarized in Table 3.3

Most sampling locations had elevated results for one or more pollutants. Many locations showed elevated *E.coli* concentrations, with recent results in Company Branch of Crafts Colley Creek showing the highest geometric mean concentration (1722 cfu/100 ml). Field conductivity was found to be extremely elevated in numerous locations, frequently measuring above 1000 µS/cm. Aluminum, iron, and sulfate were also frequently above benchmark levels, while copper, lead, nickel, and zinc concentrations exceeded benchmarks protecting warmwater aquatic habitat use for at least one location.

Figure 3.2: Watershed Watch Monitoring Locations

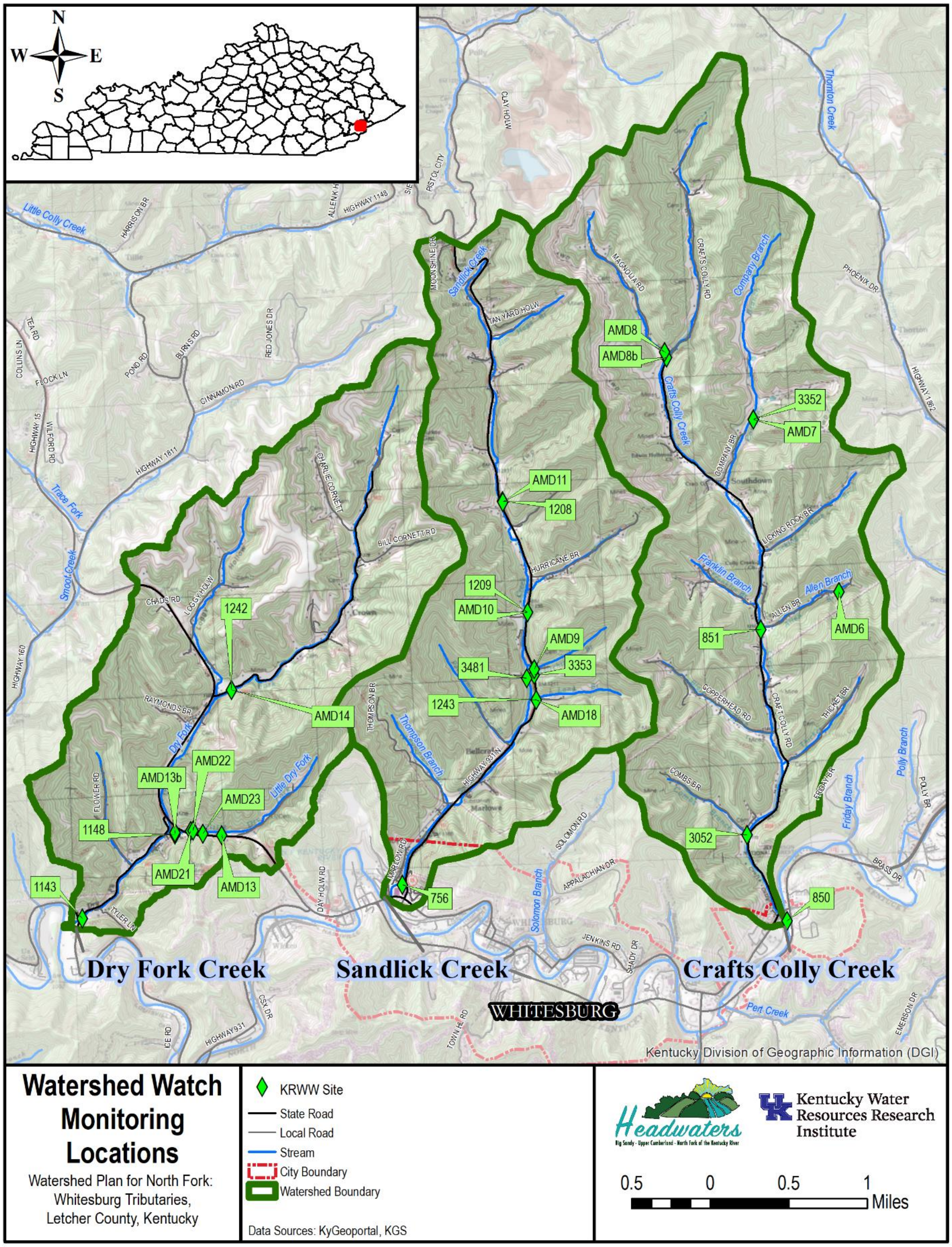


Table 3.2 - KRWW Monitoring Site Summary for North Fork Whitesburg Tributaries, 1998-2017

Site ID	Watershed Name	Stream name	Site Location	Latitude	Longitude
1143	Dry Fork	Dry Fork	Mouth of Dry Fork	37.1214	-82.874
1148	Dry Fork	Little Dry Fork	At the mouth, above culvert, via Lion Drive	37.1289	-82.863
1242	Dry Fork	Dry Fork	Acid Mine Drainage entering Dry Fork near Horns on Little Dry Fork Rd (aka Crown)	37.14209	-82.856
756	Sandlick Creek	Sandlick Creek	Near mouth at Caudilltown	37.1236	-82.837
1208	Sandlick Creek	Sandlick Creek	Beside fire department	37.15871	-82.8241
1209	Sandlick Creek	Sandlick Creek	Acid Mine Drainage across from Rainbow Drive, sampled just above culvert at confluence of two streams	37.1484	-82.8215
1243	Sandlick Creek	Long Branch	Near mouth just above Hwy 931 N culvert by Refuse Dr.	37.1403	-82.8209
3353	Sandlick Creek	Fairchild Branch	At mouth of Sandlick Creek.	37.14261	-82.821
3481	Sandlick Creek	Sandlick Creek	About 100 ft south of Sparrow Drive.	37.14233	-82.8219
850	Crafts Colly Creek	Colley Creek	Mouth beside Ermine Post Office below bridge.	37.11917	-82.7928
851	Crafts Colly Creek	Allen Branch	Mouth of Allen Branch.	37.14611	-82.7947
3052	Crafts Colly Creek	Combs Branch	Just off Crafts Colly	37.12723	-82.7971
3352	Crafts Colly Creek	Company Branch	At mouth before Craft's Colley	37.16556	-82.7948

Table 3.3 - KRWW Monitoring Results Overview for North Fork Whitesburg Tributaries, 1998-2017

Site ID	Stream	# of samples	Years Sampled	Average Field Conductivity (µS/cm)	Geomean *E. coli* (#/100mLs)	Other Water Quality Exceedances
1143	Dry Fork	13	2006-2017	1162	280	**Iron, Sulfate** (DWS)
1148	Little Dry Fork	9	2006-2015	1785	131	**Iron** (DWS, WAH-chronic & acute)
1242	Dry Fork	4	2007-2016	1330	No data	**Iron** (DWS, WAH-chronic & acute)
756	Sandlick Creek	16	1998-2017	931	266	**Aluminum** (USEPA WAH), **Iron** (DWS, WAH-chronic), **Sulfate** (DWS)
1208	Sandlick Creek	1	2006	1062	No data	**Iron** (DWS, WAH-chronic & acute)
1209	Sandlick Creek	4	2006-2016	1884	10	**Aluminum** (USEPA WAH), **Copper** (WAH-acute & chronic), **Iron** (DWS, WAH-acute & chronic), **Lead** (WAH-chronic), **Nickel** (DWS, WAH-acute & chronic), **Zinc** (DWS, WAH - acute & chronic), **Sulfate** (DWS)
1243	Long Branch	6	2007-2017	1527	24	**Chromium** (WAH-chronic), **Copper** (WAH-acute & chronic), **Iron** (DWS, WAH-chronic), **Nickel** (WAH-chronic), **Zinc** (DWS, WAH-acute & chronic), **Sulfate** (DWS)
3353	Fairchild Branch	2	2014-2016	1120	460	**Iron (DWS, WAH-chronic & acute), Nickel (DWS, WAH-acute & chronic), Zinc (DWS, WAH-acute & chronic), Sulfate (DWS)**

Table 3.3 - KRWW Monitoring Results Overview for North Fork Whitesburg Tributaries, 1998-2017 (continued)

Site ID	Stream	# of samples	Years Sampled	Average Field Conductivity (µS/cm)	Geomean *E. coli* (#/100mLs)	Other Water Quality Exceedances
3481	Sandlick Creek	2	2016-2017	730	914	**Aluminum** (USEPA WAH), **Iron** (DWS)
850	Colly Creek	27	2002-2017	718	531	**Iron** (DWS), **Total Nitrogen** (KRWW WAH), **Sulfate** (DWS)
851	Allen Branch	5	2006-2015	651	51	**Aluminum** (EPA WAH), **Iron** (DWS), **Sulfate** (DWS)
3052	Combs Branch	1	2011	210	No data	None
3352	Company Branch	2	2014-2015	610	1722	None

3. Kentucky Water Resources Research Institute and Eastern Kentucky PRIDE, 2001

In 2001, through funding from Personal Responsibility in a Desirable Environment (PRIDE), the Kentucky Water Resources Research Institute (KWRRI) was tasked with creating a baseline data set for watersheds in Eastern Kentucky. Of the data collected, 10 sites were within the NFKY River watersheds of interest. Volunteers collected a total of 54 samples, testing for field physical / chemical data, fecal coliforms, and acid mine drainage (AMD) samples. Field data included flow, water temperature, pH, and dissolved oxygen. AMD samples included acidity, alkalinity, aluminum, chlorine, total and dissolved iron, total and dissolved manganese, dissolved magnesium, dissolved potassium, and sulfates. Table 3.4 breaks down what types of samples were taken at each location, and the locations are shown in Figure 3.3. Table 3.5 shows the average field and AMD results.

Table 3.4 – KWRRI PRIDE Sampling Summary, 2001

Site ID	Watershed	Latitude	Longitude	Field Data	Fecal Bacteria Samples	AMD Samples	Total # of Samples
KL2	Little Dry	37.1412	-82.8577	3		3	3
KL3	Sandlick	37.1643	-82.8250	3		3	3
KL4	Crafts Colly	37.1715	-82.8050	3		3	3
KL5	Crafts Colly	37.1680	-82.7942	3		3	3
KL6	Crafts Colly	37.1678	-82.7942	3		3	3
KL8	Crafts Colly	37.1677	-82.8047	3		3	3
KL9	Crafts Colly	37.1750	-82.7900	3		3	3
K114	Crafts Colly	37.1192	-82.7928	2	2		2
K115	Crafts Colly	37.1461	-82.7947	3	2		3
KP18	Sandlick	37.1253	-82.8365		3		3

Figure 3.3: KWRRI Monitoring Locations

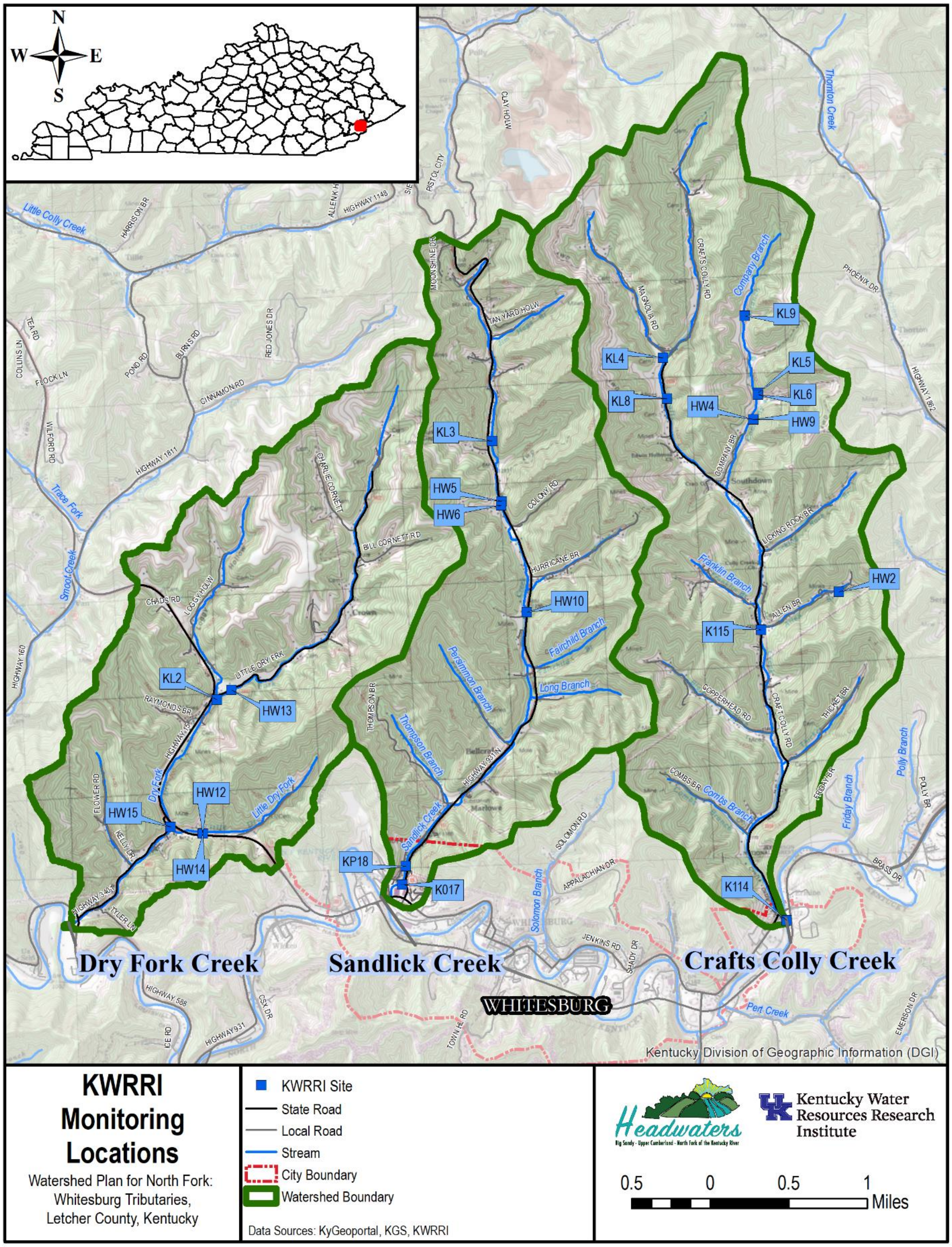


Table 3.5 – Average KWRRI PRIDE Metals Sampling Results, 2001

Site ID	pH (SU)	DO (mg/L)	Conductivity (µs/cm)	TDS (mg/L)	Acidity (mg/L)	Alkalinity (mg/L)	Aluminum (mg/L)	Chlorine (mg/L)	Total Fe (mg/L)	Dissolved Fe (mg/L)	Total Mn (mg/L)	Dissolved Mn (mg/L)	Dissolved Mg (mg/L)	Dissolved K (mg/L)	Sulfates (mg/L)
KL2	7.0	8.3	1691	846	0	365	0.01	15.7	0.49	0.05	0.35	0.34	28.6	8.4	538
KL3	6.0	2.7	1252	627	0	299	0.01	6.13	3.96	<0.01	0.64	0.53	31.6	8.0	223
KL4	3.7	5.3	667	334	50	0	3.75	5.47	8.68	3.19	0.81	0.75	25.3	5.7	253
KL5	6.6	8	1026	514	0	121	0.70	4.73	3.21	0.03	0.84	0.25	51.1	9.4	502
KL6	6.3	9	1045	523	0	118	0.02	3.6	0.48	0.03	0.46	0.4	51.3	8.7	503
KL8	2.7	11	1204	603	225	0	27.9	7.87	2.54	1.62	3.2	3.1	57.5	5.4	773
KL9	6.2	9.7	1040	521	1.8	33	13.3	5.47	0.63	0.05	1.3	1.26	54.9	8.6	595

Based on the data collected by the volunteers, it was determined the **alkalinity** in each of the sites except for KL4 and KL8 was high. Reference reaches in the area have alkalinity concentrations averaging 19 mg/L. Four sites averaged over 100 mg/L. **Dissolved iron** was elevated at KL4 and KL8, both on Crafts Colly Creek below Magnolia Rd. KL4 and KL8 had dissolved iron levels of 3.19 mg/L and 1.62 mg/L respectively, as compared to regulatory criteria of 1 mg/L. These sites also had low alkalinity and pH. **Aluminum** concentration at sites KL4, KL5, KL8, and KL9, all on Craft Colly Creek and its tributaries, ranged from 0.704 to 27.87 mg/L as compared to the aquatic criteria of only 0.087 mg/L. **Chlorine** was high at all locations.

Only three sites were tested for **fecal coliform**. These sites had particular interest due to the number of straight pipes and non-functioning septic tanks in the area. Of these three locations, KP18, located on Sandlick Creek, showed extremely high concentrations, averaging 45,000 fecal coliforms per 100 mL. K114 and K115 averaged, 483 and 150 colonies/100 mL, respectively.

4. Kentucky River Watershed Watch Fecal Monitoring, 2003

In 2003, KRWW conducted focused fecal monitoring study in the Kentucky River Watershed. Several samples were taken throughout the entire Kentucky River Watershed, but only two sites were within the project area. These sites were each monitored five times for flow rate, turbidity, oxygen, pH, conductivity, temperature, fecal coliform, total dissolved solids, salinity, dissolved oxygen, and oxidation reduction potential. Samples were taken once a week for five weeks. Table 3.6 provides the averages for each site. The sampling locations are shown in Figure 3.2

Table 3.6 - Summary of KRWW's 2003 Fecal Focused Monitoring Study

Site ID	Latitude	Longitude	Flow Rate (0-5)	Turbidity (0-3)	Oxygen (mg/L)	pH (SU)	Cond (µS/cm)	Fecal Coliform (#/100mL)	Total Dissolved Solids (mg/L)
K114	37.1192	-82.7928	2.4	0.4	7.6	7.76	922.8	1148	600
K017	37.1236	-82.8370	3	0.2	8.4	8.08	1130.2	1312	735

Site K114 was located at the mouth of Colley Creek, and site K017 was located near the mouth of Sandlick Creek. Samples at these sites exceeded the regulatory limits of fecal coliform for both swimming and wading use. This can most likely be attributed to reports of many straight pipes and failing septic tanks in the area. Conductivity and total dissolved solids concentrations were also high at these locations.

5. Hazard Community and Technical College, 2005

In 2005, students from the Hazard Community and Technical College, led by Brian Stewart, collected data on streams to help support the PRIDE project mentioned above. This was called the Kentucky River Quality Monitoring (KRQM) project. Two of the 19 sites that they sampled fell within the three watersheds of interest for this project. KP19 is located at the mouth of Sandlick Creek and KL4 is located at the mouth of Crafts Colly Creek. These samples were tested for temperature, dissolved oxygen, pH, conductivity, turbidity, and fecal coliforms. Data was even collected on the width of the stream, the velocity, the discharge, and the depth. At each site, 5 samples were taken over a period of two months. Table 3.7 displays the average results of the five samples at each site.

Table 3.7: Summary of Data from KRQM Study, 2005

Site ID	Latitude	Longitude	Discharge (ft3/s)	Temp (C)	D.O. (mg/L)	pH (SU)	Cond (µS/cm)	Turbidity (NTU)	Fecal Coliform (cfu/100mL)
KP19	37.12354	-82.83788	3.67	20.86	8.95	8.00	976.20	4.47	758.00
KL4	37.11935	-82.79359	2.38	22.92	9.05	8.10	813.20	3.34	322.00

Based off the data from this study, both sites have reasonably good water quality. Fecal coliform levels are above the 200 cfu/100mL recommended for primary contact recreation (i.e. swimming), however they are well below the 1000 cfu/100mL threshold for secondary contact (i.e. boating). Conductivity levels are somewhat high for this region.

6. Eastern Kentucky University's Big Dip Project, 2006

In 2006, Eastern Kentucky Environmental Research Institute (EKERI) took on a large sampling project coined the "Big Dip" to create baseline observations for 917 headwater streams in Eastern Kentucky for future projects. Of these sites, 42 were located within the North Fork Whitesburg Tributaries watershed area. Four sites (A56-59) were along Dry Fork, 21 sites (E24-E42) were on Sand Lick Creek and its tributaries, and 16 sites (H71-H85) were on Crafts Colly Creek and its tributaries. These locations are shown in Figure 3.4. Volunteers sampled for pH, conductivity, temperature, alkalinity, hardness, nitrite, nitrate, and iron. EcoCheck 5-in-1 test strips were used to measure pH, alkalinity, hardness, nitrite, and nitrate. Iron was measured using LaMotte test tabs, and a YSI 556 multi-probe was used to read parameters including temperature, conductivity, pH and dissolved oxygen. The sampling for this project occurred during the summer of 2006. Flow and turbidity were recorded on a visual scale. Summaries of the results may be found online at Eastern Kentucky University's Environmental Sustainability & Stewardship webpage (env.eku.edu).

Table 3.8 represents the data that was collected from this sampling project. Eight samples taken during the Big Dip project exceeded the regulatory limits for pH. Five sites located along Sand Lick Creek (all near Sandlick Creek Road) and three on Crafts Colly Creek (located along Allen Branch) showed levels that were below a pH of 6. In particular, site E34B, an acid mine drainage site, had a pH of 2.7. Test strip results for alkalinity at ten sites were below 20 ppm which may indicate a lack of buffering is present in some areas. Test strip data for iron levels at 15 sites tested above the criteria for warm water habitats (1 ppm). The majority of conductivity levels showed degradation (above 300 µS/cm), with ten sites showing severe impacts from conductivity (>1000 µS/cm).

Figure 3.4: EKU "Big Dip" Monitoring Locations

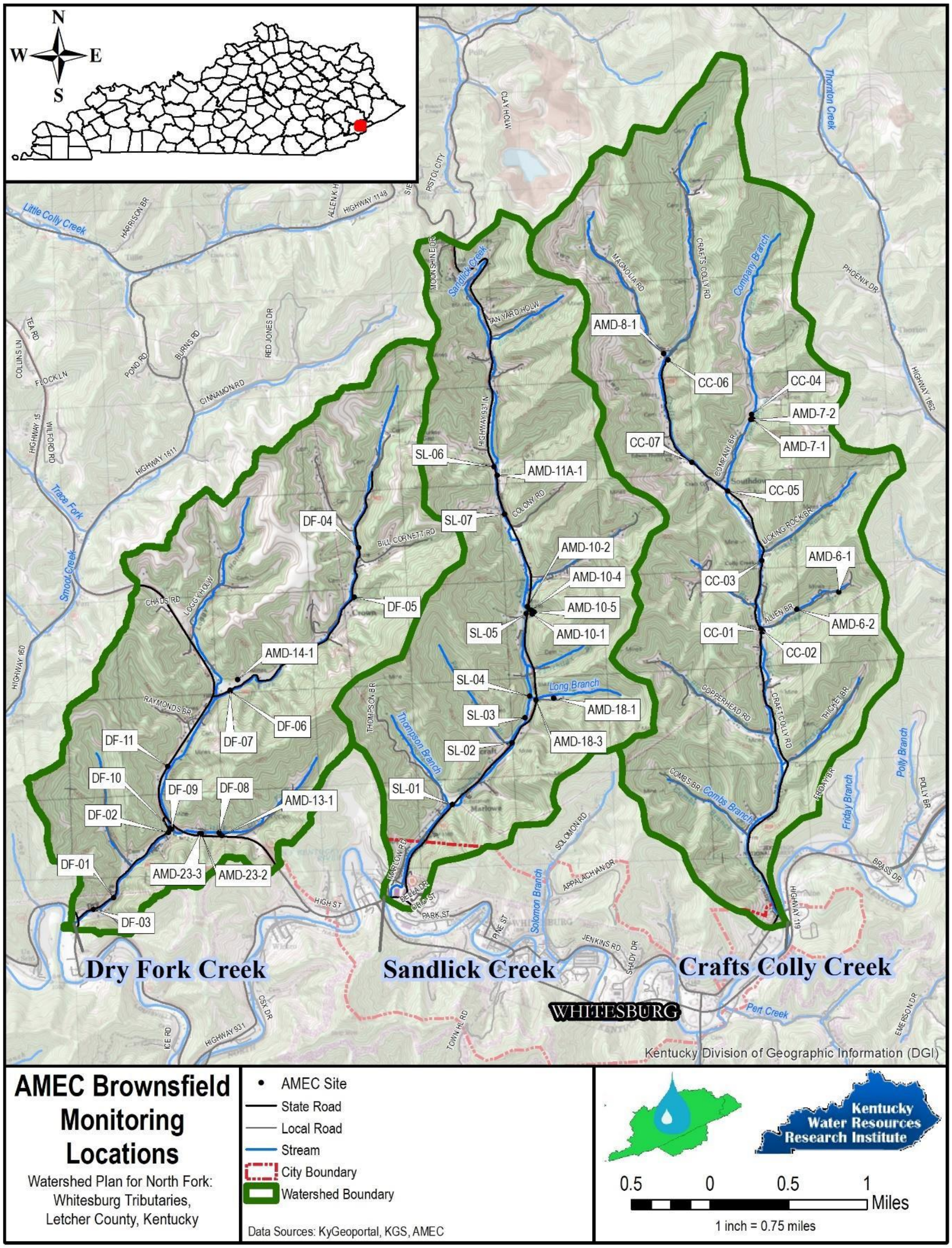


Table 3.8: "Big Dip" Sampling Locations Within North Fork Tributary Watersheds, 2006

Site ID	Date	Latitude	Longitude	Temp (C)	Cond (µS/cm)	pH	Alkalinity (mg/L)	Hardness (mg/L)	Nitrate (mg/L as NO3)	Iron (mg/L)
A56	6/17	37.150193	-82.841607	23.1	610	8.6	300	300	20	1
A57	6/17	37.142430	-82.854933	22.0	521	7.9	720	300	40	3
A58	6/17	37.142093	-82.855983	14.7	1336	7.3	720	0	20	8
A59	6/17	37.141843	-82.856347	15.7	1267	7.1	720	300	10	5
E24	6/19	37.178720	-82.828043	17.0	520	7.5	100	200	0	4
E25	6/19	37.176183	-82.825477	18.0	540	7.7	120	400	40	0
E26	6/19	37.163447	-82.825497	18.0	690	7.7	300	300	1	0
E27	6/19	37.158800	-82.824273	13.0	940	6.0	600	150	0	10
E28	6/19	37.158647	-82.824027	14.0	930	6.5	200	200	0	10
E28b	7/15	37.158713	-82.824070	14.0	913	6.7	400	300	0	7
E29	6/19	37.156507	-82.823067	15.0	920	7.0	720	200	0	5
E30	6/19	37.156000	-82.823063	19.0	500	7.7	100	250	2	0
E31	6/19	37.156670	-82.823167	20.5	680	7.7	300	250	0	1
E32	6/19	37.150430	-82.821197	19.0	600	7.8	120	250	2	0
E33	6/19	37.148250	-82.821453	16.0	1990+	5.0	0	75	20	10+
E34	6/19	37.148190	-82.821727	17.0	1990+	3.5	0	25	20	10+
E34b	7/15	37.148400	-82.821540	17.9	2292	2.7	0	10	40	10
E35	6/19	37.148127	-82.822037	20.0	770	7.9	600	300	1	1
E36	6/19	37.147980	-82.821907	18.0	270	6.5	60	50	0	9
E37	6/19	37.147500	-82.822310	20.0	880	6.5	120	400	10	5
E38	6/19	37.142607	-82.820907	25.0	1600	5.0	0	1000	20	1
E39	6/19	37.140440	-82.820670	23.0	1370	5.0	0	900	5	1
E40	6/19	37.136507	-82.824577	24.0	340	6.8	20	150	0	0
E41	6/19	37.131063	-82.831363	22.0	1280	7.5	180	1000	0	1
E42	6/19	37.122960	-82.838430	22.0	1000	7.7	120	300	1	1
H71	7/13	37.127217	-82.796883	19.6	293	7.4	150	100	0	0.2
H72	7/13	37.133927	-82.792077	21.2	330	8.1	200	125	5	0.35
H73	7/13	37.136527	-82.794170	20.6	390	8.0	120	50	8	0
H74	7/13	37.149383	-82.785540	14.1	661	3.5	0	150	5	0.1
H74b	7/16	37.149393	-82.785570	14.4	661	3.5	0	75	0	0
H75	7/13	37.149320	-82.785230	19.4	316	7.2	150	100	2	0.1
H76	7/13	37.146287	-82.794613	17.9	647	5.1	0	300	10	0.1
H77	7/13	37.148247	-82.795097	20.9	451	7.8	120	150	1	0.1
H78	7/13	37.153347	-82.794047	21.5	450	8.2	40	150	0	0.1
H79	7/13	37.159120	-82.798097	19.1	797	7.7	40	1000	2	1
H80	7/13	37.171560	-82.804783	19.8	946	7.6	120	700	2	2
H81	7/13	37.171543	-82.804730	20.8	1416	7.8	200	1000	1	0.1
H82	8/3	37.166473	-82.794260	22.0	890	7.5	100	500	0	1
H83	8/3	37.166620	-82.794360	26.0	890	7.3	80	500	0	2
H84	8/3	37.165940	-82.794923	19.0	920	<5	0	300	0	0
H85	8/3	37.165553	-82.794827	17.0	870	<5	0	300	2	1

7. AMEC Phase II Environmental Site Assessments, 2010-11

In 2008, the Letcher County Conservation District (LCCD) received a Brownfield Petroleum and Hazardous Substances Assessment Grant through the U.S. Environmental Protection Agency. LCCD decided to begin a new project that would evaluate watersheds in the area that are affected by acid mine drainage sites. To begin the project, LCCD hired AMEC Earth and Environmental Consultants to collect samples from sites across the county to further expand the on the data collected in the KRWW Acid Mine Drainage study conducted in 2006 and 2007 (AMEC 2011a-f). Table 3.11 displays the data that was collected in two separate samplings in 2010 and 2011 under a Brownfield Grant. The sampling locations are shown in Figure 3.5.

Acid mine drainage sites typically had pH levels below the regulatory minimum of 6 SU and no alkalinity detections. Conductivity levels frequently exceeded 1,000 µs/cm. Total iron frequently exceeded the acute regulatory criteria for warm water aquatic habitat use at 4 mg/L. Aluminum, magnesium, and sulfate concentrations were also regularly high, although these have no regulatory criteria. Beryllium, chromium, nickel, zinc, and mercury all had exceedances of regulatory criteria at one or more AMD sites. These elevated levels were also detected to a lesser degree in the streams and tributaries downstream, with Dry Fork showing elevated iron and mercury levels and Sandlick Creek and Crafts Colly Creek with high nickel and zinc.

Figure 3.5: AMEC Brownfield Monitoring Locations

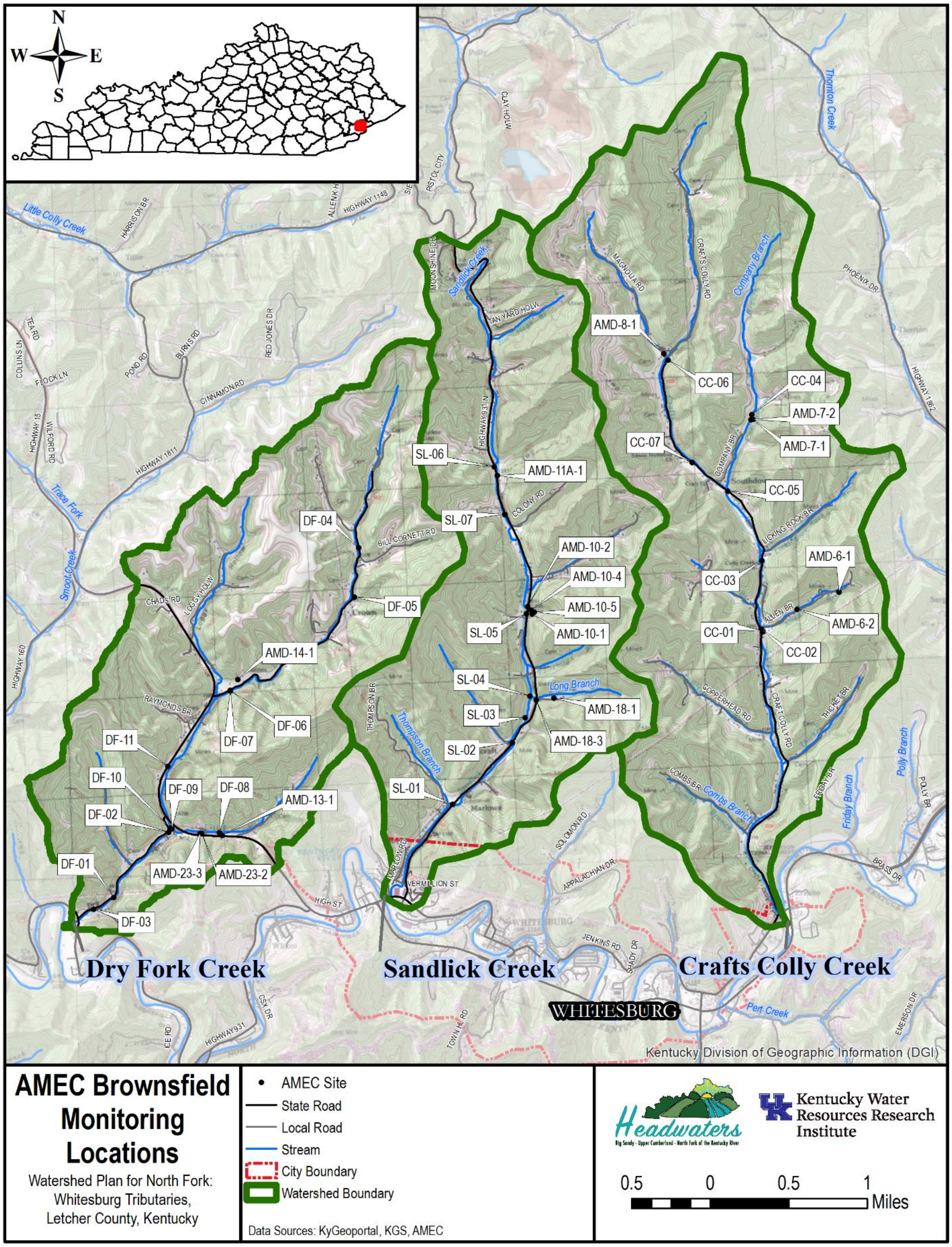


Table 3.9: AMEC Acid Mine Drainage Studies, 2008

Site ID	pH (S.U.)	Alkalinity (mg/L)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Total Aluminum (mg/L)	Total Iron (mg/L)	Total Magnesium (mg/L)	Total Manganese (mg/L)	Sulfate (mg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Zinc (µg/L)	Mercury (µg/L)
AMD-6-1	3.7	0	7.6	715	0	7.5	0.2	35	0.6	329	14	2	0	0	30	14	74	0	140	0
AMD-6-2	4.7	0	11.0	626	5	5.4	0.1	34	0.9	326	27	2	0	0	30	5	67	0	134	0
AMD-7-1	3.5	0	8.2	940	0	17.4	2.9	53	2.0	474	0	3	0	0	65	19	138	0	325	0
AMD-7-2	6.4	63	11.3	908	33	2.7	1.0	48	0.8	421	21	0	0	0	0	0	30	0	65	0
AMD-8-1	7.4	109	5.5	763	20	0	7.5	19	0.3	136	77	0	0	0	0	0	0	0	0	0.027
AMD-10-1	3.6	0	12.7	690	-	25.0	8.4	91	2.4	885	-	6	-	8.5	-	12	264	5.9	501	0
AMD-10-2	3.6	0	11.0	1686	3	20.4	5.2	115	3.1	1049	18	5	0	0	213	15	253	4.3	515	0
AMD-10-4	3.4	0	6.7	1917	-	18.9	4.3	154	1.8	1260	-	5	-	0	-	42	250	6.4	503	0
AMD-10-5	3.5	0	7.6	1891	-	17.6	2.2	145	1.7	1340	-	4	-	0	-	37	234	5.8	463	0
AMD-11A-1	-	-	-	-	19	0	18.4	22	0.2	152	88	0	0	0	0	0	0	0	0	0
AMD-13-1	7.3	320	2.4	1665	10	0	7.7	33	0.7	603	29	0	66	0	0	0	0	0	0	0.115
AMD-14-1	7.0	350	7.2	1259	4	0	4.6	35	0.4	405	23	0	63	0	0	0	0	0	0	0
AMD-18-1	5.2	0	11.0	504	4	2.3	0.1	29	1.8	261	21	0	0	0	42	0	81	0	192	0
AMD-18-3	6.0	10	9.7	664	3	0	0.3	47	1.1	328	26	0	0	0	0	0	49	0	99	0
AMD-23-2	7.5	300	10.2	1697	21	0	12.6	25	1.1	655	16	0	87	0	0	0	0	0	0	0.030
AMD-23-3	7.6	295	9.3	1694	18	0	11.7	25	1.0	636	16	0	86	0	0	0	0	0	0	0

NOTE: Yellow values indicate one or more samples exceeded regulatory criteria. Results are averages of two sampling events. All results that were less than the method detection limits were averaged with a zero value.

Table 3.9: AMEC Acid Mine Drainage Studies, 2008 (continued)

Site ID	pH (S.U.)	Alkalinity (mg/L)	Dissolved Oxygen (mg/L)	Specific Conductivity (µS/cm)	Total Suspended Solids (mg/L)	Total Aluminum (mg/L)	Total Iron (mg/L)	Total Magnesium (mg/L)	Total Manganese (mg/L)	Sulfate (mg/L)	Barium (µg/L)	Beryllium (µg/L)	Boron (µg/L)	Chromium (µg/L)	Cobalt (µg/L)	Copper (µg/L)	Nickel (µg/L)	Selenium (µg/L)	Zinc (µg/L)	Mercury (µg/L)
CC-01	7.2	33	10.9	884	4	0	0.2	55	0.5	424	44	0	0	0	0	0	27	0	45	0
CC-02	6.8	22	10.4	770	0	0.5	0	33	0.6	387	30	0	0	0	0	0	35	0	76	0
CC-03	7.2	29	10.9	817	28	2.2	1.3	41	1.2	362	37	0	0	0	0	0	36	0	86	0
CC-04	6.9	64	10.9	945	32	1.7	1.1	49	0.6	460	22	0	0	0	0	0	15	0	30	0
CC-05	7.5	48	10.8	866	34	2.8	1.6	50	1.2	448	25	0	0	0	0	0	45	0	89	0
CC-06	8.0	109	11.2	1123	25	0.8	1.2	87	0.1	483	73	0	0	0	0	0	0	0	24	0
CC-07	7.6	58	11.3	1067	16	2.0	1.1	81	0.9	498	52	0	0	0	0	0	25	0	39	0
DF-01	8.1	182	11.5	936	0	0	0.4	34	0.1	305	39	0	0	6.7	0	0	0	0	0	0.055
DF-02	8.2	214	12.1	972	3	0	1.3	35	0.2	340	32	0	0	0	0	0	0	0	0	0.027
DF-03	8.3	249	12.7	1268	4	0	0.5	39	0.1	437	38	0	52	0	0	0	0	0	0	0
DF-04	8.1	154	11.2	807	19	0.7	0.9	39	0.1	256	69	0	0	0	0	0	0	0	0	0.074
DF-05	8.1	96	11.9	623	0	0	0.1	34	0.0	234	60	0	0	0	0	0	0	0	0	0
DF-06	7.4	217	9.2	963	6	0	4.0	34	0.3	317	30	0	52	0	0	0	0	0	0	0
DF-07	7.3	348	6.2	1337	6	0	4.0	35	0.4	437	23	0	62	0	0	0	0	0	0	0.051
DF-08	7.5	131	9.8	769	0	0	0.5	55	0.1	256	45	0	0	0	0	0	0	0	0	0
DF-09	8.0	243	10.9	1436	4	0	4.6	30	0.7	489	20	0	77	0	0	0	0	0	0	0.031
DF-10	8.5	197	12.8	946	0	0	0.2	40	0.0	369	32	0	0	0	0	0	0	0	0	0
DF-11	8.1	193	12.3	968	0	0	0.2	41	0.1	340	31	0	0	0	0	0	0	0	0	0
SL-01	8.2	126	11.4	1027	4	0	0.4	58	0.7	378	40	0	0	0	0	0	23	0	25	0
SL-02	8.0	137	11.9	1069	10	1.5	1.4	60	1.2	430	38	0	0	0	0	0	36	0	53	0
SL-03	7.7	140	11.4	1089	18	2.5	2.2	59	1.3	447	39	0	0	0	0	0	38	0	64	0
SL-04	7.2	155	10.9	1091	29	3.9	3.5	55	1.2	442	42	0	0	0	25	0	37	0	68	0
SL-05	7.4	184	11.2	1032	13	2.3	0.8	38	0.4	360	42	0	59	0	0	0	28	0	62	0
SL-06	7.2	165	7.8	640	3	0	0.1	22	0.0	176	64	0	0	0	0	0	0	0	0	0
SL-07	6.8	244	9.6	1039	10	0	4.3	36	0.5	311	31	0	56	0	0	0	0	0	0	0

NOTE: Yellow values indicate one or more samples exceeded regulatory criteria. Results are averages of two sampling events. All results that were less than the method detection limits were averaged with a zero value.

8. KWRRI Heavy Metal Sampling, 2011

In 2011, KWRRI collected data across the entire Kentucky River Basin. The study targeted all tributaries to the North Fork of the Kentucky River for testing of the following heavy metals: arsenic, barium, chromium, lead, mercury, nickel, selenium and zinc. Ten sample locations fall within the watersheds of the three Whitesburg tributaries and are summarized in Table 3.10. The locations are shown in Figure 3.2.

Table 3.10: KWRRI Heavy Metal Sampling Results, 2011

Site ID	Date	Latitude	Longitude	DO (mg/L)	Cond (µS/cm)	pH (SU)	As (mg/L)	Ba (mg/L)	Pb (mg/L)	Hg (mg/L)	Ni (mg/L)	Se (mg/L)	Zn (mg/L)
HW2	11/20	37.14939	-82.78557	8.6	330	5.5	<0.0005	0.022	0.0011	<0.0002	0.0397	<0.001	0.07
HW4	11/21	37.16555	-82.79483	10.4	1360	<7.0	<0.0005	0.025	0.0020	0.0003	0.0108	<0.001	0.02
HW5	11/22	37.1587	-82.82414	1.4	1530	<6.0	0.0022	0.028	0.0024	<0.0002	0.0022	<0.001	<0.01
HW6	11/23	37.15832	-82.82423	5.2	1530	6.5	0.0090	0.034	0.0025	<0.0002	0.0027	<0.001	<0.01
HW9	11/26	37.16555	-82.79483	10.4	1360	<7.0	<0.0005	0.026	0.0022	0.0002	0.0120	0.001	0.02
HW10	11/27	37.1484	-82.82166	-	>1990	<5.0	0.0027	0.008	0.0034	<0.0002	0.6360	0.001	1.28
HW12	11/29	37.1289	-82.8598	9.0	1660	7.25	<0.0005	0.032	0.0010	<0.0002	0.0023	<0.001	<0.01
HW13	11/30	37.14209	-82.85598	9.0	1330	6.5	0.0011	0.026	0.0015	<0.0002	0.0025	<0.001	<0.01
HW14	12/1	37.1289	-82.8598	9.0	1660	7.25	<0.0005	0.034	0.0011	0.0002	0.0039	0.001	<0.01
HW15	12/2	37.1296	-82.86349	-	1080	7.25	0.0006	0.027	0.0016	<0.0002	0.0033	0.002	<0.01

Comparison to regulatory criteria for lead, nickel and zinc requires the measurement of hardness, which was not collected. However, site HW10, located on Sand Lick Creek near Hurricane Branch, had levels of these three metals that were substantially higher than at all other sites. Arsenic and mercury levels were below regulatory criteria at all sites. Almost every site had conductivities that would impact aquatic life. Site HW5, located on Sandlick Creek above Colony Road, had dissolved oxygen below the regulatory limit (1.4 mg/L).

9. Eastern Kentucky University's Big Dip Redux Project, 2016

In 2016, EKERI returned to some of the same sampling stations that they had visited in 2006 for the Big Dip project to collect follow-up data. Of this sampling, six sites within this project area were resampled for conductivity and pH, along with some biological factors (woody debris, garbage, algal mats, oil and grease, etc.). These sites, located along Sand Lick Creek and Crafts Colly Creek, were sampled on September 10, 2016 - ten years after the initial study. The results are summarized in Table 3.12. The sampling locations are shown in Figure 3.4

Conductivity at four or the six sites, all along Sand Lick Creek, exceeded 1000 µS/cm. These results were mostly increases from the original sampling, although the two sites on Crafts Colly Creek showed decreases. Site E31, located near Colony Road on Sand Lick Creek, had pH levels of 2 SU, despite being within normal limits during initial sampling.

Table 3.11: "Big Dip Redux" Sampling Locations within North Fork Tributary Watersheds, 2016

Site ID	Latitude	Longitude	Sample Date	Cond (µS/cm)	pH	General Observations
E31	37.157	82.823	9/10/2016	1230	2	None
E35	37.148	82.822	9/10/2016	1200	8	Floating garbage, litter, and suds
E40	37.137	82.825	9/10/2016	1170	7.6	Floating garbage, litter, and light blue tint
E41	37.131	82.831	9/10/2016	1180	8.5	Suds present, slightly turbid, acid mine drainage, potential straight-piping, thick film possibly oil/grease
H80	37.172	82.805	9/10/2016	250	7.5	Very clear. Lots of garbage
H81	37.172	82.805	9/10/2016	310	8.5	Not extensive flow. Clean stream

C. Monitoring Needs and Plans

While numerous studies and sampling sites have occurred in the Whitesburg tributaries of the North Fork Kentucky River, the majority of these sampling projects only required one sample from each site. This helps provide some initial screening and background, but it is insufficient for watershed planning purposes. Each site sampled needed to be tested more frequently and for more parameters in order to accurately determine the health of these stream sites. Macroinvertebrate or habitat assessment data was not found, which leaves more uncertainty about the condition of these stream sites and the overall health of the ecosystems.

In 2017, KDOW developed a quality assurance project plan that addresses all aspects of the monitoring process and data management for this project. The "Success Monitoring Program Study Plan" (Culp 2017) details specific monitoring needs for the three Whitesburg tributaries to Nork Fork Kentucky River. This plan's stated goal is "to collect data to determine water quality assessments of these three tributaries for Aquatic Life and Primary Contact Recreation, and to estimate pollutant loading for E. coli bacteria."

Seven sites were selected within the three watersheds. The sampling activities at these sites are summarized in Table 3.13 and their locations are shown in Figure 3.6. All seven of the sites were sampled for bacteria (*E. coli*) with a 5 and 30 (5 samples in 30 days) beginning in May. All seven sites were sampled monthly for *E. coli*, water chemistry, and flow. Flow was taken at each sampling event to calculate bacteria loading. Four of the seven sites were sampled for biology (macroinvertebrates only), habitat, and water chemistry. Water chemistry included bulk parameters, nutrients, total metals and alkalinity/acidity.

There is also an inactive mining portal entering Dry Fork where total metals and alkalinity were sampled monthly for 6 months above and below the mining portal. This will allow the KDOW assessment coordinator to evaluate whether Dry Fork below the mining portal should be listed for any metals exceeding the water quality standards.

Additional metals monitoring was conducted in 2018 subsequent to the initial study to provide additional data for assessments.

