Using Remote Sensing Tools to Target Stream Protection and Wastewater Treatment BMPS in Rural Kentucky

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Hinkston Creek drains 260 square miles of the Outer Bluegrass Region in east-central Kentucky, joining with Stoner Creek at Ruddells Mill to form the South Fork of the Licking River. The watershed is home to 21,000 people, mostly living in and around the towns of Mount Sterling, Millersburg, Carlisle, and Sharpsburg. Approximately 70 percent of the watershed is pasture land, with forest covering 20 percent, development on 8 percent, and row crops – mostly tobacco – on 2 percent. Carlisle and Millersburg draw their drinking water from surface sources in the watershed.

The *2010 Kentucky Division of Water Integrated Report to Congress* identified several segments of the mainstem and tributaries as impaired due to bacterial contamination, sedimentation/siltation, nutrient enrichment, and poor habitat. A Tetra Tech watershed assessment – based on sampling conducted by Morehead State University students, data from the all-volunteer Licking River Watershed Watch, and other information – identified the major problem sources as free cattle access to stream channels, overgrazing, removal of vegetation along channel banks, channel and upland erosion, and stormwater management.

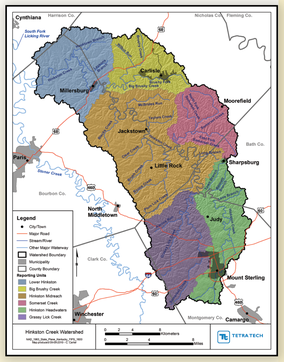
Remote sensing tools – such as GIS mapping, aerial photography, and tailored analysis – can help to identify areas with high risks from septic systems, inadequate riparian vegetation, and livestock concentrations near streams. Results for such analyses can be used to identify pollutant source areas and target management practices.

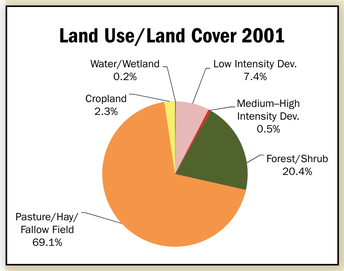
For the Hinkston Creek Watershed CWA 319 Project in east central Kentucky, Tetra Tech produced **a riparian buffer assessment, an onsite wastewater system risk analysis, and a focused study of two selected tributaries** affected by livestock access to the stream corridor.

Montgomery County Conservation District Supervisors co-sponsored the Hinkston Creek Project and provided key support for the cost-share program. The project purchased stream crossing and "entering the watershed signs," which were installed by public works crews. Building basic awareness of the waterbody and its importance as historical feature and natural resource was an important project goal.

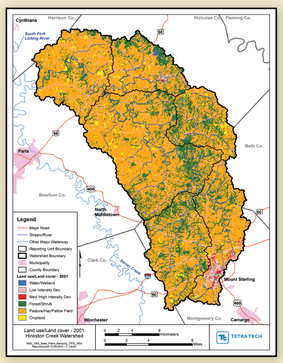
Riparian Buffer Assessment

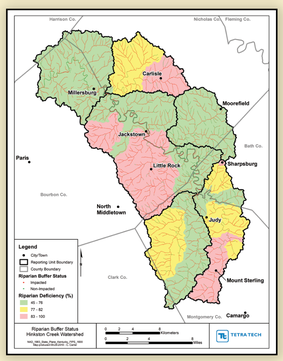
The ***riparian buffer assessment and deficiency analysis*** used aerial photography to determine canopy cover presence/absence and buffer zone widths. The stream layer used for the analysis was the high resolution streams data layer created by the United States Geological Survey (USGS) as part of the National Hydrography Dataset (NHD; USGS, 2007). These streams were buffered to create polygons representing riparian buffer areas for this analysis. A 100 foot buffer was created along each side of the mainstem of Hinkston Creek downstream from the Grassy Lick/Hinkston confluence. A 50-foot buffer was created along each side of Hinkston Creek upstream from the Grassy Lick/Hinkston confluence and along all tributaries within the Hinkston Creek watershed.





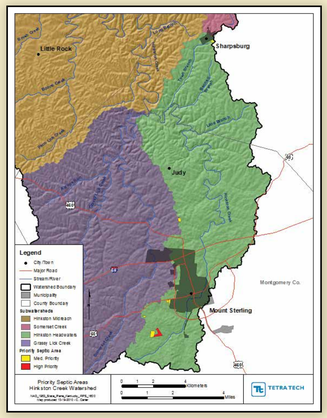
A Multi-Resolution Land Characteristics Consortium (MRLC) geospatial dataset known as the Landscape Fire and Resource Management (LANDFIRE) map, that provides vegetation and wildland fuel maps, was obtained to determine riparian buffer health status (impacted vs. intact). Using methodology from a recent study (Roy et al., 2005), any vegetated layers with less than 30 percent coverage were lumped together with other impacted riparian habitat LULCs (e.g., developed, open space, pasture/hay, etc.). The percent buffer deficiency within each assessment subwatershed was estimated using GIS. The riparian buffer deficiency, at the assessment subwatershed level, ranges from 45 percent to 100 percent throughout the Hinkston Creek watershed. The riparian buffer deficiency for the entire watershed is 75 percent.

