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HEADWATERS OF BLACKLICK CREEK

HUC: 05060001 15 03

Nine-Element Nonpoint Source Implementation Strategic Plan (NPS-IS Plan)

Developed by:

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The following Franklin Soil and Water teams and staff are acknowledged for their contribution to this report:

The Geomatics Team for GIS data acquisition and maintenance, the creation of the Stream Resource Database, the Urban Subwatershed Initiative, impervious surface, canopy and other natural resource datasets,

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The Conservation Implementation Team for its ongoing work to protect our waterways through education, project implementation, and partnerships with communities and individuals across the county,

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Chapter1: Introduction

The Headwaters Blacklick Creek HUC-12 (05060001 15 03) is located at the northeast edge of Franklin County, Ohio, with its northernmost tip extending into Delaware County and its eastern edge in Licking County. This Huc-12 is immediately upstream from the Town of Brice-Blacklick Creek HUC -12 (05060001 15 04), which ends at the confluence of Blacklick Creek with Big Walnut Creek. Blacklick Creek is approximately 31 miles long and drains an area of 61.3 square miles. At 48.9 square miles the Headwaters of Blacklick Creek HUC-12 contains over two thirds of the total Blacklick watershed. The landscape of the watershed reflects the spectrum of land uses in Central Ohio, with residential areas ranging from low density rural to high density suburban, row crop agriculture with a dairy farm and a sheep farm, small and large commercial developments, parks, wooded riparian areas, and small industrial areas.

State and Federal nonpoint source funding is now tied to the development of an NPS-IS plan that is accepted by the US EPA and Ohio EPA as meeting the 9-minimum element requirement outlined in the US EPA's *Handbook for Developing Watershed Plans to Restore and Protect our Waters*. Franklin Soil and Water Conservation District and its partners also recognize the importance of strategic project implementation as we seek to address the impairments of Franklin County's streams. Franklin Soil and Water anticipates multiple similar updates being written for watersheds across Central Ohio, a process in which Franklin Soil and Water Conservation District hopes to play a central role.

1.1 Background

This NPS-IS is an update to the Headwaters Blacklick Creek HUC-12 portion of *Our Blacklick Watershed Action Plan*, which was completed and endorsed in 2010. That document provided a basis for initial project implementation to improve and protect the waters of Blacklick Creek. Over the past five years, that plan has guided the implementation of several projects within the Blacklick watershed, as well as initial Level 2 macroinvertebrate and bacteriological monitoring of Blacklick Creek and its tributaries.

The growing impact of urbanization in the county and the need to increase focused implementation efforts are driving the development of this NPS-IS. The percentage of impervious surface in the Blacklick Creek watershed has crossed the threshold for impacting Blacklick (10% impervious) and some of its tributary watersheds are approaching and may have passed the level associated with nonattainment (20%).

Sampling done in the next HUC-12 downstream, Town of Brice-Blacklick Creek HUC -12, suggest that there may be some deterioration of water quality in the Blacklick mainstem in lower reaches. There has not been sufficient sampling to determine whether or not this is the case, nor is it possible to determine when any such deterioration might begin. However, it is possible that changes in Headwaters HUC-12 are having a negative impact downstream, creating non-attainment in the Town of Brice-Blacklick Creek HUC-12.

When the entire Blacklick Creek watershed was sampled by the Ohio EPA in 2000, it was noted that that the macroinvertebrate community in the reach of the mainstem of Blacklick in Reynoldsburg was only marginally meeting WWH standards. The characteristics of that community indicated water quality degradation. This suggests that the mainstem of Blacklick in Reynoldsburg was at some risk of falling below attainment standards already in 2000.

The overarching intent of this plan is to bring the streams in Headwaters Blacklick HUC-12 into attainment, and arrest and reverse the impacts of urbanization on the watershed, attending to ongoing problems created by more rural land uses as well.

1.2 Watershed Profile and History

Big Walnut Creek extends from Morrow County, southeast from Mt. Gilead and immediately south of U.S. Route 42, to its confluence with the Scioto River just south of the Franklin County line and west of the Village of Lockbourne. Blacklick Creek flows from western Licking County, just north of Jug St. and east of Clover Valley, west into Franklin County, and then south through New Albany, Plain and Jefferson Townships, eastern suburbs of Columbus, and Reynoldsburg, skirting the east edge of Pickerington, and running through Madison Township until entering Big Walnut Creek in Three Creeks Metro Park, just south of Williams Rd. The entire watershed is divided into two HUC-12 watersheds. Headwaters Blacklick Creek HUC-12 ends at the eastern edge of Turnberry Golf Course on the border between Columbus and Pickerington just north of Refugee Rd. at RM 10.3, where the Town of Brice-Blacklick Creek HUC-12 begins (see Figure 1). The creek starts at an elevation of 1087' approximately 20.5 miles from its from the southern end of Headwaters of Blacklick Creek HUC-12, dropping 284' by the time it reaches that boundary for an average fall of 13.8'/mi.