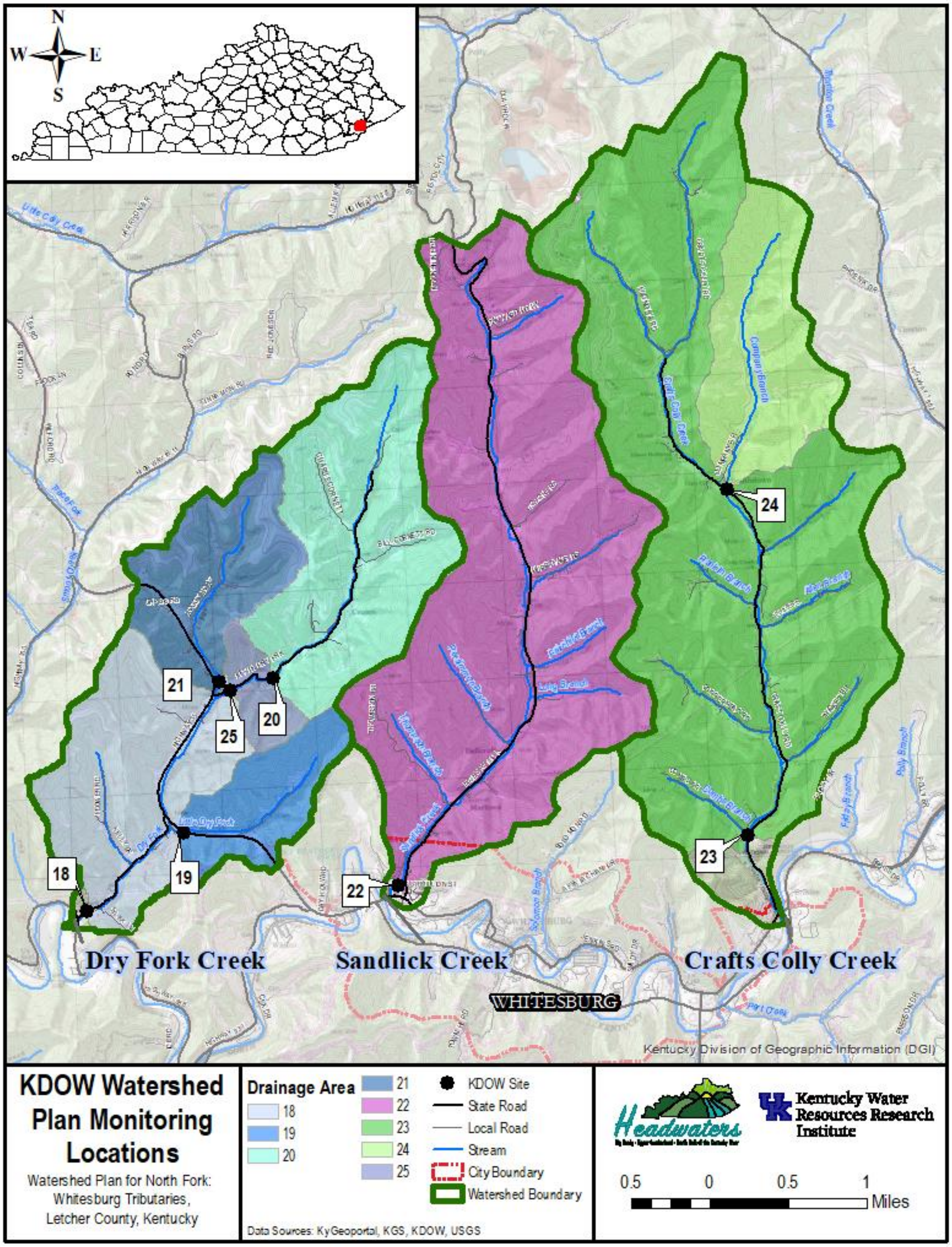
In addition to this monitoring, Headwaters, Inc has partnered with Eastern Kentucky University to conduct surveys for severe erosion and habitat in these watersheds. This monitoring will allow for improved assessment of the impacts to aquatic life in the area.

Table 3.12: KDOW Monitoring in North Fork: Whitesburg Tributaries, 2017

Site ID	Short ID	Area (mi2)	Watershed	Location	Latitude	Longitude	Sampling*
DOW04059018	18	5.11	Dry Fork	Dry Fork off KY 3401 – access Tyler Ln	37.12197	-82.87346	B / E / C
DOW04059019	19	0.59	Dry Fork	Little Dry Fork off KY15 – Parkway Inn	37.12900	-82.86200	E / C
DOW04059020	20	1.85	Dry Fork	Dry Fork off Dry Fork Road, upstream of mine portal	37.14300	-82.85100	B / E / C
DOW04059021	21	0.94	Dry Fork	UT Dry Fork off KY 15 – Drill Steel Services	37.14246	-82.83765	E / C
DOW04059022	22	4.87	Sandlick	Sandlick off KY15 – abandoned parking lot	37.12345	-82.83740	B / E / C
DOW04059023	23	6.68	Crafts Colly	Crafts Colly off KY 2034 – access Combs Br	37.12713	-82.79697	B / E / C
DOW04059024	24	1.11	Crafts Colly	Company Br off KY 2034, upstream culvert	37.15906	-82.79802	E / C
DOW04059025	25	2.08	Dry Fork	Dry Fork off Little Dry Fork Road, downstream of mine portal	37.14200	-82.85600	M / Alk

*B = Biology (macroinvertebrates), E = *E.coli*, C = Chemistry, M = Metals, Alk = Alkalinity

Figure 3.6: KDOW Watershed Plan Monitoring Locations



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AMEC. March 2011c. Phase II Environmental Site Assessment Sandlick Creek Watershed, Letcher County, Kentucky. Brownfields Grant Number BF-95407408. Prepared for Letcher County Conservation District, Whitesburg, KY.

AMEC. June 2011d. Phase II Environmental Site Assessment March 2011 Sampling Event: Sandlick Creek Watershed, Letcher County, Kentucky. Brownfields Grant Number BF-95407408. Prepared for Letcher County Conservation District, Whitesburg, KY.

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AMEC. June 2011f. Phase II Environmental Site Assessment March 2011 Sampling Event: Little Dry Fork / Dry Fork Watershed, Letcher County, Kentucky. Brownfields Grant Number BF-95407408. Prepared for Letcher County Conservation District, Whitesburg, KY.

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Chapter IV: Analysis

A. Aquatic Community and Habitat

1. Fish

Fish have not been surveyed in the Whitesburg tributaries of the North Fork Kentucky River. However, the Kentucky Department of Fish and Wildlife Resources maintains a list of species observations from each county (KDFWR 2019). A total of 64 species are listed for Letcher County (Appendix A). Most of these fish are from four families: carp and minnow (25 species), perch (14 species, including darters and logperch), sunfish (10 species), and suckers (6 species). Sportfish comprise 17 species including four catfish, four bass, four sunfish, two carp, black crappie, and two non-native trout species. Four fish species within the county are listed as state or federally threatened or of concern, including the blackside dace, hornyhead chub, cumberland arrow darter, and kentucky arrow darter. Of these, blackside dace and cumberland arrow darter are both native to the Cumberland River basin (not the Kentucky River basin), and hornyhead chub has never been verified in the upper Kentucky River Basin.

2. Macroinvertebrates

Macroinvertebrates were sampled by the Kentucky Division of Water at four locations in North Fork Whitesburg Tributaries on May 2, 2017. Macroinvertebrate biotic indices (MBI) were calculated for each location. The “poor” macroinvertebrate communities were located on Sandlick Creek and on Dry Fork upstream of the mine portal. “Fair” communities were located on Crafts Colly Creek and Dry Fork near the mouth of the watershed. These results are shown in Figure 4.1. Based on these scores, the North Fork tributaries are partially or not supporting their warmwater aquatic habitat use.

3. Habitat

Results from habitat assessments, conducted in conjunction with the macroinvertebrate collections by the Kentucky Division of Water, are summarized on Figure 4.1.

Total habitat scores for three sites were “fair” while Dry Fork near the mouth was “poor.” Habitat scores are only representative of the reach assessed, while macroinvertebrate communities are impacted by both in-stream habitat and upstream watershed water chemistry. However, improvement of habitat will be necessary to aid streams in supporting their designated use for warmwater aquatic habitat.

The range of results for each habitat parameter is shown in Figure 6. Riparian vegetation zone width was typically poor at all sites and was the lowest ranked parameter among all assessed sites. Median results for embeddedness were “marginal” with all reaches being comprised of over 25% sand. Channels had “optimal” flow and frequency of riffles and bends. Most other parameters were “suboptimal” (see Figure 6).

The sandy, unstable substrate in most streams of the watersheds can fill niche habitat in riffles, removing necessary habitat for some macroinvertebrate species. Efforts to reduce bank erosion should reduce the supply of sand in the stream. Similarly, narrow riparian corridors are a problem in much of the watershed due to encroachment of roadways and houses in stream floodplains.

Figure 4.1: Macroinvertebrate and Habitat Assessment

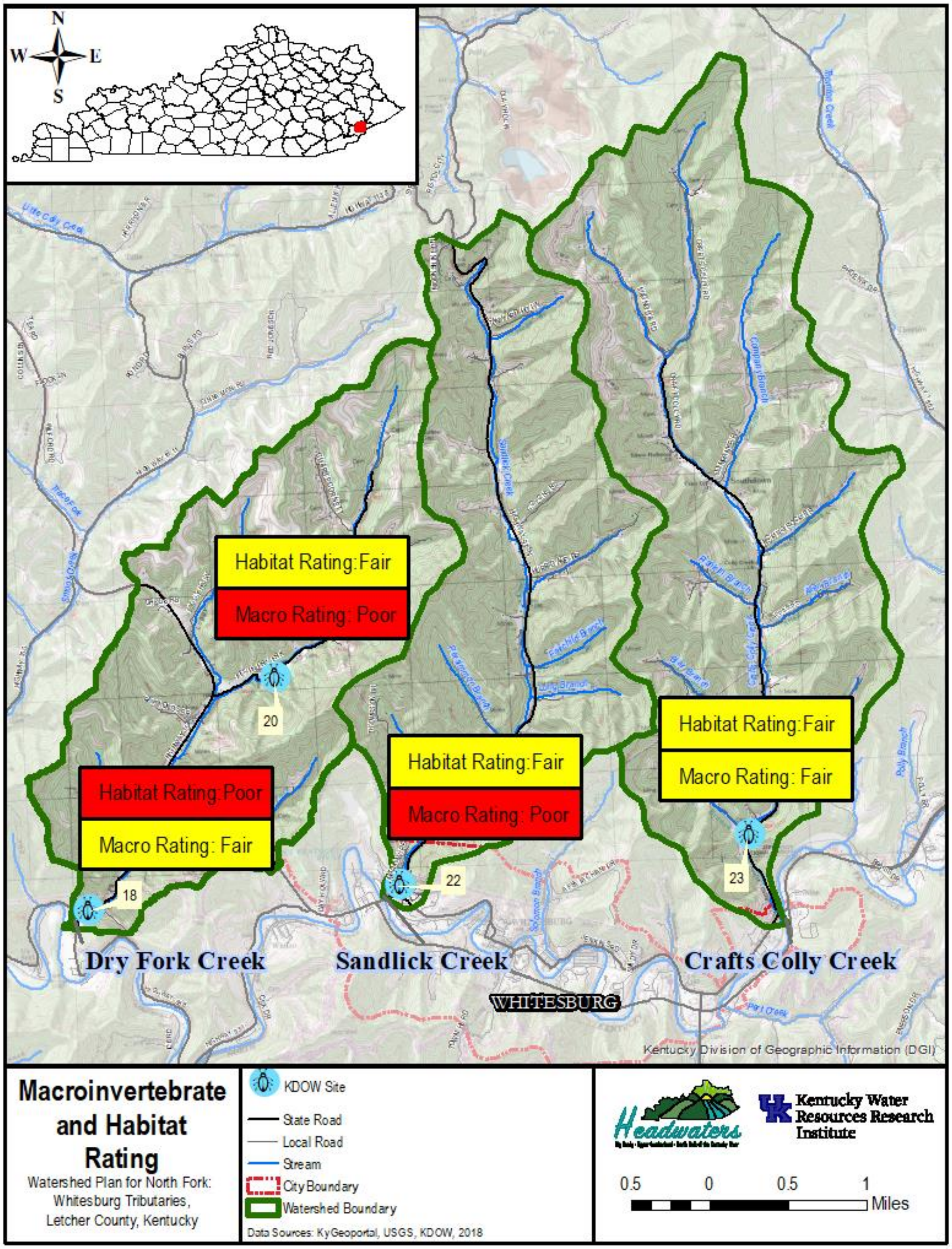
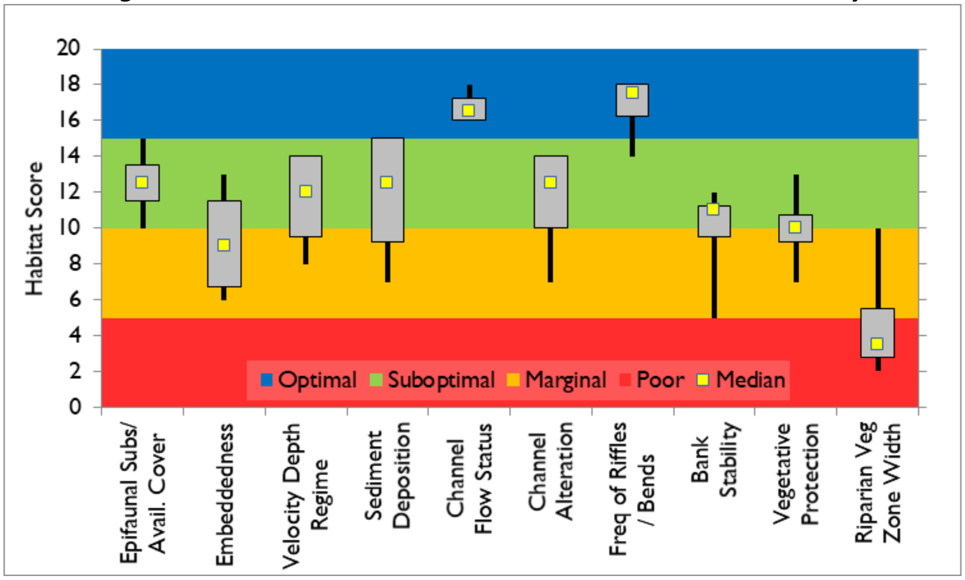


Figure 4.2: North Fork Tributaries Watershed Habitat Summary



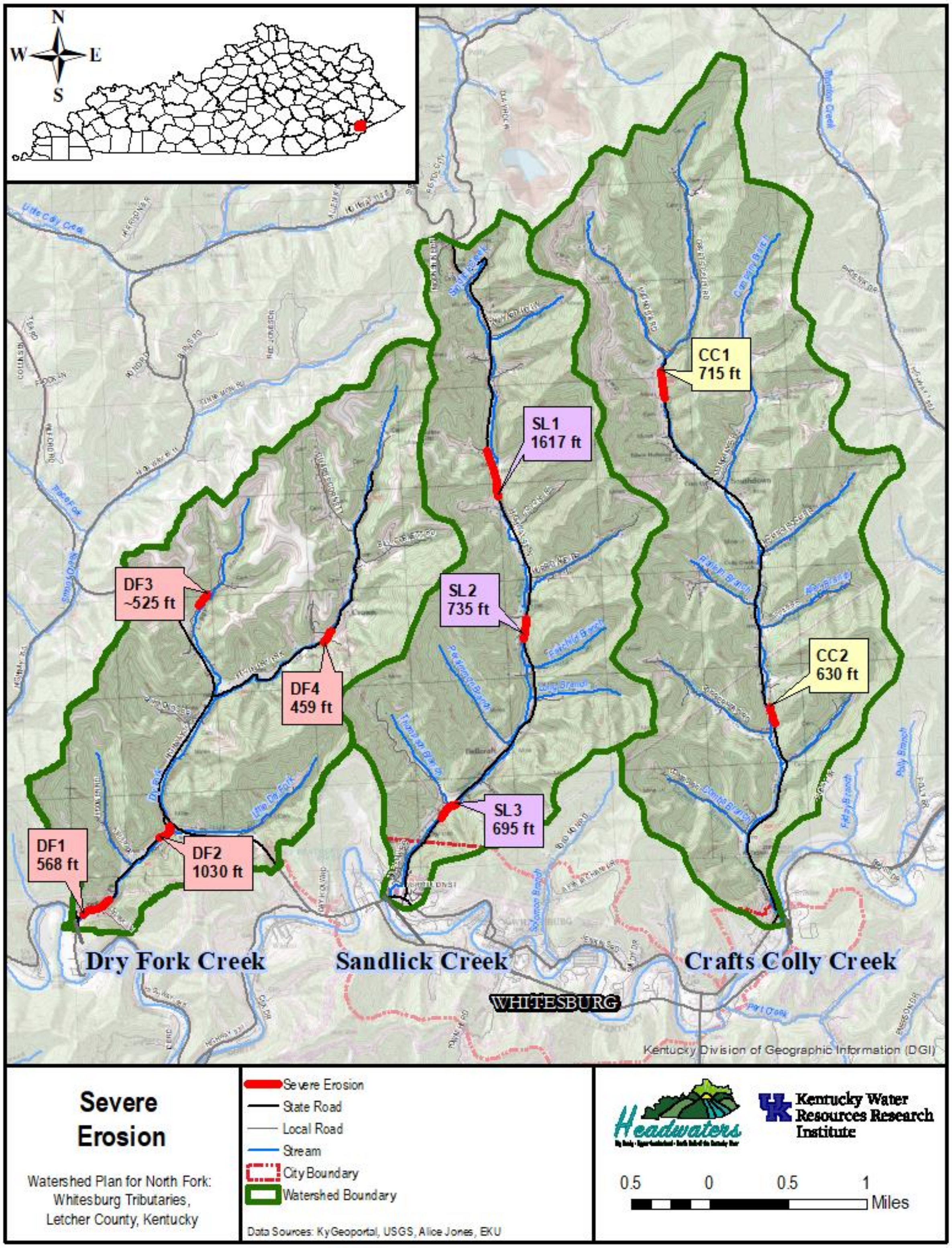
4. Severe Erosion

All streams in the North Fork Whitesburg Tributaries watersheds with accessibility by road were visually surveyed by Dr. Alice Jones of Eastern Kentucky University and Alex Beer and Garth Adams of Headwaters, Inc on August 25, 2018. A preliminary watershed assessment was performed on April 21-22, 2019 as part of an EKU Geosciences undergraduate applied research project, so visual surveys were targeted to areas identified in that effort. The assessment was conducted using the Maryland Stream Corridor Assessment Survey Protocols (Yetman 2001). Only areas of severe erosion, defined as erosion that exceeds average reach conditions or threatens property and infrastructure, were assessed.

Ten stream reaches on Dry Fork, Sandlick, and Crafts Colly of a total length of about 1.32 miles (4.4% of streams) were identified as having severe erosion and assessed. The locations are shown in Figure 4.3 (page 4.4). The full report is included in Appendix B. The report indicated that almost all erosion issues were related to channelization due to road construction or placement. In several cases the streams had washed out embankments and culverts or were undercutting roads and threatening collapse. Recommendations to address these erosion sources included installation of riparian buffers, small-scale sinuosity improvements, and landowner education.

(Left) Metal posts have been inserted to address roadway washout associated with erosion on Sandlick Creek near Dan's Crossing Road. (Right) Roadway washout along Dry Fork near Heartbreak Ridge due to erosion.

Figure 4.3: Severe Erosion



B. Water Quality

Water quality monitoring was conducted by the Kentucky Division of Water staff on 21 dates from May 2017 to November 2018 at the locations shown in Exhibits 3.6. Seven sites were monitored for *E.coli* during five events in May 2017 (May 9, 10, 16, 23, 24) to calculate the geomean, and monthly from June to October 2017 (6/27, 7/26, 8/15, 9/12, and 10/17). Water chemistry, including bulk parameters (total suspended solids, total dissolved solids, organic carbon, fluoride, chloride, sulfate, conductivity, turbidity), nutrients (ammonia, nitrogen, phosphorus), total metals and alkalinity/acidity was tested at seven sites during six events from May 2017 to October 2017 (5/2 or 5/24, 6/28, 7/27 or 8/3, 8/16, 9/13, or 10/17). One site was tested for metals, alkalinity and acidity only during these events. To supplement the metals dataset, four sites were sampled an additional five events during 2018 (5/17,6/19, 7/31, 9/19, and 11/8). Flow and field chemistries were measured during all events except under extenuating circumstances. A summary of the monitoring events is shown in Table 4.1.

Table 4.1: Watershed Monitoring Event Summary

Site Name	2017																2018				
	May						June		July		Aug			Sept		Oct	May	June	July	Sept	Nov
	2	9	10	16	23	24	27	28	26	27	3	15	16	12	13	17	17	19	31	19	8
18	C	E	E	E	E	E	E	C	E		C	E	C	E	C	E/C	M	M	M	M	M
19		E	E	E	E	E/C	E	C	E	C		E	C	E	C	E/C					
20	C		E	E	E	E	E	C	E	C		E	C	E	C	E/C	M	M	M	M	M
21			E	E	E	E/C	E	C	E		C	E	C	E	C	E/C	M	M	M	M	M
22	C	E	E	E	E	E	E	C	E	C		E	C	E	C	E/C					
23	C	E	E	E	E	E	E	C	E	C		E	C	E	C	E/C					
24		E	E	E	E	E/C	E	C	E	C		E	C	E	C	E/C	M	M	M	M	M
25						M		M		M			M		M	M					

NOTE: E = E.coli, C = bulk parameters, nutrients, total metals and alkalinity/acidity, M = total metals and alkalinity/acidity.

1. Benchmarks

To evaluate the nature and extent of impairments in the watersheds, results were compared to applicable water quality criteria. Both numeric and narrative criteria are applicable for this analysis. Numeric criteria are those for which a specific concentration of the pollutant is directly linked with impairment in the designated use. Other parameters, such as nutrients, specific conductance, suspended solids, or dissolved solids, are expressed as narrative statements in regulation due to the variable relationship between biological integrity and concentration levels in different waterbodies. For this plan, the narrative criteria have been translated using watershed-specific information into "benchmarks" that represent levels below which the narrative criteria are likely to be met in these streams. For the purposes of this plan, we refer to the criteria and narrative benchmarks all as "benchmarks" for simplicity. The benchmarks used for this analysis are summarized in Table 4.2 (page 4.6).

The water quality criteria for surface waters in Kentucky are found in 401 KAR 10:031. The regulation provides minimum water quality criteria for all surface waters as well as criteria that apply to specific designated uses. All streams monitored have designated uses of warmwater aquatic habitat (WAH), primary contact recreation (PCR), and secondary contact recreation (SCR). Criteria for PCR are applicable during the recreation season of May 1 through October 31. SCR criteria are applicable to the entire year.

Table 4.2: Water Quality Benchmarks

Parameter	Human Drinking Water	Human Fish Consumption	Aquatic Habitat: Acute	Aquatic Habitat: Chronic	Narrative-Based	Primary Contact Recreation	Secondary Contact Recreation
E. coli (CFU/100 mL)	-	-	-	-	-	130[1] 240[2]	386[1,3] 676[2,3]
pH (SU)	-	-	Between 6.0 and 9.0, and not +/- 1.0 over 24 hours				
Temperature (°C)	-	-	< 31.7			-	-
Dissolved oxygen (mg/L)	-	-	> 4.0 for instantaneous, > 5.0 as a 24-hour average			-	-
Alkalinity (mg/L)	-	-	Not reduced more than 25% of natural, and if natural <20 not a reduction below natural			-	-
Specific Conductance (µS/cm)	-	-	-	-	300	-	-
Total Dissolved Solids (mg/L)	250	-	-	-	250	-	-
Total Phosphorus (mg/L as P)	-	-	-	-	0.025	-	-
Total Nitrogen (mg/L as N)	-	-	-	-	0.7	-	-
Un-ionized Ammonia (mg/L)	-	-	0.05 Based on pH, Temp, and NH_3-N			-	-
Chloride (mg/L)	250	-	1200	600	-	-	-
Fluoride (mg/L)	4	-	-	-	-	-	-
Iron (mg/L)	0.3	-	4.000	1.000	-	-	-
Sulfate (mg/L)	250	-	-	-	-	-	-
Antimony (µg/L)	5.6	640	-	-	-	-	-
Arsenic (µg/L)	10	-	340	150	-	-	-
Barium (µg/L)	1000	-	-	-	-	-	-
Beryllium (µg/L)	4	-	-	-	-	-	-
Cadmium (µg/L)	5	-	5.2-9.0[4]	0.51-0.77[4]	-	-	-
Chromium (µg/L)	100	-	-	-	-	-	-
Copper (µg/L)	1300	-	32-53[4]	20-31[4]	-	-	-
Lead (µg/L)	15	-	246-494[4]	9.6-19.2[4]			
Mercury (µg/L)	2.0	0.051	1.4	0.77	-	-	-
Nickel (µg/L)	610	4600	977-1694[4]	109-188[4]	-	-	-
Selenium (µg/L)	170	4200	-	5.0	-	-	-
Silver (µg/L)	-	-	17-51[4]	-	-	-	-
Thallium (µg/L)	0.24	0.47	-	-	-	-	-
Zinc (µg/L)	7400	26000	250-433[4]	250-433[4]	-	-	-

NOTE: Designated uses abbreviated as follows: warmwater aquatic habitat (WAH), primary contact recreation (PCR), secondary contact recreation (SCR).
[1]Geometric mean based on not less than five samples taken during a 30-day period.
[2]Instantaneous standard is not to be exceeded in 20% or more of all samples taken during a 30-day period. If less than five samples are taken in a month, this standard applies.
[3]Conversion of fecal coliform criteria to E.coli based on Akasapu and Ormsbee, 2011.
[4]Based on geomean of hardness values for individual sites sampled during KDOW project using equations provided in 401 KAR 10:031.

WAH (warmwater aquatic habitat) criteria are often divided between acute (protective of aquatic life based on one-hour exposure) and chronic (protective of aquatic life based on 96 hours of exposure). DWS (drinking water supply source) criteria apply to the existing points of public water supply intakes. The human fish consumption criteria protects against exposure from eating fish in these waters.

The narrative-based benchmarks for aquatic life support were provided by KDOW based on reference reaches from the same ecoregion. No load reduction benchmarks were provided by KDOW for total suspended solids or turbidity as sediment problems in the watershed are best addressed by targeting the severe erosion assessments and not by water quality loading calculations.

2. Pollutant Concentrations

The sampling results were compared to the benchmarks in Table 4.2 (page 4.6) for each site to identify locations in which criteria were exceeded. Table 4.3 (page 4.8) indicates the percent of samples that exceeded a water quality benchmark at each site. Only parameters and benchmarks that have at least one exceedance are shown in this table. Table 4.4 (page 4.9) provides the geometric mean concentrations for these parameters, utilizing the minimum reporting limit for "less than" results. The geometric mean is utilized to reduce the bias of high concentration samples. Appendix C provides boxplot charts of the complete results of each parameter for each sampling site.

Some parameters, such as *E. coli*, conductivity, total dissolved solids, total nitrogen, sulfate, and iron, had high concentrations throughout the watersheds. Other parameters, including total phosphorus, fluoride, cadmium, copper, lead, mercury, thallium, and zinc, only have exceedances at one or two sampling sites.

a. E. coli

E. coli exceeds the primary and secondary contact recreation criteria at all sites except Site 19. The geometric mean exceeds the secondary contact criteria at Sites 20, 21, 23, and 24. The primary source for this impairment is human waste due to straight pipes and / or failing septic systems, with dogs and wildlife providing other contributing sources.

Site 19 had extremely low concentrations of *E. coli* as compared to the other sites monitored. These low *E. coli* concentrations were also paired with high iron concentrations. The color of water at this site was consistently orange due to the iron. A brief literature survey indicates that high iron concentrations can act as an inhibitor of *E. coli* in some circumstances (Kalantari and Ghaffari 2008, Sun etal 2011, and Bird etal 2013). Therefore, it may be possible that human health risks during recreational use may be present despite the *E. coli* concentration being low. Alternatively, the extension of sanitary sewer to a portion of the residences along KY-15 in Dry Fork could be contributing to the lower concentrations.

b. Trace metals

For trace metals, most of the exceedances at Site 20 occurred during one event on July 27, 2017 during a steady rain in which the suspended sediments in the stream reached the unusually high concentration of 3,900 mg/L. These same metals often had high concentrations at Site 25, but during baseline flow conditions unrelated to high suspended solids. Mine drainage and coal waste pile runoff is the most probable source for these metals. Because the pH was found to be neutral during all sampling events at all sites, these drainages are expected to be metalliferous but not acidic.

c. Conductivity, Total Dissolved Solids, and Sulfate

Conductivity, total dissolved solids, and sulfates all exceed benchmarks for most (in the case of sulfate) or all sites. To evaluate the sources of the high conductivity and total dissolved solids, the sums of the geometric means of the most abundant cations and anions were converted from concentrations (mg/L) into milliequivalents/Liter (meq/L) by dividing by the atomic weight and then multiplying by the valence or charge. The sum of the milliequivalents of the anions or cations times 100 is typically within 10% of the conductivity. This is often used as a cross-check for accuracy of measurements. Figures 4.4 and 4.5 (page 4.10) show that sulfate is the primary anion contributor to the conductivity (ranging from 55-82% of total across sites). Calcium, magnesium, and sodium were the primary cation contributors.

Table 4.3: Percent of Samples Exceeding Water Quality Criteria by Site and Parameter

			% Exceedance by Site							
			Dry Fork	Little Dry Fork	Dry Fork	Dry Fork UT	Sand-lick Creek	Crafts Colly Creek	Company Branch	Dry Fork
Parameter	**Criteria**	**Limit**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
E. coli	SCR	676 CFU/100mL	20%	0%	60%	30%	20%	44%	80%	N/A
	PCR	240 CFU/100mL	50%	0%	80%	70%	70%	78%	100%	N/A
Conductivity	Narrative	300 µS/cm	100%	100%	100%	89%	100%	100%	100%	100%
Total Dissolved Solids	Narrative / DWS	250 mg/L	100%	100%	100%	100%	100%	100%	100%	N/A
Total Nitrogen	Narrative	0.7 mg/L	33%	100%	33%	40%	50%	18%	0%	N/A
Total Phosphorus	Narrative	0.025 mg/L	0%	50%	83%	0%	0%	0%	33%	N/A
Fluoride	DWS	4 mg/L	0%	0%	0%	0%	0%	0%	0%	50%
Sulfate	DWS	250 mg/L	100%	100%	0%	80%	100%	83%	100%	N/A
Iron	Acute	4 mg/L	0%	33%	9%	0%	0%	0%	0%	83%
	Chronic	1 mg/L	9%	100%	18%	10%	0%	0%	18%	83%
	DWS	0.3 mg/L	73%	100%	18%	80%	33%	17%	100%	83%
Arsenic	DWS	10 µg/L	0%	0%	9%	0%	0%	0%	0%	40%
Cadmium	Acute	5.2-9.0 µg/L	0%	0%	0%	0%	0%	0%	0%	17%
	Chronic	0.51-0.77 µg/L	0%	0%	9%	0%	0%	0%	0%	17%
	DWS	5 µg/L	0%	0%	0%	0%	0%	0%	0%	17%
Copper	Acute	32-53 µg/L	0%	0%	9%	0%	0%	0%	0%	17%
	Chronic	20-31 µg/L	0%	0%	9%	0%	0%	0%	0%	17%
Lead	Chronic	9.6-19.2 µg/L	0%	17%	9%	0%	0%	0%	0%	17%
Mercury	Fish	0.051 µg/L	0%	0%	9%	0%	0%	0%	0%	17%
Thallium*	Fish	0.47 µg/L	0%	0%	9%	0%	0%	0%	0%	0%
	DWS	0.24 µg/L	0%	0%	9%	0%	0%	0%	0%	0%
Zinc	Acute	250-433 µg/L	0%	0%	9%	0%	0%	0%	0%	0%
	Chronic	250-433 µg/L	0%	0%	9%	0%	0%	0%	0%	0%

**Thallium laboratory reporting limit is 0.5 µg/L which is above the fish and drinking water supply benchmarks. Any detected concentration was considered an exceedance.*

Table 4.4: Geometric Mean Concentrations for Parameters with Exceedances by Site

Parameter	Unit	Dry Fork 18	Little Dry Fork 19	Dry Fork 20	Dry Fork UT 21	Sand-lick Creek 22	Crafts Colly Creek 23	Company Branch 24	Dry Fork 25
E. coli (5 in 30, PCR) [1]	CFU/100mL	462	18	2706	684	571	709	763	N/A
E. coli (All, SCR) [1]	CFU/100mL	302	21	846	465	377	462	1209	N/A
Conductivity	µS/cm	1097	1058	533	532	1165	732	705	1013
Total Dissolved Solids	mg/L	781	754	376	620	842	496	549	N/A
Sulfate	mg/L	312	342	179	272	400	299	316	N/A
Fluoride	mg/L	0.34	0.41	0.15	0.17	0.29	0.20	0.19	2.34
Total Nitrogen	mg/L	0.71	1.29	0.84	0.71	0.66	0.44	0.41	N/A
Total Phosphorus	mg/L	0.01	0.03	0.06	0.02	0.01	0.01	0.02	N/A
Iron	mg/L	0.38	4.5	0.27	0.45	0.19	0.26	0.54	2.89
Arsenic	µg/L	0.56	1.49	0.72	0.53	0.5	0.5	0.5	4.17
Cadmium	µg/L	0.20	0.20	0.22	0.20	0.20	0.20	0.20	0.70
Copper	µg/L	1.09	1.9	2.31	1.78	1.84	1.94	3.69	1.73
Lead	µg/L	0.2	0.38	0.39	0.25	0.24	0.23	0.5	0.87
Mercury	µg/L	0.020	0.021	0.024	0.020	0.020	0.020	0.021	0.045
Thallium[2]	µg/L	0.50	0.50	0.51*	0.50	0.50	0.50	0.50	0.50
Zinc	µg/L	3.02	3.97	5.22	2.77	7.64	5.14	46.7	8.42

NOTE: Underlined numbers exceed one or more benchmarks for the parameter and require load reductions.
[1]Differences in the *E.coli* concentrations for the PCR criteria and the SCR criteria are due to taking the geometric mean of the 5 samples collected in 30 days during May versus all events collected, respectively.
[2]Thallium laboratory reporting limit is 0.5 µg/L which is above the fish and drinking water supply benchmarks. Any detected concentration was considered an exceedance.

Based on the high levels of sulfate (in conjunction with high iron concentrations), mine drainage or metalliferous mine drainage is indicated to be the primary contributor to the high conductivity and dissolved solids. The low levels of chloride indicate that oil and gas wells are not significant contributors to the conductivity or dissolved solids. According to Marty Parris, a geologist at Kentucky Geological Survey (personal communication, May 2019), this data provides no evidence of oil and gas brine influence. Most of the oil and gas wells are in the Devonian Ohio shale, which has little to no associated water production historically. The higher concentrations of sodium were suggested to be due to alteration of sodium-rich feldspar by mine drainage.

Figure 4.4: Sum of Cations Contributing to Conductivity by Site

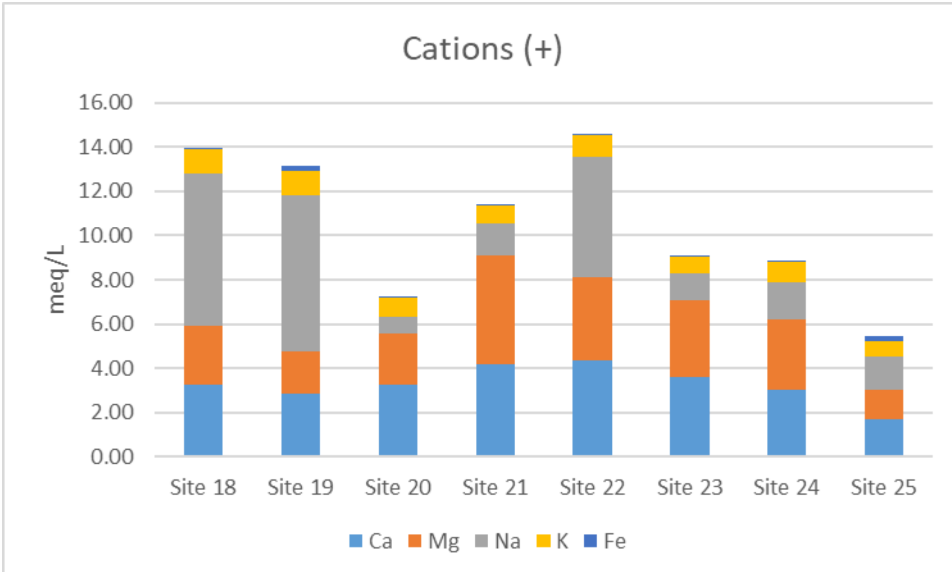
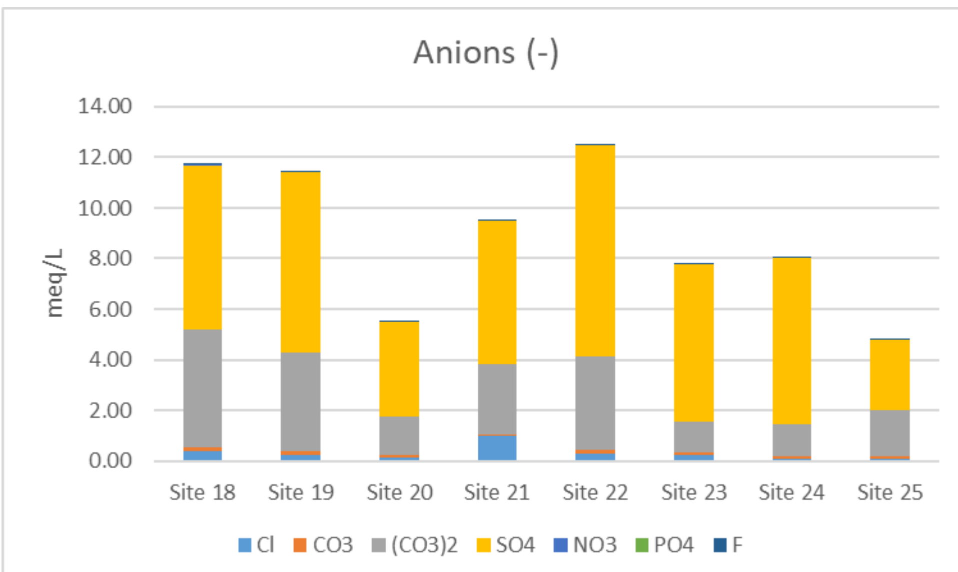


Figure 4.5: Sum of Anions Contributing to Conductivity by Site

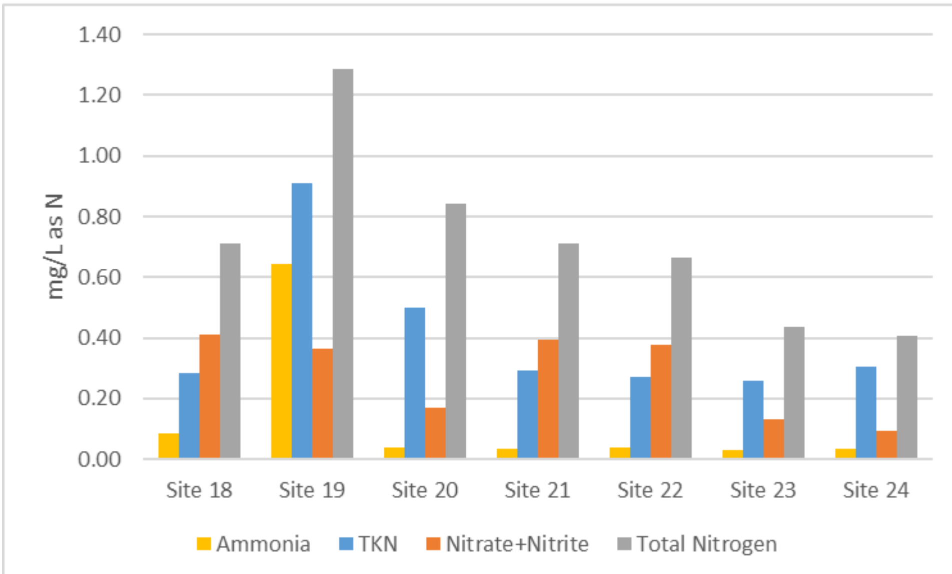


d. Nutrients

Total nitrogen is the sum of nitrate, nitrite, and TKN. TKN includes ammonia as well as organic nitrogen. Figure 4.6 shows the breakdown of the total nitrogen species for each site. Compared to the benchmark for total nitrogen as N of 0.7 mg/L provided by KDOW, all sites except Site 24 had at least one exceedance with the geometric means of Sites 18, 19, 20 and 21 each exceeding the benchmark. Site 19 had the highest concentration due to high levels of ammonia.

Ammonia can be used to actively treat high iron and manganese concentrations in acid mine drainage. Because a mine drainage is just upstream of Site 19, this could be a potential source. Alternatively, anhydrous ammonia is used in the production of methamphetamines. According to personal communication with Kentucky Abandoned Mine Lands field staff, small meth production buildings have been observed in the area nearby and even over top of streams using the water to carry away the hazardous waste byproducts. Ammonia can also be an indicator of fresh human or animal waste inputs. Other sources of nitrogen can include fertilizer, atmospheric deposition, and soil leaching.

Figure 4.6: Geometric Means of Total Nitrogen and Nitrogen Species by Site



Total phosphorus (as P) exceeded the narrative benchmark provided by KDOW of 0.025 mg/L at three sites, Sites 19, 20, and 24. Sites 19 and 20 had geometric means above the benchmark. Sources of phosphorus can include fertilizer, geological weathering or leaching, human or animal wastes, or decay.

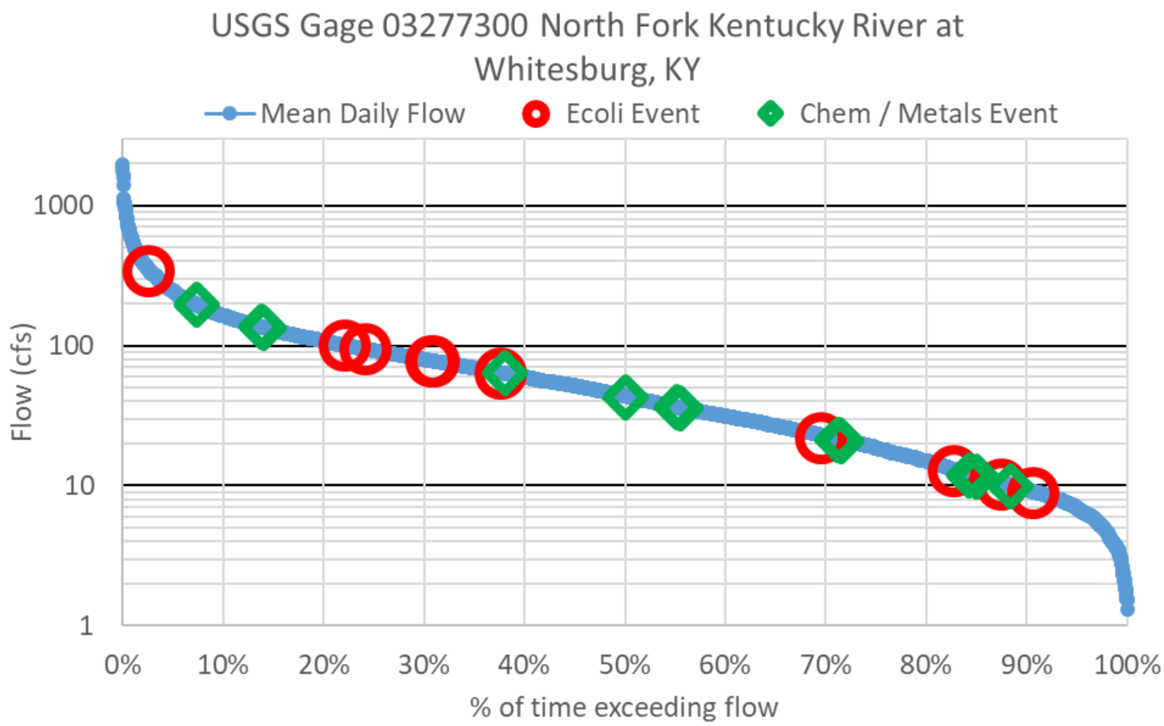
3. Pollutant Loads and Target Reductions

Pollutant loads are calculated by multiplying the concentration by the flow and a conversion factor to generate a mass of pollutant over time. For this plan, annual loads were calculated by multiplying the geometric mean concentrations by the median flow of the USGS Gage on North Fork of Kentucky River just upstream of Whitesburg scaled using linear regression equations developed from field flow measurements.

Figure 4.7 (page 4.12) depicts the flow duration curve of the Kentucky River at Whitesburg, KY with the highest flows on the left and the lowest flows on the right. The days on which the sampling occurred are marked by circles (E.coli) and diamonds (chemical or metals). Because not all events occurred during the same days, a low number of total samples were collected, and few samples were collected during wet weather conditions, the load was not calculated based on weather conditions. The geometric mean was chosen as the best representative of the annual concentrations at each site.

In selecting the flow condition to use in the annual load calculations, various methods were considered. Using an average of the measured flow rates at each site would bias the overall load to the time of sampling rather than the annual conditions. Therefore, the median flow (50% exceedance) of the USGS gage results was scaled based on a linear regression between the flow at the USGS gage at the time of sampling and the measured flow at the site. The regression plots for each site are shown in Figure 4.8 (page 4.13).

Figure 4.7: Flow Duration Curve of the USGS Gage at North Fork Kentucky River at Whitesburg, KY

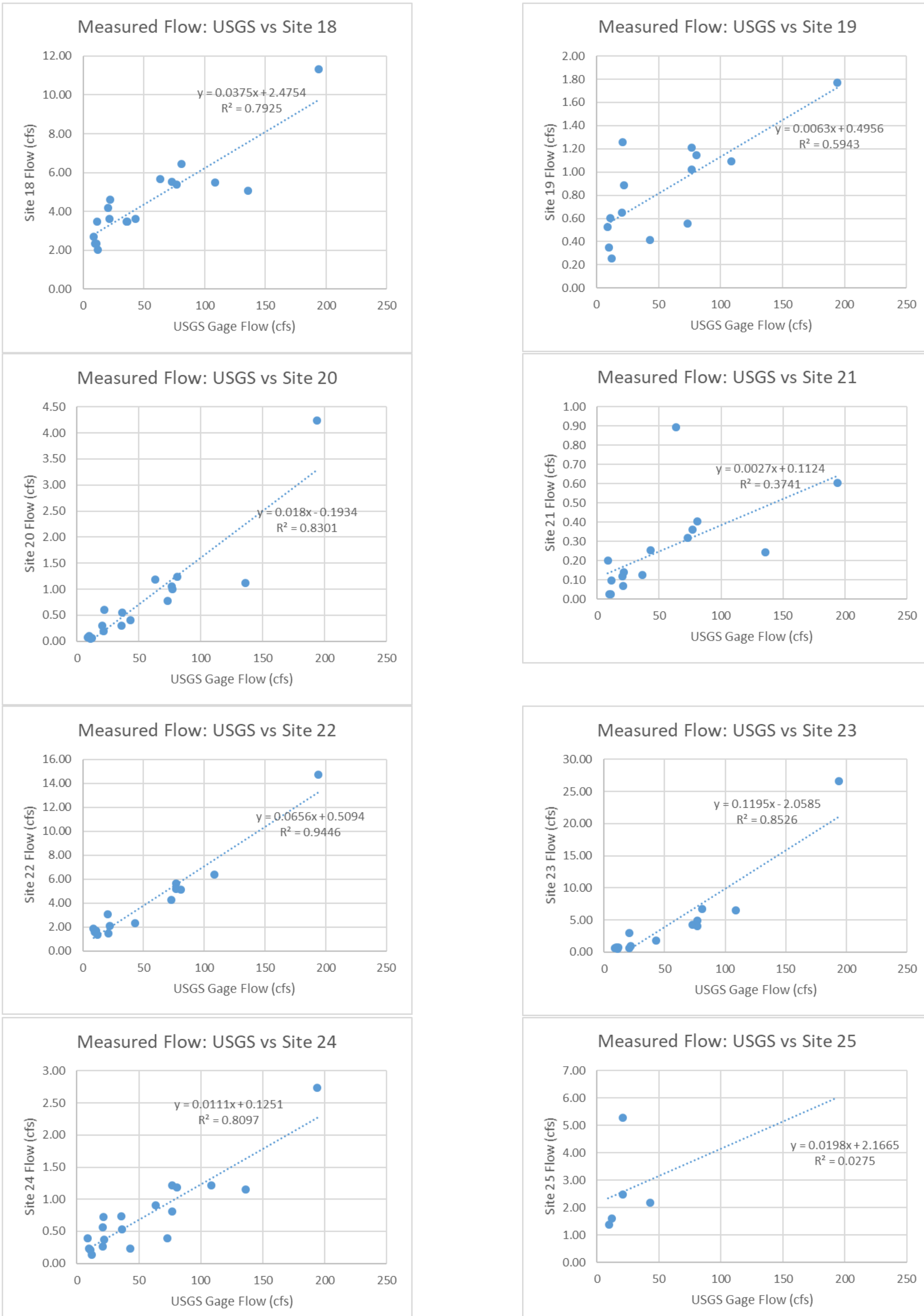


Using the geometric means, the median flows based on the regression analysis (as shown in Table 4.5), and a unit conversion factor, the measured annual load was calculated for each site. To calculate the target load for each site, this same process was utilized, substituting the benchmark concentrations for the measured concentrations. This target load was then subtracted from the measured annual load to determine the load reduction needed to reach the target load. Finally, the percent load reduction was calculated by dividing the load reduction by the measured load.