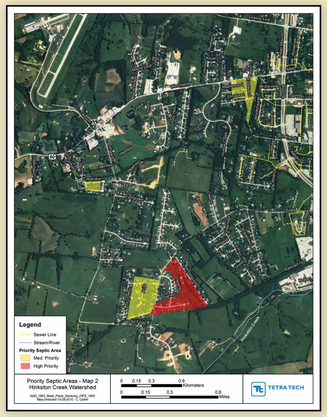




Septic System Risks

Onsite wastewater treatment system potential risk to water quality was assessed via mapping analyses that considered system densities (i.e., number per square mile), system age, and proximity to surface waters. Prioritization was based on level of household density, closeness to streams, and closeness to karst topography (to account for impacts to groundwater). Publicly serviced areas with centralized wastewater treatment were eliminated first; household density was calculated for areas outside of public sewer line boundaries in the areas surrounding the municipalities – within 2 miles of publicly serviced areas in Mount Sterling and within 1 mile of publicly serviced areas for all other municipalities. Household density was not calculated across the entire watershed because septic failure impacts to water quality were assumed to be low in agricultural areas where household density is less than 1 house per acre. Data for calculating household density was obtained from the U.S. Census Bureau's 2000 Census Block data. Closeness to streams was calculated using the high resolution streams data layer created by the United States Geological Survey (USGS) as part of the National Hydrography Dataset (NHD; USGS, 2007). Closeness to karst was calculated using a geologic data layer developed by the Kentucky Geological Survey. Only areas having a household density greater than one household per acre were considered and household density, closeness to streams, and closeness to karst geology received equal weights throughout the prioritization process. Eight census blocks within the Hinkston Creek watershed received prioritization ratings at levels of medium priority (7 blocks) and high priority (1 block). All other census blocks included in the prioritization analysis received ratings of low priority due to low levels of household density (<1 house per acre).





Thanks To Our Project Partners!

- Kentucky Division of Conservation
- Kentucky Division of Water
- Kentucky Transportation Cabinet
- Montgomery County Conservation District
- Bourbon County Conservation District
- Nicholas County Conservation District
- Morehead State University
- University of Kentucky Extension Service
- US Environmental Protection Agency
- USDA Natural Resources Conservation Service
- City of Mount Sterling
- Montgomery County Fiscal Court
- Mount Sterling Advocate Newspaper

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Targeting Selected Stream Channels

A broader, desktop analysis of ***high-risk stream channel areas*** was also conducted via mapping work that analyzed riparian vegetation (i.e., canopy cover), cattle access points, and property ownership records. The riparian deficiency data described above was overlaid with imagery from the National Agriculture Imagery Program (NAIP), downloaded from the USDA: NRCS Geospatial Data Gateway website. This was used to assess the intensity of impact on riparian areas within the Blacks and Boone Creek watersheds. Imagery used covered all of Bourbon County and was acquired by NAIP during the agricultural growing season in 2010. Reaches within each watershed were visually scanned against the NAIP imagery to assess the land cover context for riparian buffers. Impacted riparian areas were divided into four levels of impact based on stress conditions observable from the aerial imagery, such as proximity of intense tilling and/or grazing to the stream edge, cattle access points, and lack of tree or shrub cover in the riparian buffer. Best professional judgment was used to assign a level of impact to each reach segment according to the definitions of levels of impact. Cattle access points were visible along some reach segments from the aerial imagery. Evidence of bare stream or pond banks that were within observable pasture boundaries were considered cattle access points. These points were highlighted for the targeted streams.

Definition for Each Level of Impact

Level of Impact	Definition
1	**Low**[1] **–** Reaches that appear to be under low stress conditions. There is observable evidence of riparian protection consisting of tree lines or considerable scrub/shrub areas along both sides of the stream and/or evidence of intense tilling and/or grazing is an acceptable distance from stream edges (Figure 3).
2	**Moderate –** Reaches that appear to be under slightly stressed conditions and are surrounded by agricultural areas but there is observable evidence of riparian protection. Evidence of riparian protection consists of an observable tree line or scrub/shrub area along at least one side of the stream and/or intense tilling and/or grazing do not appear to be directly adjacent to stream edges (Figure 4).
3	**High –** Reaches that appear to be under moderately stressed conditions and are surrounded by agricultural areas but there is some observable evidence of riparian protection. Evidence of riparian protection consists of an observable fence line and/or intense tilling and/or grazing do not appear to be directly adjacent to stream edges (Figure 5).
4	**Very High –** Reaches that appear to be under severely stressed conditions and are surrounded by agricultural areas; there is no apparent riparian protection. Intense tilling and/or grazing are directly adjacent to stream edges and/or there is a noticeable cattle access point to the stream (Figure 6).

[1] Reaches identified as having a low level of impact may have sources of impact that are not visible from aerial imagery, such as cattle access points that are under the tree canopy. Ground truthing is strongly recommended for these reaches to ensure the correct level of impact has been captured.