Table 4.5: Linear Regression Equations to Convert Flow at USGS Gage to Sites

Site	USGS Median Flow (cfs)	Linear Regression Equation	R-squared Values	Median Flow by Site (cfs)
18	42.95	Y = 0.0375x + 2.4754	0.7925	4.09
19	42.95	Y = 0.0063x + 0.4956	0.5943	0.77
20	42.95	Y = 0.0180x - 0.1934	0.8301	0.58
21	42.95	Y = 0.0027x + 0.1124	0.3741	0.23
22	42.95	Y = 0.0656x + 0.5094	0.9446	3.33
23	42.95	Y = 0.1195x - 2.0585	0.8526	3.07
24	42.95	Y = 0.0111x + 0.1251	0.8097	0.60
25	42.95	Y = 0.0198x + 2.1665	0.0275	3.02

Figure 4.8: Linear Regressions of Measured Site Flow and USGS Gage Flow



The load calculations and reductions are shown for parameters requiring load reductions including: *E.coli* (Tables 4.6 – 4.7), nitrogen and phosphorus (Tables 4.8), total dissolved solids (Tables 4.9), sulfate (Tables 4.10), iron (Tables 4.11), and cadmium (Tables 4.12). A summary of the maximum load reduction percentage required to meet the most stringent benchmark at each site is shown in Table 4.13.

For *E. coli*, load reductions (Tables 4.6 - 4.7) between 72% and 95% are required to meet the most stringent of the primary contact recreation criteria, at all sites except Site 19, at which high metals concentrations are suspected to be inhibiting *E. coli*. These reductions range from 15.83 trillion *E.coli* per year at Site 23 on Crafts Colly Creek to 1.14 trillion per year at Site 21 on the unnamed tributary of Dry Fork. Reductions at Site 18 can be achieved by addressing sources on upstream tributaries and sites. To meet secondary recreation criteria, reductions are needed at four sites on Dry Fork and Crafts Colly Creek (Sites 20, 21, 23, and 24) with reductions ranging from 16% to 54%.

Table 4.6: E.coli Load Calculations

Site	***E. coli*** **Load (Trillion/year)**		**Target Load (Trillion/year)**			
	Geomean (5 in 30)	**Geomean (All)**	**PCR 130 CFU/100mL (5 in 30)**	**PCR 240 CFU/100mL (All)**	**SCR[1] 386 CFU/100mL (5 in 30)**	**SCR[1] 676 CFU/100mL (All)**
18	16.85	11.00	4.74	8.74	14.06	24.63
19	0.12	0.14	0.89	1.65	2.65	4.64
20	13.98	4.37	0.67	1.24	1.99	3.49
21	1.40	0.95	0.27	0.49	0.79	1.39
22	16.93	11.19	3.86	7.12	11.45	20.05
23	19.38	12.63	3.56	6.56	10.56	18.49
24	4.08	6.46	0.69	1.28	2.06	3.61

[1]*Conversion of fecal coliform criteria to E.coli based on Akasapu and Ormsbee, 2011.*

Table 4.7: E.coli Load Reductions to Target Load

Site	**Load Reduction to Meet Targets (Trillion/year)**				**% Reduction**			
	PCR (5 in 30)	**PCR (All)**	**SCR (5 in 30)**	**SCR (All)**	**PCR (5 in 30)**	**PCR (All)**	**SCR (5 in 30)**	**SCR (All)**
18	12.11	8.10	0	0	72%	48%	0%	0%
19	0	0	0	0	0%	0%	0%	0%
20	13.31	12.74	2.38	0.88	95%	91%	54%	20%
21	1.14	0.91	0.16	0	81%	65%	17%	0%
22	13.07	9.81	0	0	77%	58%	0%	0%
23	15.83	12.82	2.07	0	82%	66%	16%	0%
24	3.38	2.80	4.40	2.85	83%	69%	68%	44%

For nitrogen (Table 4.8), only four sites (Sites 18, 19, 20, and 21), all in the Dry Fork watershed, require load reductions to meet the narrative-based benchmark of 0.7 mg/L. Only minor reductions are necessary on Sites 18 and 21 (1% and 2% respectively). Site 19 on Little Dry Fork requires a load reduction of 46% (900 lbs / year) primarily due to high ammonia input. Site 20 on Dry Fork requires a 17% reduction (160 lbs/year) to meet narrative-based benchmarks. Reductions upstream of Sites 19 and 20 would also achieve the reductions at Site 18 at the mouth of Dry Fork.

For phosphorus (Table 4.8), Sites 19 and 20 require reductions of 17% (7.6 lbs/year) and 59% (41.2 lbs/year), respectively to achieve the narrative-based benchmark of 0.025 mg/L.

Table 4.8: Nutrient Load Calculations and Reductions to Meet Target Loads

	Total Nitrogen (lbs/year)				Total Phosphorus (lbs/year)			
Site	Load	Target Load (narrative 0.7 mg/L)	Load Reduction	%	Load	Target Load (narrative 0.025 mg/L)	Load Reduction	%
18	5720	5640	80	1%	89	201	0	0%
19	1960	1060	900	46%	46	38	7.6	17%
20	959	799	160	17%	70	29	41.2	59%
21	322	317	5	2%	7	11	0	0%
22	4330	4590	0	0%	79	164	0	0%
23	2660	4230	0	0%	85	151	0	0%
24	3750	6390	0	0%	219	228	0	0%

To reduce instream concentrations of total dissolved solids (Table 4.9) to the domestic water supply criteria or narrative benchmark of 250 mg/L, a reduction of between 34% and 70% is required at all sites. The largest load reductions are required at the mouth of each watershed (Site 18, 22, 23), with between 1.49 and 4.28 million pounds per year to be removed.

Table 4.9: Total Dissolved Solids Load Calculations and Reductions to Meet Target Loads

	Total Dissolved Solids (lbs/year)			
Site	Load	Target Load (narrative 250 mg/L)	Load Reduction	%
18	6,290,000	2,010,000	4,280,000	68%
19	1,140,000	379,000	761,000	67%
20	429,000	285,000	144,000	34%
21	281,000	113,000	168,000	60%
22	5,520,000	1,640,000	3,880,000	70%
23	3,000,000	1,510,000	1,490,000	50%
24	649,000	295,000	354,000	55%

Much of these total dissolved solids load reductions can be achieved through reductions of sulfate (Table 4.10) to below 250 mg/L. All sites except Site 20 on Dry Fork require reductions of sulfate ranging from 8.1% at Site 21 on the unnamed tributary to Dry Fork to 37.4% at Sandlick Creek. At Sandlick Creek for instance, load reductions to sulfate alone would achieve about a quarter of the total dissolved solids load reduction.

Table 4.10: Sulfate Load Calculations and Reductions to Meet Target Loads

Site	Sulfate (lbs/year)			
	Load	Target Load (narrative 250 mg/L)	Load Reduction	%
18	2,510,000	2,010,000	500,000	20%
19	518,000	379,000	139,000	27%
20	204,000	285,000	0	0%
21	123,000	113,000	10,000	8%
22	2,620,000	1,640,000	980,000	37%
23	1,810,000	1,510,000	300,000	17%
24	373,000	295,000	78,000	21%

Iron loading (Table 4.11) requires a reduction at five sites (Sites 18, 19, 21, 24, and 25) to meet domestic water supply criteria, two (Site 19 and 25) to meet chronic warmwater aquatic habitat criteria and one (Site 19) to meet acute warmwater aquatic habitat criteria. Reductions at Site 18 may be achieved through reductions at Sites 19, 21, and 25 upstream. Sites 25 and 19 require the greatest load reductions at 15,420 lbs / year (90%) and 6365 lbs / year (93%), respectively, to meet domestic water supply criteria. Load reductions at Sites 24 and 21 are more modest at 284 lbs / year (45%) and 68 lbs / year (33%), respectively.

Table 4.11: Iron Load Calculations and Reductions to Meet Targets

Site	Iron (lbs/year)									
	Load	Target Load			Load Reduction			% Reduction		
		DWS (0.3 mg/L)	Chronic (1.0 mg/L)	Acute (4.0 mg/L)	DWS	Chronic	Acute	DWS	Chronic	Acute
18	3060	2420	8050	32200	640	0	0	21%	0%	0%
19	6820	455	1520	6060	6365	5300	760	93%	78%	11%
20	308	343	1140	4570	0	0	0	0%	0%	0%
21	204	136	453	1810	68	0	0	33%	0%	0%
22	1250	1970	6560	26200	0	0	0	0%	0%	0%
23	1570	1810	6040	24200	0	0	0	0%	0%	0%
24	638	354	1180	4730	284	0	0	45%	0%	0%
25	17200	1780	5950	23800	15420	11250	0	90%	65%	0%

Cadmium loading, as shown in Table 4.12, requires a reduction at only one site (Site 25) to meet chronic warmwater aquatic habitat criteria. Site 25 requires a load reduction of 17% (0.71 lbs / year).

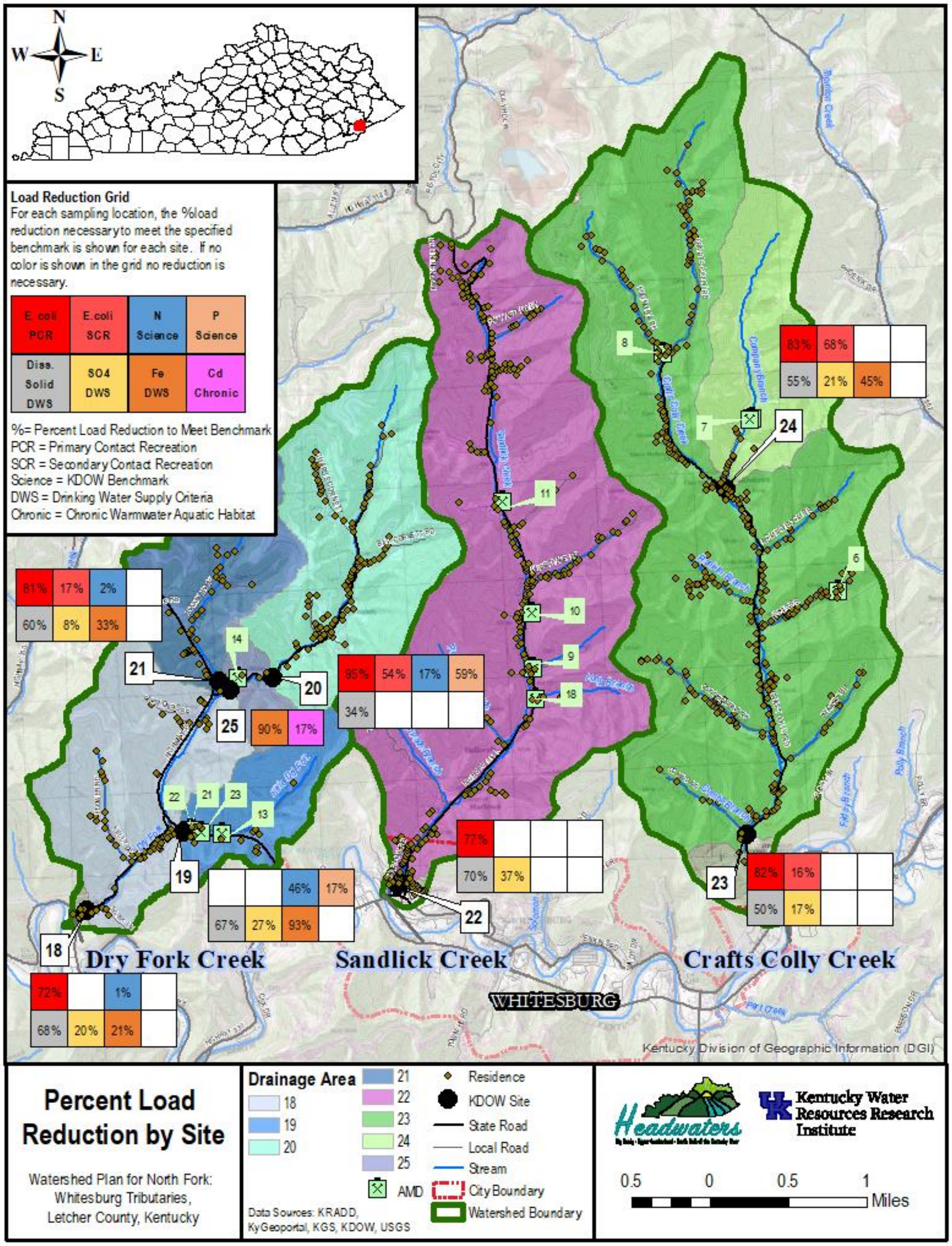
Table 4.12: Cadmium Load Calculations and Reductions to Meet Targets

	Cadmium (lbs/year)									
		Target Load			Load Reduction			% Reduction		
Site	Load	DWS (5 ug/L)	Chronic	Acute	DWS	Chronic	Acute	DWS	Chronic	Acute
18	1.61	40.3	4.6	47.7	0	0	0	0%	0%	0%
19	0.30	7.6	0.8	7.8	0	0	0	0%	0%	0%
20	0.26	5.7	0.6	6.3	0	0	0	0%	0%	0%
21	0.09	2.3	0.3	4.1	0	0	0	0%	0%	0%
22	1.31	32.8	5.0	58.0	0	0	0	0%	0%	0%
23	1.21	30.2	4.2	46.7	0	0	0	0%	0%	0%
24	0.24	5.9	0.7	7.9	0	0	0	0%	0%	0%
25	4.16	29.7	3.5	36.1	0	0.71	0	0%	17%	0%

Table 4.13: Summary of Annual Load Reductions to Meet Most Stringent Benchmarks

Site	E.coli	Nitrogen	Phosphorus	Dissolved Solids	Sulfate	Iron	Cadmium
	Trillion	Lbs	Lbs	Million Lbs	Million Lbs	Million Lbs	Lbs
	PCR	narrative	narrative	narrative /DWS	DWS	DWS	Chronic
18	72% - 12.11	1% - 80	0%	68% - 4.28	20% - 0.500	21% - 0.640	0%
19	0%	46% - 900	17% - 7.6	67% - 0.761	27% - 0.139	93% - 6.365	0%
20	95% - 13.31	17% - 160	59% - 41.2	34% - 0.144	0%	0%	0%
21	81% - 1.14	2% - 5	0%	60% - 0.168	8% - 0.010	33% - 0.068	0%
22	77% - 13.07	0%	0%	70% - 3.88	37% - 0.980	0%	0%
23	82% - 15.83	0%	0%	50% - 1.49	17% - 0.300	0%	0%
24	83% - 4.40	0%	0%	55% - 0.354	21% - 0.078	45% - 0.284	0%
25	-	-	-	-	-	89.7% - 15.42	17% - 0.71

Figure 4.9: Percent Load Reduction by Site



4. Pollutant Allocation

To achieve the reductions in the pollutant loads for *E. coli*, nitrogen, phosphorus, dissolved solids, iron and cadmium, the sources of pollution in the North Fork Whitesburg Tributaries must be clearly identified and allocated. To estimate the load contributions from various sources, a combination of historic monitoring data and literature values were utilized.

a. Human wastewater

Only part of the Crafts Colly watershed has access to sanitary sewers, with the remaining areas of Crafts Colly, Sandlick Creek, and Dry Fork utilizing either septic systems or straight pipes.

To estimate the pollution contributions for human waste discharges, literature values from national and local studies were analyzed.

According to the US EPA (2002), typical residential wastewater has a concentration of 26 - 75 mg/L total nitrogen, 6 - 12 mg/L total phosphorus, and one million to one hundred million fecal coliform per 100 mL based upon an assumed water use of 60 gallons per day. Case studies show that while traditional septic systems are effective in removing bacteria and phosphorus, about 40% of the nitrogen load reaches the edge of the drainfield. In the Chesapeake Bay Watershed (EPA 2010), the typical influent of the septic system was indicated to average about 60 mg/L total nitrogen, being reduced to about 39 mg /L leaving the drainfield.

Evans (2016) found residential sewage in Lexington, KY to have median concentrations of 20.45 mg/L ammonia-nitrogen, 0.73 mg/L nitrate-nitrogen, 3.76 mg/L orthophosphorus, and 1.548 million *E.coli* per 100 mL. These E.coli concentrations confirmed the findings of Apgar (2013) in Sanitation District No. 1 in northern Kentucky where the median residential sewage *E.coli* concentration was 1.553 million per 100 mL. In both studies, commercial sewage contains higher *E.coli* concentrations leading to higher overall expected sewage effluent concentration.

Based on these studies, untreated sewage was estimated to contribute 1.5 million *E.coli* per 100 mL, 60 mg/L nitrogen, and 10 mg/L total phosphorus. Using a rate of 60 gallons per day, a residence with untreated wastewater is estimated to annually contribute 1.5 trillion E.coli, 2.2 lbs of phosphorus, and 13 lbs of nitrogen. As summarized in Table 4.14, it is estimated that effective treatment of raw wastewater from a total of 34 equivalent residences (14 in Dry Fork, 9 in Sandlick Creek, and 11 in Crafts Colly) can achieve the load reductions. According to data provided by the Kentucky River Area Development District, a total of 817 residential structures are in the three watersheds, with 219 in Dry Fork, 271 in Sandlick Creek, and 330 in Crafts Colly. Except for residences along the lower half of the main stem of Crafts Colly, these residences are all unsewered. The actual number of residences that may need to be treated in a given area may be higher if partial failure of a treatment system is occurring in some areas. For Site 19, the number of residences was projected based on the phosphorus load, as inhibition of the *E.coli* is probable (due to the high metals concentrations). Also, for Site 19, human wastewater does not appear to be the sole source of the high total nitrogen concentrations.

Table 4.14: Estimated Number of Households with Untreated Sewage to be Addressed to Achieve Target Loads for E.coli, Nitrogen, and Phosphorus

		Load Reduction Required			Load Reduction Achieved by Addressing Untreated Human Wastewater				Approx. Total Number of Residences Upstream[1]
Site	Stream	*E.coli* (Trillion / year)	Nitrogen (lbs / year)	Phosphorus (lbs / year)	Number of Equiv. Residences	*E.coli* (Trillion / year)	Nitrogen (lbs / year)	Phosphorus (lbs / year)	
18[2]	Dry Fork	12.11	80	-	14	20.86	184.2	30.7	214
19	Little Dry Fork	-	900	7.6	4	5.96	52.6	8.8	18
20	Dry Fork	13.31	160	41.2	9	13.41	118.4	19.7	90
21	Dry Fork UT	1.14	5	-	1	1.49	13.2	2.2	35
22	Sandlick	13.07	-	-	9	13.41	118.4	19.7	254
23[2]	Crafts Colly	15.83	-	-	11	16.39	144.8	24.1	323
24	Company Branch	4.40	-	-	3	4.47	39.5	6.6	12

[1]Based on residential structure data provided by Kentucky River Area Development District.
[2]Site 18 reductions include those made in upstream Sites 19, 20, and 21. Site 23 reductions include those made in Site 24 upstream.

b. Mine Drainage

To estimate the load contributions from known mine drainage sites, the series of reports produced by AMEC (2011a-f) were used to project annual loadings where locations, flow rates and total dissolved solids or iron concentrations were available. Of the 13 AMD sites identified in those reports, 7 had enough data to provide loading estimates.

Due to the few samples represented in this dataset and the range of flows expected at these sites throughout the year, the figures provided in Table 4.15 are very coarse estimates on annual loadings. However, these rough projections, taken in combination with the high contribution of sulfate to the dissolved solids loading, indicate that mine drainage is the primary source contribution to the dissolved solids, sulfate, iron, and cadmium.

During field visits, a 2.8-acre coal waste pile was also identified immediately adjacent to Company Branch upstream of Site 7. Runoff from this pile is expected to contribute to the total dissolved solids loading downstream.

C. Summary of Watershed Impacts and Pollution Load Reduction Needs

Because of concerns about the health of the waterways in Letcher County, the nonprofit group Headwaters, Inc. pursued an EPA grant to study the three tributaries of the North Fork Kentucky River near Whitesburg. Based on the monitoring performed by the Kentucky Division of Water as well as prior studies performed by universities, volunteers, and consultants; the data indicate that Dry Fork Creek, Sandlick Creek, and Crafts Colly Creek are each impaired for human primary contact recreational use (swimming) and secondary contact recreational use (wading, boating, etc.) and warmwater aquatic habitat use. Although the waterways are not currently utilized for public domestic water supply use, it would not currently meet the criteria for that use.

Table 4.15: Dissolved Solids and Iron Loading from Mine Drainage Sites

Site	AMD ID	Flow (cfs)		Concentrations				Estimated Annual Load	
				TDS (mg/L)		Iron (mg/L)		TDS	Iron
		11/2010	3/2011	2006-07	2010-11	2006-07	2010-11	Lbs/year	Lbs/year
19	13	0	0.007	1089	1220	11.67	7.7	15,900	130
19	23	0	2.84	1594.5	1200	10	12.15	3,906,000	31000
22	10	-	0.71	1063	1860	11.25	5.03	2,043,000	11400
22	11	1.39*		766	402	8	18.4	1,598,000	36100
22	18	0.025	0.664	585.5	391	1.43	0.2	331,000	550
24	7	0.762	0.95	-	665	-	2.9	1,121,000	4900
25	14	0.62	1.56	798.5	890	4.625	4.6	1,812,000	9900

*Measured in field by KWRRI in May 2019.

1. Human Recreation

Human recreation in the North Fork Whitesburg Tributaries is unsafe due to the presence of *E. coli* exceeding the water quality criteria developed to protect the citizens of Kentucky. *E. coli* is a type of fecal coliform bacteria that is commonly found in the intestines of animals and humans and is an indicator of human or animal fecal contamination. Except for Little Dry Branch (along KY-15 and Bryan Baker Road) where high metals concentrations are suspected to be inhibiting growth, all sampled sites had concentrations exceeding the criteria. To reduce the *E. coli* concentrations to safe levels, the data indicates the following sources need to be addressed:

a. Human wastewater

Except for about 70 residences along the lower reach of Crafts Colley Creek, all other residences (approximately 747) in the area are either on septic systems or straight pipes. Based on pollution load calculations, removing raw, untreated sewage from approximately 34 residences (14 in Dry Fork, 9 in Sandlick Creek, and 11 in Crafts Colly) through sewer projects or improved onsite treatment could achieve the reduction goal. Failing septic systems may provide some treatment of sewage waste, therefore if contributions are from failing septic systems rather than straight pipes additional residences would need to be addressed. Eliminating straight pipes and failing septic systems from throughout watersheds should be the goal for planners.

In the Dry Fork Watershed, no sewer projects have been proposed by the City of Whitesburg or Letcher County. Most of the *E. coli* loading was contributed by the approximately 90 residences near the Crown community along Little Dry Fork Rd (KY-3402). The equivalent of raw, untreated sewage from 9 residences from this area would need to be removed to achieve water quality goals. Other areas in need of removal of human sewage include the unnamed tributary along SR-15 near Loggy Hollow Road (1 equivalent residence) and the residences along KY3401, SR-15, Bryan Baker Rd (4 equivalent residences).

The Whitesburg Sandlick Area Sewer Extension project (SX21133010) has been proposed by the City of Whitesburg to reach 105 of the 254 residences along Sandlick Creek at a cost of $2.053 million. According to the project data, the project would address 20 failing septic systems and 80 non-failing septic systems. The proposed project would not extend to the cluster of about 31 residences near Moonshade Drive at the headwaters of Sandlick Creek as well several side roads. According to load calculations, the equivalent of raw, untreated sewage from 9 residences from this area would also need to be removed to achieve water quality goals for this watershed.

Crafts Colly Sewer Extension Phase II (Project SX21133019) is proposed to connect 79 additional residences on Crafts Colly to sewer at a cost of $1.215 million. However, no projects have been proposed to reach the approximately 158 residences upstream of the existing infrastructure. According to load calculations, the equivalent of raw, untreated sewage from 11 residences from the Crafts Colly watershed would need to be removed to achieve water quality goals. Specifically, the 12 residences along Company Branch should be a focus area for a project as concentrations from this area indicate at least 3 residences need to be addressed.

b. Animal Sources

Although considered a lesser source in these watersheds, animals can be a source of *E.coli*. It is estimated that almost 400 dogs and 900 cats are kept as pets in the watershed areas. Bacteria and other pathogens from uncollected pet waste can be washed into streams from runoff of lawns and surrounding areas and contribute to stream pollutant loading. Pet waste pick-up programs can help reduce this source of pollution. Additional wildlife and livestock can also contribute to the instream concentrations. Minimal livestock management occurs in these watersheds, therefore agricultural best management practices are not a priority for bacteria reductions.

2. Aquatic Wildlife Health and Flooding

The warmwater aquatic habitat impairment is caused by a lack of habitat, erosion and channelization, and high pollutant loads of dissolved ions, nutrients and heavy metals. The habitat and erosion impacts are due to residences and roadways constructed in or near the floodplain while the increased dissolved ions and heavy metals are due primarily to mine drainage.

a. Habitat and Erosion Due to Floodplain Encroachment

Field surveys indicated that 1.32 miles of severe erosion were identified along the 29.7 miles of streams in the area. Erosion has recently washed out roadways and threatens in other areas. Habitat was rated as “fair” or “poor” in the four reaches assessed. Narrow riparian vegetated zones were a problem on these reaches as well as 87% of the streams in the watersheds. Embeddedness from sediment clogging the riffles was also a problem in these areas.

These problems all stem from the encroachment of houses and roadways upon the streams’ floodplains. Impervious surfaces, such as roads and rooftops, cause more water to runoff of surfaces faster leading to more intense flood events (which cause erosion) as well as lower groundwater levels and more frequent low flows. To improve the overall habitat and decrease erosion, planners should identify areas best suited for stream restoration, riparian zone plantings, bank stabilization, and stormwater detention.

b. Mine Drainage

Thirteen mine drainage sites have been identified in the Crafts Colly, Sandlick Creek, and Dry Fork watersheds. Comparison of the estimated pollution loads being produced by these sites to the overall loading in the stream based on Kentucky Division of Water monitoring indicates that these sites are the primary contributors to the conductivity, dissolved ions, sulfate, iron, and cadmium parameters which exceed numeric criteria or benchmarks derived from narrative criteria. Installation of best management practices to treat these legacy mine drainages will be necessary to help restore a healthy aquatic ecosystem. It is possible that the mine drainage along Little Dry Branch is being treated with ammonia leading to high nitrogen concentrations in the stream.

c. Human wastewater

Reducing human wastewater discharges to streams, as discussed in the previous section, will not only reduce the *E. coli* concentrations but will also reduce nutrient concentrations in the Dry Fork watershed to safe levels. High nutrient concentrations in the water can cause algal blooms locally and contribute to the hypoxia “dead zone” in the Gulf of Mexico. Eliminating straight pipes and failing septic systems from the watersheds will address this contribution to impairment.

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Chapter V: Best Management Practice Selection and Feasibility Concerns

A. Building Capacity in the Watershed

To develop a strategy to improve the watershed and meet the goals of the watershed plan, it was necessary to build capacity for watershed planning within the community. This was achieved by building a team of advisors and partners, as well as conducting significant community outreach. Local watershed coordinators provided education and elevated awareness on water quality impacts through events and activities, surveys about interests and priorities, and meetings with key stakeholders about the most reasonable and feasible Best Management Practices (BMPs) to address pollutants. The following sections describe the methods in which capacity was built in the North Forth Whitesburg Tributaries.

1. Watershed Advisory Committee and Partners

Beginning with the initiation of watershed plan development in February 2018, the Watershed Advisory Team met quarterly to discuss planning efforts and the development of appropriate and feasible BMP options. Members of the Watershed Advisory Team have included technical partners such as KWRRI, Kentucky Division of Water, KRWW, EKU and local leaders such as the City of Whitesburg, Letcher County Conservation District, Letcher County Water and Sewer, and the local Sierra Club Chapter.

In addition to the Watershed Advisory Team, various partners and stakeholders have been involved in the development of the watershed plan. These partners and stakeholders have offered guidance and provided input as well as participated in on-the-ground activities that have facilitated project progress. For the selection of BMPs, the following partners and stakeholders have offered input and assistance with community engagement to gather feedback related to local buy-in: Appalshop, City of Whitesburg, Letcher County Health Department, Letcher County Conservation District, Letcher County Cooperative Extension Office, Letcher County Schools, Kentucky River Area Development District, and Sierra Club Cumberland Chapter.

2. Community Engagement and Outreach Events

Community support and participation in mitigation efforts is necessary in order to achieve the watershed plan's goals of water quality improvement and watershed health restoration. For residents to select and implement BMPs, there must first be a general understanding and awareness of water quality and watershed health and how it impacts their lives. The following outlines the education and engagement activities that have been completed throughout watershed plan development:

a. Youth Watershed Camps

"Headwaters on the Creek" is a week-long camp in a monthlong summer camp called "Kids on the Creek", intended to get local youth in touch with the outdoors. Developed in July 2018 by Headwaters in conjunction with the Cowan Community Center, Division of Forestry, Letcher County Extension, Department of Transportation, Letcher County Schools, and other partners, this day camp for children age 5-12 focuses on topics of environmental education and watershed health. With 20-30 participants in each of the two years it has been hosted, it is planned for continuation in 2020 as well. (See link http://kyheadwaters.org/2018/headwaters-creek-summer-camp/) Instruction themes include ornithology, macroinvertebrates, water chemistry, plant identification, and other outdoor skills, with participation from the Division of Forestry, the Division of Water, Letcher County Cooperative Extension, and Letcher County Conservation District as instructors.

In fall 2019, Headwaters partnered with Eastern Kentucky University and the Pine Mountain School to host the Appalachian Mountain Ecology Camp, which focused on monitoring salamanders as bioindicators of ecosystem health and water quality sampling of North Fork Kentucky River. This camp primarily attracted Letcher County elementary school students, in addition to students from Breathitt, Pike, and Perry Counties, with a total attendance of roughly 20.

b. Letcher County School System Education and Outreach

In Fall 2018 – Spring 2019, Project WET curriculum, which focuses on a broad array of water education topics, was introduced by Headwaters to the class of Regina Donour at Letcher County Central High School until her retirement. Headwaters is currently conducting outreach into the school system to find a replacement relationship in Letcher County Central, either in biology or outdoor education. The principal is assisting with this, but thus far no response has been elicited.

Beginning in early 2020, Headwaters will partner with Arlie Boggs Elementary school to bring watershed education to 5th, 6th, 7th, and 8th graders in Letcher County. Headwaters will continue to use the project WET curriculum, in addition to sampling demonstrations and volunteer opportunities. This is a part of Headwaters' strategy to connect the west side of Letcher County with the other side of Letcher County, and oft-maligned area with limited access to city drinking water and other amenities available in the Whitesburg area. Though students at Arlie Boggs do not live in the North Fork watershed, they will attend Letcher County Central with North Fork residents, and Headwaters is confident their education will impact other students and their parents.

Headwaters has also worked with the 4-H program at the County Extension Office to participate in the quarterly youth retreat, reaching about 15 high school students hand-picked by their instructors, as well as other environmental education programming efforts. These students are mostly from the Letcher County school system, though a few come from Breathitt and Perry Counties. 4-H and Headwaters believe in the importance of passing watershed education between coalfield counties, as there is not a similar grassroots water organization in neighboring counties. Headwaters will continue to attend these quarterly retreats and build on prior lessons while bringing new students into aquatic science.

c. Stream Litter Cleanup Events

Stream cleanups have been hosted by Headwaters in April 2018 and April and November 2019. Each event included between 10 and 30 people, including Letcher County Central High School students, Southeast Kentucky Community and Technical College students, and Americorps National Civilian Community Corps volunteers. Between 30 and 60 large trash bags of litter were removed during these events. These cleanups focus specifically on visible areas of the North Fork in downtown Whitesburg. However, with added volunteer capacity, expansion into the subwatersheds of Crafts Colly, Dry Fork, and Sand Lick may be possible. Headwaters is hoping to recruit 8-10 regular volunteers by 2021.

d. Kentucky Watershed Watch Volunteer Stream Sampling

Volunteer water quality sampling with Kentucky River Watershed Watch is conducted three times a year in spring, summer, and fall and continued throughout the project period. Currently, six volunteers sample 12 sites regularly in Letcher County, forming one of the more densely sampled networks in the rural portions of the Kentucky River basin. This monitoring provides ongoing feedback on the water quality in the area, including bacteria concentrations, field chemistries, and metals at locations with high conductivity.

e. Community Outreach and Education

To reach the adult community, Headwaters has maintained a presence at community events and meetings, looked to improve passive education, and has participated in community environmental workshop series.

Typically held annually in the last week of September, the Mountain Heritage Festival in Whitesburg, KY represents the community's largest annual event of entertainment, crafts, parades, booths, and other events. The event draws from Letcher and the surrounding counties. Headwaters has maintained a table for this event and provided educational materials and discussions about the status of water quality in the area. About 70 interactions were made in 2019 concerning water quality.

Headwaters staff attend and support regular meetings of the Letcher County Culture Hub, the Letcher County Fiscal Court, the Letcher County Water Board, and other organizations to explore opportunities for community engagement and project implementation.

Two watershed educational signs will be installed along the North Fork riverfront in downtown Whitesburg in 2020, containing educational information about the North Fork watershed and stewardship. The most likely location is downstream of the East Main Street crossing of North Fork and the Veterans Memorial Museum. These signs should provide passive education at this popular recreational area.

In cooperation with the University of Kentucky Community and Economic Development Initiative of Kentucky (CEDIK), Appalshop, and Friends of Whitesburg, Headwaters helped coordinate a monthly workshop series focused on downtown revitalization and landowner education regarding best management practices. This workshop series is ongoing throughout 2020 and will include a total of at least 5 and up to 10 workshops on watershed-related topics. This series, called Water Works, is a combination of hands-on and presentation-based learning intended to grow the Headwaters volunteer base and drive support for downtown projects. Below are the planned and executed workshops, which Headwaters and partners are seeking funding to continue.

- December 2019: Stormwater and You with Dr. Walter Smith of UVA-Wise
  - Dr. Smith discussed the UVA-Wise constructed wetlands project, providing a pathway for reduction of mine drainage in Letcher County streams. There was high enthusiasm for this idea within the group in attendance, which numbered 10.
- February 2020: Healthy Forests, Healthy Streams with the Division of Forestry
  - Jake Hall of the Letcher County Division of Forestry discussed the importance of sustainable logging and native riparian plants.
- March 2020: [Unnamed] with Alice Jones of Eastern Kentucky University
  - Alice Jones will discuss erosion in the North Fork of the Kentucky River watershed and help identify solutions with the community members in attendance.
- April 2020: Stream Planting with Volunteer Support
- Future Dates: TBD

Finally, Headwaters, Appalachian Citizens' Law Center, and Livelihoods Knowledge Exchange Network are working towards developing curricula for "popular education" style trainings on municipal water systems and rates affordability. Headwaters' role in this project will be to connect surface water quality to drinking water quality. These trainings will occur in multiple counties across East Kentucky and build on one another towards the construction of a white paper by ACLC containing policy recommendations to ensure high drinking water quality in East Kentucky.

Together, these activities were utilized to help build capacity in the watershed and community for the need for water quality improvements and the processes through which improvements can be achieved.

B. Stakeholder Survey and Community Forum

With the analysis of the water quality data summarized in Chapters 2-4 of this plan completed in June 2019, efforts to educate the community on the findings of the analysis were increased. A short summary of the planning efforts was developed (Appendix A) as an educational tool.

To get feedback from the community on best management practices, three major approaches were utilized: 1) a stakeholder survey was developed and distributed through various events, 2) one-on-one meetings were held with stakeholders to allow for private feedback and questions, and 3) a public meeting was held to inform the community of results.

1. Stakeholder Survey Development and Distribution

The Water Quality Survey (Appendix B) was developed to assess water quality concerns and views, as well as current stewardship levels. Results for the survey can be found in Appendix C. The survey was distributed through participation in the following events and methods:

- Mountain Heritage Festival, Whitesburg, KY: September 26-28 (around 30 surveys completed)
- Oktoberfest, Whitesburg, KY: October 19
- Tabling and survey distribution at Harry M. Caudill Library, Hemphill Community Center, Sandlick Volunteer Fire Department, Whitesburg Food City, and Whitesburg Walmart in September - October 2019
- Stream Cleanup in November 2019
- Canvassing door-to-door
- One-on-one stakeholder meetings

Feedback was received from 62 stakeholders, all of whom were asked to mark their home residence location on a map when turning in the survey. The majority of respondents (92%) were Letcher County residents, although most were not from this plan’s focus watersheds. Headwaters staff attempted home visits in the watersheds to correct for this but received little response from this method. Headwaters is willing to explore other outreach options if any are suggested.

2. Community Education and Outreach Strategy Lessons Learned

In both one-on-one and public meetings, the advisory committee and Headwaters have highlighted the results of several years of water sampling along Crafts Colly, Sand Lick, and Dry Fork. Through community education and engagement, Headwaters and partners presented information about salient issues identified in previous community gatherings. Headwaters and partners:

- Educated community members on the results of water quality monitoring using graphs, maps, other visuals and explanations to facilitate understanding.
- Discussed general watershed health, defining key terms and ideas relevant to the North Fork watershed, including descriptions of issues and their sources, possible BMPs recommended by experts, and possible funding for solutions.
- Emphasized the importance of Riparian Buffer Zones to property owners, county officials, and residents who live directly adjacent to stream beds.
- Utilized a Letcher County watershed map to spark conversation at community events about water quality, get an idea of the geographic spread of community members with which

Headwaters held conversations, and mark locations of both special personal/community importance (e.g. swimming and fishing locations) and environmental concern.
- Placed an emphasis on erosion, land loss, and flood control BMPs, as these were issues of concern to community members.

The advisory committee identified several target groups for outreach efforts in the Whitesburg and North Fork area community. Outreach was targeted to the following groups:
- property owners (both resident and non-resident)
- city officials
- county officials
- land and resource managers
- Congregation members and leaders at houses of worship
- Youth spaces such as schools and local youth drop-in centers
- variety of community stakeholders and leaders, many of whom work in nonprofits and social service organizations, such as Appalshop, Appal-TREE, Cowan Community Center, and others.

During communications with stakeholders in Letcher County, we found that the most helpful information sharing came through clear and concise communication. The best practices for communication are both short-term and long-term, requiring that both partners and community members build rapport and trust with one another. When discussing BMPs with community members, it is best to:

- Deliver actionable information for attendants to take home.
- Remain positive – the point of a watershed plan or best management practices is not to penalize property owners or chastise residents. It is best to focus on the positive aspects of healthy watersheds, such as encouraging a flourishing economy, recreational opportunities, clean drinking water, and a beautiful, clean environment.
- Utilize clear, concise, and direct language. Steer clear of highly technical terms.
- Short informational videos using interviews on local water interests were requested.
- Social media and print media campaigns to help spread information and build support were thought to be logical next steps.

To communicate effectively, the team determined that the following education and engagement tools were needed. These included:
- Informative Handouts and Flyers
- Online surveys
- Door-to-door canvassing in the watershed area
- Public trail signage for downtown Whitesburg, designed through a public input process.
- Large scale watershed maps for notes/pointers/interaction among community members
- Examples of BMPs in other watersheds

3. Stakeholder One-on-One Meetings

Headwaters met with 17 stakeholders in advance of the Community Forum in order to gain a better understanding of community needs. These included representatives from city and county officials, regional and state agencies, businesses, and non-profits.

All stakeholders were provided information about KDOW sampling results and consulted on the feasibility of a variety of BMPs. Many expressed reservations about the cost of sewer installation and about the possibility of threatening relationships with local mining companies. However, all understood bacterial contamination to be a long-running problem. Two project applications for sewer extensions in the focus watersheds are currently in place through KRADD and support would be needed from all partners to gain traction on these.

4. Community Forum

A community forum was held on October 14, 2019 at the Southeast Community and Technical College in Whitesburg. The event was advertised in the local paper and covered by WYMT television. The community forum delivered information on prior sampling efforts and some best management options to be prioritized by community members and stakeholders. The forum presented results on water quality and potential solutions for pollution causes and sources. Open discussion was held on stakeholder views and potential strategies for effective implementation. A total of 19 people attended the meeting.

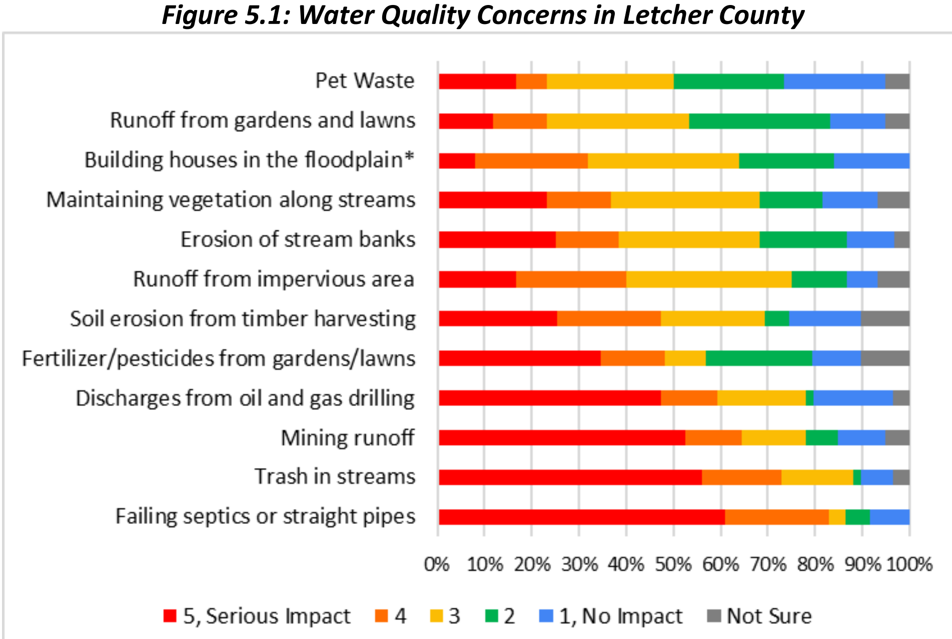
5. Survey Results

The 62 survey responses represented a balanced cross-section of age and gender of Letcher County Residents (92%). About half of the participants knew that they lived in a watershed, with around 68% able to correctly specify their watershed (typically to the basin or sub-basin level).

The respondents used streams for fishing (40%), wading (31%), children playing (21%), and swimming (12%), although 43% did not use the streams for any of these uses. While most (74%) recognized that their personal actions affected water quality, some (17%) did not take ownership of the contributions all individuals make as inhabitants of the land.

The greatest impacts to water quality in the area (Figure 5.1) were perceived to be failing septic systems or straight pipes, trash in streams, mining runoff, and discharges from oil and gas; the latter of which was shown not to be the case in our focus watersheds. Most people did not see a strong impact from pet waste, runoff from gardens and lawns, or building houses in the floodplain.

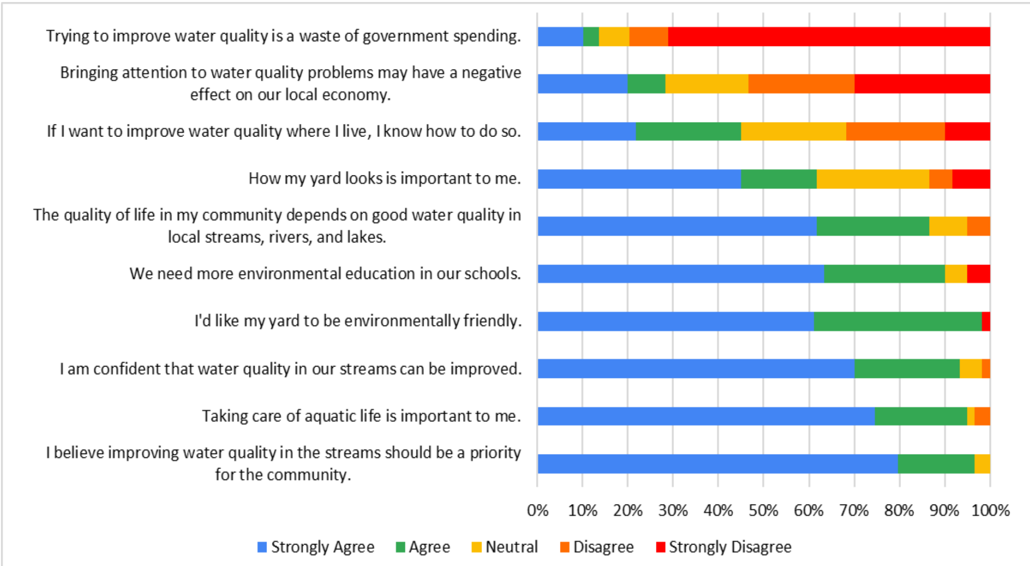
Figure 5.1: Water Quality Concerns in Letcher County



NOTE: Concerns are ranked from least to greatest, based on degree of perceived impact to water quality on a scale from 1 to 5, with 5 being a "serious impact" and 1 is "no impact at all." Result shown as percentage of responses in each category.

Most survey respondents had strong positive positions on water quality (Figure 5.2). A strong majority thought government spending to improve water quality was worthwhile and that improving water quality should be a priority for the community. They were concerned about aquatic life impacts and were optimistic about making improvements. However, almost 30% of respondents thought that bringing attention to water quality issues might have negative economic effects. Residents were supportive of environmentally responsible management of their yard and are in favor of more environmental education in schools.

Figure 5.2: Water Quality Views in Letcher County



In terms of home stewardship, most respondents live in single-family homes (69%) but mobile homes (19%) and apartments (12%) were common. Two-thirds owned their properties. Most respondents (75%) were on municipal (city or county) water sources, but a significant percentage (25%) obtained their drinking water from wells or springs. Rain barrels were utilized by 13% of the respondents to capture rainwater.

Survey respondents indicated that septic systems (61%) were the most common method of treating sewage, with 27% connected to the public sanitary sewer system. Straight pipes were used by 5% of respondents, and 6% were not sure how their sewage was treated. For those with septic systems or straight pipes, 46% were installed during the 1990s or prior. This is notable because until 1992, properties with 10 or more acres weren't required to have an approved onsite system, and in 1998 a state law was passed requiring a properly installed septic system before the power company could turn on electric service for new construction. Thirty-seven percent of systems were installed subsequent to 2000, but 17% of respondents were not sure when their system was installed. Only 33% of septic system owners indicated that their sewage had been inspected or pumped within the past 5 years (the recommended maintenance requirement), despite 20% noting signs of system failure (e.g. foul odors in drains, sewage backup, or slow drains). This indicates that septic systems are not being operated properly, are failing, and many may have been installed prior to modern inspection requirements.

Over 70% of respondents indicated that a stream was located on or adjacent to their property, showing the high degree of interaction between the respondents and water resources. Of those near a stream, 50% indicated that they maintained a 25-foot buffer on each side. For those who did not maintain a buffer, lack of space (20%), access issues (15%), or aesthetics (looks bad) (10%) were indicated to be reasons why the area was not expanded. Twenty-seven percent of streamside inhabitants indicated that erosion was a problem on their property, with 27% of these "fixing" it themselves.

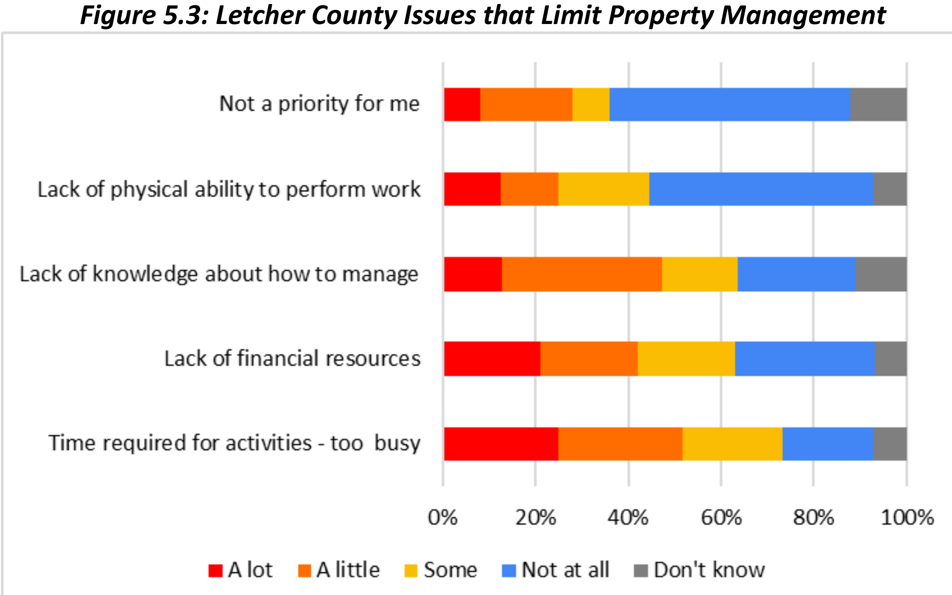
In surveying about animal waste sources, only 10% owned some sort of livestock, with cattle, chickens, and horses being the most common. However, 55% of respondents owned dogs, with the average owning 2. Half (50%) of dog owners never pick up their dog waste, while 39% pick it up once a week or more frequently. This could possibly be correlated with the view that pet waste does not impact water quality.

Lawn and garden maintenance levels are thought to have minimal potential water quality impacts based on survey responses. Fifty-seven percent grow a garden, but about 60% never fertilize or use herbicides on their lawn or garden and about 25% only do so once a year.

Responses to the question about how much various issues "limit your ability to improve how you manage your property," shown in Figure 5.3, indicate that many would improve management of their property for environmental purposes, but currently lack time, money, and knowledge of how to do so properly.

These survey results indicate a need to develop simple, straightforward "how-to" guides for backyard stream management for Letcher County residents, as well as environmental education on water quality issues. Further, they suggest a general awareness of the issues affecting water quality and support for improvement, but also some caution on how bringing attention and action on these issues might affect the local economy or the perceptions of the area.

Figure 5.3: Letcher County Issues that Limit Property Management



6. Feedback from Community Forum and One-on-One Meetings

Despite numerous direct invitations to community members and one-on-one meetings, the community forum was only lightly attended. Nevertheless, the forum provided an important source of feedback on how to prioritize best management practices and what solutions may be feasible.

Some of the key takeaways from the meeting included the following:

- Some voiced that attendance was low at the forum due to a perception that action is not taken when concerns are voiced. Demonstration projects were proposed to provide community engagement and hope. In the meantime, one-on-one meetings are critical to obtain input.
- Residences built on reclaimed strip mines have unique challenges regarding infrastructure for human sewage due to construction on bedrock.
- The charge for sanitary sewer is currently 150% of the drinking water bill. These costs often deter residents from tapping on to sewer even if it is available. Enforcement is difficult for a variety of factors. Community resistance to additional fees may torpedo various sanitary solutions, and community analysis of ability to support additional services rates may be needed.
- An anecdote of a resident who had repeatedly replaced his septic system in recent years due to repeated failure was given as a caution against this as a solution in all areas.

From one-on-one meetings, the following notes were found to be the most insightful:

- Solutions for mine drainage impacts must be individually analyzed and developed based on the unique geological contributions to the discharges. The treatment methods can also change over time. Generally, passive treatment through a series of settling basins or aerobic wetlands are the best options, but significant land surface area is needed. Eligibility for Abandoned Mine Land funding must first be determined by individually reviewing each site that is submitted through a complaint or request, then connecting the drainage to an individual mine. The confirmed drainage is then prioritized based on risk of impact to human health and environment and feasibility of remediation. There must be landowner agreement for remediation to be pursued on their private property. Additional pilot project funding is available if remediation can be linked with economic benefit.
- Several court cases in the area were referenced as causing justification of public mistrust of responses to environmental concerns related to water resources.
    - Golden Oak Mining Company vs Lucas (2011), found that in the 1990's, Golden Oak Mining impacted water quality and water quantity in drinking water wells for residents in the Camp Branch watershed just north of Sandlick Creek along KY-931. Although a settlement of $1.5 million was used to provide drinking water to the area, the later lawsuit seeking payment for injuries was dismissed based on the statute of limitations. This was brought up by several stakeholders as an injustice.
    - The Childers Oil Company spilled diesel fuel into the North Fork of the Kentucky River in Whitesburg in October 2008 and was fined $500,000 in 2010. This spill, and a second shortly after it in 2009, impacted the water supplies of about 7,500 people in Whitesburg. However, a lawsuit settlement of $50,000 over another spill in February 2011 was initially kept secret until the request was rejected by the circuit judge in 2015. This was noted as eroding public trust.
- High in-stream ammonia concentrations were found in the past to have been linked to methamphetamine production upstream. This was suggested as a potential cause of the high ammonia levels on Site 19.
- For timber logging, the "Kentucky Logging BMP Field Guide" (Stringer 2018) provides a comprehensive guide to practices to be used to protect streams when logging. Although no active logging is occurring in the focus watershed, there is a perception that sedimentation from logging is a big issue for Letcher County streams. The Kentucky Division of Forestry is supposed to be notified before logging begins, but sometimes this does not happen. Further, loggers are supposed to file for exceptions to BMP implementation, but some do not file. A bad actor list of loggers ought to be maintained, but currently is not. Oversight is viewed as challenging.

- Many residents in the area are on fixed income, and some perceived that most of the working-age people had left the area. Even small rate or tax increases (as low as 2%) are perceived as having a devastating effect on residents. It is often difficult for renters to find financial assistance unless they are very low-income or a senior. There is some resistance for renters to fix up their properties due to the perception that landlords, who are often absentee or won't pay for fixes, might sell the property after improvements are made.
- The challenges of the mountainous terrain often do not always make sanitary sewers the best option for sewage treatment due to the high cost of maintenance and the need for lift pumps.
- The economic development of "Thunder Mountain" on Thompson Branch near the mouth of Sandlick Creek through an Abandoned Mine Lands economic grant may provide a potential opportunity for implementation of improved sewage treatment in the watershed. The development is planned to provide recreational opportunities through gun ranges, archery, and ATV riding. RV sewage disposal would also need to be properly discharged from tourists attracted to the site. This project is still early in planning and needs additional funding and planning.
- Some officials viewed working with the Department of Transportation to "ditch" roads as being a solution to mitigate water damage from flooding during rain events. These perceived "ditches" alongside roadways are actually the streams and tributaries of the focus watersheds. Thus, the "ditching" effort may be removing habitat and increasing channelization in streams. Discussion with the Department of Transportation on management of roadside streams may prove insightful.

Based on the community survey and stakeholder feedback, as well as consultation with technical experts, a list of potential best management practices for consideration was developed.

C. Potential Water Quality Best Management Practices

As stated in Chapter 4, the causes of impairment are primarily due to 1) human sewage, 2) legacy mine drainage, and 3) habitat and erosional impacts due to residences in the floodplain. Therefore, potential BMPs related to these causes are described. Additionally, potential BMPs related to common water quality issues mentioned by stakeholders in Letcher County will be evaluated.

1. Human Sewage

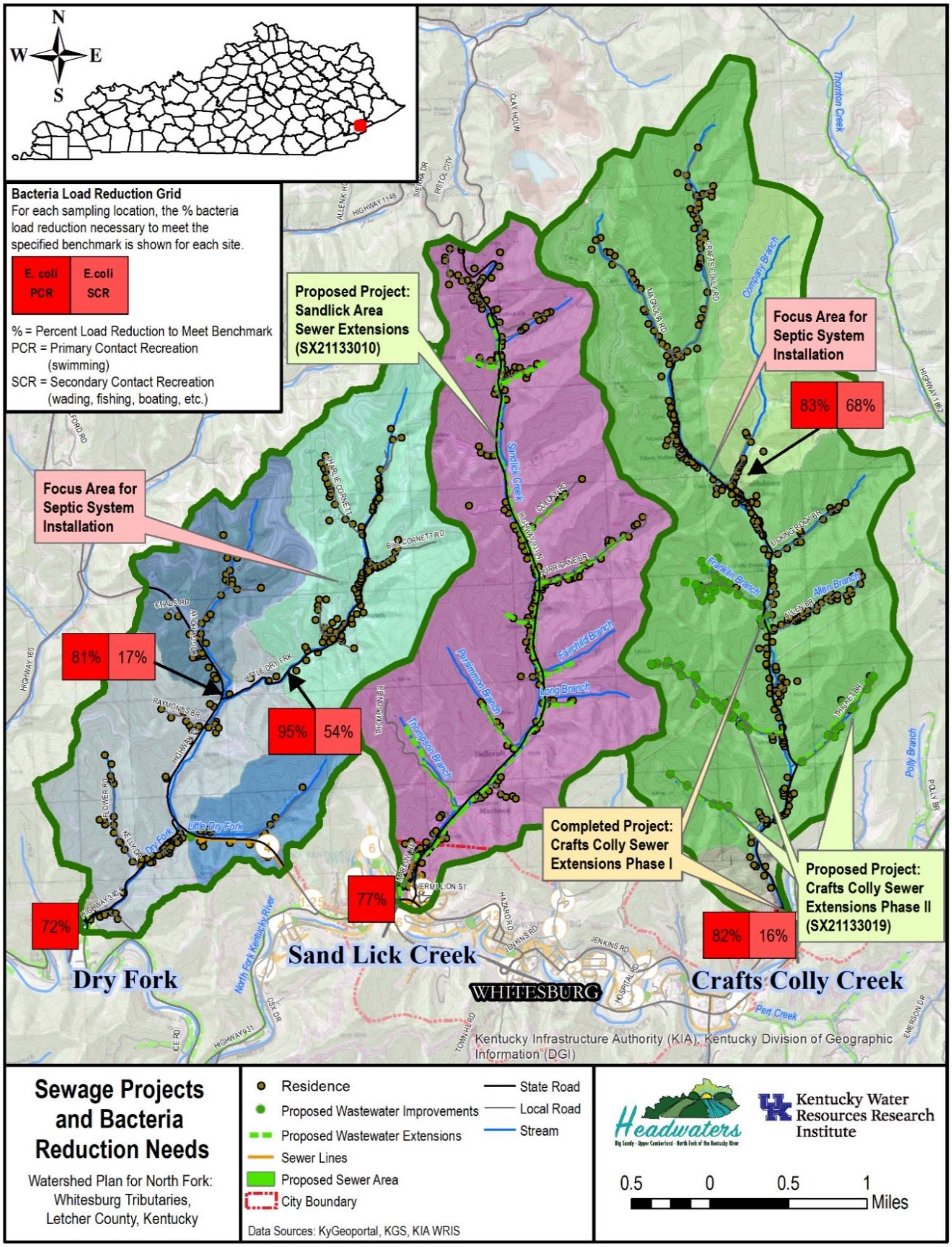
Providing adequate treatment for human wastewater is important to protect human health from threats from waterborne bacterial and viral disease risks. Sanitary sewers, properly maintained septic systems, or other onsite sewage treatment options are available practices to treat sewage. Figure 5.4 (page 5.11) details the bacteria load reduction needs in the area, as well as focus areas for septic system improvements.

Sanitary Sewer

Dry Fork has sanitary sewer lines along a small portion of the tributary of Little Dry Fork along KY-15. Crafts Colly has limited sewer service in the lower portion of the watershed, and Sandlick Creek does not have any sewer infrastructure. The Whitesburg Sandlick Area Sewer Extension project (SX21133010) has been proposed to reach 105 of the 254 residences along Sandlick Creek at a cost of \$2.053 million, or about \$15,000 per customer. The Crafts Colly Sewer Extension Phase II (Project SX21133019) is proposed to connect 79 additional residences on Crafts Colly at a cost of \$1.215 million, or about \$19,000 per customer. These projects do not include costs to connect residences to the public sewer (tap-on fees), which vary by distance and bedrock depth.

The high cost for installation and maintenance due to the steep terrain are drawbacks to sanitary sewer expansion. Further, there is no guarantee that homeowners will tap-on if the lines are run to the area and enforcement is difficult, particularly in low-income situations. Non-point source grant assistance is potentially available to defray the cost of tap-on fees. An additional concern is homeowners' ability and willingness to pay monthly sewer service costs.

Figure 5.4: Sewage Projects and Bacterial Reduction Needs



Septic Systems

Properly maintained septic systems can effectively treat human waste at individual residences. For some residences, repair and maintenance of existing septic systems may restore proper function. Septic systems with traditional gravel bed leach fields can be used in areas with enough space, but alternatives such as leaching chambers, leaching chamber beds, drip irrigation, and constructed wetland cells can be used in confined areas. Clustered systems may be suitable in some areas where residences are close together and can share a leach field. Figure 5.5 shows schematics of the differences between the system types. Grant funding may be available to assist homeowners with system replacement or repair or the installation of a shared cluster system.

Other Alternatives

Composting toilets are a small-scale, individualized solution which utilizes biological breakdown processes without the addition of water. Compost toilets do not require septic tanks or sewer systems, but also do not eliminate pathogens. Composting toilets have a limited capacity and are not an acceptable alternative for all households due to odor and maintenance issues. This may be an alternative for some homeowners in the area.

Aerobic Treatment Units (ATUs) are an alternative to septic systems that facilitate bacterial breakdown of sludge and separate non-biodegradeable materials that can clog septic systems through injection of oxygen into the tank. These systems cost more to operate than septic systems and require routine maintenance but are an option for areas where land area or soil conditions prohibit septic installation.

Wastewater lagoons are sometimes used by smaller communities to artificially aerate sewage, and generally consist of a pond which contains motor-driven surface aerators or submerged aerators to mix sludge and water. This facilitates

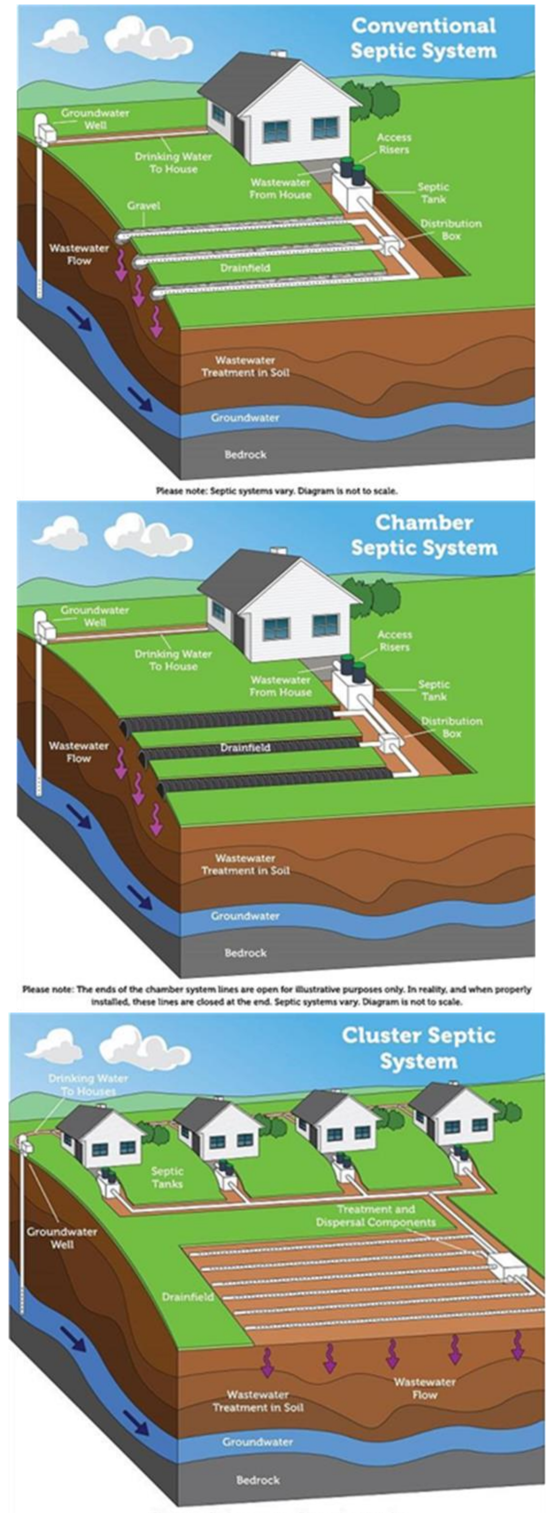


Figure 5.5: Alternatives for Sewage Treatment by Septic System

Conventional (top), leaching chambers (middle), and cluster systems (bottom). Graphics from EPA SepticSmart program, https://www.epa.gov/septic/.

biological breakdown of bacteria. With health department approval, this could provide an alternative in some areas.

2. Legacy Mine Drainage

Most of the mine drainage impacts to the Whitesburg tributaries are due to legacy drainage from abandoned coal mines. Heavy metals from mine drainage are transported through waterways. Therefore, it is crucial to divert, prevent, and control the flow of contaminated waterways before they impact human health or aquatic flora and fauna. The Abandoned Mine Land (AML) Reclamation Program, funded by fees on coal production, is set aside to addresses the hazards and environmental degradation from legacy mine issues.

Passive Treatment

Treatments for mine drainage impacts must be designed specific to each area, as the composition of metals varies depending on the geology. Passive treatments are preferred above active treatment due to cost and maintenance needs. According to Hedin et al (2013) and Christ (2014), passive treatment for mine drainage typically involves one or more of the following BMPs as diagrammed in Figure 5.6: 1) aerobic settling ponds, 2) constructed wetlands, 3) anoxic limestone bed, 4) anaerobic vertical flow wetlands, and 5) drainable limestone beds.

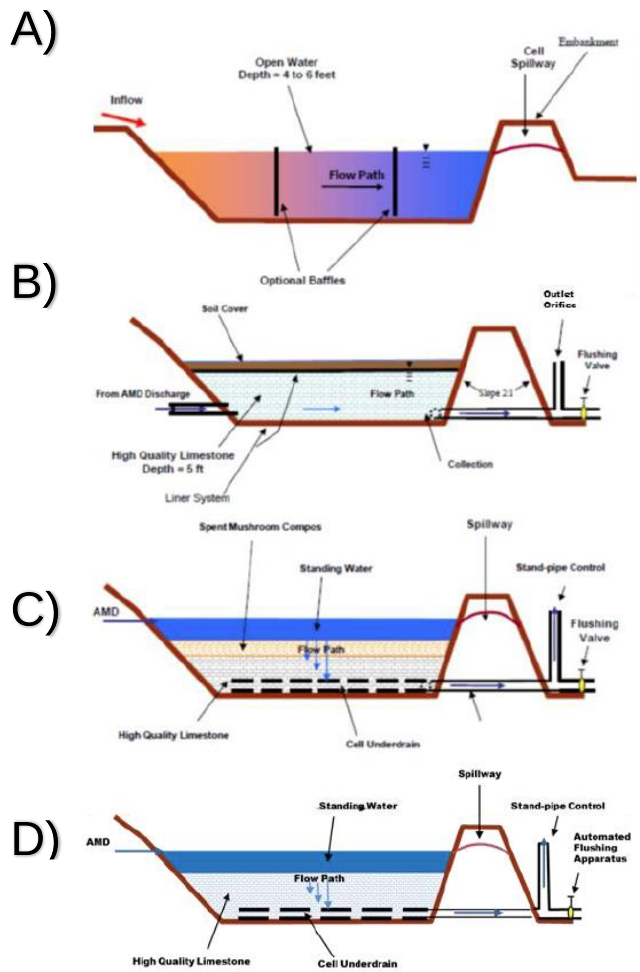


Figure 5.6: Common Passive Treatments for Mine Drainage

Diagrams from top to bottom depict A) Aerobic wetland, B) anoxic limestone bed, C) anaerobic vertical flow wetland, and D) drainable limestone bed. Source: West Virginia Department of Environmental Protection, "Operation and Maintenance of Passive Acid Mine Drainage Treatment Systems." (Christ 2014)

Settling ponds (not shown in Figure 5.6) retain water long enough to oxidize ferrous iron (which is soluble in water) into ferric iron (an orange colored solid at neutral or alkaline pH) and to allow the ferric iron to settle out along with other metals. This treatment is for neutral or alkaline drainage (not acid mine drainage).

Constructed aerobic wetlands (Diagram A) are positioned after settling ponds where the shallower water removes residual suspended sediments and metals as a polishing step. These wetlands are also effective in removing manganese. In conjunction with settling ponds, approximately 20 grams of iron per square meter of treatment per day may be removed through this approach (Christ 2014). Sludge periodically needs to be dredged and removed.

Anoxic limestone beds (Diagram B) include high quality limestone buried under a liner and soil cover such that the mine drainage that flows through it is does not interact with oxygen. This treatment cannot be applied to waters with ferric iron or aluminum, because it will clog. However, for ferrous iron and manganese, this effective treatment works by increasing the alkalinity of the water when positioned before a settling pond. Drawbacks are that they are difficult to repair and have only a limited lifespan (20 years) at best.

Anaerobic vertical flow wetlands (Diagram C) are treatments for acidic waters containing aluminum and ferric iron. Water flows into the wetland and vertically downward through a layer of submerged organic matter that removes the oxygen. Then, the water flows through a limestone bed where the alkalinity increases. The water leaves via an underdrain which typically flows into a settling pond in which iron and other contaminants can be removed.

Finally, the drainable limestone bed (Diagram D) is simply a pond filled with limestone with an underdrain. The limestone treats the acidic water, allowing the metals to precipitate out. Draining the bed on a weekly basis via an automatic timer can help prolong the life of this treatment system by decreasing the amount of iron crusting over rocks and filling of spaces between limestone.

These passive treatments have the drawback of requiring a large amount of space which can exceed the amount of land available. Therefore, the treatment may not be feasible for all drainages. In some cases, the aesthetics may make these practices undesirable for property owners, whose permission would be necessary for implementation. The locations in need of remediation are shown in Figure 5.7 (page 5.15).

Currently, many of these drainages flow directly into streams. In some cases, mine drainage would need to be rerouted or diverted to flow through these treatments before entering streams. Additionally, pumping of the drainage to an area where sufficient land surface is available for treatment may be required.

Other Mine-Related BMPs

In addition to passive treatment of drainage, removal of old spoil piles in the watershed would reduce runoff pollution from these sources.

Legacy mine sites can also be repurposed through renewable energy and ecological restoration practices such as solar farming, reforestation, and agriculture. Economic development of sites may provide opportunities for treatment during the construction process.

3. Habitat and Erosional Impacts

The habitat impacts and erosion issues in the focus watershed areas are interrelated. Erosion and sedimentation occur where stream channelization and increased impervious surfaces in the watershed have led to greater stormwater runoff volume and velocity. The hydrologic changes reduce the available habitat for aquatic and semi-aquatic wildlife through downcutting of the stream beds and failure of eroding stream banks. Flooding becomes more common, impacting infrastructure placed within the floodplain, such as roads and buildings. Under dry weather conditions, the amount of sustained baseflow in the streams decreases. Figure 5.8 (page 5.16) shows areas in need or BMPs to address erosion and streamside habitat.

Water volume and velocity

Three key approaches should be utilized to reduce the storm flow volume and velocity in the area: 1) slow water down, 2) spread it out, and 3) soak it in. Water may be slowed by restoring meanders to streams in flatter ground (horizontal variance) or by adding step pools in steeper tributaries (vertical variance).

Figure 5.7: Mine Drainage Load Reduction by Site

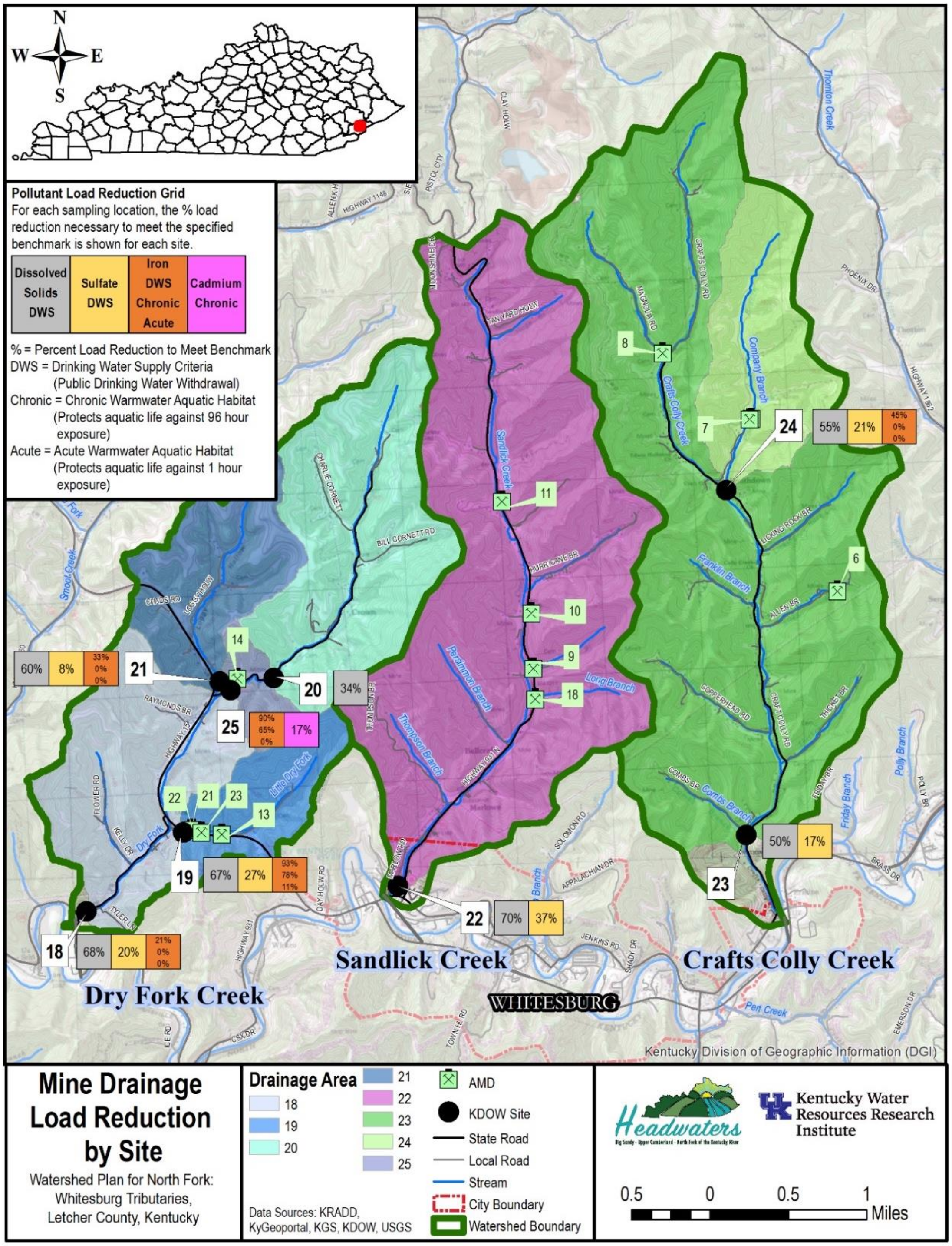
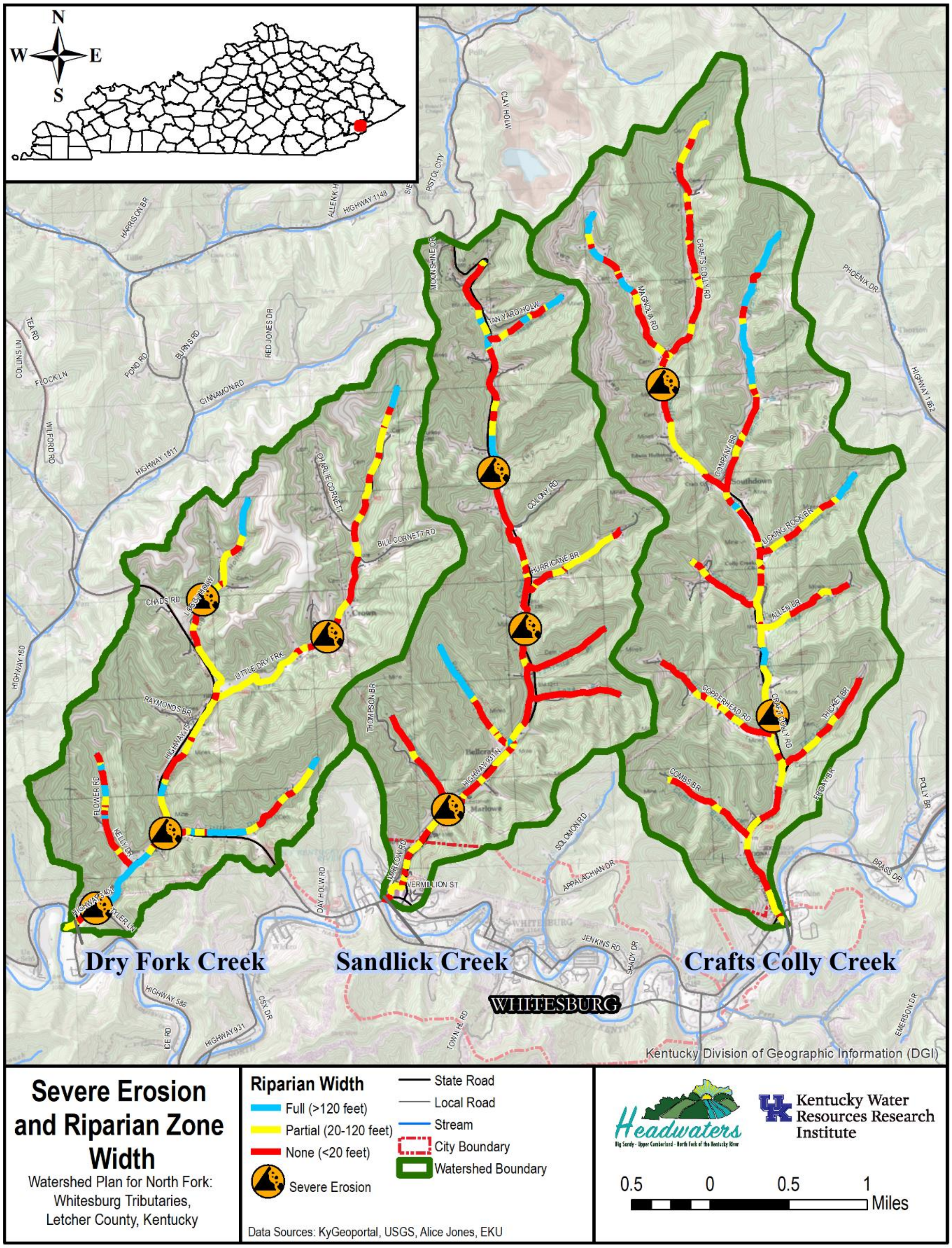


Figure 5.8: Severe Erosion and Riparian Zone Width



Streamside detention basins or floodplain wetlands can be included in open areas to expand floodwater storage and allow the water runoff to spread out. Additionally, rain barrels or rain gardens can be installed at individual residences to capture rainwater. Or, runoff from roadways and rooftops can be redirected to areas where it can soak into the ground more gradually.

In cases where sufficient land is present to protect and enhance floodplain areas, detention areas could be constructed as multifunction areas and utilized as parks during non-storm conditions. Implementers of this process would need public input to understand how areas could be made more visually appealing and acceptable. FEMA is a potential source of funding for supporting flooding and erosion control measures. The National Park Service is also a potential source of funding and technical advice.

Bank stabilization and Repair
Some areas with erosion may require stabilization and armoring to prevent infrastructure damage or additional erosion. Where possible, reducing the bank angle and armoring with toe logs, root wad bank deflectors, coir fabric with willow stakes, or other natural means should be utilized over riprap or steel reinforcement.

Stream Habitat Improvement
To improve the stream habitat, trees and shrubs can be planted along the stream banks in areas where feasible, ideally creating vegetated buffers of at least 50 feet, to improve stream habitat. These riparian vegetated buffers also help slow runoff and soak in the water before it reaches the streams. Native plants such as willow, spice bush, arrowwood viburnum, deer tongue grass, and swamp milkweed would be planted to stabilize stream banks, filter runoff pollutants, and decrease the risk of colonization by invasive species. Invasive species would need to be cleared from these areas prior to planting to prevent competition and enable successful establishment of native species.

Outreach and education efforts emphasizing vegetation maintenance in erosion-prone areas and the importance of maintaining and improving stream sinuosity could have cumulative effects throughout the watershed. Education on the effects of dredging on aquatic ecosystems should also improve management efforts.

Specifically, a riparian zone planting project along the North Fork Trail in Whitesburg or at Southeast Kentucky Community & Technical College campus could provide residents with a highly visible demonstration of this management practice and may encourage community familiarity and adoption. Associated educational signage about the importance of riparian areas for erosion control, habitat enhancement and water quality improvement would educate the public, encouraging residents to create their own protective riparian buffers with native plants.

Beyond riparian restoration, stream restoration by natural channel design principles and streamside wetland construction should be implemented where feasible.

4. Logging and Deforestation

The cover of deciduous forest in Crafts Colly and Sand Lick is about 74% and approximately 76% in Dry Fork. It is therefore crucial that BMPs address issues pertaining to logging, including habitat restoration, streambank stabilization, and reduction of sediment runoff. Although logging is not currently occurring on a broad scale, an awareness of appropriate logging techniques is important to protecting water quality and habitat conditions if future logging occurs.

In Kentucky, the use of appropriate Best Management Practices (BMPs) for timber harvesting operations are required by the Kentucky Forest Conservation Act (KFCA - KRS 149.330 to 149.355). The BMPs found in the "Kentucky Logging BMP Field Guide" (Stringer 2018) are "practices designed specifically for logging operations to use before, during, and after timber harvesting. If implemented correctly, they will reduce or eliminate water pollutants that have the potential to be generated from logging operations where drainage channels and water bodies are present." While 319h funding is available for reducing nonpoint source runoff impacts from logging operations, it can only help fund practices that exceed those already required by law.

The guide include requirements for 1) access roads, trails, and landings, 2) revegetation of disturbed areas, 3) streamside management zones (an alternative name for riparian buffers), 4) sinkholes, sinking streams and caves, 5) fluids and trash, 6) proper planting of tree seedlings by machine, 7) fertilization, 8) application of pesticides, 9) site preparation for reforestation, and 10) silviculture in wetland areas. The guide is available online at https://forestry.ca.uky.edu/files/for_130_bmp_guide_small.pdf.

D. Feasibility Considerations

1. Geography

The watershed is subject to a combination of high-gradient terrain, close proximity of homes and other structures to waterways, and extremely narrow or non-existent riparian zones around channelized streams. Most land is owned privately, either by large or small landholders, making relationships with landowners necessary to access land in locations where stream improvements are necessary. Almost all potential improvements require riparian area access. Some, such as installing stormwater retention and detention basins or constructed wetlands, specifically require flat land and a relatively large area for installation.

2. Property Ownership

Best management practices can only be implemented where property owners are willing. However, there are challenges in Sand Lick, Dry Fork, and Crafts Colly Creeks due to ownership.

Absentee landowners of large areas can prevent residents from feeling accountable towards the local watershed and water quality. Recognition programs such as media spotlights or implementation signage can be used to bring recognition to reward adoption by landowners. Further, education and outreach to strengthen relationships and promote cost-effective, sustainable practices will be necessary.

Residents desire to maintain valuable flat lands in valley bottoms and floodplains for either future development or recreational use. This may cause residents to reject projects or BMP implementation on grounds of protecting personal property. However, it is important educate residents about the risk of further loss of flat land through erosion and failure to improve stream bank conditions. Successful demonstration projects can show others what is possible, especially if funding assistance can be acquired and utilized.

Community perception of mine drainage mitigation can also be challenging for project buy-in due to the role of coal in the community's past and present economy. However, Headwaters staff and partners are working to make community connections through environmental education, arts projects, and direct landowner assistance, and operate under the understanding that trust is built when visible results are delivered.

3. Barriers to Funding

Although the Kentucky Division of Abandoned Mine Lands (AML) provides funding for AML restoration projects, these projects are only available to minelands existing before the 1977 Surface Mining Control and Reclamation Act (SMCRA) and funding is highly competitive due to high demand. Companies opening new mines after the institution of SMCRA are required by law to provide funding and support for ecological restoration of these lands. The diversity of ownership and mine ages in the Whitesburg area makes seeking corporate accountability for mineland restoration and determination of eligibility for AML funding difficult and will require close investigation and mapping.

A lack of a community-supported plan to comprehensively address sewage problems in the area could also be a barrier to funding. A rate analysis is likely necessary to determine what residents in the area could support. The reluctance of some residents to tap-on to existing sewage service in Crafts Colly may discourage external funding sources from expanding sewage in the area.

4. Local Capacity

While many public officials are able to move some of these projects forward, some have expressed doubt that stream improvement projects will receive the funding and continued support needed for success. Several municipal public servants expressed concern that many community members would not pay into sewer bills, making a functional sewer system difficult to maintain. Many BMPs, such as riparian buffer zones and constructed wetlands, require consistent, labor-intensive management in order to remain successful. Past wetlands projects have been cited in Letcher County as failures for this reason.

In addition, during the community outreach process, multiple community members expressed to Headwaters staff uncertainty about their personal ability to manage the work needed for stream improvements. Some older residents do not have the physical ability for yard management, while younger and lower-income residents lacked the finances, spare time, and technical knowledge for ecologically sound yard upkeep. Headwaters will work with the community to address these challenges and support the goals of this project.

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Chapter VI: Implementation Plan

A. Goals and Objectives

Based on the survey results and community feedback, the project team developed the following list of goals, prioritized from greatest to least concern:

1. Bacteria: Decrease fecal indicator bacteria levels to allow for safe recreational use;
2. Trash: Remove trash and litter from streams;
3. Mine Drainage: Reduce toxic metals and dissolved ions from mine drainage to levels that support a healthy aquatic ecosystem and do not impact drinking water supplies;
4. Community Engagement: Educate the local community on the water resource impacts and how they can help improve water quality;
5. Habitat and Erosion: Restore stream and riparian habitat to stable, natural channel conditions to address impacts from hydromodification (including flooding, erosion, and sedimentation) and habitat alteration.

For each goal, the pollutant source or cause, measurable indicator of success, and the objectives to be addressed in order to accomplish the goal were identified and summarized in Table 6.1 (page 6.2). Most of the goals and objectives address impairments and pollutants identified in the watershed. The water quality concerns expressed in the stakeholder survey, as well as human recreational health impacts, were used to prioritize the goals. Measurable indicators of success were selected based on regulatory standards (such as *E. coli*) or impairments indicated in the watershed monitoring. Other parameters may be utilized as appropriate to gage the success of a given best management practice (BMP); however, to evaluate overall progress in water quality improvement, the measurable indicators should be prioritized. Objectives express specific results or steps that are needed to achieve the goals.

B. BMP Implementation Plan

The watershed goals and objectives were used as a framework to develop a comprehensive BMP Implementation Plan with projects and opportunities necessary to restore the designated uses to the watershed and achieve the community goals. The BMP Implementation Plan is intended to guide efforts and represent the scope and types of activities that will be required to meet the watershed goals. As more information is obtained or as individual stakeholders are reached, the approach to obtaining the goals and objectives is expected to evolve.

The *North Fork: Whitesburg Tributaries Watershed Implementation Plan* has been divided into categories based on the BMP goals. Within each category, the information necessary for project implementation is summarized, as best as currently possible, including type of BMPs, target audience or area, description of the project including action items, impairment/pollutant addressed, responsible parties including technical assistance, cost estimates, load reductions, funding source(s) or program(s), and milestones. The objective that each BMP is intended to meet is specified, and in cases where the BMP crosses several goals, it is listed with the most relevant goal.

The implementation plan has been developed to the depth of specificity currently possible through the watershed planning team. The plan is intended to be adaptive and iterative as the community and opportunities change. Currently, best management practice implementation opportunities are limited by landowner willingness, financial constraints, and spatial restrictions, among other factors. As willingness changes, grants become available, and property ownership changes, new opportunities are expected to

Table 6.1: North Fork: Whitesburg Tributaries Watershed Plan Goals and Objectives

Goal	Source, Cause, Pollutant, or Threat	Measurable Indicator	Objectives
1. Decrease fecal indicator bacteria levels to allow for safe recreational use	Major • Straight pipes • Failing septic systems Minor • Dog waste	• E. coli • Ammonia	1.1 Exceed *E.coli* instantaneous criteria in less than 20% of samples. 1.2 Determine the current status of wastewater treatment in the watersheds and feasible treatment options. 1.3 Analyze the affordability of wastewater treatment options for community members. 1.4 Develop a community supported sanitary infrastructure plan for the area. 1.5 Implement a septic system repair / replacement / installation program in targeted areas. 1.6 Implement a dog waste pick up education campaign.
2. Remove trash and litter from streams	• Trash and litter • Fallen structures	• Estimated amount of trash removed	2.1 Organize groups to remove trash and litter from the watershed on a routine basis. 2.2 Develop outreach materials to reducing littering and dumping. 2.3 Install roadside signage for litter outreach. 2.4 Identify and remove collapsing structures near streams.
3. Reduce toxic metals and dissolved ions from mine drainage to levels that support a healthy aquatic ecosystem and do not impact drinking water supplies	• Mine drainage	• Iron • Cadmium • Total hardness • Sulfate • Conductivity • Total dissolved solids	3.1 Reduce iron and cadmium below acute and chronic regulatory criteria for aquatic habitat protection. 3.2 Reduce iron and sulfate below domestic water source criteria in Crafts Colly. 3.3 Reduce conductivity below 300 uS/cm as a long-term goal and 500 uS/cm as an interim goal to support a healthy aquatic ecosystem.
4. Educate the local community on the water resource impacts and how residents can help improve water quality	• Lack of education on impairments and solutions	• Number of interactions • Educational materials developed and distributed • Measured behavior change	4.1 Increase public knowledge about water quality impairments. 4.2 Develop targeted educational materials for each problem area. 4.3 Reach targeted audiences about implementation activities on their property. 4.4 Perform ongoing monitoring of stream health conditions 4.5 Provide demonstration projects as examples of best management practices.
5. Restore stream and riparian habitat to stable, natural channel conditions to address impacts from hydromodification (including flooding, erosion, and sedimentation) and habitat alteration.	• Channelization and entrenchment • Increased runoff from mined lands • “Cleaning out” streams • Buildings / roadways in the floodplain	• Macro-invertebrate score • Habitat score • Visual erosion surveys • Turbidity • Riparian width measurements	5.1 Increase the width of the riparian zone where landowner permission and safe roadway navigation allows. 5.2 Stabilize bank erosion in severely eroding areas. 5.3 Restore natural riffle-run-pool sequences and connections to the floodplain where possible. 5.4 Reduce the runoff velocity and volume during storms through infiltration, stormwater detention, streamside wetlands, and floodplain connection. 5.5 Decrease flooding and impacts to adjacent infrastructure.

emerge. Thus, this plan provides the general programmatic framework that would be necessary to achieve the goals, along with some potential locations for demonstrating specific practices based on the current community landscape.

C. BMP Implementation Plan

1. General

A watershed coordinator should continue to be supported by Headwaters, Inc. A coordinator is necessary to serve as a central point of contact for the watershed implementation projects. The coordinator will work with local landowners and technical advisors to develop and implement the other BMPs identified in this plan. The coordinator will also be responsible for tracking progress on implementation and scheduling events.

The watershed coordinator will also be responsible for working with implementation partners on education and outreach materials. The cost of developing these materials will primarily be covered through support of the coordinator.

As of 2020, this support is estimated to be around $32,000 annually. A 319(h) grant from the Kentucky Division of Water in conjunction with other funding sources are available to support a coordinator. The coordinator should preferably be from the region to facilitate understanding of local culture, practices, and outreach approaches.

The coordinator should be supported during the plan development and should continue through implementation to allow for seamless transition from planning to action.

2. Bacteria

Best management practices to address bacteria are listed in Table 6.2. These practices focus on treatment of human wastewater primarily and secondarily on dog waste pickup. Human wastewater treatment options could include sanitary sewer extension, septic system repair or replacement, or a clustered onsite system. It is know that some residences in the area are on straight pipe systems.

To implement a cost-effective, reasonable solution for human wastewater treatment in the area, more preliminary information needs to be gathered on the status of wastewater treatment, the location of failures, the affordability of various options, and potential funding sources. Based on the results of these studies, a regional wastewater plan should be developed for the focused watersheds with community support. Several proposals and opportunities for sanitary sewer extension exist, if this is deemed the most reasonable and feasible option. Because this is a point source, 319(h) nonpoint grant monies could not be used to implement these sewer projects, but could potential be used to supplement tap-ons for non-sewered areas or to engage residents through community education and outreach.

It is likely that some areas, particularly in steeper more remote areas, will need onsite solutions appropriate to space and soil requirements. A septic system education program with an accompanying pump out, repair, or replacement program has been successful in other Kentucky watershed plans and could provide a template for implementation in Letcher County.

It is estimated that a residence with completely untreated sewage will annually discharge 1.5 trillion *E. coli*, 2.2 lbs of phosphorus as P, and 13 lbs nitrogen as N. These numbers should be treated as a maximum

Table 6.2: Bacteria BMPs

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Estimated Timeframe
1.2	1	Health department officials to perform a sanitary survey of the area to determine the current types of wastewater treatment being utilized in the watershed. This survey will identify areas connected to sanitary sewer, functional septic systems, failing septic systems, and straight pipes. The survey should include limitations on potential treatment options.	All	Cabinet for Health, Letcher County Health Department	N/A	Fall 2021 - 2023
1.3	2	Conduct an affordability analysis of wastewater treatment alternatives, including sewer tap-on, to evaluate potential strategies. Some have access to sewer but tap-on may cause economic hardship. The current rate is 150% of the drinking water bill. An examination of this rate as a percentage of household income would help determine the best approach for wastewater treatment. It may also identify environmental justice issues associated with enforcement of straight pipe violations.	All	Headwaters, Appalachian Citizen's Law Center, Livelihoods Knowledge Exchange Network, City of Whitesburg, Letcher County Water and Sewer, KRADD, Whitesburg Mayor	$5,000 (watershed coordinator time)	Fall 2020 – Fall 2021
1.3, 4.2	3	Identify financial resources available to help low-income residents supplement the cost for the maintenance of septic systems or paying sanitary sewer tap-on and monthly bills. Plan public outreach around this program.	Low income	Headwaters, City of Whitesburg, Appalshop, Community Action	$2,000	October 2020 research, January 2021 launch
1.1, 1.4	4	Develop a regional plan for wastewater infrastructure. The steps taken to fulfill objectives 1.2 and 1.3 will provide a basis to evaluate a comprehensive plan for wastewater infrastructure in the area including whether sanitary sewer, clustered septic systems, or other septic options are most appropriate and cost-effective and associated monthly fees to support the treatment.	All	KRADD, State Representative, County Judge, KACO, RCAP, City of Whitesburg, Letcher County Water and Sewer, Whitesburg Mayor	$20,000 of Headwaters staff time in combination with partner in-kind match	2022

Table 6.2: Bacteria BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
1.1, 1.5	5	Implement a septic system repair / replacement / installation program in targeted areas. Based on the results of objective 1.4, a program to assist homeowners with failing septic systems and straight pipes should be developed. Applicants would apply to the program. A ranking system, which would include severity of failure, proximity to waterway, and financial need, would be devised in order to assist those eligible.	Targeted based on wastewater infrastructure plan for area	Letcher County Health Department, Headwaters	Replacement: ~$4,500 per 3-bedroom home. Pumpout: ~$200 per system.	Fall 2021 – Fall 2022 – Program research. Spring 2023 - Implementation
1.5	6	Develop or compile educational materials on septic system options, maintenance, and operation. Distribute at workshops and community events. Provide guidance on why some residents may experience repeat septic system failure	Non-sewer users	Headwaters, UK Cooperative Extension, Letcher County Health Department, City of Whitesburg, Appalshop	$2,000 for materials and Headwaters staff time (watershed coordinator time)	February 2021 – materials completed
1.1, 1.4	7	“Thunder Mountain” Economic Development Wastewater Expansion. While in the early stages of planning, the proposed development at Thompson Branch near the mouth of Sandlick Creek could present an opportunity to expand sewer service to the area. Planned to provide recreational opportunities such gun ranges, archery, and ATV riding, the site would need waste treatment to address RV sewage and tourists. An Abandoned Mine Lands Economic and Community Development Pilot grant has been awarded, but additional funding, investors, and planning are needed to fund the development.	Sandlick Creek Sanitary Sewer	AML, Thunder Mountain Investors, East Kentucky Heritage Foundation, City of Whitesburg, Letcher County Water and Sewer	Over $3,500,000	2020 - 2025

Table 6.2: Bacteria BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
1.1, 1.4	8	The Crafts Colly Sewer Extension Phase II (Project SX21133019) is proposed to connect 79 additional residences on Crafts Colly. Depending on the results of the regional plan for infrastructure, this may be a viable project to build community support around.	Lower half of Crafts Colly Sanitary Sewer	Letcher County Fiscal Court, KRADD	$1,215,000 (about $19,000 per customer)	2024
1.1, 1.4	9	Whitesburg Sandlick Area Sewer Extension project (SX21133010) has been proposed to reach 105 of the 254 residences along Sandlick Creek. Depending on the results of the regional plan for infrastructure, this may be a viable project to build community support around.	Sandlick Creek Sanitary Sewer	City of Whitesburg, KRADD	$2,053,000 (about $15,000 per customer)	2024
1.1, 1.6, 4.2	10	Develop and implement a dog waste pick up education campaign. An education program designed around "If you think picking up dog poop is unpleasant, try swimming in it." or "Do your Duty, pick up after your pet." has been successful with focus groups in Lexington, KY.	Letcher County dog owners	Headwaters, UK Cooperative Extension, Appalshop, Letcher County Schools	$2,000 materials, workshop expense, and time (watershed coordinator)	Fall 2020 develop, Winter 2021 order materials, Spring 2021 roll out

that can be obtained by treatment of a single residence's wastewater because even straight pipes with storage tanks or failing septic systems provide some treatment.

Partners in accomplishing a reduction of bacteria levels include Headwaters, Kentucky Division of Water, Kentucky Cabinet for Health, Letcher County Health Department, Appalachian Citizen's Law Center, Livelihoods Knowledge Exchange Network, City of Whitesburg, Letcher County Water and Sewer, Kentucky River Area Development District, Whitesburg Mayor, University of Kentucky Cooperative Extension Service, State Congressional Representatives, County Judge, Kentucky Association of Counties, and the Kentucky Rural Community Assistance Program.

3. Trash

Trash in streams was the second highest rated water quality concern in Letcher County based on stakeholder feedback, and therefore implementation toward removing trash and debris from streams and preventing litter from reaching streams is a priority for the community.

Headwaters has established an annual stream cleanup program which needs to be grown and expanded. There are also several community waste collection programs, such as the used tire collection and the Kentucky River Authority's River Sweep, which need to be further promoted. Beyond these programs, additional litter and trash programs are necessary, as are additional education and outreach efforts.

Table 6.3 details BMPs to address trash, litter, and debris in the area. A Google Earth visual survey of the watershed identified several abandoned buildings near collapse that are located adjacent to streams. These buildings are potential health hazards, and discussions should be had with local officials about methods to assist in their removal. Further, some large bulk items such as appliances and old vehicles have accumulated on scattered properties along area streams. Inquiries should be made to determine if local scrap metal recycling services may be willing to pick up such materials upon request.

Partners for these BMPs include Headwaters, Letcher County Solid Waste Coordinator, Division of Waste Management Field Office, Letcher County Judge-Executive, City of Whitesburg Mayor, Letcher County Central High School, Southeast Kentucky Community and Technical College, AmeriCorps National Civilian Community Corps volunteers, and local residents.

4. Mine Drainage

To accomplish goals and objectives related to mine drainage and impacts, mining BMPs are detailed in Table 6.4. It will be necessary to have the Kentucky Division of Abandoned Mine Lands catalog all 13 of the known mine drainage sites as well as mine spoil piles, shown in Figure 6.1, to determine the eligibility and priority level of each site. Based on the results of this analysis, landowners may be approached about their willingness to install treatments on their properties and/or additional funding sources may need to be identified. Because implementation is contingent on landowner participation, handling outreach sensitively and effectively is essential to the success of this goal.

As the prioritization process is affected by human health risks, a domestic water testing program would help identify how mine sources might be impacting drinking water sources. This program would primarily be targeted towards individuals reliant on domestic well water but could also apply to those receiving water from the Whitesburg Water System whose source waters are impacted by mining in Crafts Colly Creek. Should impacts exist, then developing a program to assist individuals with contaminated water sources will be a priority.

Table 6.3: Trash BMPs

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
2.1	11	Organize groups to remove trash and litter from the watershed on a routine basis. Biannual events have been hosted by Headwaters in conjunction with partners. This effort needs to be expanded to include a regular group of 8-10 volunteers. A method of signing up for group emails and providing public notification about clean-up events should be devised.	Volunteers, all streams	Headwaters, Letcher County Central High School, Southeast Kentucky Community and Technical College, and Americorps volunteers, local residents, Letcher County Solid Waste Coordinator	$200 per year	Annually, May and November
2.1	12	Survey the watershed to identify hot spots for littering, dumping, and trash accumulation. Estimate amounts of trash or debris in terms of bags of trash or pickup trucks full. These sites can potentially be the focus of community clean-ups.	General community	Headwaters	$200	October 2020
2.2, 4.2	13	Develop outreach materials to promote reducing littering and dumping. Materials should show pictures of previous cleanups demonstrating success in cleaning area streams (before/after photos). Paper and online materials should be developed. Emphasis should be on proper disposal and economic impacts of trash on streams	General community	Letcher County Solid Waste Coordinator, Headwaters	$500 in printing cost	Spring 2021 – Fall 2021
2.2, 4.2	14	Publicize the Waste Tire Collection Event on June 4-6, 2020 in Letcher County at 359 Hwy 7, South Isom and subsequent similar events.	Used Tires	Judge Executive, Letcher County Solid Waste Coordinator, DWM Field Office	N/A	June 2020, Contact for scheduling in February 2021
2.3	15	Install roadside signage for litter outreach. Meet with Kentucky Transportation Cabinet Officials to determine road sign specifications and best messaging. Determine the most visible locations with the greatest likelihood of littering. Install one or more signs in each of the three watersheds.	General community	Letcher County Solid Waste Coordinator, Judge Executive, City of Whitesburg Mayor	$7000	Fall 2020 – meet with KYTC, January 2021 design, March 2021 approval, Spring 2021 install

Table 6.3: Trash BMPs (Continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
2.4	16	Identify and remove collapsing structures near streams. Several buildings located in close proximity to the stream are in danger of collapse. Additionally, some large junk piles are scattered throughout the watershed near streams. Work to organize cleanup days, scrap metal pickup days, or other events to help clean up the community.	Large bulk appliances, cars, collapsing buildings	Letcher County Solid Waste Coordinator, Judge Executive, City of Whitesburg Mayor	$200-300 per year $50,000 for demolition and waste pick up of collapsing structures	November 2020 - Meet with officials, November 2022 - completion

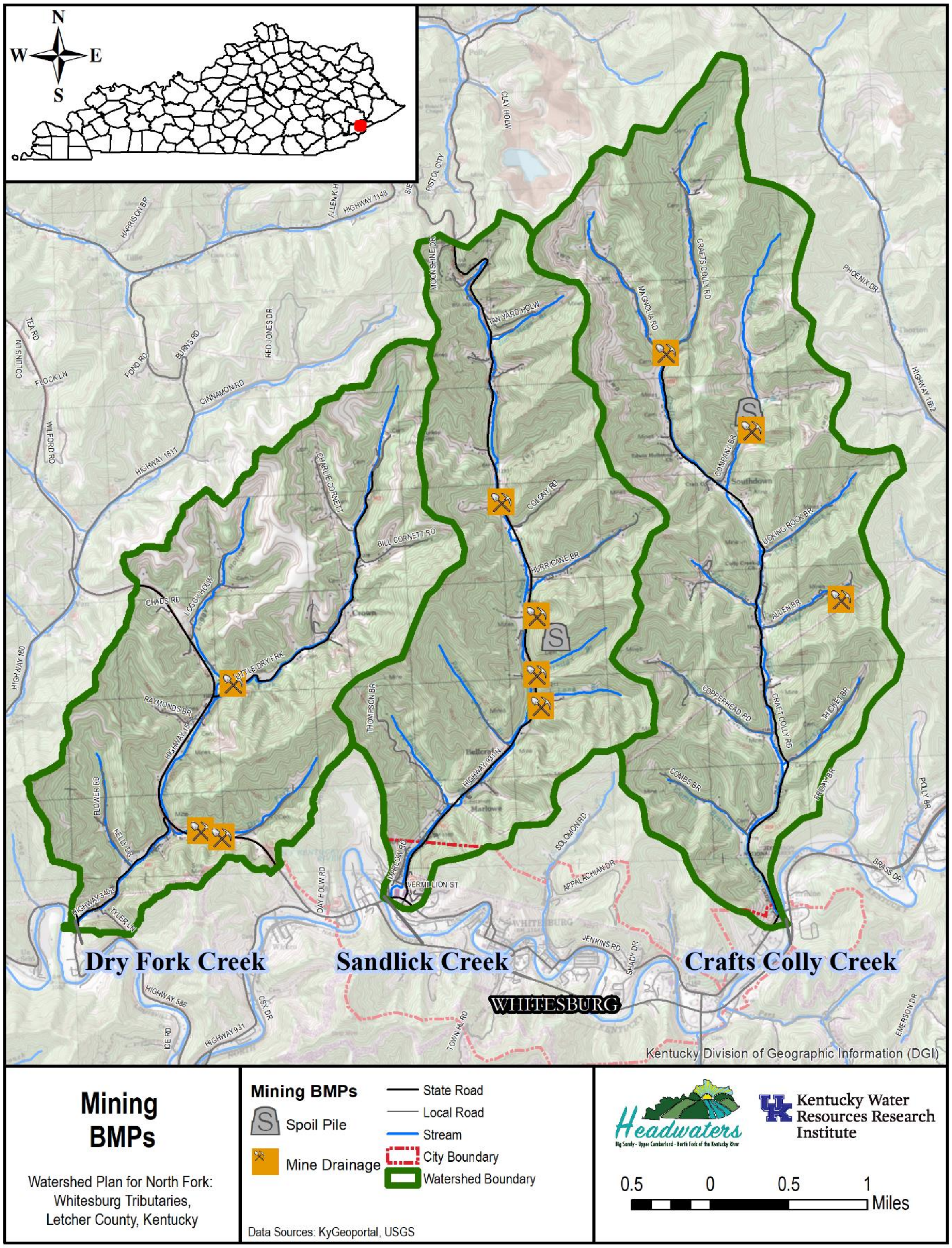
Table 6.4: Mining BMPs

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
3.1, 3.2, 3.3	17	Determine the eligibility and prioritization of all 13 mine drainage sites for Abandoned Mine Land Remediation	13 AMD sites	Division of Abandoned Mine Lands	N/A	2020 - 2022
3.1, 3.2, 3.3	18	For eligible, priority mine drainage sites, approach landowners about potential remediation utilizing appropriate passive mine treatment options.	13 AMD sites	Headwaters, Division of Abandoned Mine Lands	$154,000 for AMD site 14, other sites likely similar	Spring 2022
3.1, 3.2, 3.3, 4.3	19	For ineligible or low priority sites, determine whether remediation using passive mine treatment is feasible. If so, identify alternative sources of funding and access landowner willingness to participate.	13 AMD sites	Headwaters	$30	Spring – Summer 2022

Table 6.4: Mining BMPs (Continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
3.1, 3.2, 3.3, 4.3	20	Advertise for and provide domestic water testing service for people with domestic drinking water wells, as well as locations where source waters are impacted by mine drainage. Testing parameters should include *E.coli*, chlorine, iron, nitrate, lead, arsenic, total dissolved solids, and other parameters of local interest.	Domestic Well Users, Whitesburg Water System Users	Headwaters, Letcher County Health Department, UK CARES	$2500 per year	Fall 2020 - ongoing
3.1, 3.2, 3.3	21	Develop a grant program to assist individuals with contaminated water to connect to a safe water source.	Domestic Well or Water Users with Confirmed Contamination	Headwaters, RCAP, KRADD	$200,000 seed money	2022 - 2025
3.1, 3.2, 3.3	22	Remove, regrade, and revegetate 2.8-acre coal mine waste pile near Company Branch. If possible, provide a catchment or treatment for runoff from the pile.	Company Branch	Headwaters, Division of Abandoned Mine Lands	$500,00	2022 Apply, 2023 Begin implementation
3.1, 3.2, 3.3	23	Remove, regrade, and revegetate coal mine waste pile at active Raven Energy site along Sandlick Creek.	Sandlick Creek	Headwaters, Division of Abandoned Mine Lands	$500,00	2022 Apply, 2023 Begin implementation

Figure 6.1: Mining BMP Locations



Partners in this process include Headwaters, Kentucky Division of Abandoned Mine Land, Letcher County Health Department (well testing assistance), City of Whitesburg, University of Kentucky CARES, RCAP, and KRADD.

The cost of BMPs to address mine drainage will be determined during the AML prioritization process. However, in a series of reports by AMEC Earth & Environmental analyzing brownfield cleanup alternatives for the Letcher County Conservation District (2011 a, b, and c), cost estimates were developed for three sites in Letcher County, one of which, AMD site 14, is located on Dry Fork. Potential remediation activities analyzed in these reports included chemical treatment via a lime treatment system, sodium hydroxide treatment system, chemical oxidant treatment system, Aquafix system with pebble lime, anoxic limestone drainage system, aerobic ponds and wetlands, vertical flow ponds, or drainable limestone beds as well as treatments on the mine source such as mine sealing and alkaline injection into underground mines. For these three sites, only sodium hydroxide treatment systems, Aquafix system with pebble lime, aerobic ponds and wetlands, and vertical flow ponds were found to meet screening criteria for further consideration with detailed cost analyses.

For AMD Site 14, the estimated costs were as follows sodium hydroxide treatment systems ($514,200), Aquafix system with pebble lime ($623,000), and aerobic ponds and wetlands ($162,500). Aerobic ponds and wetlands were recommended with a pond of $12,000 ft^2$ (55 ft wide by 220 ft long) and a wetland of $47,000 ft^2$ (can be any size but if square would be 220ft by 220 ft). Similar costs and recommendations were made for another site with vertical flow ponds ($375,000) being recommended for a site in the Quellen Fork watershed where the pH of the drainage was too acidic to allow for aerobic ponds and wetlands.

These costs, while representative, give some idea of the cost and land requirements that may be required to implement these BMPs, with passive treatment being routinely the recommended treatment.

5. Community Engagement

Stakeholder feedback indicated a general awareness of issues affecting water quality, support for improvements to streams, and a call for more environmental education. However, these supportive views were balanced by some concern about the negative economic impacts accompanying acknowledgment of environmental concerns, eroded trust in environmental institutions due to past perceived injustices, and some skepticism about the ability to accomplish meaningful change due to prior unfulfilled promises. This cautious support by the community speaks to the need for quality targeted education and public engagement in implementation and planning. Well-planned, targeted BMP demonstration projects will also help local residents understand and visualize needed management practices.

During the watershed planning process, Headwaters has established a variety of educational programing, materials, and events targeted to different audiences. Watershed team meetings, youth environmental camps and retreats, environmental education through the Letcher County school system, stream cleanups, and volunteer water quality monitoring activities should all continue and expand as activities transition from planning into implementation.

However, a variety of new education and outreach activities are necessary to explain the specific issues causing impairment in these watersheds and simple steps that can be taken to address these impairments to the general public. This will require a variety of media, including social media campaigns, print brochures and pamphlets, newspaper articles, documentaries, workshops, community events, and other avenues. Simple overviews such as landowner guides and backyard stream manuals will help give guidance to those who aren't confident about what to do to address water quality problems (over 50% of surveyed stakeholders). Outdoor environmental field days will help bring attention and focus to water quality problems by the community and workshops for rain barrels and rain gardens will provide demonstrations on how people can make a difference. Other targeted materials will address bacterial, mining, habitat, and erosion impacts and solutions.

A detailed list of community engagement BMPs is provided in Table 6.5

Partners in community engagement include Headwaters, Kentucky Division of Water, University of Kentucky Cooperative Extension Services, Kentucky Water Resources Research Institute, Appalshop, Watershed Watch in Kentucky, Kentucky River Watershed Watch, Letcher County Schools, Cowan Community Center, UK CEDIK, UVA-Wise, EKU, Sierra Club, Kentucky Transportation Cabinet, Kentucky Division of Forestry, Letcher County Soil Conservation District, Southeast Community and Technical College, and others.

Much of the cost for community engagement activities (with the exception of print materials, facility space for workshops, and educational equipment) is supported by funding of a watershed coordinator.

Table 6.5: Community Engagement BMPs

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
4.1	24	Expand the quarterly Watershed Team meetings to a larger audience of community members who are interested in implementation to coordinate community engagement.	All	Headwaters, Inc, KDOW	$100 per year	Continuing, Quarterly
4.1	25	Regularly attend community meetings and public events (at least one per month) hosted by other organizations and agencies to share project updates and coordinate community affairs	Community / Public	Headwaters	$500 per year	Continuing, at least one per month
4.1, 4.3	26	Create new opportunities for the community to improve community support for watershed improvement projects by facilitating community gatherings and events.	Community / Public	Headwaters	$1000 per year	As needed
4.2	27	Collect useful information materials (pamphlets / flyers / handouts) from project partners and distribute if appropriate.	All	Headwaters	$500 per year	Continuing
4.2	28	Develop and submit for approval newly developed education and engagement materials. Share and disperse KDOW approved materials to stakeholders and community members.	All	Headwaters and KWRRI	$200 per year	Summer 2020
4.1	29	Maintain Project WET (Water Education for Teachers) certification and utilize educational activities in workshops, trainings, and events.	Youth	Headwaters	$270 per year	Continuing

Table 6.5: Community Engagement BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
4.4	30	Maintain Watershed Watch in Kentucky (WWKY) sampling certification and organize water sampling demonstrations annual. Maintain monitoring of water quality three times annually. Utilize testing kits to provide community demonstrations and participation in water quality testing.	All	Headwaters, WWKY, KRWW	$1,000 in mileage and equipment	May, June, September annually
4.1, 4.3	31	Continue "Headwaters on the Creek" watershed education camp for youth to teach about watersheds, water quality, and environmental stewardship.	Youth	Headwaters, Cowan Community Center, Division of Forestry, Letcher County Extension, Kentucky Transportation Cabinet, Letcher County Schools, Division of Water	$5,000 per year	Each summer
4.3, 4.4	32	Work with Letcher County Extension office and 4-H program to use water quality sampling training in youth education activities in quarterly youth retreat and develop a 4-H Stream Team program.	Youth	Headwaters, Letcher County Extension Office, 4-H Stream Team	$250 per year	Continuing, Quarterly
4.1	33	Letcher County High School Environmental Education - Continue environmental education using Project WET materials at high school. Utilize results of watershed planning in classes.	High School	Headwaters, Letcher County High School	$100 per year	Once quarterly during school year
4.1	34	Partner with Arlie Boggs Elementary School to educate 5th to 8th graders on watershed environmental issues using Project WET curriculum or other resources.	Middle School	Headwaters, Arlie Boggs Elementary	$100	Once quarterly during school year

Table 6.5: Community Engagement BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
4.1	35	Develop a classroom lesson(s) about history and status of the North Fork River and headwater tributaries. Materials developed by Kentucky Riverkeeper for the Kentucky River Basin could be used as a template. Utilize the "Our Kentucky River" documentary video developed by Herb Smith at Appalshop.	Youth	Headwaters, Appalshop, Letcher County Schools	$50 per year	Fall 2020
4.1	36	Create a video on the local background and the hope for Appalachian streams. Use the "This is Our River" initiative in the Upper Tennessee River Basin as a model.	Community / Public	Headwaters, Appalshop, Evan Smith	$10,000	Summer 2021 – planning and grant writing, present Summer 2023
4.1, 4.3	37	Develop social media material to highlight favorite locales and activities, educate on the needs of the watershed, and describe simple things people can do to help improve water quality.	Community / Public	Headwaters, Appalshop	$150	Fall 2020
4.1, 4.3	38	Write articles to the Mountain Eagle newspaper summarizing results, highlighting actions needed and describing achievements.	Community / Public	Headwaters, Appalshop	In-Kind Board Member	Summer 2020
4.1, 4.3	39	In conjunction with partners, host the monthly "Water Works" workshop series focused on watershed-related topics associated with Whitesburg revitalization and landowner BMP education.	Community / Public	Headwaters, UK CEDIK, Appalshop, Friends of Whitesburg, UVA-wise, Division of Forestry, EKU	$2,000	Monthly until Summer 2020

Table 6.5: Community Engagement BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
4.3	40	Develop and implement a program to recognize good environmental stewards through signage or media spotlights.	Community / Public	Headwaters, Appalshop	$1,000	January 2021 – begin monthly highlight series
4.1, 4.3	41	Landowner Home Water Education Brochure – Develop a colorful, informative brochure that provides background info to residents about the general water improvement goals for the community and offers suggestions about how they can be involved. This can include ways to be a part of service activities.	Community / Public	Headwaters, UK Cooperative Extension, Appalshop	$300	Fall 2020
4.1, 4.3	42	Environmental Field Day – Work with community schools (elementary, middle, high school) to host an environmental field day to provide education on environmental issues in the county.	Youth	Headwaters, Letcher County Schools, UK Cooperative Extension	$500	Fall 2020 – planning, Spring 2021 – execution
4.1, 4.3, 5.4	43	Rain Garden and Rain Barrel Workshop – Develop and host a rain garden and rain barrel workshop for residents to provide demonstrations of these BMPs and encourage their use.	Community / Public	Headwaters, UK Cooperative Extension, Appalshop, CEDIK	$1,000 for workshop, $50 - $150 per barrel,	Winter 2021 prepare lessons / order materials, April – May 2021 workshop
4.1, 4.3	44	Develop a community assistance program to address community environmental disasters including flooding and drinking water quality. This program should include disaster relief efforts and emergency relief. Efforts may include emergency portage water treatment system	Disaster Relief	Headwaters, Livelihoods Knowledge Exchange Network, Appalachian Citizen's Law Center, Letcher County Culture Hub, WaterStep	$10,000	2021 - 2023

6. Habitat and Erosion

To address the related impacts of streambank erosion, in-stream sedimentation and habitat loss, it will be necessary to make changes to restore more natural water flow paths and infiltration processes to these modified streams and watershed. In tandem with restoring more balanced water flow dynamics, aquatic habitat will be improved. A list of Habitat and Erosion BMPs is found in Table 6.6.

The modification of the hydrology focuses on 1) slowing down runoff and floodwaters through temporary storage and slow release (detention), stream meanders or curves (on flatter terrain), or step-pool sequences (in steeper streams), 2) spreading out waters over a floodplain to decrease erosive energy, and 3) allowing precipitation to soak into the groundwater system through runoff redirection and infiltration practices. Habitat restoration and repair includes riparian planting, bank stabilization, and stream restoration.

Spatial restrictions due to the encroachment of roadways or buildings on the stream and its floodplain limit the locations where such best management practices can be implemented. Therefore, a survey was conducted to identify potentially feasible locations using a combination of Google Earth aerial photographs, Google Earth Streetview, and a visual "windshield survey." Figure 6.2 identifies locations where adequate space is present to allow for potential expansion of the riparian zone by planting. Figure 6.3 indicates locations where sufficient space is available to implement bank stabilization, floodplain detention, or step-pool restoration. Locations in Figure 6.3 could also be utilized for riparian expansion if these more intensive practices are rejected by landowners. If a roadway is redirected away from a stream (or vice versa) or a residence is abandoned and demolished, further potential implementation opportunities may emerge over time. However, this survey effort should provide an initial scope of potential sites to begin solicitation for landowner participation.

Because these hydrologic and habitat BMPs are not commonly utilized in this region, it is recommended that a series of demonstration projects be implemented in high visibility areas, such as in downtown Whitesburg or at Letcher County schools, as well as at locations in each of the three focus watersheds.

Figure 6.2: Japanese Knotweed

For habitat improvement, native riparian planting is needed along 87% of the stream length in the watershed. As mentioned in Chapter 5, native trees, shrubs, herbaceous plants, and grasses such as black willow, spice bush, arrowwood viburnum, deer tongue grass, and swamp milkweed would be planted to increase habitat. A "Backyard Streams" planting and care guide would need to be developed to support proper landowner planting and management. Invasive species, most prominently Japanese knotweed (*Polygonum cuspidatum,* see Figure 6.2), would also need to be identified and removed from these areas prior to planting to prevent competition and enable successful establishment of native species. Workshops on riparian management, including simple planting guides have been developed for other areas of the state and could serve as templates for work in Letcher County specifically, and eastern Kentucky in general. Encouraging no-mow zones would also be beneficial throughout the area. Figure 6.3 shows potential locations for plantings in the watershed. Riparian planting is a relatively low-cost practice ($10 - $20 per linear foot).

Table 6.6: Habitat and Erosion BMPs

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
4.1, 4.5, 5.1	45	Develop a riparian planting and streamside wetland demonstration project on the streambank of the North Fork Kentucky River at Southeast Community and Technical College and /or along the downtown trail system. Provide passive and active educational outreach through associated community service events, signage, outdoor classroom amenities, and field trips.	Community / Public	Headwaters, Appalshop, City of Whitesburg, , Letcher County Public Schools, Southeast Kentucky Community and Technical College	$10,000 - $20,000	Fall 2020 - planning, Winter 2021 – start education and design April 2021 – work days, May 2021 – opening day event
4.2, 5.1, 5.5	46	Work with the UK Cooperative Extension Service to develop a simple "how-to" guide for backyard streams in Eastern Kentucky including native species for riparian planting plans, invasive species to remove, education on erosion, runoff, floodplains and other associated issues.	Community / Public	KWRRI, UK Cooperative Extension Service	$5,000	2021 - 2023
4.1, 4.2, 5.1	47	Use “Saving Your Streambank” workshops (piloted by Bluegrass Greensource) or “Plant by Numbers” programs (developed by Lexington-Fayette Urban County Government) as templates for local property owner riparian education activities.	Streamside Landowners	Headwaters, Letcher County Conservation District, UK Cooperative Extension	$5,000	Fall 2020
4.3, 5.1	48	Approach landowners in areas where riparian zone expansion is feasible to plant native species or leave a no-mow zone. A Google Earth survey was performed to identify potential areas where expansion of the riparian zone is feasible (Figure 6.3).	Streamside Landowners	Letcher County Conservation District, Southeast Kentucky Community & Technical College	$10 - $20 per linear foot	Fall 2020

Table 6.6: Habitat and Erosion BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
5.1	49	Host an Arbor Day event and give out free trees for planting along the stream. Consider offering an associated community project to plant trees and offer instruction on best practices for planting.	Streamside Landowners	Letcher County Conservation District	N/A	Spring 2021
4.1, 4.2, 5.1	50	Conduct knotweed identification and treatment training and subsequent invasive species control workdays to suppress the large populations of this invasive species along the stream corridor.	Streamside Landowners	Lilly Cornett Woods, Division of Forestry, Headwaters	$10 - $20 per linear foot	Summer 2021
4.1, 4.5, 5.4	51	Design and install a rain garden system on the grounds of Whitesburg Elementary, Middle School, or High School. In addition to providing water quality benefits, the rain gardens will allow for outdoor education.	Letcher County Schools	Letcher County Conservation District, Headwaters, Letcher County Public Schools,	$500 - $2,000 (size dependent)	Fall 2020 – planning / design Winter 2021 – signage / materials, Spring 2021 – installation via work day.
5.3, 5.4	52	Meet with KDFWR Stream Teams, AML, FEMA Hazardous Mitigation Grant Coordinators, and other potential stream restoration funding sources to determine eligibility of potential sites identified by a Google Earth Survey (Figure 6.4). Active or legacy mine sites often have the best opportunities for such measures due to the absence of residences. Approach landowners in these areas about willingness to participate.	Funding Sources	Headwaters, KWRRI, Letcher County Conservation District	In-kind	Fall 2020, reach out to landowners Spring 2021,

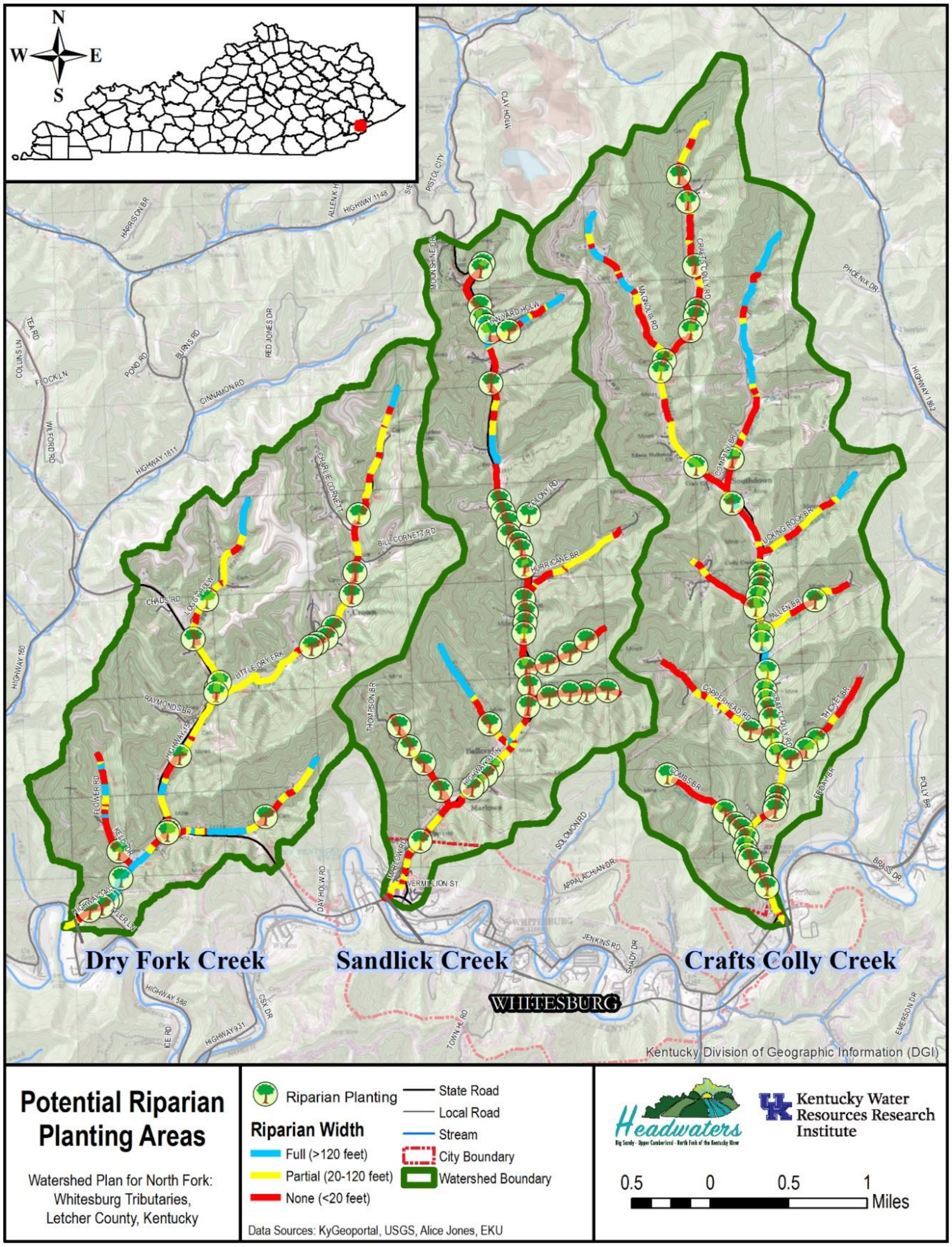
Table 6.6: Habitat and Erosion BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
5.3, 5.4	53	Decrease the volume and velocity of runoff by restoring stream meanders in flatter areas with adjacent undeveloped land and by adding step pool sequences in steeper terrain. In floodplain areas, detention ponds, floodplain wetlands, or simply terraced streambanks can be utilized to increase runoff storage capacity within the stream corridor.	Streamside Landowners	Letcher County Fiscal Court, UK Cooperative Extension, Letcher County Conservation District, Headwaters	Bank stabilization $10-50 per ft, Detention basins $0.15-0.30 per cubic foot, Floodplain wetland $30,000-40,000 per acre, Step-pools $50 – 100 per ft	Fall 2021 - 2024
5.4	54	Choose 3-5 sites and develop demonstration projects for stream stabilization / regional detention. Ideally, one would be located in each of the three focus watersheds (Dry Fork, Sand Lick Creek and Crafts Colly Creek). Field days and community service projects could be scheduled at these sites to maximize utility.	Streamside Landowners	Headwaters, Letcher County Public Schools, Letcher County Fiscal Court		Fall 2021 - 2024
5.2, 5.3	55	Meet with Kentucky Transportation Maintenance Crew to understand dredge activities along the streams and develop alternative approaches to protect habitat while preventing flooding.	Road Maintenance Crews	Headwaters, Fiscal Court, KYTC, KWRRI	N/A	Develop list of alternative approaches and meet Fall 2020
4.2, 5.3	56	Develop educational materials on the effect of dredging on the aquatic ecosystem and stream channel evolution pattern.	Road Maintenance Crews and Streamside Landowners	Headwaters, KWRRI	$200	Fall 2020

Table 6.6: Habitat and Erosion BMPs (continued)

Objective	BMP	BMP Description and Action Items	Target Audience or Area	Potential Partners	Cost Estimate	Timeframe
5.2	57	Severe erosion areas were identified on 1.32 miles of streams in the area. Approach landowners and Transportation Cabinet maintenance crews about potential bank stabilization measures at these locations. Utilize toe logs, root wad bank deflectors, coir fabric, or other natural means where possible.	Road Maintenance Crews and Streamside Landowners	Kentucky Transportation Cabinet, Letcher County Conservation District, Headwaters	Bank stabilization $10-50 per ft	Summer 2021

Figure 6.3: Potential Riparian Planting Areas



Additionally, a riparian zone planting project along the North Fork Trail in Whitesburg or at Southeast Kentucky Community & Technical College campus could provide residents with a highly visible demonstration of this management practice and may encourage community familiarity and adoption. Riparian plantings can also provide outdoor education at local schools. Associated educational signage about the importance of riparian areas for erosion control, habitat enhancement and water quality improvement would educate the public, encouraging residents to create their own protective riparian buffers with native plants. Signage can cost between $10 - $300 per sign depending on the size.

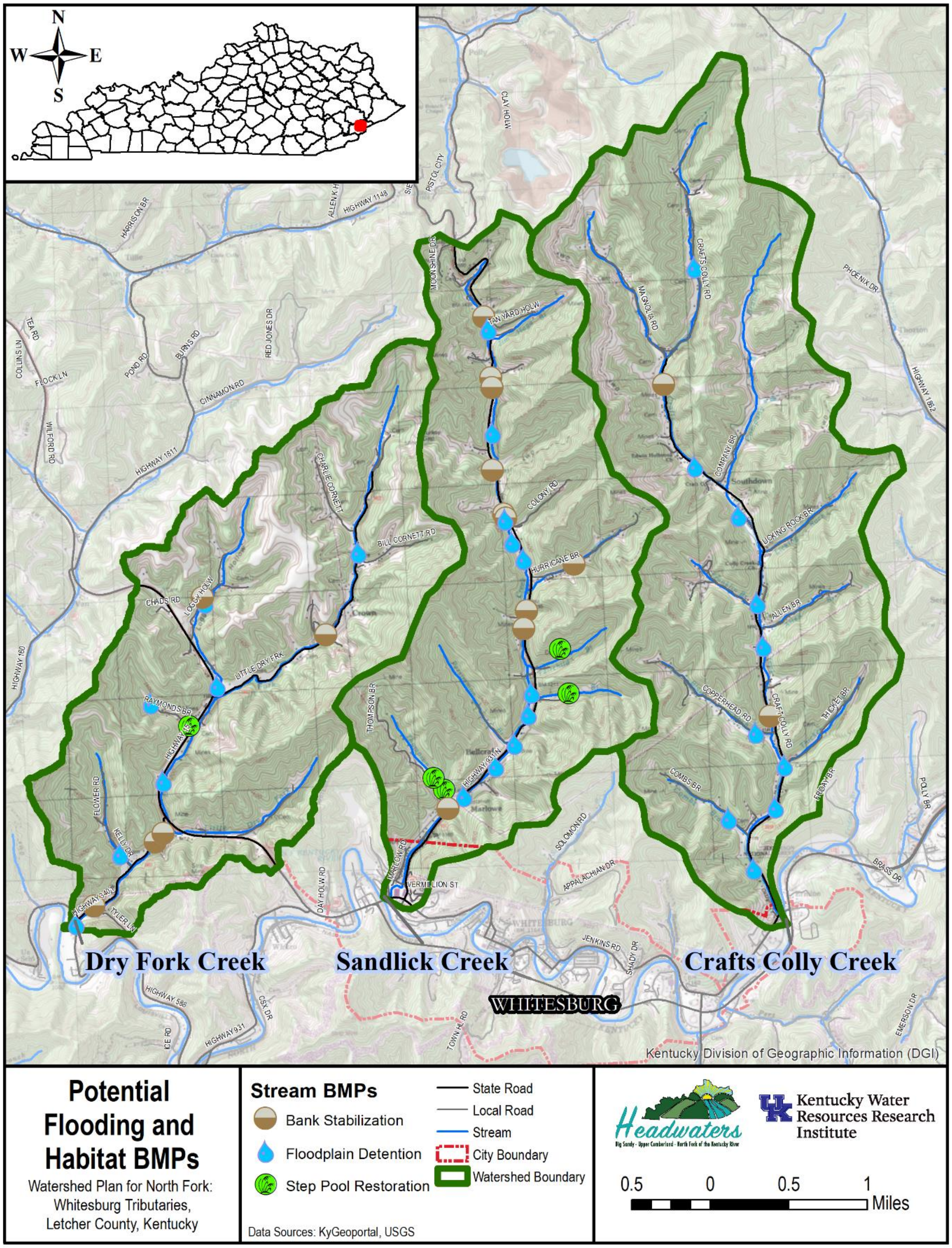
The visual survey of the watershed showed that many of the streams in the watershed lack riffle, run, pool sequences and have a rather uniform width and depth. This may be due to “ditching” practices utilized by road maintenance crews or by landowners themselves. To address these impacts, educational materials on stream channel evolution and the impacts of channel modification would help to prevent further impacts from ditching. Discussions with local road maintenance crews about their maintenance practices may also provide insights on ways to addressing flooding impacts while maintaining stream habitat. Over 1.32 miles of stream were found to have erosional impacts requiring bank stabilization (Figure 6.4). In addition to stabilizing these areas, discussion with roadway maintenance crews may also identify current erosion control practices in use and more natural methods that could be utilized in the area instead of riprap or armored walls during future impact. Bank stabilization cost estimates using natural methods are between $10 - $50 per linear foot.

On Figure 6.4, floodplain detention markers identify areas where adequate space is available adjacent to the streams to allow for implementation of floodplain detention or habitat improvement. The practices utilized in these areas could take multiple forms. The floodplain could be expanded or terraced to provide additional instream storage and area where flood waters could expand and dissipate energy. These areas could be used to add meanders and bends to the stream which would also slow the streams’ velocity and reduce erosion. The areas could also be utilized to install floodplain wetlands, which would enhance the habitat and provide storage, or small detention ponds, which would hold floodwaters for short periods in order to reduce peak flows during storms. A demonstration project for these practices, ideally, one in each of the three focus watersheds (Dry Fork, Sand Lick Creek and Crafts Colly Creek) or in a high visibility area (schools / downtown Whitesburg) could serve to encourage wider adoption. The cost for dry detention basins is estimated to be between $0.15 - $0.30 per cubic foot, depending on the size. The cost for wetland construction is estimated to be between $30,000 - $40,000 per acre.

In steeper areas, a series of step-pools can be used to slow the velocity of stream storm flows while also improving habitat. Many of these areas are located on current or previous mined lands, so there may be opportunity to utilized mining funds for restoration. Installation of step-pools are expensive ($50 – 100 per linear foot of stream) but will help reduce erosion, sedimentation, and flooding at locations downstream.

In addition to these streamside BMPs, rain barrel and rain garden installation workshops can be utilized to educate homeowners on methods to reduce runoff from their buildings. Rain barrels, also called cisterns, typically cost between $50 - $150 per barrel, and though it varies based on size and labor, rain gardens can cost between $500 - $2,000.

Figure 6.4: Potential Flooding and Habitat BMPs



Partners in the implementation of these practices include Headwaters, Letcher County Extension Office, Letcher County Soil Conservation District, U.S. Army Corps of Engineers 401/404 Program, Letcher County Schools, Southeast Community and Technical College, Appalshop, Kentucky Transportation Cabinet, Kentucky Department of Fish and Wildlife Stream Teams, UK Cooperative Extension Service, and others.

With the exception of riparian zone planting, some bank stabilization methods, and rain barrel / rain garden installation, most of the activities proposed in this habitat and erosion section would require a licensed engineer to develop and stamp design plans for the project and ensure that the proper permitting is obtained. In Kentucky, most stream restoration activities are funded through the Kentucky Department of Fish and Wildlife Resources' Fee In-Lieu Of (FILO) "Stream Team" Program or through the FEMA Hazard Mitigation Grants Program (HMGP) or Flood Mitigation Assistance (FMA) Program. Other agencies related to mining, agriculture, or habitat can also provide assistance in restoration activities. In each case, the funding agency will work with the local government or individual landowners to manage the project. In most cases, a water resources engineer will be hired to developed design plans and permitting, and then a construction contract will be provided to implement the plans. The design process can take 6-18 months and the construction can take a year depending on the size of the project.

D. Funding Sources

Funding for projects listed in the BMP implementation plan may come from a variety of sources to help the property owners or responsible parties to implement the BMPs. The Kentucky Division of Water maintains a catalog of many available funding sources including grants, low interest loans, and cost share at eec.ky.gov/Environmental-Protection/Water/Pages/Funding-Resources.aspx. Some of the resources available there as well as additional relevant funding sources for this watershed plan are described below:

EPA 319(h) Grants

The US EPA provides funding through Section 319(h) of the Clean Water Act to the Kentucky Nonpoint Source (NPS) Pollution Control Program. These funds can be used to pay for 60 percent of the total cost for qualifying projects but require a 40 percent nonfederal match. Grants are available for watershed implementation, and priority consideration will be given to projects for which implement a watershed plan, such as this one. Project proposal forms may be submitted to the Kentucky NPS Pollution Control Program at any time; however, deadlines apply to specific federal funding cycles. For more information on this grant program, see Kentucky Division of Water website: https://eec.ky.gov/Environmental-Protection/Water/Protection/Pages/Section-319(h)-Grant-Program-Funding.aspx.

FEMA Hazard Mitigation Grant

FEMA's Hazard Mitigation Assistance grant programs provide funding for eligible mitigation activities that reduce disaster losses and protect life and property from future disaster damages including the Hazard Mitigation Grant Program, Pre-Disaster Mitigation, Flood Mitigation Assistance, Repetitive Flood Claims, and Severe Repetitive Loss. If a project will reduce or eliminate the risk of flood damage to the population or structures insured under the National Flood Insurance Program, it may be eligible for funding under one of these programs. For additional details on eligibility requirements and grant details, visit the FEMA website: https://www.fema.gov/hazard-mitigation-assistance.

Kentucky Department of Fish and Wildlife Resources Stream Team

The Stream Team works with private landowners and others to identify stream restoration projects and offer free repairs to eroding and unstable streams and wetlands. Projects are funded from the Mitigation

Fund held in trust solely for repairing streams and wetlands. No state tax general funds or hunting/fishing license dollars are used. Landowners must meet certain criteria regarding stream instability and habitat, stream size, stream banks, project protection, and mineral ownership and leases. For more information, go to fw.ky.gov/Fish/Pages/Stream-Team-Program.aspx.

Abandoned Mine Lands Economic Development Pilot Program
The Office of Surface Mining Reclamation and Enforcement (OSMRE) has funding available for projects in the Abandoned Mine Land Reclamation Economic Development Pilot Program (AML Pilot). This pilot program will provide grants to six Appalachian states, including Kentucky, with the highest amount of unfunded Priority 1 and Priority 2 Abandoned Mine Land sites. Kentucky receives $25 million. The intent of the pilot program is to explore and implement strategies to return legacy coal sites to productive uses. For more information of this grant fund and others from OSMRE, go to www.osmre.gov/resources/grants.shtm.

USDA Rural Development Grants
The USDA provides several grant and loan programs through their Rural Development section.
The Single Family Housing Repair Loans and Grants Program, also known as the Section 504 Home Repair program, this provides loans to very-low-income homeowners to repair, improve or modernize their homes or grants to elderly very-low-income homeowners to remove health and safety hazards. The maximum loan is $20,000 and the maximum grant is $7,500. More information on this grant program can be found at http://www.rd.usda.gov/programs-services/single-family-housing-repair-loans-grants.

The Water and Waste Disposal Loan and Grant Program provides funding for clean and reliable drinking water systems, sanitary sewage disposal, sanitary solid waste disposal, and storm water drainage to households and businesses in eligible rural areas. Eligible entities include states, local governments, and private nonprofits. Long-term, low-interest loans and, if funds are available, a grant may be combined with a loan to keep user costs reasonable. More information on this grant program can be found at www.rd.usda.gov/programs-services/water-waste-disposal-loan-grant-program.

Kentucky Division of Forestry
The Kentucky Division of Forestry operates two seedling nurseries for the purpose of planting on public and privately-owned land. The nurseries offer different species of hardwoods and conifers for sale for planting on open crop or pasture land, developing a Christmas tree plantation, enhancing wildlife habitat, improving urban areas and reclaiming surface mining sites. Seedlings can be order in bulk at low cost and shipped to individuals. For more information, go to eec.ky.gov/Natural-Resources/Forestry/state-nuseries-and-tree-seedlings/Pages/default.aspx

University of Kentucky Community Economic Development Initiative of Kentucky (CEDIK)
The University of Kentucky College of Agriculture, Food, and the Environment's Community Economic Development Initiative of Kentucky (CEDIK)'s mission is to catalyze positive change to build engaged communities and vibrant economies. CEDIK's work extends to all areas of the Commonwealth of Kentucky, including Letcher County. CEDIK offers a wide array of programming and services, which includes Downtown Revitalization in Southeast Kentucky. This program has goals of economic diversification, job creation, capital investment, and workforce development. CEDIK administers several grant funds and provides technical assistance. For more information, go to cedik.ca.uky.edu.

Letcher County Conservation District

The Letcher County Conservation District offers a limited number of cost-share matching grants to help people put the best practices on the land. Grants range from $300 - $2,500 based upon the described improvements and resources. Applications are received through the email or via their facebook page. For more information, go to www.facebook.com/pg/LetcherCountyConservationDistrict/.

EPA Environmental Justice Collaborative

The Environmental Justice Collaborative Problem-Solving (CPS) Cooperative Agreement Program provides financial assistance to eligible organizations working on or planning to work on projects to address local environmental and/or public health issues in their communities, using EPA's "Environmental Justice Collaborative Problem-Solving Model." The CPS Program assists recipients in building collaborative partnerships to help them understand and address environmental and public health concerns in their communities. For more information, go to www.epa.gov/environmental-justice/environmental-justice-collaborative-problem-solving-cooperative-agreement-0.

Peace Development Fund

The Peace Development Fund is an organization that seeks to support community-based organizations and grassroots groups and their locally-grown leaders, including young people, to articulate their realities, develop their analyses, critical thinking, and strategic action in order to challenge and transform the world around them. They also seek to strengthen community based and other intermediary capacity building organizations and create, support and enhance opportunities for movement building through networking and alliance building. For more information, go to www.peacedevelopmentfund.org.

Clif Bar Family Foundation

The Clif Bar Family Foundation supports innovative small and mid-sized groups working to strengthen our food system and our communities, enhance public health, and safeguard our environment and natural resources. Small grants are awarded for general organizational support as well as funding for specific projects. For more information, go to clifbarfamilyfoundation.org.

Indigenous Environmental Action Network and Western Mining Action Network

The Western Mining Action Network's (WMAN) mission is to foster and support a strong network that protects communities, land, water, air, and wildlife by reforming mining practices and holding government and corporations accountable. WMAN cohosts a unique mining mini-grant program with the Indigenous Environmental Network. In 2019, the WMAN-IEN Mining Mini-Grant Program gave away more than $200,000 in $3,000 and $5,000 increments to grassroots organizations across the US and Canada. For more information, go to wman-info.org/programs/mini-grant-program/.

Abelard Foundation

Abelard East is committed to supporting local progressive social change activities that expand and protect civil liberties and civil and human rights, and promote and strengthen community involvement in, and control over, the decisions that affect their lives. Their grantees are involved in a broad range of issues which involve the question of civil and human rights. The average grant size is $10,000. For more information, go to fdnweb.org/abelardeast/.

North Face Explore Fund
North Face has established the Explore Fund Grant program has created access and driven equity in the outdoors by funding hundreds of nonprofit organizations around two themes: Enabling Exploration and Loving Wild Places. The Explore Fund grants are offered in three main categories: 1) creating a community of new explorers, 2) protecting wild places, and 3) the Move Mountains grant. Applicants must have 501(c)(3) nonprofit status or be in a formal relationship with a qualified fiscal sponsor. For more information, go to www.thenorthface.com/about-us/outdoor-exploration/explore-fund.html.

Patagonia Corporate Grant
Patagonia's Corporate Grants Program funds projects that take place within the US and Canada and are either national in scope or are not local to one of the North American retail stores. The Corporate Grants Program supports small, grassroots activist organizations that have provocative direct-action agendas and that are working strategically on multipronged campaigns to preserve and protect our environment. They support local groups that work to protect local habitats and frontline communities through bold, original actions. The funding range is typically between $10,000 and $20,000, depending on the specific needs of the project. For more information, go to www.patagonia.com/how-we-fund/corporate-grant/.

Appalachian Community Fund
The Appalachian Community Fund (ACF) funds and encourages grassroots social change in Central Appalachia. ACF works to build a sustainable base of resources to support community-led organizations seeking to overcome and address issues of race, economic status, gender, sexual identity, and disability. The fund is seeking to address the underlying causes of poverty and oppression in the Appalachian counties of Kentucky, Tennessee, Virginia, or West Virginia. General Fund grants up to $5,000 will be awarded for projects or general operations. For more information, go to www.appalachiancommunityfund.org.

Max and Victoria Dreyfuss
The Max and Victoria Dreyfus Foundation awards grants to organizations for whom a small amount of money can make a big difference. The Foundation welcomes requests for support from community-based non-profit organizations located within the United States, and typically range from $1,000 to $20,000. For more information, go to www.mvdreyfusfoundation.org/.

Appalachian Stewardship Foundation
The Appalachian Stewardship Foundation (ASF) was created as a result of a settlement with Longview Power that set up a mitigation fund to correct the damage to the environment caused by the mining and burning of coal. ASF will fund innovative projects that mitigate the impacts of energy development and use in Appalachia by reducing greenhouse gases, restoring streams and fisheries, promoting public awareness, and creating innovative carbon-reduction research and projects, including programs directed at the reduction, offset, sequestration, mitigation and storage of carbon dioxide and other greenhouse gases. For more information, go to appalachianstewards.org/.

Center for Health, Environment, and Justice
The Center for Health, Environment & Justice helps build healthy communities nationwide. They have a Small Grants Program for grassroots groups working on environmental health and justice issues. Grant activities can include board development, membership outreach, and fundraising efforts. Project activities could also include meetings to develop an organizing/strategic plan, training leaders to go door-to-door,

events, educational activities which are directly connected to a strategic plan, or general events. For more information, go to chej.org.

Kentucky River Authority

In 2003, the Kentucky River Authority initiated a Watershed Grant Program to provide financial assistance to local groups interested in engaging in watershed education, management or water quality sampling activities. These watershed grants from the Kentucky River Authority have provided much-needed funding assistance for local efforts to improve water quality conditions throughout the Kentucky River Basin. Annual grants of up to $3,000 have been awarded to applicants since 2004. For more information, go to www.krww.org/action/kra-watershed-grants/.

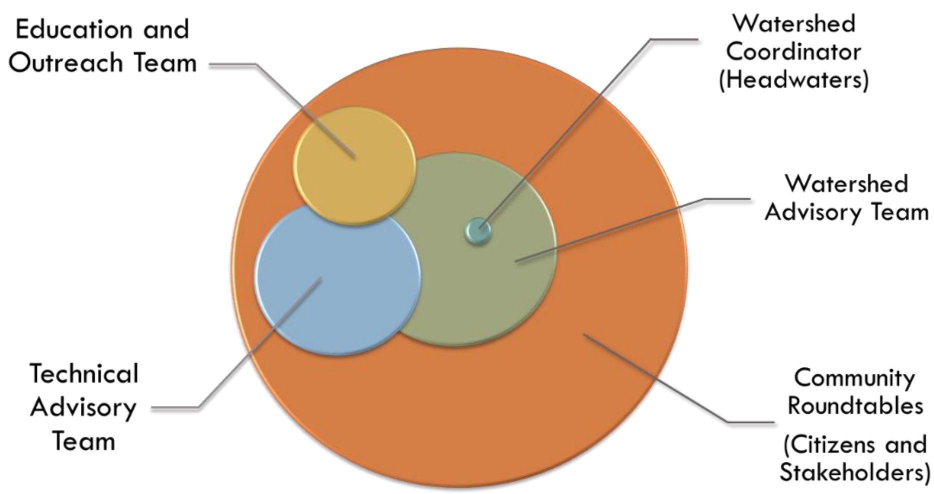
Chapter VII: Strategy for Success

The implementation plan for the North Fork: Whitesburg Tributaries Watershed Plan has numerous best management practices, partners, timelines, objectives, and goals. To achieve successful implementation, it is important to monitor implementation progress. This section describes how the watershed plan implementation will be evaluated to ensure its success.

A. Organization

With the completion of this watershed plan, the efforts will transition from planning to implementation. Progress on the plan goals, objectives, and action items will need to be coordinated and monitored in order to ensure that implementation moves according to schedule and achieves the expected level of success. The transition in focus from planning to implementation must also be accompanied by a transition in organizational structure, roles and responsibilities. Figure 7.1 provides a visual representation of the various individuals, groups, and teams that will make implementation a success.

Figure 7.1: Watershed Plan Implementation Group Organization



1. Watershed Coordinator

The Watershed Coordinator will provide a central contact for watershed plan implementation. The responsibilities of this position include oversight and coordination of the various responsible parties, funding sources, stakeholders, partners, and technical resources, as well as tracking progress of implementation projects and scheduling team meetings. It is recommended that this position be funded, at least in part, through program grants. The Watershed Coordinator would follow the implementation plan to ensure responsible parties remain on schedule and progress on implementation is occurring. The Watershed Coordinator should use adaptive management as the watershed and desires of the stakeholders change. If possible, the Watershed Coordinator position should be filled with someone from Letcher County or the surrounding area, who will be more familiar with local issues, partners and feasibility considerations.

Headwaters is a non-profit community watershed organization in Letcher County that was created in 2005 in response to water quality concerns. The group's mission is "to improve the watersheds in Letcher County through community education, access to timely and accurate water quality information, and stewardship of local waterways. The Watershed Coordinator will be a Headwaters employee.

Headwaters has overseen numerous watershed coordinators since the organization's formation, including positions funded by the Americorps/VISTA program and USEPA 319h grants. Thus, the Watershed Coordinator position could continue to be housed and overseen through Headwaters' support. As an official 501c3 organization, Headwaters can serve as a potential grant recipient for funds supporting the Watershed Coordinator, as well as the plan's recommended BMP activities.

Headwaters also has experience with working with local residents to select solutions that work best in the community, and collaborating with local government and partner organization to implement those solutions. This experience is critical to the success of continued endeavors and will be provide valuable guidance in working with current and establishing relationships with future partners.

The community water-related education that Headwaters board members and staff have provided through school visits and field trips, booths at local festivals, community workshops, and summer camps has increased awareness of local waterways and the issues affecting them. Their continued involvement in this realm is necessary to achieving the practices and related improvements in water quality outlined in the plan.

2. Watershed Advisory Team

The Watershed Advisory Team is a group of decision makers who receive feedback from the community roundtables, technical advisory team, and the education and outreach team. The Watershed Advisory Team is responsible for reviewing and approving all documents, determining strategies, coordinating public meetings, and providing an overall strategy for partners to work within. The Watershed Advisory Team is led by the Watershed Coordinator and meets quarterly. The Advisory Team acts as a sounding board and guide to the Watershed Coordinator.

Members of the Watershed Advisory Team have included partners such as KWRRI, Kentucky Division of Water, KRWW, EKU and local leaders such as the City of Whitesburg, Letcher County Conservation District, Letcher County Water and Sewer, and the local Sierra Club Chapter. This group should be expanded to reflect the implementation needs.

3. Implementation Subgroups

At a minimum, the Watershed Advisory Team should have two subgroups: a Technical Advisory Team and an Education and Outreach Team. Additional teams may be added as the Advisory Team deems necessary over the course of implementation.

The technical advisory team would be responsible for reviewing the technical feasibility, design, and suitability of best management practices on a given site. Partners on this team would provide input on all technical aspects of projects to the Advisory Team. The education and outreach team would focus on the comprehensive strategy, timing, and medium for interactions with targeted audiences for various BMPs. Members of these teams may or may not also be members of the Watershed Advisory Team.

4. Community Roundtables

Community roundtables are opportunities to get input from the community on watershed implementation activities, concerns, opportunities, and needs.

Monthly community roundtables have been held at various locations in Whitesburg during the past year, with topics covering various economic development and environmental themes including *Trail Signage, Wetlands, Stormwater and You*, *Healthy Forests, Healthy Streams* and *Infrastructure and Ecotourism*. The continuation of these offerings that engage public interest and input in water quality issues will help build local support for implementation activities.

Additionally, community roundtables will be held to present progress on the watershed plan goals and objectives and to receive feedback from the community about emerging opportunities and issues for adaptive management. All local citizens and stakeholders will be invited to participate in such events.

B. Presentation and Outreach

Presentation of this watershed plan to the general public is a key part of education and outreach. Without the buy-in and support of local residents, most of the recommended BMPs are unlikely to be feasible. Thus, it is critical that promotional outreach connect with local interests and desires for improving quality of life and provide the guidance and support needed to implement the various water quality improvement practices.

For many of the BMPs, milestones were less concrete because landowner support for implementation had not been evaluated. This plan organizes initial implementation and outreach efforts in order to evaluate the support for participation, and then refocus milestones and priorities based upon the response.

A Fact Sheet has been developed which condenses the findings of the plan for consumption by local leaders and important audiences. Slideshow presentations of the plan findings will provide one medium for outreach to local groups and meetings. Additional targeted outreach material needs are specified in Chapter 6.

C. Monitoring Success

Success of the Watershed Plan should be monitored in terms of implementation progress, education and behavior change, as well as water quality sampling results. Review of these success indicators will allow the Implementation Team to evaluate whether changes in the implementation strategy or planning are necessary.

1. Implementation Tracking

One measures of success is the evaluation of whether the implementation plan is actually being carried out. As such, the Implementation Team should document progress on each of the BMPs over time. Tracking should include responses from responsible parties, funding updates, design and construction updates, impediments, and pending responses. In addition to tracking the status of the individual BMPs, specific measurable indicators of success should be tracked for each BMP. For instance, the number of outreach events should be recorded as well as the number of rain barrels installed and the length of stream stabilized. The latitude and longitude of each of the implemented BMPs should also be documented in order to aid future success monitoring.

2. Education and Outreach Tracking

For education and outreach activities, where appropriate pre- and post-educational surveys should be utilized to document changes in perceptions and behaviors as a result of educational activities. These surveys may be used to refine and improve training workshops and outreach events based on the aspects of the programs view as most valuable. These activities should also be evaluated as to whether they are utilizing the most appropriate venues and addressing the desired audiences to accomplish the plan goals.

3. Water Quality Monitoring

Water quality monitoring should be performed, using the parameters listed in Table 6.1 with the goals and objectives, in order to measure the progress made towards the watershed plan goals. The primary source of additional monitoring will be through the Kentucky River Watershed Watch and Headwaters. Monitoring should be conducted to investigate the sources of *E.coli* in watersheds identified as impaired, monitor downstream of permitted sewer treatment facilities to confirm output levels, and at the sites monitored under this plan to review improvements due to implementation. Also, when construction projects are funded through a grant, pre- and post-construction sampling should be conducted in order to evaluate the load reduced by the project, where feasible and appropriate. When sufficient best management practices have been implemented in a drainage area such that a load reduction is suspected, monitoring should be conducted by volunteers or the watershed coordinator to evaluate these changes. If these volunteer results indicate that the water quality has improved enough to change the impairment status for a pollutant, the watershed coordinator should contact the Kentucky Division of Water to perform a formal success monitoring study.

D. Evaluating and Updating the Plan

The goals, objectives, and recommended BMPs were based upon the best available information and needs of the community at the time of plan development. With time, the watershed and the desires of the people within it will change and the plan will be adapted accordingly. Also, the pollution sources within the watershed are not static, so future monitoring is important to find new and changing impacts Therefore, the Watershed Plan must have the flexibility to change with time.

As mentioned previously, some development of implementation plan details will be needed after the first two years of implementation. Focused outreach activities are needed to develop capacity in the watershed and awareness of potential solutions for the water quality problems. Once these landowners have been contacted to determine their support, the milestones and implementation schedules for individual BMPs should be clarified and this document revised. Specifically, greater clarity on the types of projects likely to be successful and additional education and outreach efforts that might be necessary will be revealed with increased interaction with the community.

It is recommended that the Implementation Team update the plan on a five-year basis thereafter and consider significant changes in approaches on an annual basis. The five-year evaluation allows sufficient time for improvements to occur between evaluation periods. Annual evaluations of changes in approach allow for sufficient flexibility to adjust to changes as they occur.

APPENDIX A: FISH OF LETCHER COUNTY

Family	Sportfish	Scientific Name	Common Name	US Status	KY Status
Carp and Minnow		Campostoma anomalum	Central Stoneroller	N	N
Carp and Minnow		Campostoma oligolepis	Largescale Stoneroller	N	N
Carp and Minnow		Carassius auratus	Goldfish	N	N
Carp and Minnow		Chrosomus cumberlandensis	Blackside Dace	T	T
Carp and Minnow		Chrosomus erythrogaster	Southern Redbelly Dace	N	N
Carp and Minnow	Y	Ctenopharyngodon idella	Grass Carp	N	N
Carp and Minnow		Cyprinella spiloptera	Spotfin Shiner	N	N
Carp and Minnow	Y	Cyprinus carpio	Common Carp	N	N
Carp and Minnow		Hybopsis amblops	Bigeye Chub	N	N
Carp and Minnow		Luxilus chrysocephalus	Striped Shiner	N	N
Carp and Minnow		Lythrurus fasciolaris	Scarlet Shiner	N	N
Carp and Minnow		Nocomis biguttatus	Hornyhead Chub	N	S
Carp and Minnow		Nocomis effusus	Redtail Chub	N	N
Carp and Minnow		Nocomis micropogon	River Chub	N	N
Carp and Minnow		Notropis atherinoides	Emerald Shiner	N	N
Carp and Minnow		Notropis buccatus	Silverjaw Minnow	N	N
Carp and Minnow		Notropis photogenis	Silver Shiner	N	N
Carp and Minnow		Notropis rubellus	Rosyface Shiner	N	N
Carp and Minnow		Notropis stramineus	Sand Shiner	N	N
Carp and Minnow		Notropis volucellus	Mimic Shiner	N	N
Carp and Minnow		Noturus flavus	Stonecat	N	N
Carp and Minnow		Pimephales notatus	Bluntnose Minnow	N	N
Carp and Minnow		Pimephales promelas	Fathead Minnow	N	N
Carp and Minnow		Rhinichthys obtusus	Western Blacknose Dace	N	N
Carp and Minnow		Semotilus atromaculatus	Creek Chub	N	N
Catfish	Y	Ameiurus melas	Black Bullhead	N	N
Catfish	Y	Ameiurus natalis	Yellow Bullhead	N	N
Catfish	Y	Ictalurus punctatus	Channel Catfish	N	N
Catfish	Y	Pylodictis olivaris	Flathead Catfish	N	N
Herring and shad		Alosa chrysochloris	Skipjack Herring	N	N
Herring and shad		Dorosoma petenense	Threadfin Shad	N	N
Perch		Etheostoma baileyi	Emerald Darter	N	N
Perch		Etheostoma blennioides	Greenside Darter	N	N
Perch		Etheostoma caeruleum	Rainbow Darter	N	N
Perch		Etheostoma flabellare	Fantail Darter	N	N
Perch		Etheostoma kennicotti	Stripetail Darter	N	N
Perch		Etheostoma nigrum	Johnny Darter	N	N
Perch		Etheostoma sagitta	Cumberland Arrow Darter	C	S
Perch		Etheostoma spilotum	Kentucky Arrow Darter	T	T
Perch		Etheostoma variatum	Variegate Darter	N	N
Perch		Etheostoma zonale	Banded Darter	N	N
Perch		Percina caprodes	Logperch	N	N
Perch		Percina maculata	Blackside Darter	N	N
Perch		Percina phoxocephala	Slenderhead Darter	N	N
Perch		Percina sciera	Dusky Darter	N	N
Sucker		Carpiodes cyprinus	Quillback	N	N
Sucker		Catostomus commersonii	White Sucker	N	N
Sucker		Hypentelium nigricans	Northern Hog Sucker	N	N
Sucker		Moxostoma breviceps	Smallmouth Redhorse	N	N
Sucker		Moxostoma duquesnei	Black Redhorse	N	N
Sucker		Moxostoma erythrurum	Golden Redhorse	N	N
Sunfish	Y	Ambloplites rupestris	Rock Bass	N	N

Family	Sportfish	Scientific Name	Common Name	US Status	KY Status
Sunfish		Lepomis auritus	Redbreast Sunfish	N	N
Sunfish	Y	Lepomis cyanellus	Green Sunfish	N	N
Sunfish	Y	Lepomis gulosus	Warmouth	N	N
Sunfish	Y	Lepomis macrochirus	Bluegill	N	N
Sunfish	Y	Lepomis megalotis	Longear Sunfish	N	N
Sunfish	Y	Micropterus dolomieu	Smallmouth Bass	N	N
Sunfish	Y	Micropterus punctulatus	Spotted Bass	N	N
Sunfish	Y	Micropterus salmoides	Largemouth Bass	N	N
Sunfish	Y	Pomoxis nigromaculatus	Black Crappie	N	N
Topminnow		Fundulus catenatus	Northern Studfish	N	N
Trout	Y	Oncorhynchus mykiss	Rainbow Trout	N	N
Trout	Y	Salvelinus fontinalis	Brook Trout	N	N

APPENDIX B: EROSION ASSESSMENT

North Fork: Whitesburg Tributaries Watershed Plan
Erosion Assessment Summary Report

An erosion assessment was conducted on Dry Fork, Sandlick, and Crafts Colley using the Maryland Stream Corridor Assessment Survey Protocols (Yetman, 2001) on August 25, 2018 by Alice Jones (Eastern Kentucky University), Alex Beer and Garth Adams (Headwaters, Inc.).[1] All streams were visually survey from accessible roads and areas with severe erosion were assessed. For purposes of this report, severe erosion is defined as erosion that exceeds average reach conditions or threatens property and infrastructure.

A total of ten stream reaches were assessed: four on Dry Fork, three on Sandlick, and two on Crafts Colly with a total length of about 775 feet.

The severity of erosion was ranked from 1 (severe) to 5 (minor) for each site. Severe (1) erosion was considered a long stream (> 1000 ft.) that had incised several feet, with banks on both sides of the stream that are unstable and eroding at a fast rate. Moderate (3) erosion was considered for either a long section of stream (> 1000 ft.) that has a moderate erosion problem, or a shorter stream reach (between 1000 and 300 ft.) with very high banks (> 4 ft.) and evidence that the stream is eroding at a fast rate. Minor erosion (5) was considered a short section of stream (< 300 ft.) where the erosion is limited to one or two meander bends or a site where an erosion problem is being caused by a pipe outfall and the area affected is fairly limited.

Correctability was ranked from 1 (best) to 5 (worst), where the best sites could be corrected by volunteers in one or two days while the worst would require significant funding (i.e., several hundred thousand dollars) and a large amount of earth moving.

Accessibility was ranked from 1 (easy) to 5 (difficult), where easy access was considered by car or foot, moderate access was easy by foot but not car, and difficult would be areas where access by foot or vehicle would be highly restricted (i.e., require an access road to allow construction).

The one notable exception to the general patterns of exposed bank height, correctibility, and accessibility is reach DF 3. In this area of Dry Fork, the roadway follows the sedimentary "bench", while the stream plunges away from the roadway over a relatively short distance of about 160 meters.

North Fork: Whitesburg Tributaries Watershed Plan
Erosion Assessment Summary

Reach	Length of Stretch	Average exposed bank height	Severity	Correctibility	Access
			5-point scale: 1= "worst" - 5="best"		
DF 1	173 Meters	2.6 Meters	3	4	3
DF 2	314 Meters	2.4 Meters	2	4	3
DF 3	.10 Miles* (approx 160 meters)	50 - 100 Meters	1	2	3
DF 4	140 Meters	1.6 Meters	2	2	3
Dry Fork Average	***196.75***	**20.40**	**2.0**	**3.0**	**3.0**
** DF 3: vegetation and rapid drop in stream elevation inhibited access. Stretch length approximated by vehicle odometer*					
SL 1	493 Meters	1.75 Meters	4.0	1.0	1.0
SL 2	224 Meters	2.2 Meters	3.5	2.0	1.0
SL 3	211.7 Meters	4 Meters	2.0	4.0	4.0
Sandlick Average	309.57	2.65	3.2	2.3	2.0
CC 1	218 Meters	4.75 Meters	4.0	2.0	2.0
CC 2	192 Meters	Lower: 2.14 Meters Upper: 5.5 Meters	2.0	3.0	2.0
Crafts Colly Average	*205.00*	*4.35*	*3.0*	*2.5*	*2.0*
Average Across All Reaches	**236.19**	**10.26**	***2.6***	***2.7***	***2.4***

[1] *Special thanks students Evan Moser, Corey Jenks, Huston Page, Jacob Lyttle, Jacob Riddle, Jonathan Adu-Dei, Jonathan Mullins, Stephen Jones, and Tanner Bryant for the preliminary watershed assessment performed on April 21/22, 2019 as part of an EKU Geosciences undergraduate applied research project.*

COMMON EROSION ISSUES Almost without exception, the common erosion issues identified at all ten sites were:

- **stream widening** related to **channelization due to road construction/ road placement**; and
- **threats to infrastructure** directly related to this channelization and widening including:
    - undercutting and road collapse,
    - washouts of embankments and culverts.

Conditions pictured at sites SL2, SL3, and DF2 illustrate the common site conditions throughout these tributary watershed.

SL2 Downstream looking upstream

The exception is DF 3, where the roadway follows along the contour of a sedimentary bench and the stream separates from the roadway, dropping in elevation nearly 100 meters over the a relatively short distance—leaving between 50-100 meters of hillside exposed to erosion.

EROSION CAUSES

The erosion problems observed throughout these headwaters are all directly related to

- the **flashy nature of the high-gradient headwaters streams** where even in very modest precipitation events banks fill rapidly and the storm surge can crest and abate in a matter of hours;
- the **historical settlement patterns** common throughout Appalachian Kentucky, where early farms and homesteads were established along the fertile stream hollow bottoms, and the natural meanders of the native streams were frequently removed and the streams rerouted to run along the edge of the hillside in order to maximize the size of farm and home sites.

SL3 Upstream looking downstream

The modern road network often follows the informal foot and cart trails along the creek that linked the early homesteads, and subsequent residential infill has occurred along these streams and roads—often within 10 meters of the stream channel. As the roads have been widened, expanded, and repaired iteratively over time, the streams have become more deeply channelized, with few—if any—floodplain or retention areas to hold the rapidly rising stream flow during even modest rain events.

DISTRIBUTED RESTORATION AND MITIGATION

The combination of high-gradient terrain, proximity of homes and other structures, and extremely narrow-or non-existent buffer zones around these channelized streams means that there are few uninterrupted areas in any of these watersheds where—even if funding were available—sufficient land could be acquired in strategic locations to implement basin-scale mitigation practices such as re-establishing natural meanders, riparian buffer plantings, or installing stormwater retention and detention basins or constructed wetlands.

DF2 Downstream looking upstream

It may be necessary, therefore, to take a more distributed approach—working in multiple sites with multiple individual landowners simultaneously to effect basin-wide change. Strategies that can be implemented in these areas include:

1. **Installation of transitional streamside transitional zone and overbank vegetation**. To avoid common nuisance plants such as kudzu and Japanese knotweed, common native species such as spice bush, arrowwood viburnum, deer tongue grass, and swamp milkweed, and other hearty shrubs and vines could be used to stabilize banks (see, for example, http://www2.ca.uky.edu/agcomm/pubs/id/id185/id185.pdf).
2. **Small-scale sinuosity improvements.** Even at the household or individual landowner scale, small rock checkdams or gabions installed alternately on either side of the bank to create small switchbacks and meanders can help slow down water flow and reduce downstream erosional force. The deep channelization will make this difficult to employ in some reaches.
3. **Landowner Education.** Outreach efforts emphasizing vegetation maintenance in erosion-prone areas and the importance of maintaining and improving sinuosity could have cumulative effects throughout the watershed.

North Fork: Whitesburg Tributaries Watershed Plan

Erosion Assessment

APPENDIX A

Sample Reach Locator Map

&

Reach Photographs

North Fork: Whitesburg Tributaries Watershed Plan

Erosion Assessment Sites 8/25/2018

Dry Fork (DF) Sandlick (SL) and Crafts Colly (CC)

https://drive.google.com/open?id=11pWJmwOC1JQh0uAWiEfSu9-JGNbpibsK&usp=sharing

Site #	DF #1
Reach Start	37.12176, -82.87387
Reach End	37.12304, -82.87082
Site Description	Directly in front of Vendor's mall.
Erosion Type	Widening
Erosion Cause	Channelization due to road construction
Reach Length (Meters)	173 Meters
Average exposed bank height	2.6 Meters
Present Land Use: Left (looking downstream)	Lawn, paved area, rural housing
Present Land Use: Right (looking downstream)	Road, embankment, paved area, shrubs, small trees
Threat to Infrastructure	Yes: Road washout.
Severity (1-Severe, 5-Minor)	3
Correctability (1-Severe, 5-Minor)	4
Access (1-Severe, 5-Minor)	3
NOTES	

	
Beginning of Reach- Looking Downstream	End of Reach Looking Upstream

Site #	DF #2
Reach Start	37.12869, -82.86479
Reach End	37.12962, -82.8637
Site Description	50 meters upstream of El Paso Drive (@ KRWW Site by sub station) to 114 meters upstream of Brewer Dr.
Erosion Type	Widening
Erosion Cause	Channelization due to road construction
Reach Length (Meters)	314 Meters
Average exposed bank height	2.4 Meters
Present Land Use: Left (looking downstream)	Paved area, lawn, rural housing
Present Land Use: Right (looking downstream)	Paved area, shrubs and small trees, road/embankment
Threat to Infrastructure	Yes: Road washout, potential house flooding.
Severity (1-Severe, 5-Minor)	2
Correctability (1-Severe, 5-Minor)	4
Access (1-Severe, 5-Minor)	3
NOTES	Recent road repair


Beginning of Reach- Looking Downstream


End of Reach Looking Upstream

Date	08/25/18
Sub-Watershed	Dry Fork
Site #	DF #3
Reach Start	37.15103, -82.8584
Reach End	37.15001, -82.85937
Site Description	Loggy Hollow (.10 mile windshield assessment)
Type	Severe sediment in riparian area
Cause	Land use change upstream, logging road, vegetation removal
Length (Meters)	.10 Miles* (approx 160 meters)
Height	50 - 100 Meters
Present Land Use: Left (looking downstream)	Pasture, shrubs, temporary road (e.g. logging road)
Present Land Use: Right (looking downstream)	Against slope, no development
Threat to Infrastructure	No
Severity 1-Severe, 5-Minor	1
Correctability 1-Severe, 5-Minor	2
Access 1-Severe, 5-Minor	3
NOTES	Good site; would need landowner permission for access ** stream inaccessible-- length approximated by car odometer*

	
DF#3- focus area of severe erosion	*DF#3 focus area of severe erosion*

Sub-Watershed	Dry Fork
Site #	DF #4
Reach Start	37.14726, -82.8442
Reach End	37.14626, -82.84521
Site Description	Heartbreak Ridge- mailbox #105 to end of guardrail downstream of mailbox 893.
Type	Widening
Cause	Channelization due to concrete/industrial plant site
Length (Meters)	140 Meters
Height	1.6 Meters
Present Land Use: Left (looking downstream)	Paved area, road
Present Land Use: Right (looking downstream)	Lawn, paved area, shrubs, small trees, rural housing, concrete/industrial plant
Threat to Infrastructure	Yes: Road fallout
Severity 1-Severe, 5-Minor	2
Correctability 1-Severe, 5-Minor	2
Access 1-Severe, 5-Minor	3
NOTES	Downcutting with gravel runnoff into stream

Beginning of Reach- Looking Downstream

End of Reach Looking Upstream

Subwatershed	Sandlick
Site #	SL #1
Reach Start	37.16347, -82.82565
Reach End	37.15922, -82.8245
Site Description	2801 Sadlick just down from Hall office to parking lot at the end of the fire department.
Type	Widening
Cause	Channelization due to road placement
Length (Meters)	493 Meters
Height	1.75 Meters
Present Land Use: Left (looking downstream)	Road and embankment/mountain
Present Land Use: Right (looking downstream)	Lawn, paved area, shrubs, small trees, rural housing
Threat to Infrastructure	Yes: Road fallout, power lines, phone poles
Severity 1-Severe, 5-Minor	4
Correctability 1-Severe, 5-Minor	1
Access 1-Severe, 5-Minor	1
NOTES	Stream contouring and vegetation one of most correctable

	
Beginning of Reach- Looking Downstream	End of Reach Looking Upstream

Subwatershed	Sandlick
Site #	SL #2
Reach Start	37.14783, -82.82176
Reach End	37.146, -82.82204
Site Description	Fairchild Dr. (abandoned home next to 1961 Sandlick) to Rainbow Dr.
Type	Widening
Cause	Channelization due to road placement
Length (Meters)	224 Meters
Height	2.2 Meters
Present Land Use: Left (looking downstream)	Road and embankment/mountain
Present Land Use: Right (looking downstream)	Lawn, paved area, shrubs, small trees, rural housing
Threat to Infrastructure	Yes: Road fallout, power lines, phone poles
Severity 1-Severe, 5-Minor	3/4
Correctability 1-Severe, 5-Minor	2
Access 1-Severe, 5-Minor	1
NOTES	

	
Beginning of Reach- Looking Downstream	End of Reach Looking Upstream

Sub-Watershed	Sandlick
Site #	SL #3
Reach Start	37.13093, -82.83035
Reach End	37.12975, -82.83214
Site Description	Dan's Crossing Rd to Thompson Br. (+ .5 mi windshield assessment, almost to mouth)
Type	Widening
Cause	Channelization due to road placement
Length (Meters)	211.7 Meters
Height	4 Meters
Present Land Use: Left (looking downstream)	Road and embankment/slope
Present Land Use: Right (looking downstream)	Lawn, paved area, shrubs, small trees, rural housing, livestock, trucking storage
Threat to Infrastructure	Yes: Road fallout, power lines
Severity 1-Severe, 5-Minor	2
Correctability 1-Severe, 5-Minor	4
Access 1-Severe, 5-Minor	4
NOTES	Measured accessible reach, including power station

	
Beginning of Reach- Looking Downstream	End of Reach Looking Upstream

Sub-Watershed	Crafts Colley
Site #	CC #1
Reach Start	37.17024, -82.8052
Reach End	37.1678, -82.80493
Site Description	Downstream 218 meters from "End of State Maintenance" sign.
Type	Unknown: Slope failure from road placement
Cause	Channelization
Length (Meters)	218 Meters
Height	4.75 Meters
Present Land Use: Left (looking downstream)	Paved area, road, mountain/slope
Present Land Use: Right (looking downstream)	Pasture, lawn, paved area, shrubs, small trees, rural housing, livestock
Threat to Infrastructure	Yes: Road fallout
Severity 1-Severe, 5-Minor	4
Correctability 1-Severe, 5-Minor	2
Access 1-Severe, 5-Minor	2
NOTES	Bank heights: 1, 8, 5.3 Meters. Erosion associated with road placement not stream morphology?

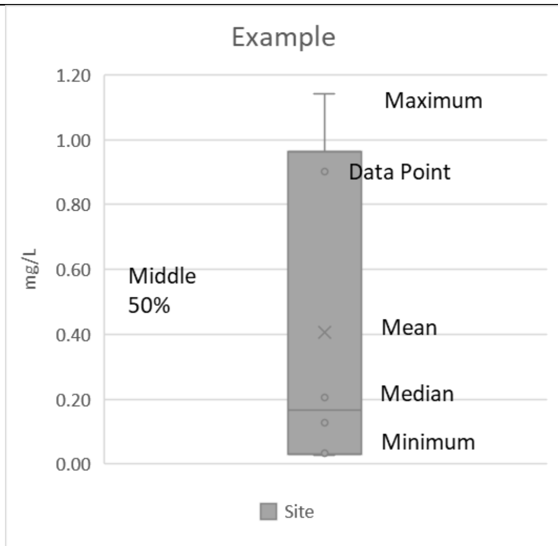
	
Beginning of Reach- Looking Downstream	End of Reach Looking Upstream

Sub-Watershed	Crafts Colley
Site #	CC #2
Reach Start	37.1389, -82.79385
Reach End	37.13728, -82.7934
Site Description	50 meters downstream of bridge. Red and white house by curve in road. 1519 Lombardi.
Type	Widening
Cause	Channelization due to road placement
Length (Meters)	192 Meters
Height	2.14 (lower), 5.5 (upper) Meters
Present Land Use: Left (looking downstream)	Lawn, paved area, shrubs, small trees, rural housing with significant yard space
Present Land Use: Right (looking downstream)	Road, hill slope/mountain
Threat to Infrastructure	Yes: Road fallout
Severity 1-Severe, 5-Minor	2
Correctability 1-Severe, 5-Minor	3
Access 1-Severe, 5-Minor	2
NOTES	

Beginning of Reach- Looking Downstream

End of Reach Looking Upstream

APPENDIX C: CONCENTRATION CHARTS



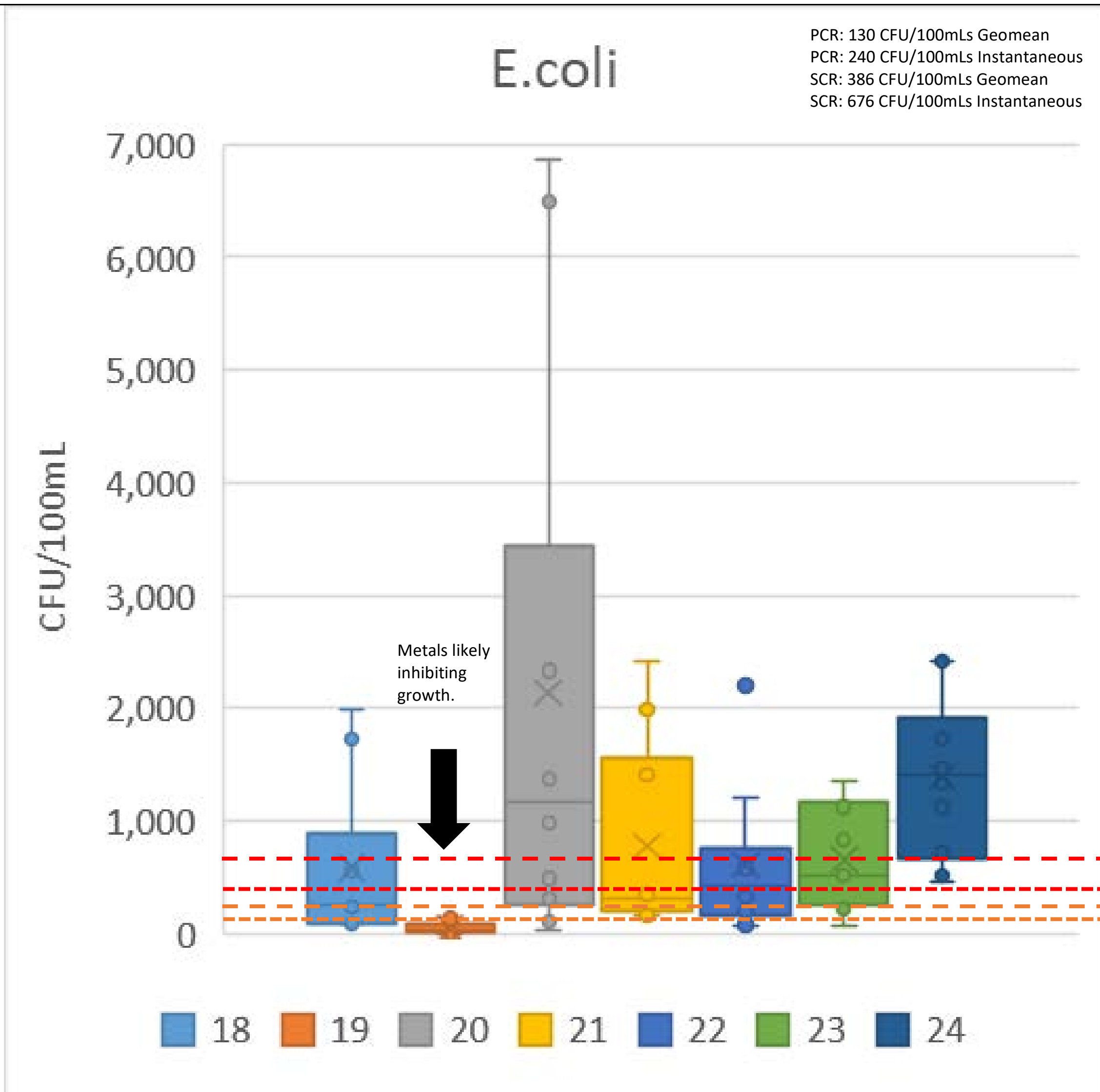
DWS: Drinking Water Supply

WAH: Warmwater Aquatic Habitat
Acute
Chronic
Fish Consumption

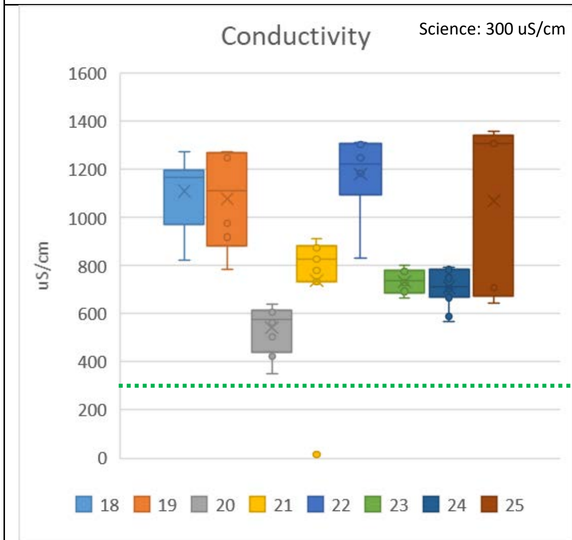
Science Benchmark

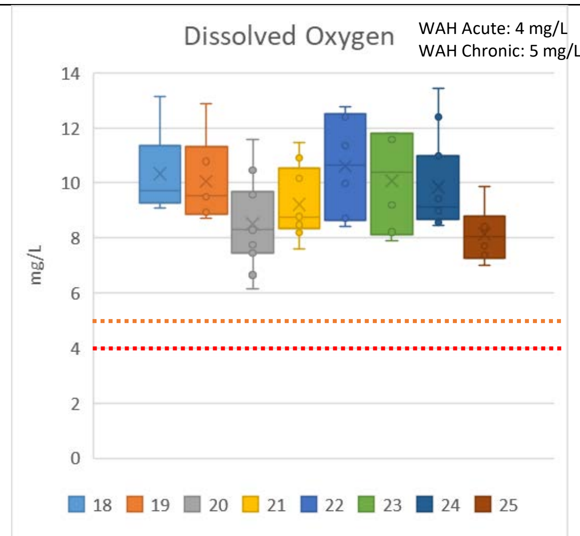
PCR: Primary Contact Recreation
Geomean
Instantaneous
SCR: Secondary Contact Recreation
Geomean
Instantaneous

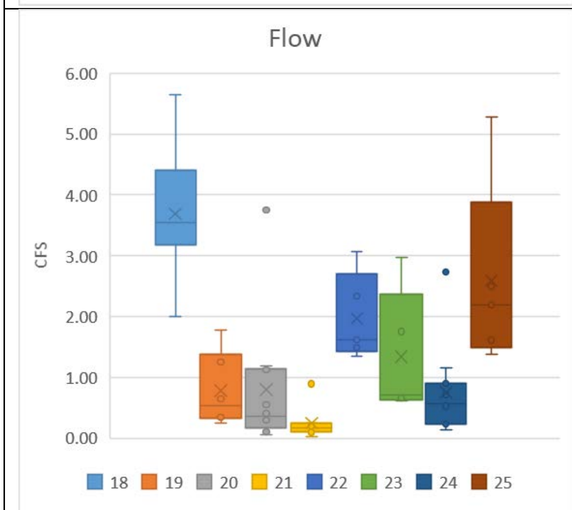
Fecal Indicator Bacteria

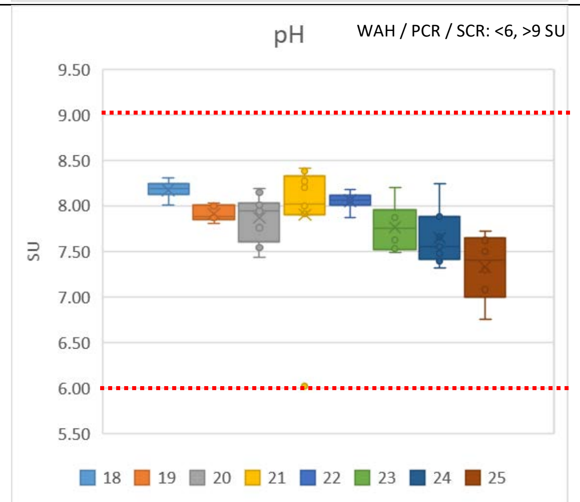


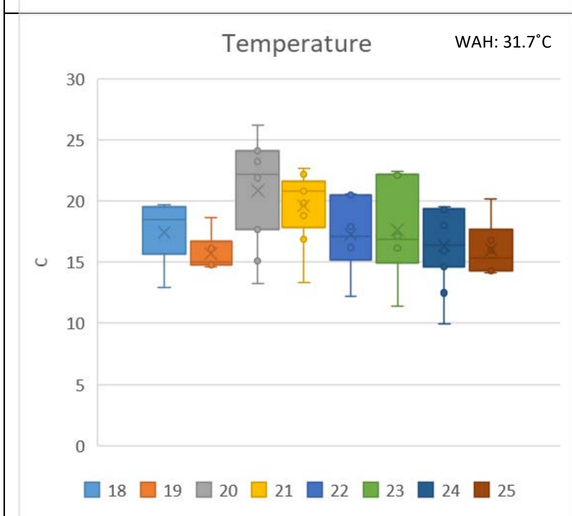
Field Parameters

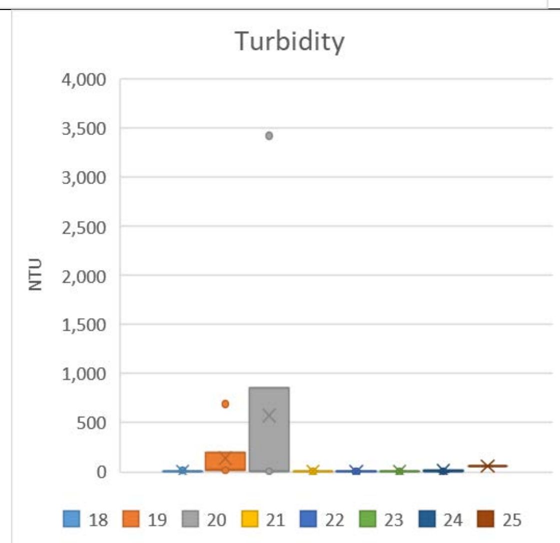




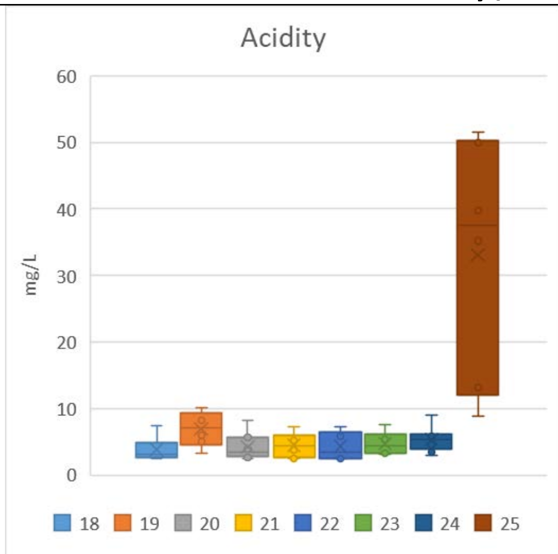


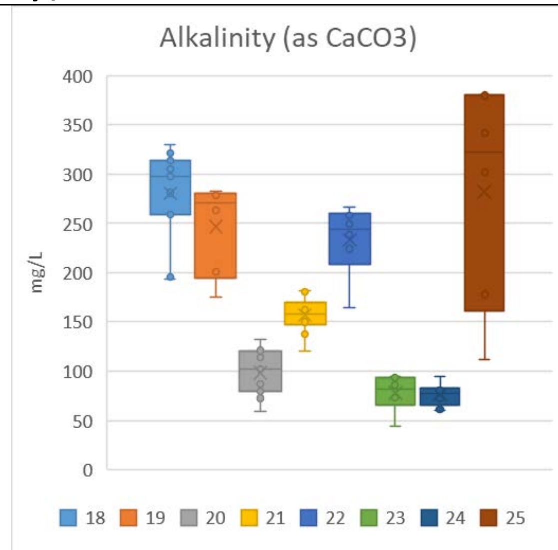


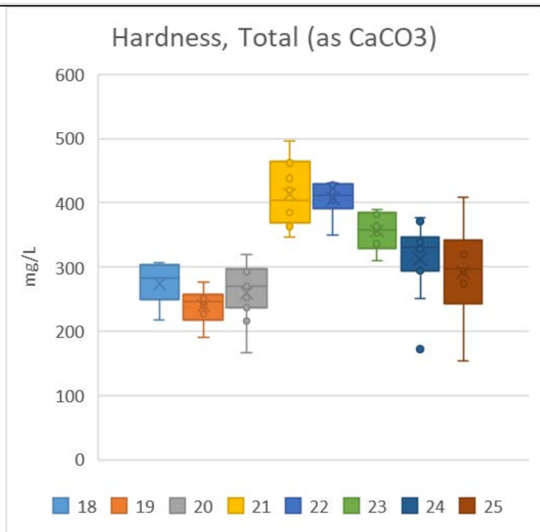




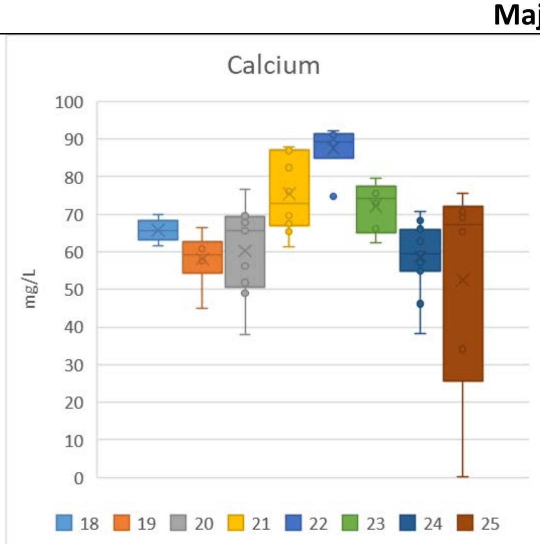
Acidity / Alkalinity / Hardness

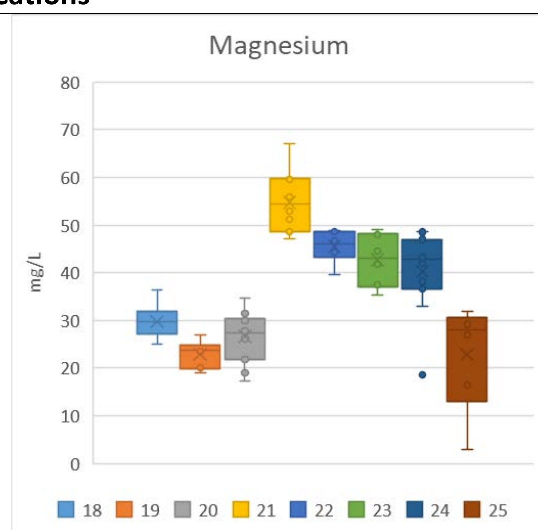


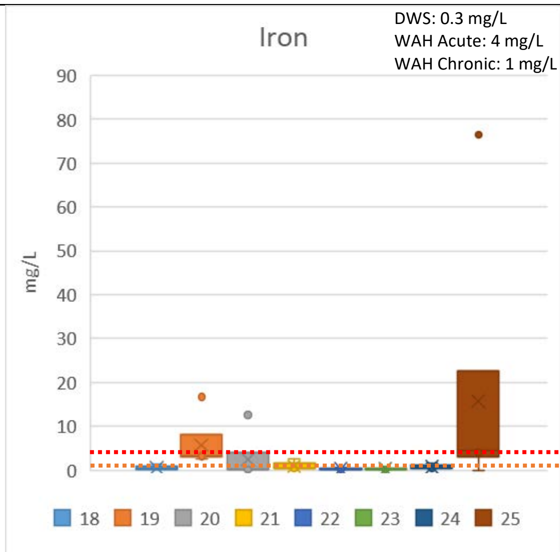


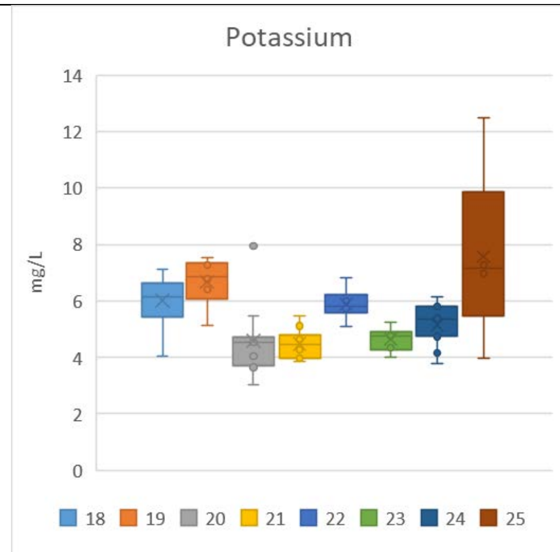


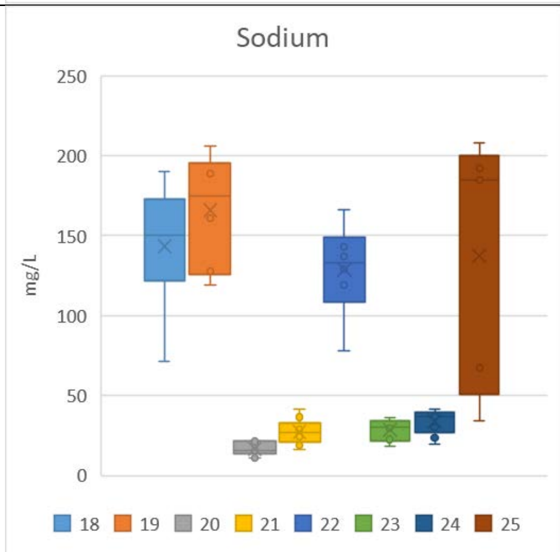
Major Cations



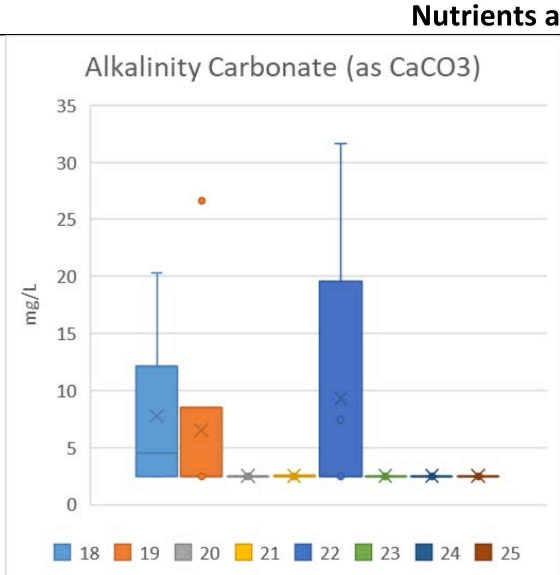


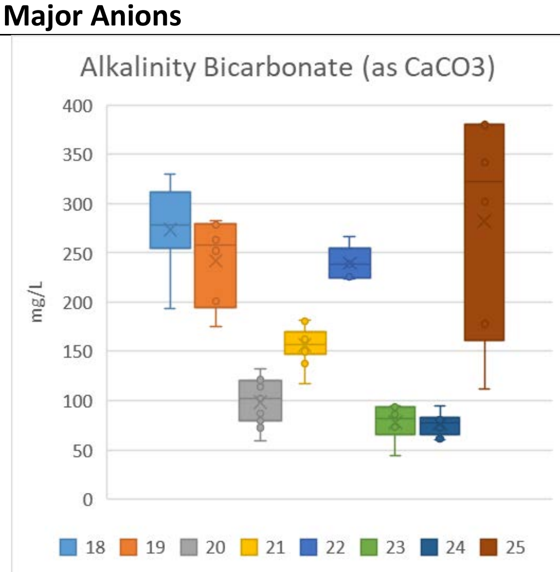


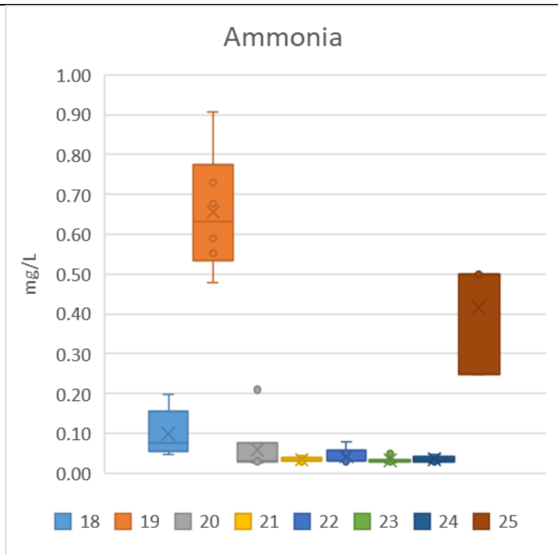


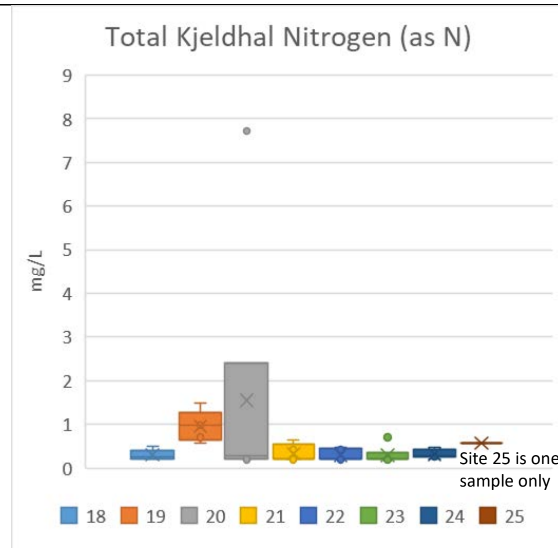


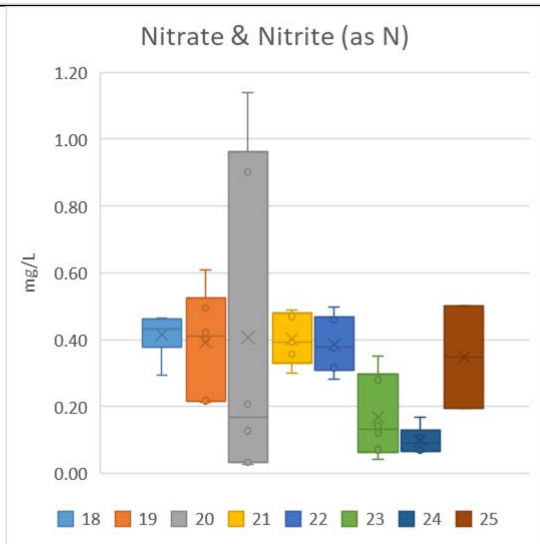
Nutrients and Major Anions

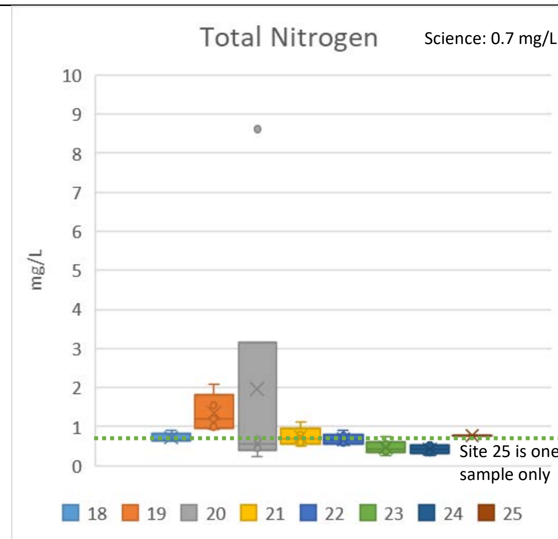


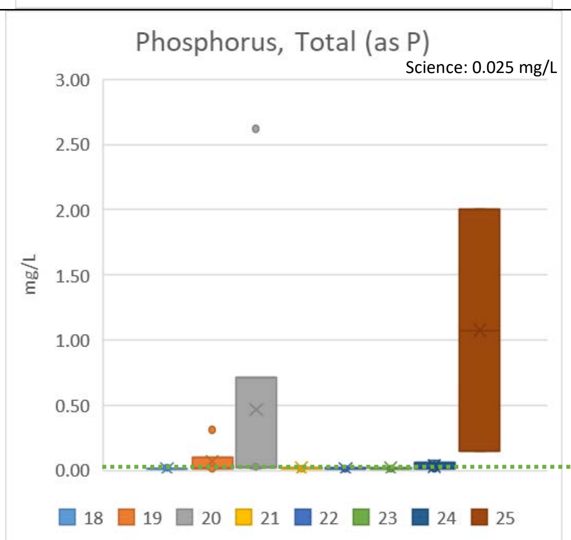


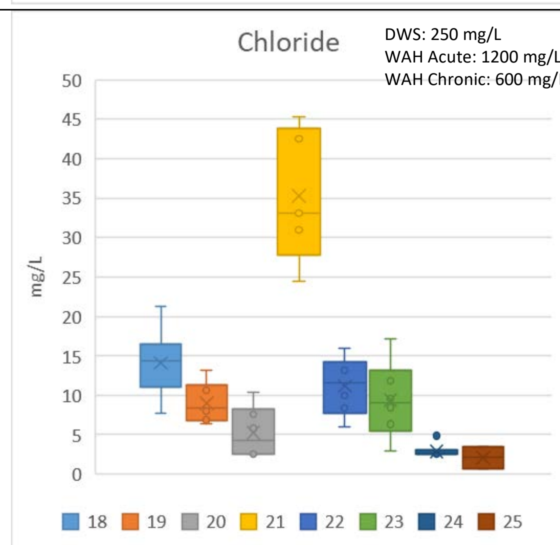

Ammonia
mg/L
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
18 19 20 21 22 23 24 25

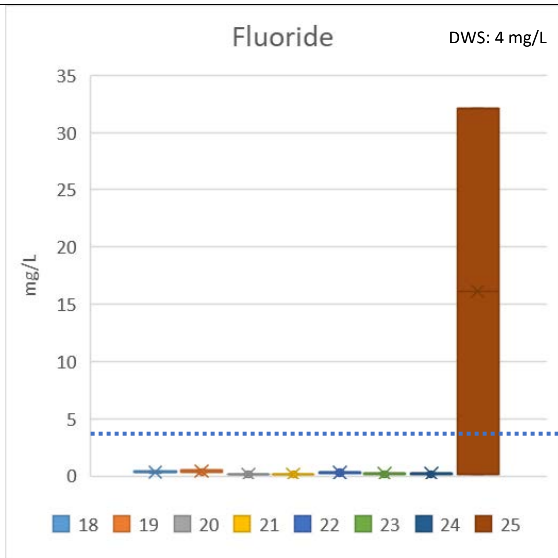

Total Kjeldhal Nitrogen (as N)
mg/L
9
8
7
6
5
4
3
2
1
0
Site 25 is one sample only
18 19 20 21 22 23 24 25

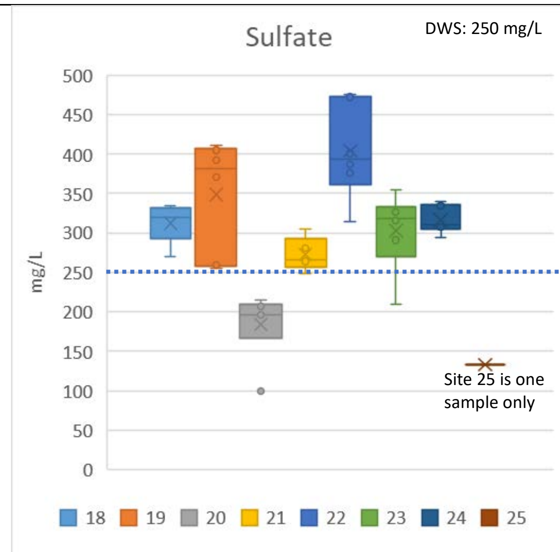

Nitrate & Nitrite (as N)
mg/L
1.20
1.00
0.80
0.60
0.40
0.20
0.00
18 19 20 21 22 23 24 25

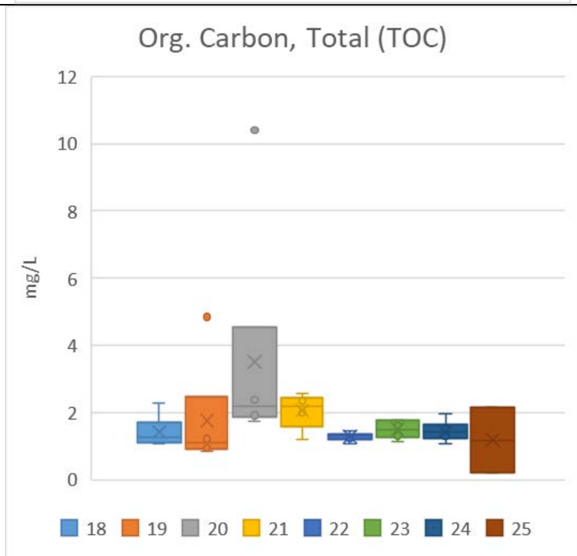

Total Nitrogen
Science: 0.7 mg/L
mg/L
10
9
8
7
6
5
4
3
2
1
0
Site 25 is one sample only
18 19 20 21 22 23 24 25


Phosphorus, Total (as P)
Science: 0.025 mg/L
mg/L
3.00
2.50
2.00
1.50
1.00
0.50
0.00
18 19 20 21 22 23 24 25

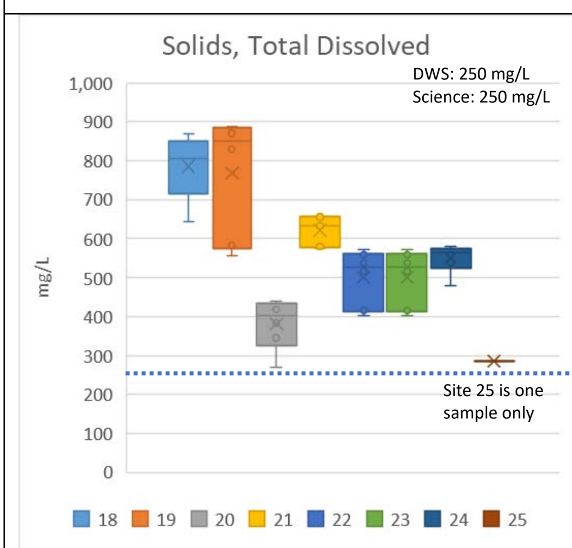

Chloride
DWS: 250 mg/L
WAH Acute: 1200 mg/L
WAH Chronic: 600 mg/L
mg/L
50
45
40
35
30
25
20
15
10
5
0
18 19 20 21 22 23 24 25

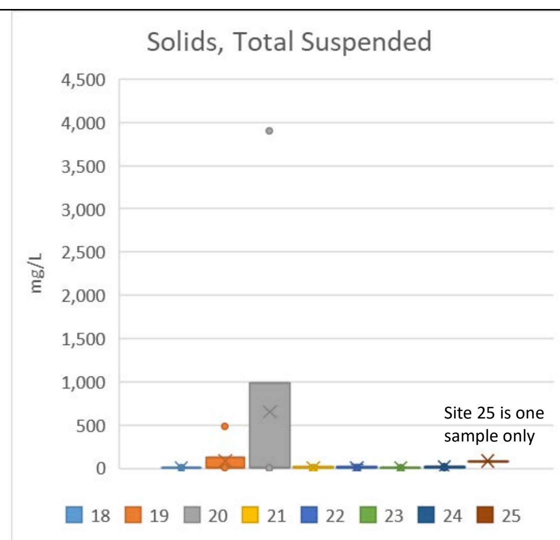

Fluoride
DWS: 4 mg/L
mg/L
0
5
10
15
20
25
30
35
18 19 20 21 22 23 24 25


Sulfate
DWS: 250 mg/L
mg/L
0
50
100
150
200
250
300
350
400
450
500
Site 25 is one sample only
18 19 20 21 22 23 24 25

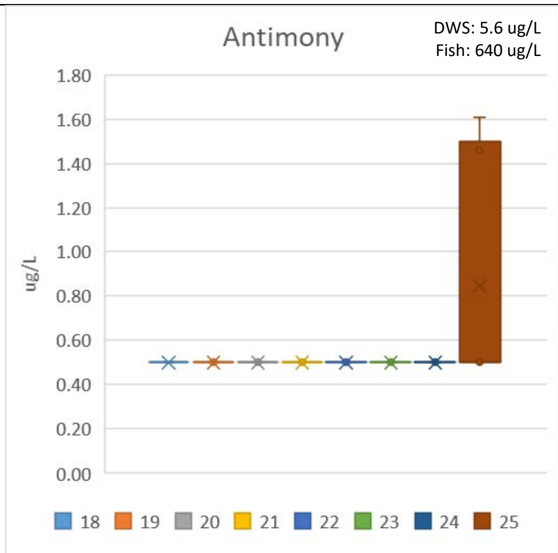

Org. Carbon, Total (TOC)
mg/L
0
2
4
6
8
10
12
18 19 20 21 22 23 24 25

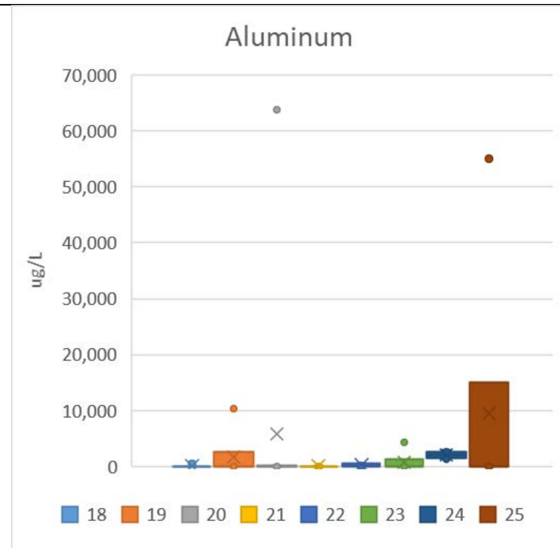
Solids

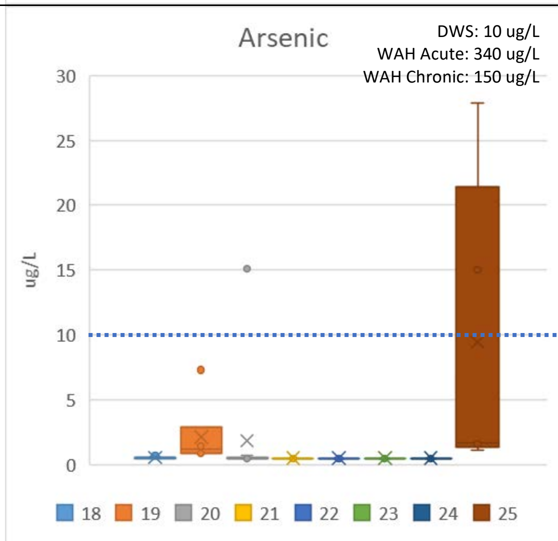

Solids, Total Dissolved
DWS: 250 mg/L
Science: 250 mg/L
mg/L
0
100
200
300
400
500
600
700
800
900
1,000
Site 25 is one sample only
18 19 20 21 22 23 24 25

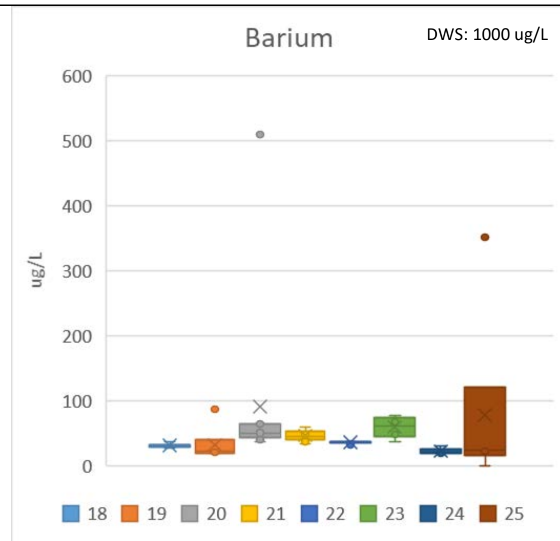

Solids, Total Suspended
mg/L
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
Site 25 is one sample only
18 19 20 21 22 23 24 25

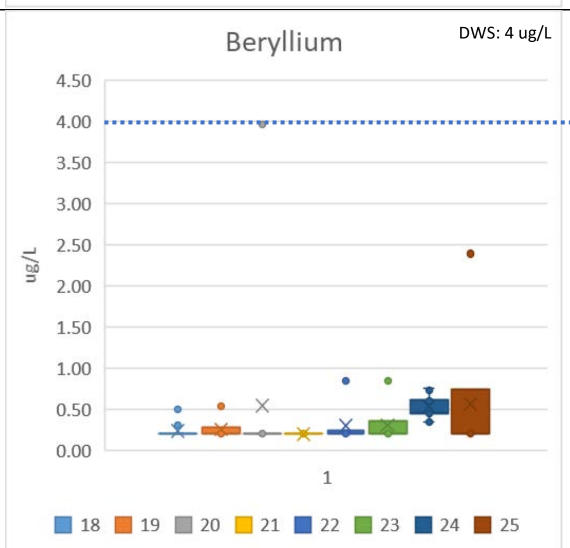
Trace Metals

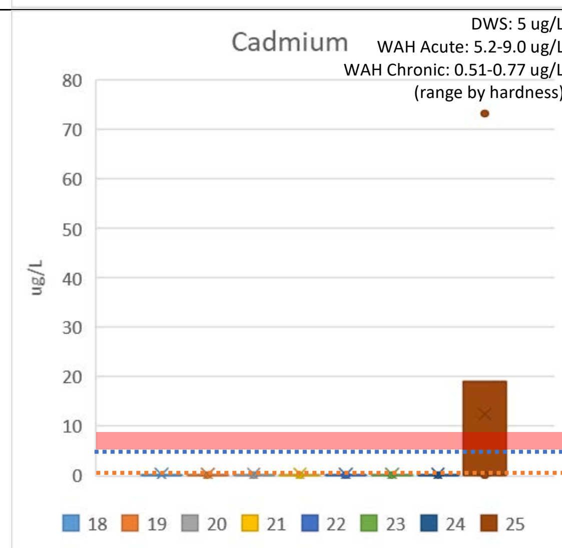


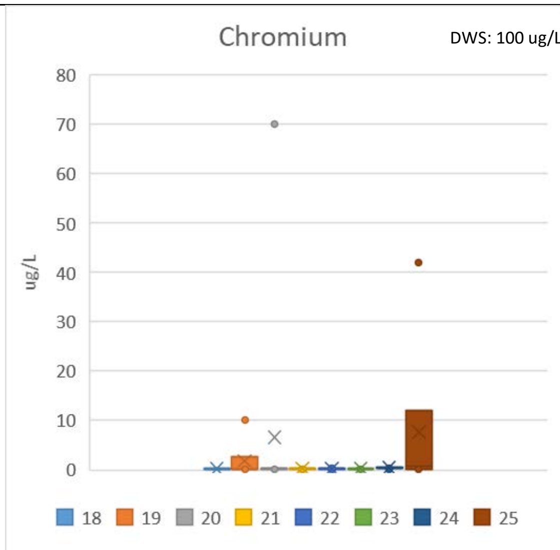


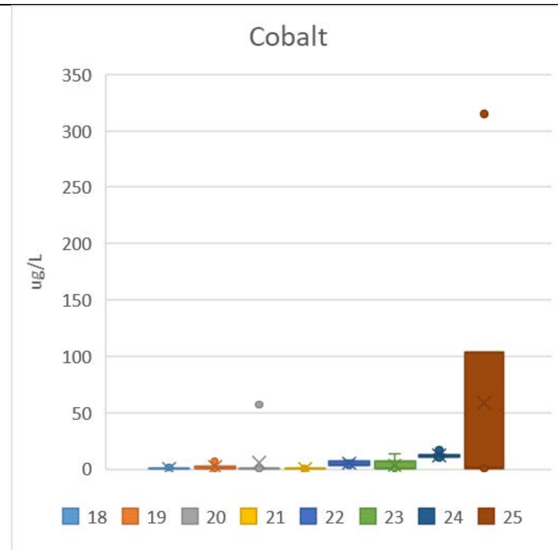


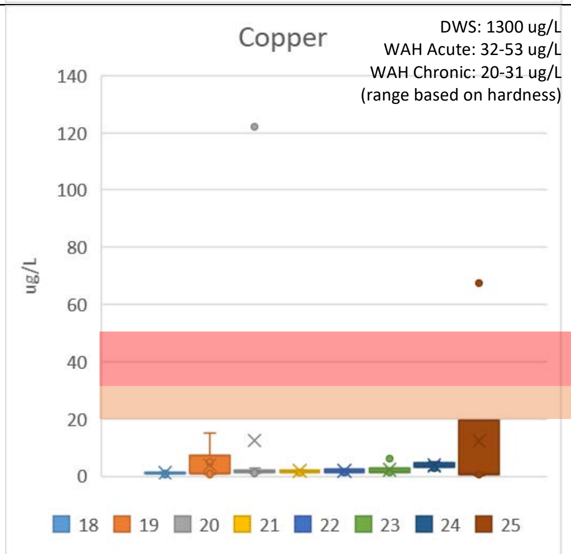


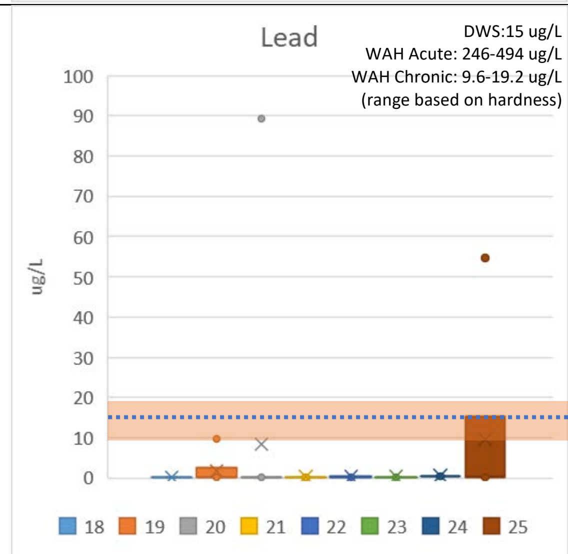


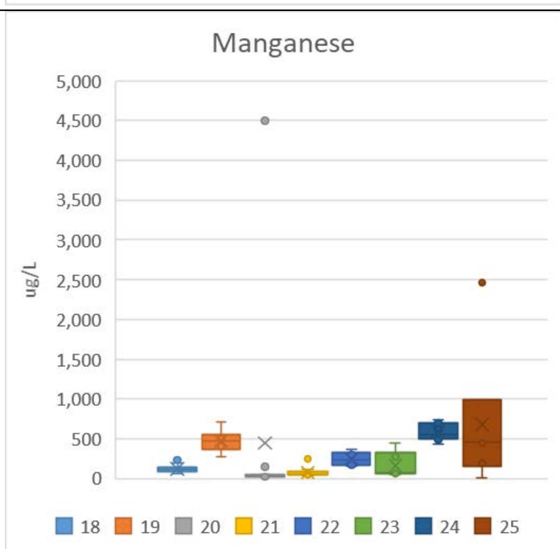


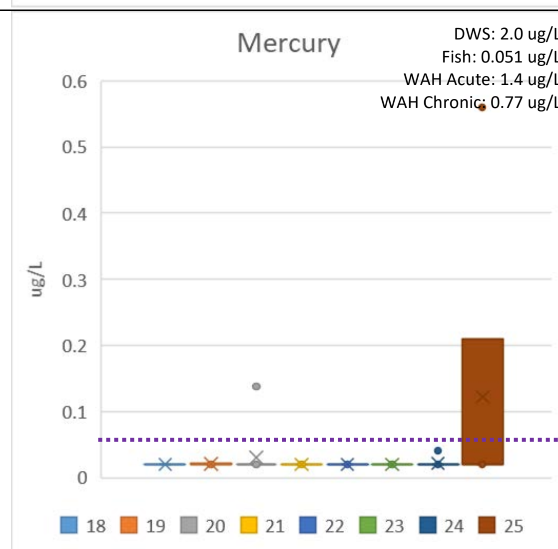

Chromium
DWS: 100 ug/L
ug/L
0
10
20
30
40
50
60
70
80
18 19 20 21 22 23 24 25

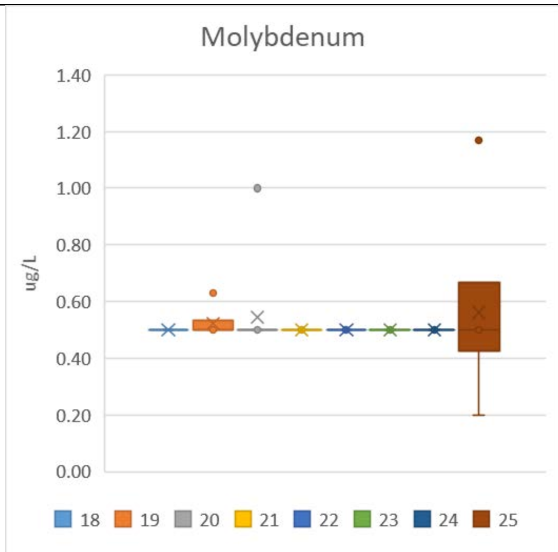

Cobalt
ug/L
0
50
100
150
200
250
300
350
18 19 20 21 22 23 24 25

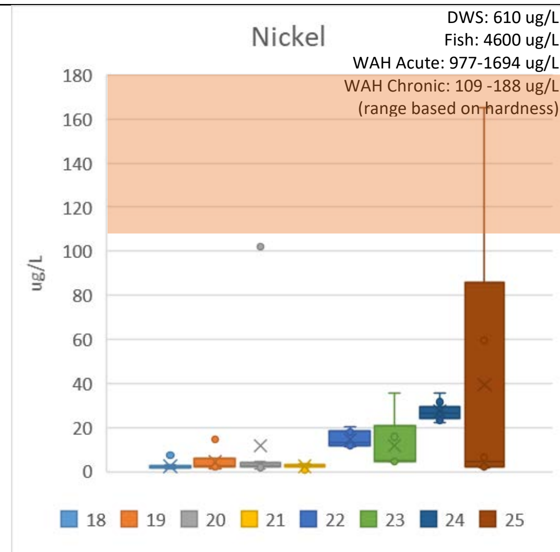

Copper
DWS: 1300 ug/L
WAH Acute: 32-53 ug/L
WAH Chronic: 20-31 ug/L
(range based on hardness)
ug/L
0
20
40
60
80
100
120
140
18 19 20 21 22 23 24 25

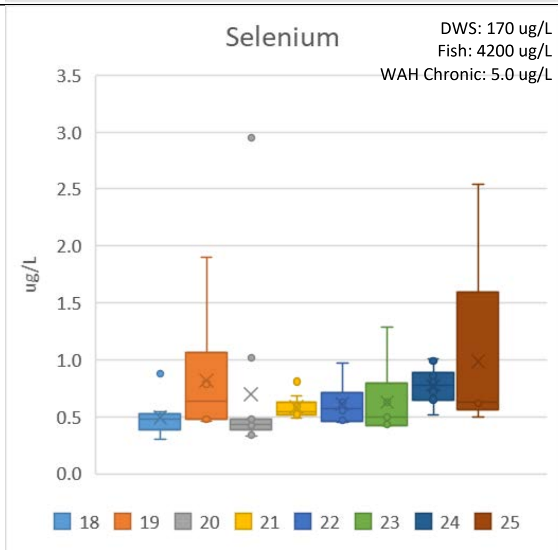

Lead
DWS:15 ug/L
WAH Acute: 246-494 ug/L
WAH Chronic: 9.6-19.2 ug/L
(range based on hardness)
ug/L
0
10
20
30
40
50
60
70
80
90
100
18 19 20 21 22 23 24 25

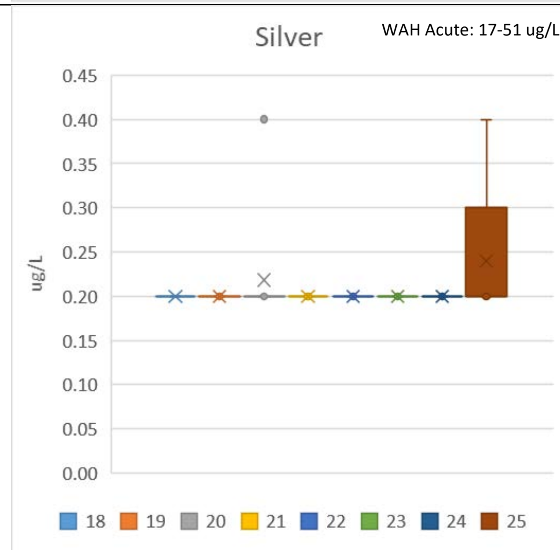

Manganese
ug/L
0
500
1,000
1,500
2,000
2,500
3,000
3,500
4,000
4,500
5,000
18 19 20 21 22 23 24 25

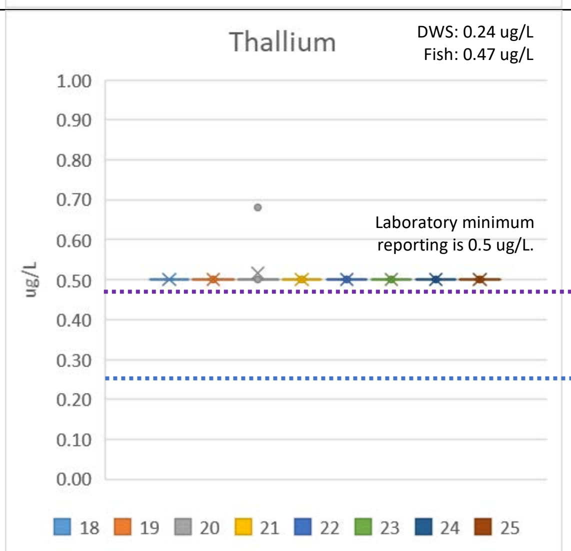

Mercury
DWS: 2.0 ug/L
Fish: 0.051 ug/L
WAH Acute: 1.4 ug/L
WAH Chronic: 0.77 ug/L
ug/L
0
0.1
0.2
0.3
0.4
0.5
0.6
18 19 20 21 22 23 24 25

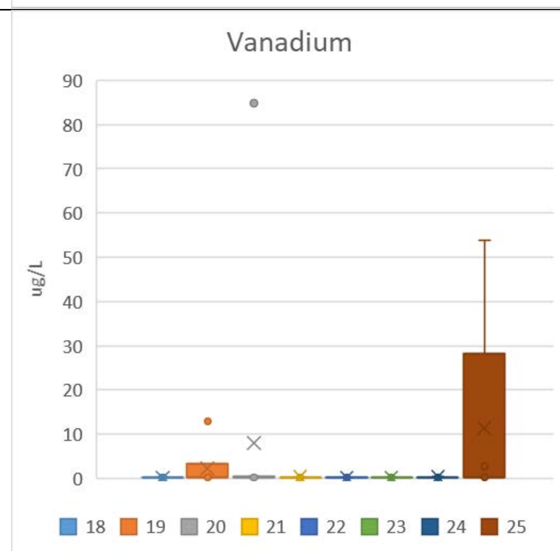

Molybdenum
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
ug/L
18 19 20 21 22 23 24 25

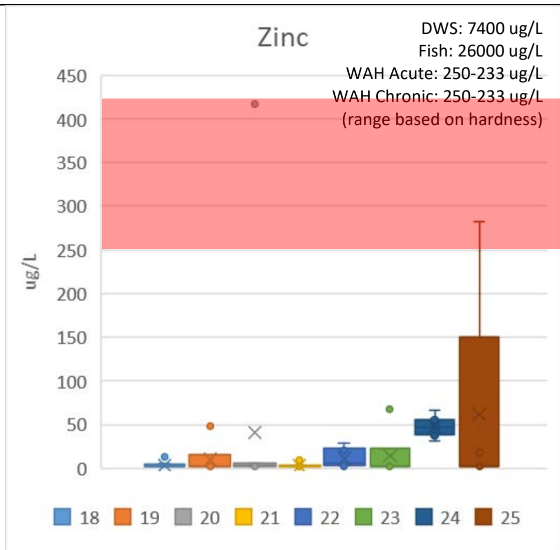

Nickel
DWS: 610 ug/L
Fish: 4600 ug/L
WAH Acute: 977-1694 ug/L
WAH Chronic: 109 -188 ug/L
(range based on hardness)
180
160
140
120
100
80
60
40
20
0
ug/L
18 19 20 21 22 23 24 25


Selenium
DWS: 170 ug/L
Fish: 4200 ug/L
WAH Chronic: 5.0 ug/L
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
ug/L
18 19 20 21 22 23 24 25


Silver
WAH Acute: 17-51 ug/L
0.45
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0.05
0.00
ug/L
18 19 20 21 22 23 24 25

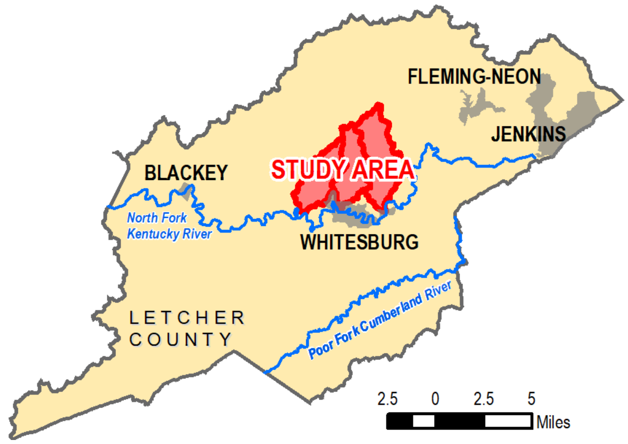

Thallium
DWS: 0.24 ug/L
Fish: 0.47 ug/L
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
ug/L
Laboratory minimum
reporting is 0.5 ug/L.
18 19 20 21 22 23 24 25


Vanadium
90
80
70
60
50
40
30
20
10
0
ug/L
18 19 20 21 22 23 24 25


Zinc
DWS: 7400 ug/L
Fish: 26000 ug/L
WAH Acute: 250-233 ug/L
WAH Chronic: 250-233 ug/L
(range based on hardness)
ug/L
450
400
350
300
250
200
150
100
50
0
18
19
20
21
22
23
24
25

APPENDIX D: NORTH FORK INFORMATIONAL HANDOUT

Background



Local and state leaders want to do more to make sure that our water is clean enough for economic development, recreation and the fish and other animals that make local creeks and rivers their home. Because the "headwaters" that feed into the North Fork Kentucky River are the best place to start, they began their focus on Crafts Colly, Sandlick Creek and Dry Fork--all of which are located just north of Whitesburg, KY. These leaders sought to identify factors impacting the stream health and develop a strategy to improve the conditions.

What Are the Problems?

The Kentucky Division of Water monitored aquatic biology, habitat, and water quality at eight stream sites on these creeks for almost a year between 2017 and 2018. The Headwaters, Inc in conjunction with researchers from Eastern Kentucky University also walked the streams to evaluate streambank erosion in 2018. These results, along with those from prior studies, indicate that Dry Fork Creek, Sandlick Creek, and Crafts Colly Creek are not safe for recreational activities such as wading, fishing or swimming. The water conditions also are not healthy enough for animals that live in the streams. And, although the creeks are not currently used for public drinking water withdrawals, they would not currently meet the requirements for that use. Several causes of these unhealthy conditions have been identified.

1. Human Sewage

Except for about 70 residences along the lower reach of Crafts Colly Creek, all residences (approx. 750) in the area are either on septic systems or straight pipes. Untreated human sewage discharges to the stream are causing levels of bacteria to exceed regulatory criteria intended to protect citizens from illness. Straight pipes provide no treatment for human waste. Improperly maintained septic systems can fail, providing little treatment. It is estimated that raw sewage from a minimum of 34 residences (14 in Dry Fork, 9 in Sandlick Creek, and 11 in Crafts Colly) must be addressed through municipal sewer projects or improved onsite sewage treatment in order to restore safe conditions.

2. Mine Drainage

Metal levels in the water, including iron and cadmium, were found to be greater than regulatory levels designed to protect animals that live in the streams. Although no public drinking water withdrawals are in these watersheds, several measurements (dissolved solids, sulfate, and iron) exceeded regulatory criteria for that use. Mine-related drainage was found to be the primary source of these high metal levels. In the watersheds, 13 mine drainage sites are known to have high metal discharges. Installing best management practices to treat these legacy mine drainages will be necessary to improve water quality and restore a healthy aquatic ecosystem.

3. Habitat and Erosion Impacts Due to Residences in the Floodplain

In healthy streams, a vegetated area of trees, shrubs, and perennials surrounds the streambanks and provides many benefits including filtering pollutants, stabilizing the streambanks, providing food for animals, and shading the water. Also during big floods, healthy streams are connected to a floodplain

The North Fork Whitesburg Tributaries Watershed Plan is being developed by Headwaters, Inc. in partnership with the Kentucky Water Resources Research Institute, the Kentucky Division of Water, and numerous other state and local partners. Planning was funded in part by a grant from the U.S. EPA under §319(h) of the Clean Water Act.

where waters can spread out and slow down, preventing damage to properties and erosion of streambanks.

Most flat land along Dry Fork Creek, Sandlick Creek, and Crafts Colly Creek is found in or near the floodplain, therefore most roadways and homes have been built in this area. As a result, much of the streamside vegetation is gone, and the streams have become disconnected from the floodplains. This means that flooding tends to be more intense, erosion increases, and streams will become drier in summer months.

This study found that 87% of streams in these areas have little to no vegetation along these important streambank zones. Further, field surveys found severe erosion on 1.32 stream miles of the about 29.7 total stream miles. Erosion impacts are threatening road infrastructure in several areas and recent repairs have had to be made to address washouts. Dirt and sediment from erosion is also clogging stream habitat, which makes it difficult for fish and other aquatic animals to survive and reproduce.

To improve the overall habitat and decrease erosion, planners should identify areas best suited for holding stormwater until it can sink into the ground (detention basins), streamside plantings, streambank stabilization, and stream restoration.

What Can We Do?

We recognize that improving the quality of our waters will take time and effort. However, we believe a plan is necessary to coordinate efforts to achieving this vision over the long-term. Here are some measures that will need to be taken to address the water quality problems:

Human Sewage

Removal of failing septic systems and straight pipes from the area is important to protect human health. Sanitary sewers, properly maintained septic systems, or other onsite sewage treatment options should all be considered in this area.

Two sanitary sewer projects have been proposed in this area in Sandlick Creek and Crafts Colly. The Whitesburg Sandlick Area Sewer Extension project (SX21133010) has been proposed to reach 105 of the 254 residences along Sandlick Creek at a cost of $2.053 million, and Crafts Colly Sewer Extension Phase II (Project SX21133019) is proposed to connect 79 additional residences on Crafts Colly to sewer at a cost of $1.215 million. If funded, these projects should help reduce the bacteria levels in these streams. However, no projects are currently proposed along Dry Fork where the concentrations are highest.

Properly maintained septic systems can effectively treat human waste at individual residences. For some residences, repair and maintenance of existing septic systems may restore proper function. Septic systems with traditional gravel bed leach fields can be used in areas with enough space, but alternatives such as leaching chambers, leaching chamber beds, drip irrigation, and constructed wetland cells can be used in areas where land area is confined. Clustered systems may be suitable in some areas where residences are close together. Grant dollars may assist homeowners in replacement or repair.

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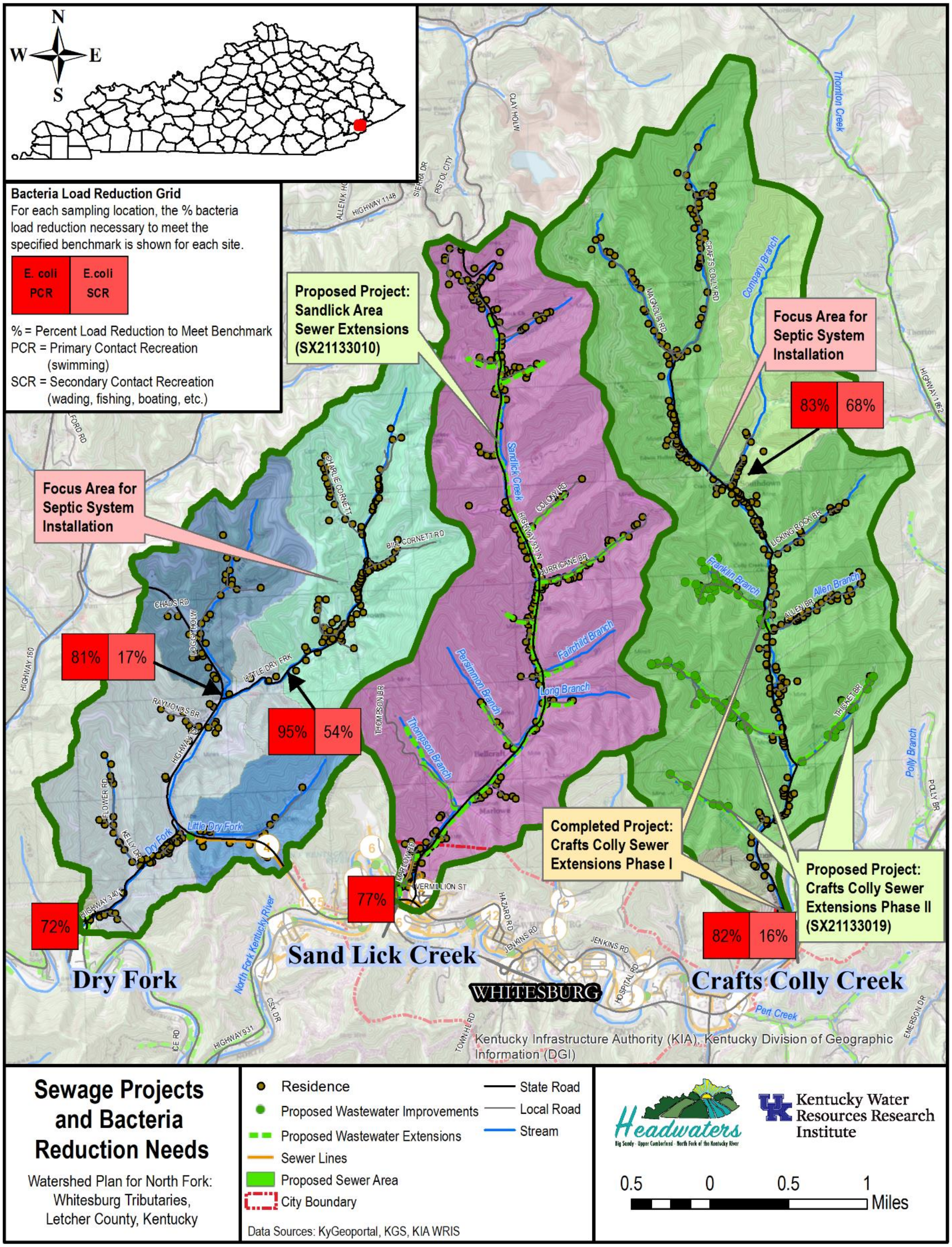

The North Fork Whitesburg Tributaries Watershed Plan is being developed by Headwaters, Inc. in partnership with the Kentucky Water Resources Research Institute, the Kentucky Division of Water, and numerous other state and local partners. Planning was funded in part by a grant from the U.S. EPA under §319(h) of the Clean Water Act.

Mine Drainage

Most of the mine drainage impacts to the Whitesburg tributaries are due to legacy mine drainages from abandoned mines. The Abandoned Mine Land (AML) Reclamation Program, funded by fees on coal production, is set aside to addresses the hazards and environmental degradation from legacy mine issues. The AML fund was used to extend drinking water lines along Crafts Colly and Sandlick Creek in the past. To address the current mine drainage impacts, sediment ponds and aerobic wetlands would need to be installed and potentially old spoil piles removed. Because the space requirements to install sediment ponds and /or aerobic wetlands can exceed the amount of land available treatment may not be feasible or is undesirable for property owners. Treatments for mine drainage impacts must be designed specific to each area, as the composition of metals varies depending on the geology.

Streambank Erosion and Vegetation Buffers

Three major approaches should be utilized to address flooding and erosion concerns in the area: 1) slow water down, 2) spread it out, and 3) soak it in. Habitat and floodwater storage can be improved by adding wetland detention basins and expanded floodplains in streamside open areas. Additionally, rain barrels or rain gardens can be installed at individual residences to capture rainwater or redirect runoff from roadways and rooftops to an area where it can soak into the ground more slowly.

Maintaining a vegetated buffer along streams benefits water quality

Some areas with erosion may require stabilization to prevent infrastructure damage or additional erosion. In areas where feasible, trees and shrubs can be planted along the stream banks, ideally creating vegetated buffers of at least 50 feet, to improve stream habitat.

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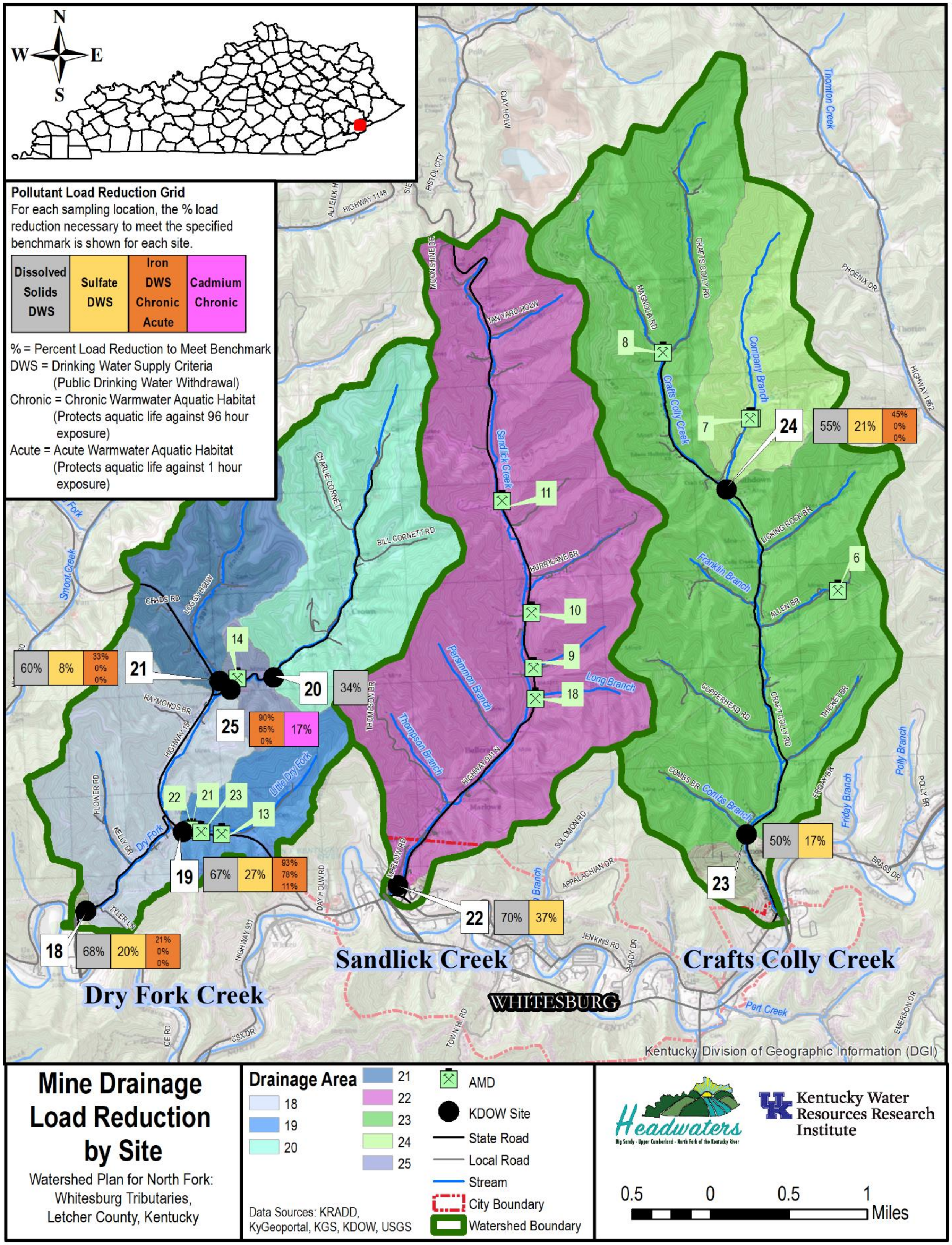

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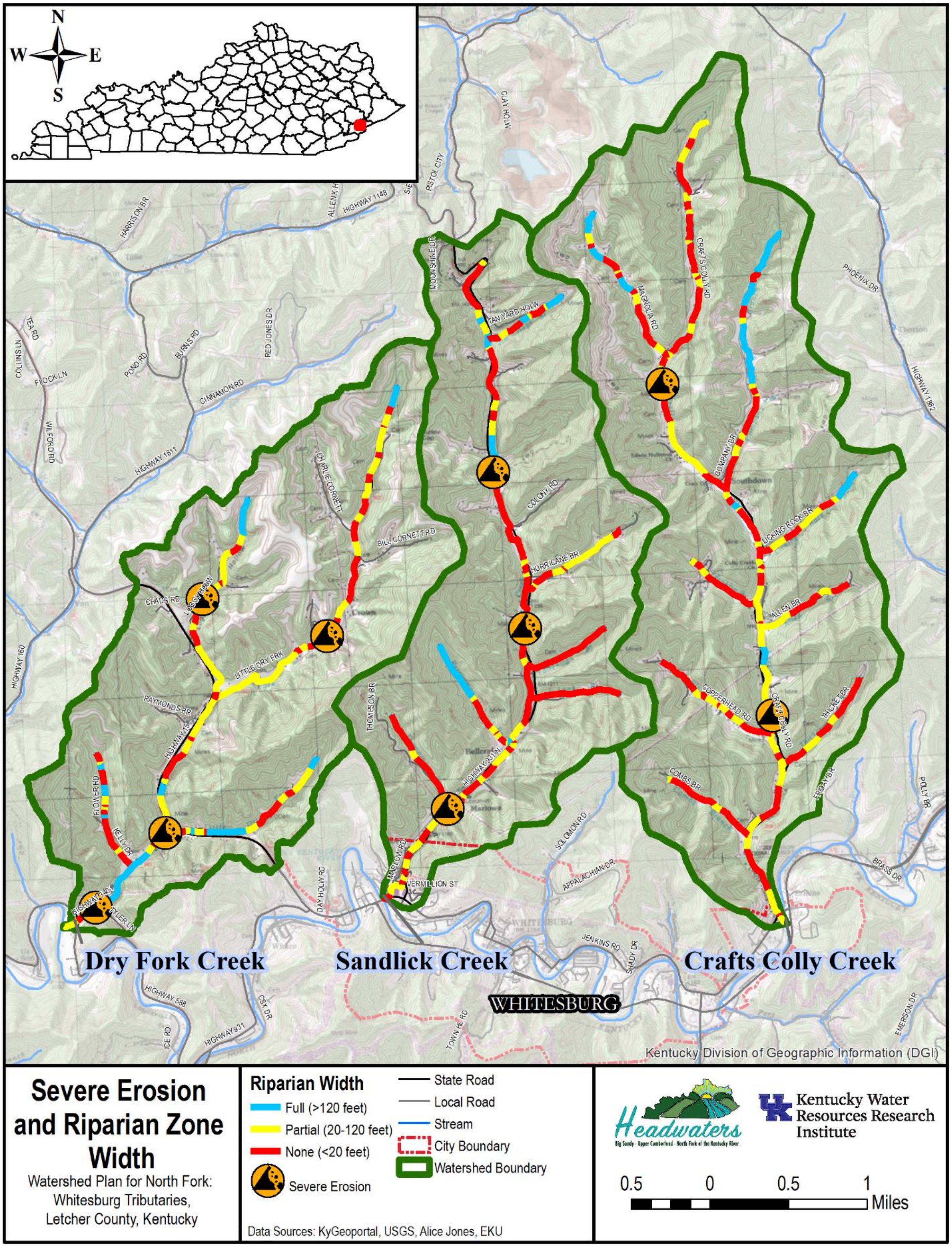

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APPENDIX E: NORTH FORK COMMUNITY SURVEY

Water Quality Survey

1. General Information

Age:	Date: ________________	I use streams for (check as many as apply):
□ < 20 □ 21-30 □ 31-40 □ 41-50 □ 51-60 □ 61-70 □ 71+	I live in Letcher County. □ Yes □ No	□ Wading □ Swimming □ Fishing □ Children Play □ I do not use in these ways
Gender: □ Male □ Female □ Prefer not to answer	I live in a watershed. □ Yes, Name: ______________ □ No □ Not Sure	My own actions affect water quality in Letcher County. □ Strongly Agree □ Agree □ Neutral □ Disagree □ Strongly Disagree

2. Water Quality Concerns

Tell us to what degree you think the following items impact water quality where you live on a scale from 1 to 5, with 5 being a "serious impact" and 1 is "no impact at all." If you are not sure, rate "NS."

Item	Rating	Item	Rating
Pet or animal waste on the ground		Soil erosion of stream banks	
Failing septic systems or straight pipes for human sewage		Runoff from roads and rooftops and parking lots	
Runoff or drainage from mining		Runoff from gardens or lawns	
Trash or litter in streams		Maintaining trees and shrubs along stream bank	
Building houses in the floodplain		Discharges from oil and gas drilling	
Soil erosion from timber harvesting		Fertilizer / pesticides from gardens / lawn care	

3. Water Quality Views

Tell us to what degree you agree with the following statements on a scale from 1 to 5, with 5 = "strongly agree", 4 = "Agree", 3 = "Neither Agree nor Disagree, 2= "Disagree", and 1= "strongly disagree."

Item	Rating	Item	Rating
I believe improving the water quality in the streams should be a priority for our community.		If I wanted to improve water quality at my residence, I am confident that I know what I should do.	
Bringing attention to water quality problems may have a negative effect on our local economy.		The quality of life in my community depends on good water quality in local streams, rivers, and lakes.	
We need more environmental education in our schools.		How my yard looks is important to me.	
Trying to improve the water quality is a waste of government spending.		I am confident that the water quality of our streams can be improved.	
Taking care of aquatic life is important to me.		I'd like my yard to be environmentally friendly.	

This work was funded in part by a grant from the U.S. EPA under §319(h) of the Clean Water Act.

Water Quality Survey

4. Home Stewardship: Please complete for your personal residence.

I am a: □ Property Owner □ Renter

My home is: □ Single Family Home □ Mobile Home
□ Duplex □ Townhome □ Apartment □ Condo
□ Other __________

Home Water Supply Source (check as many as apply):
□Well □ Municipal □ Other______________

Do you capture rainwater with any of the following?
□ Cistern □ Rain Barrel □ Rain Garden

Wastewater

The sewage at my home flows to: □ a wastewater treatment plant □ a septic system □ a straight pipe □ I'm not sure

If you use a **septic system**:

When was it installed? □ Prior to 1990 □ 1990s □ 2000s □ 2010s □ Not Sure

Has it been inspected or pumped in the last 5 years? □ Yes □ No □ Not Sure

In the last 5 years have you experience and of the following problems: (Check any that apply)

□ Foul odor near tank or drain □ Sewage flow to stream or ditch □ Slow drains □ Sewage Backup in house
□ Sewage surfacing in yard □ Frozen septic

Stream Maintenance

Is a creek on or adjacent to your property? □ Yes □ No □ Not Sure

If yes,

Do you maintain a unmowed, vegetated area on 25 feet on either side of the stream? □ Yes □ No

If not, why (check as many as apply): □ No space □ Looks bad □ Access issues □ Other: ________________

Is erosion a problem on your property? □ Yes □ No □ Not Sure

If yes, how to you address it? □ I fix it □ I don't □ Not Sure □ Other: _________________________________

Animal Waste

Do you raise livestock at your residence? □ Cattle □ Chickens □ Pigs □ Horses □ Other ____________________

Do you own dogs? □ Yes, Number ______ □ No

If you own dogs, how often do you pick up the dog waste from your dog and dispose of it in the trash?

□ Almost every day □ At least once a week □ Several times a month □ Once a month or less □ Never

Lawn and Garden Care

Do you grow a garden at your residence? □ Yes □ No

I use fertilizer on my lawn / landscaping / garden: □Never □ Once a year □2-3 times a year □4-5 times a year
□ Do not have a grass lawn □ Not sure

I use pesticides or herbicides on my lawn / landscaping / garden: □Never □ Once a year □2-3 times a year
□4-5 times a year □ Do not have a grass lawn □ Not sure

In general, how much does each issue limit your ability to improve the way you manage your property?	Not at all	A little	Some	A lot	Don't Know
Lack of financial resources					
Lack of physical ability to perform work					
Lack of knowledge about how to manage					
Time required for activities, I'm too busy					
Not a priority for me					

This work was funded in part by a grant from the U.S. EPA under §319(h) of the Clean Water Act.

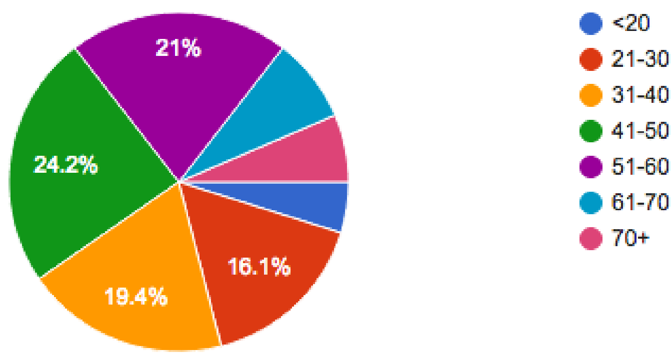
APPENDIX F: COMMUNITY SURVEY RESULTS

Community Survey Results

Headwaters, Inc

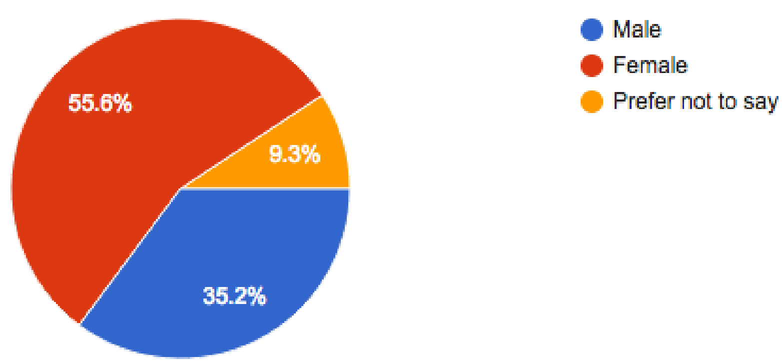
Age

62 responses



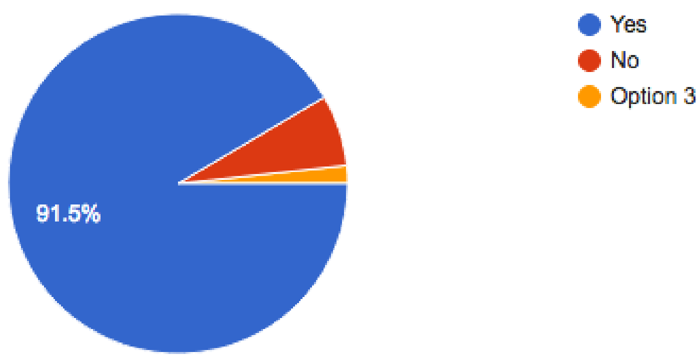
Gender

54 responses



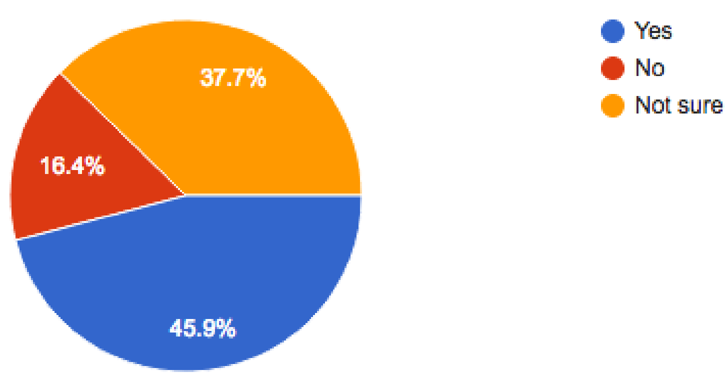
I live in Letcher County.

59 responses



I live in a watershed.

61 responses

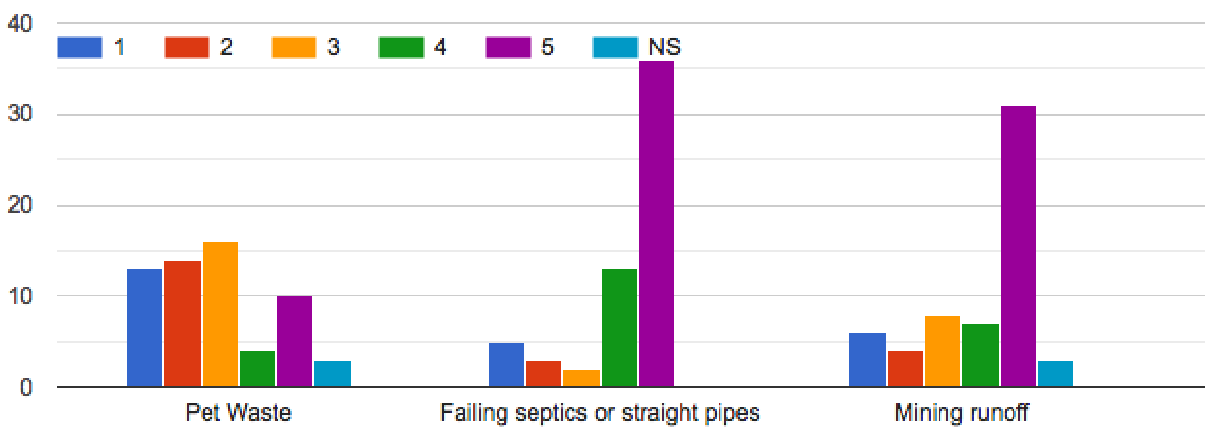


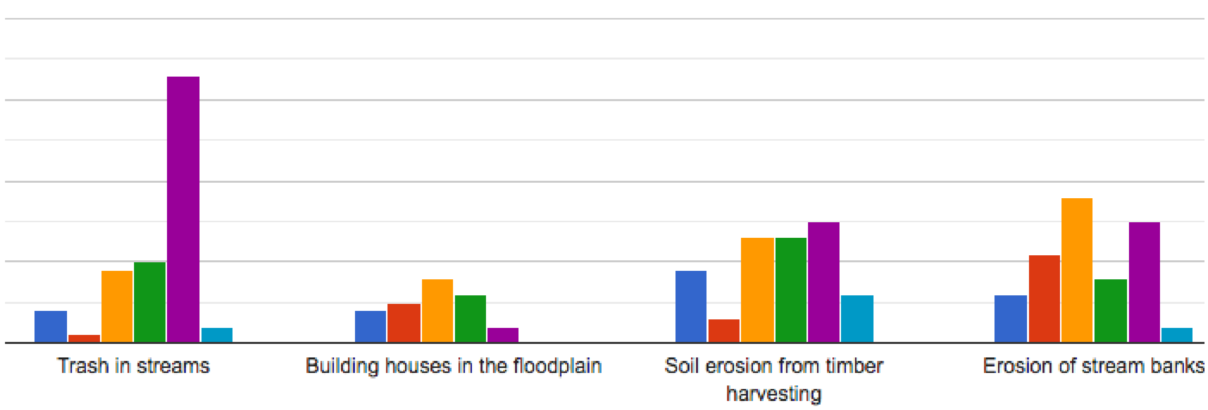
Watershed Name if known

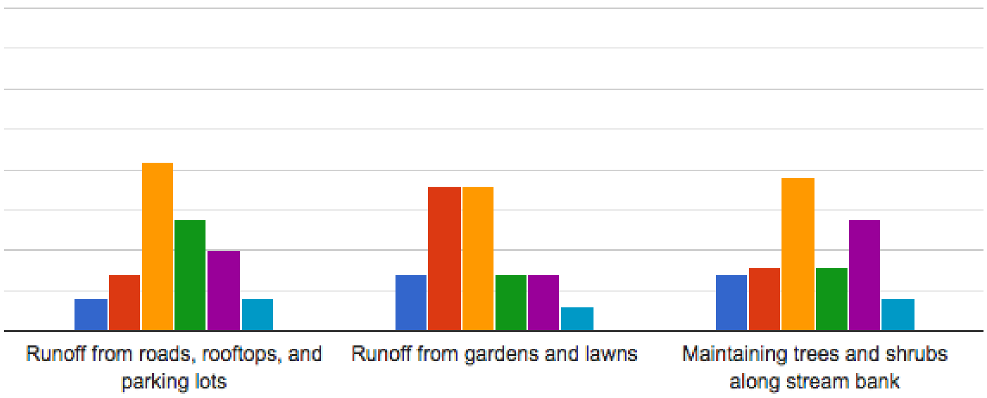
6 responses

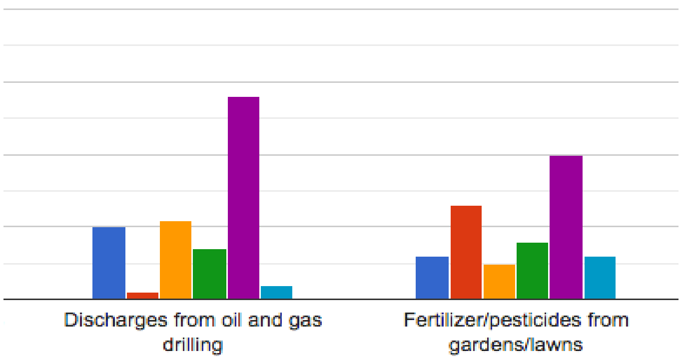
North Fork, KY River
KY River
north fork
Rockhouse Creek or North Fork KY River
North Fork Kentucky River
Dry Fork

To what degree do the following impact water quality? (1=no impact, 5=serious impact)



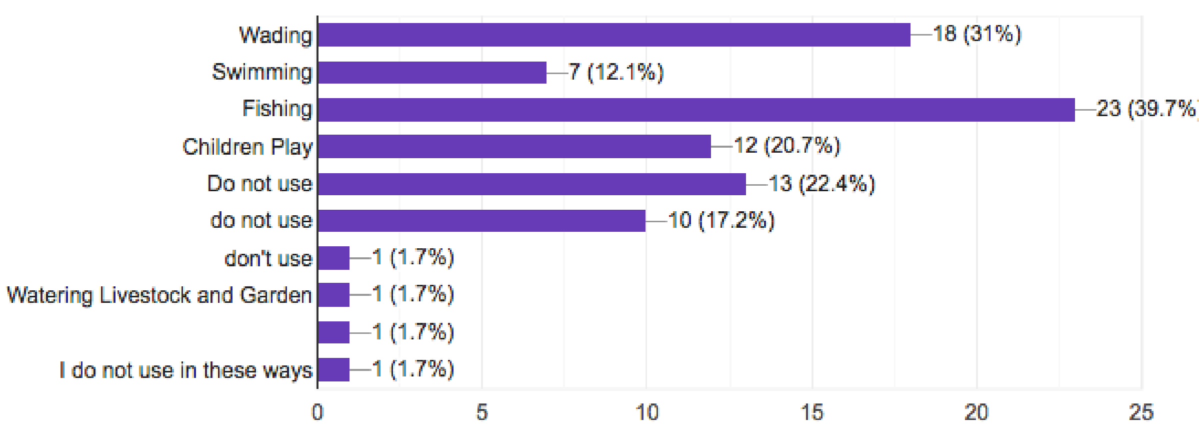






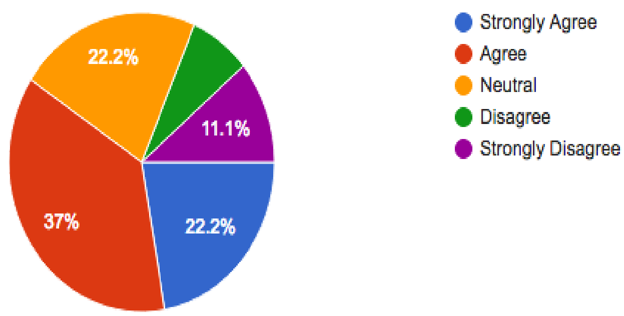
I use streams for:

58 responses



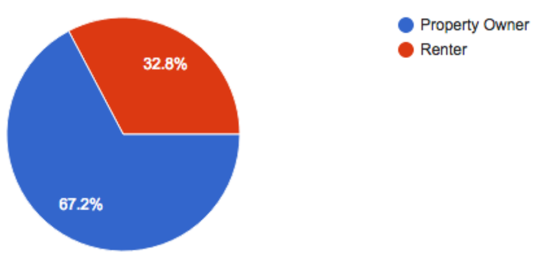
My actions affect water quality in Letcher County.

27 responses



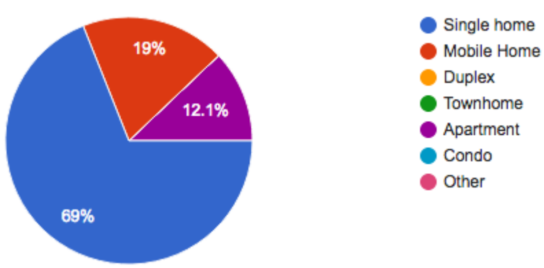
I am a

58 responses



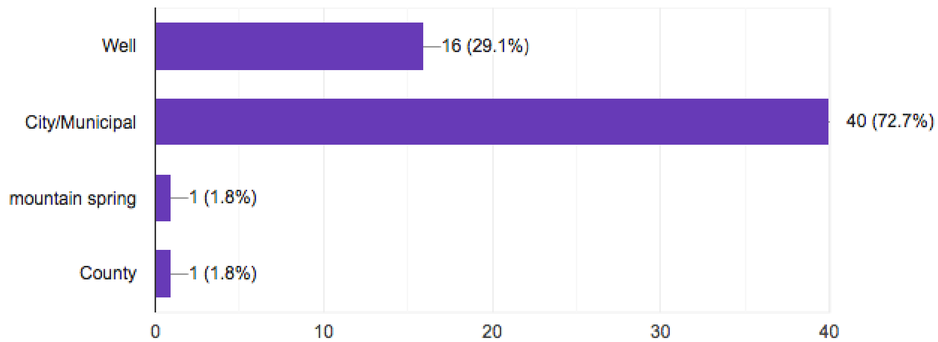
My home is

58 responses



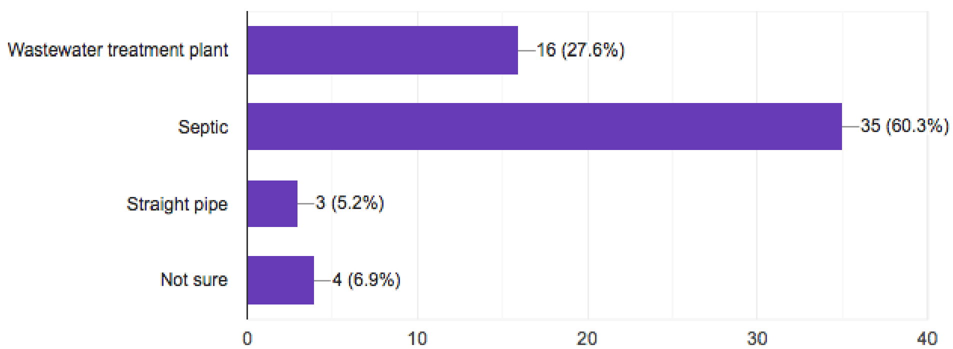
Home Water Supply

55 responses



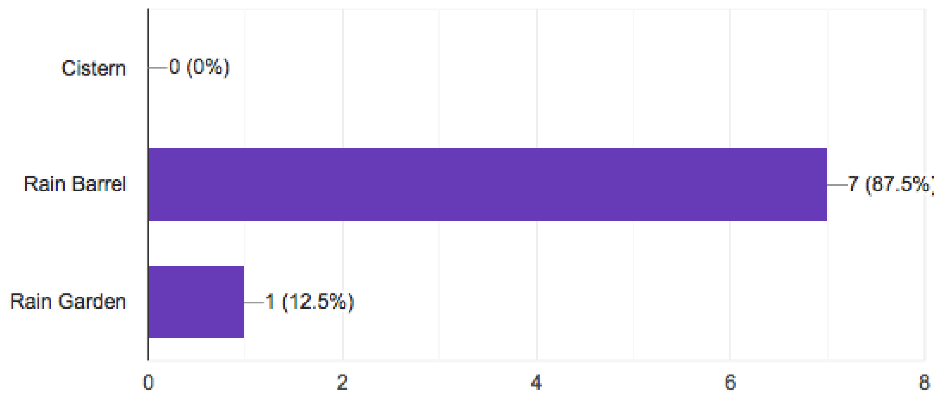
The sewage at my home flows to:

58 responses



Do you capture rainwater with any of the following?

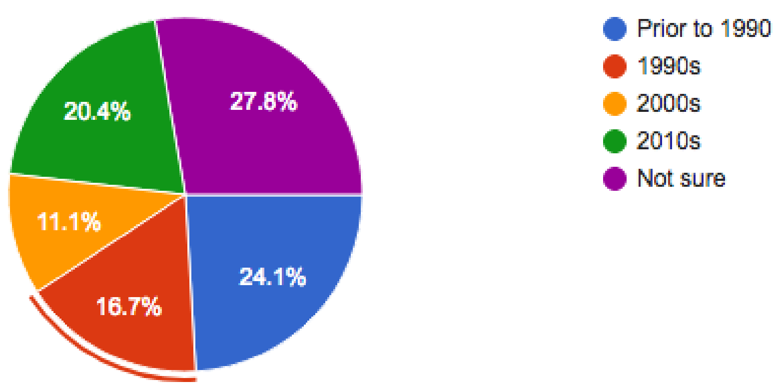
8 responses



If you use a septic:

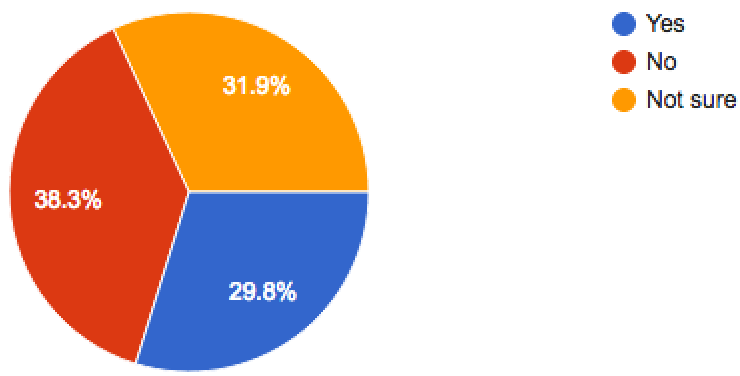
When was it installed?

54 responses



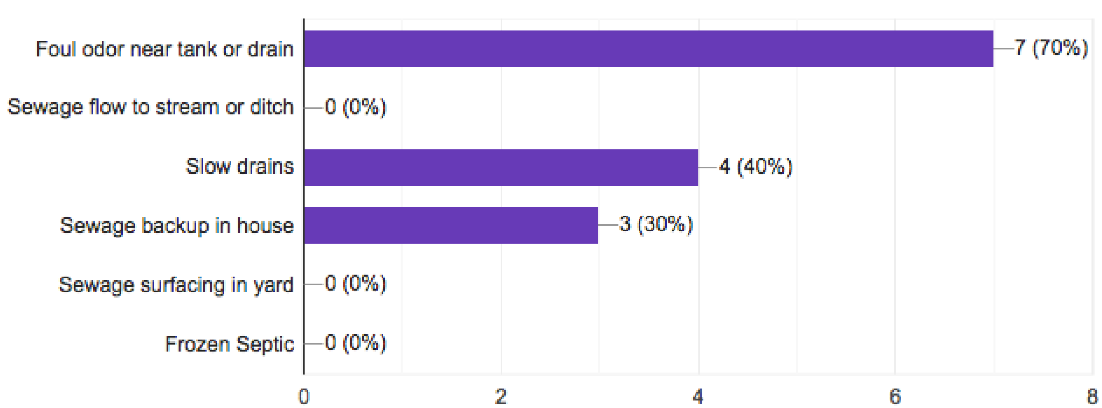
Has it been inspected or pumped in the last 5 years?

47 responses



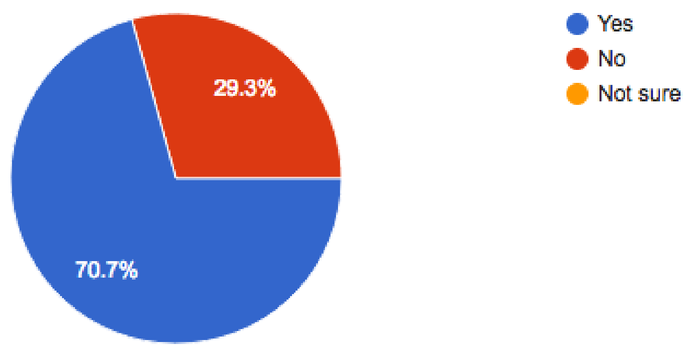
In the last five years have you experienced these problems?

10 responses



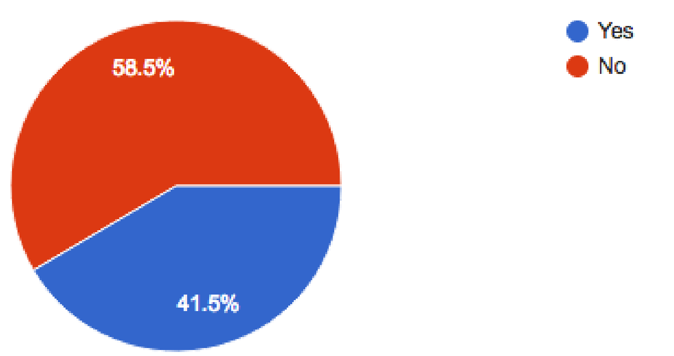
Is a creek on or adjacent to your property?

58 responses



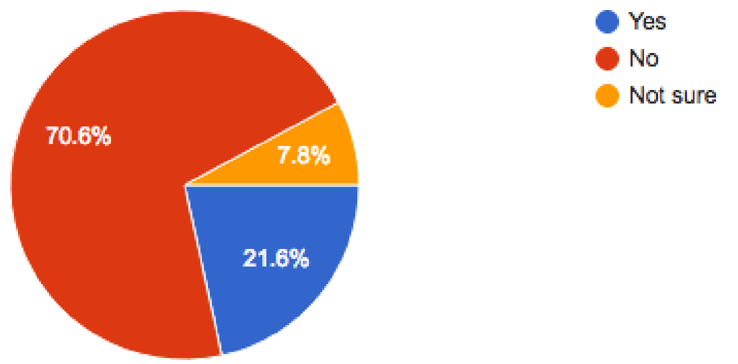
Do you maintain an unmowed, vegetated area 25 feet to either side of the stream?

53 responses



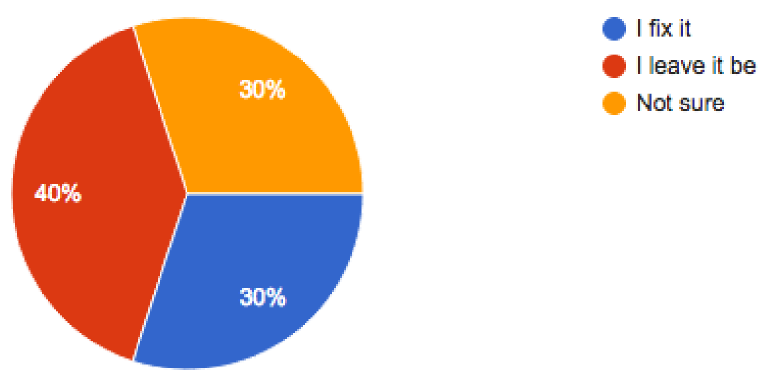
Is erosion a problem on your property?

51 responses



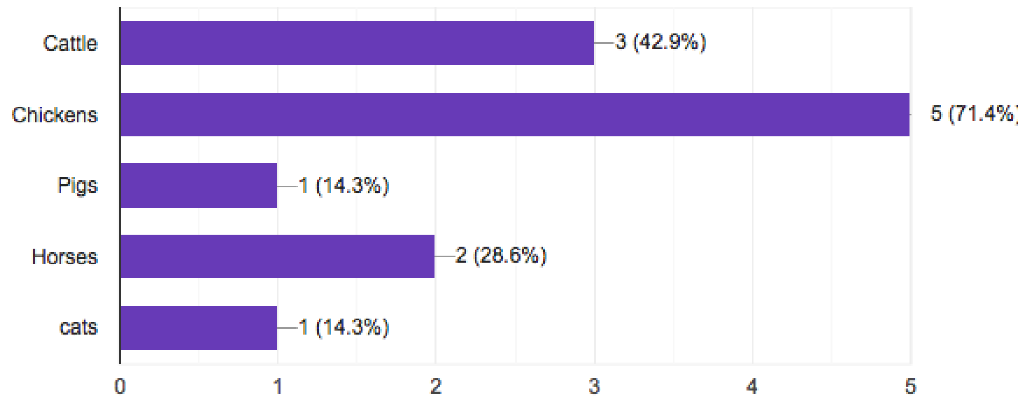
If yes, how do you address it?

10 responses



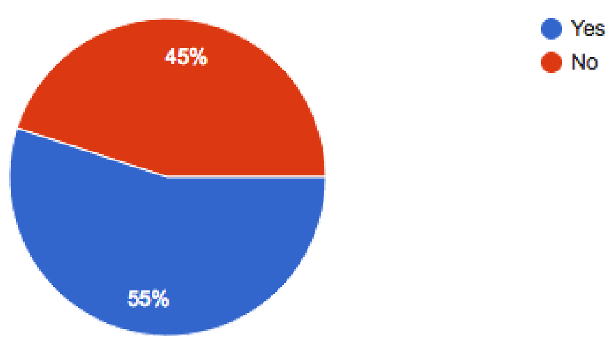
Do you raise livestock at your residence?

7 responses



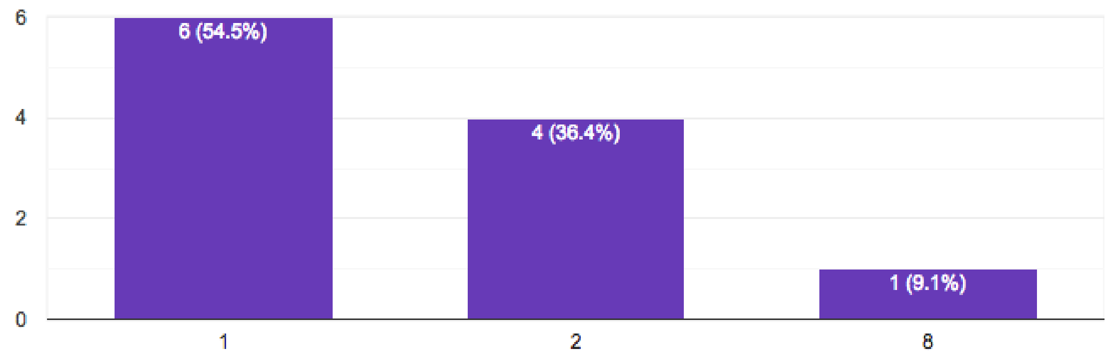
Do you own dogs?

60 responses



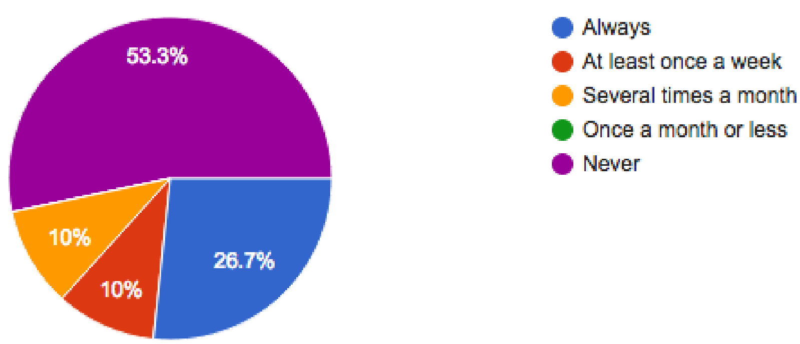
If so, how many?

11 responses



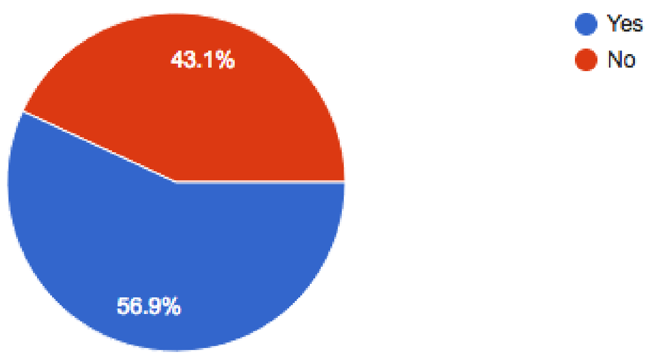
If you own dogs, how often do you dispose of dog waste in the trash?

30 responses



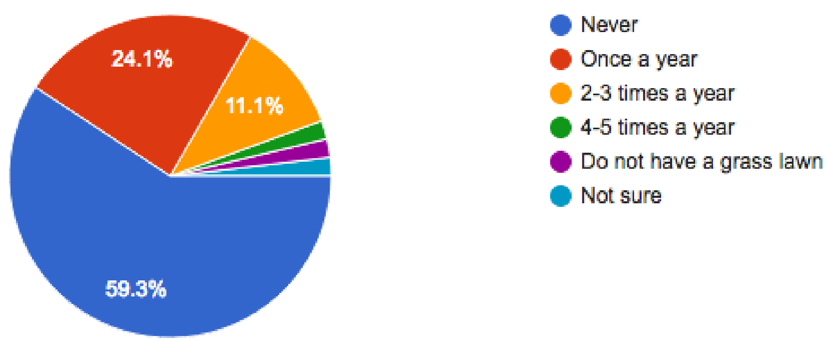
Do you grow a garden at your residence?

58 responses



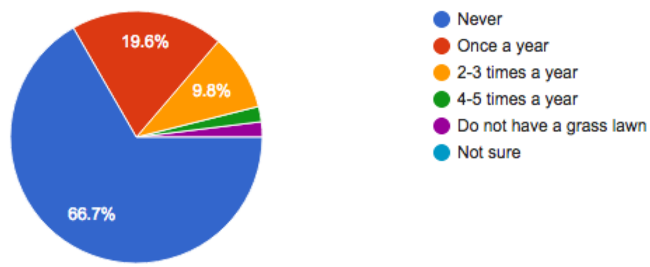
I use fertilizer on my lawn/landscaping/garden

54 responses



I use pesticides/herbicides on my lawn/landscaping/garden

51 responses



How does each issue limit your ability to improve how you manage your property?