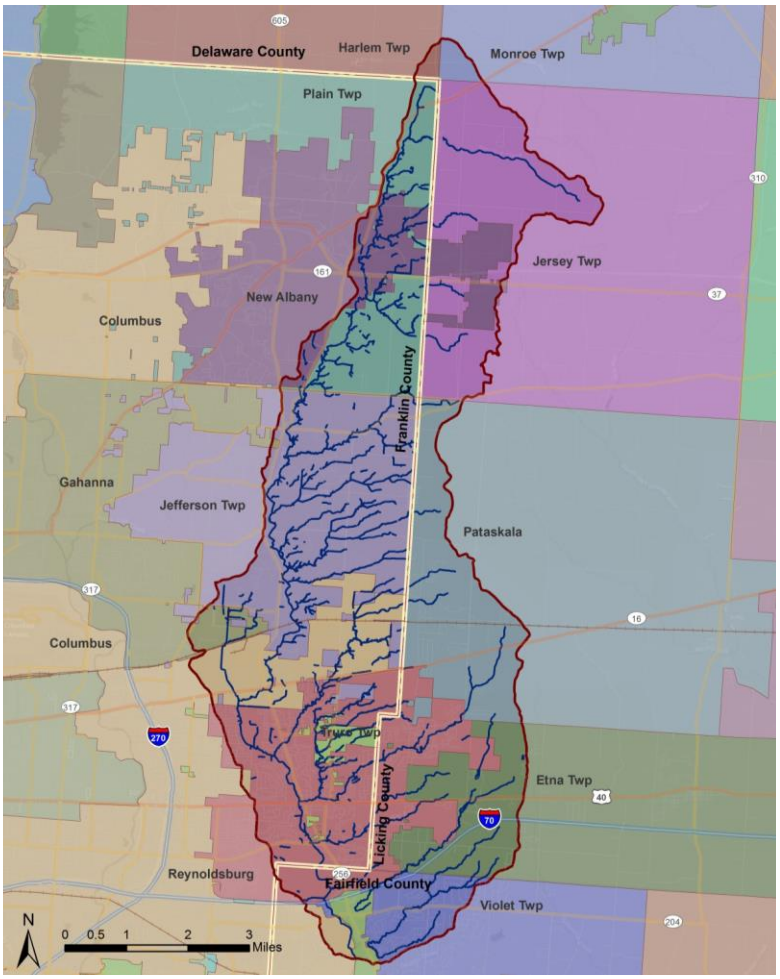

Figure 1: Jurisdictions in Headwaters of Blacklick Creek HUC-12 (counties, townships and cities)
(All Maps Credit Franklin Soil and Water Conservation District)

Prior to European settlement, the land draining into Blacklick Creek was a wooded, wilderness area with numerous "swamps" in the headwater streams in what is now western Licking and eastern Franklin Counties.

The surrounding area is dotted with extensive mound structures, remnants of the mound builders, but no major mound systems are known to be located in the watershed. There are only three known mounds in the Headwaters Blacklick Creek HUC-12 (Mills, 1914).

The area was used as hunting grounds by several native tribes. Early settlers' accounts tell of a land filled with old growth forests, abundant game, and streams filled with fish, some reportedly 4-6 feet in length. In the original survey of the area around Blacklick Creek done in 1800 done, Ebenezer Buckingham noted the presence of first-rate bottomland with birch, hazelnut, locust, walnut, blue and white ash with spice, paw paw, and prickly ash (Snyder, personal email 1/27/09).

The first settlers began to set up farms in the first decade of the 19th century. The creeks in the watershed provided an important source of power for sawmills and grist mills. The remains of at least three such mills have been found in Headwaters of Blacklick Creek HUC-12.

Populations increased enough by the second decade that villages and cities began to be established. The City of Columbus was founded in 1812, and the other smaller cities in the watershed also trace their histories back to that time period, incorporating later in the century. Reynoldsburg incorporated in 1839; Groveport in 1847; and Pickerington and Gahanna in 1881, with New Albany having been chartered in 1856.

For much of the 1900s, the Headwaters Blacklick Creek HUC-12 area was largely agricultural and what are now cities remained relatively small. The watershed has experienced rapid development since the 1980s that only accelerated in the late 1990s and early 2000s. Land use changed from open agriculture and wooded areas to suburban neighborhoods in the middle section of the watershed (see Figure 2). The current impervious cover is estimated at 11.7%, and is projected to increase.

Agricultural land uses are present in the headwaters regions, but represent a shrinking portion of the total land use in the watershed. The watershed area includes portions of the cities of Columbus, Pataskala, Reynoldsburg, New Albany, Gahanna and Pickerington, and the townships of Plain, Jefferson and Truro in Franklin County; Jersey and Etna in Licking County; and Violet in Fairfield County. Figure 3 shows a map of the watershed land uses as identified in 2014.

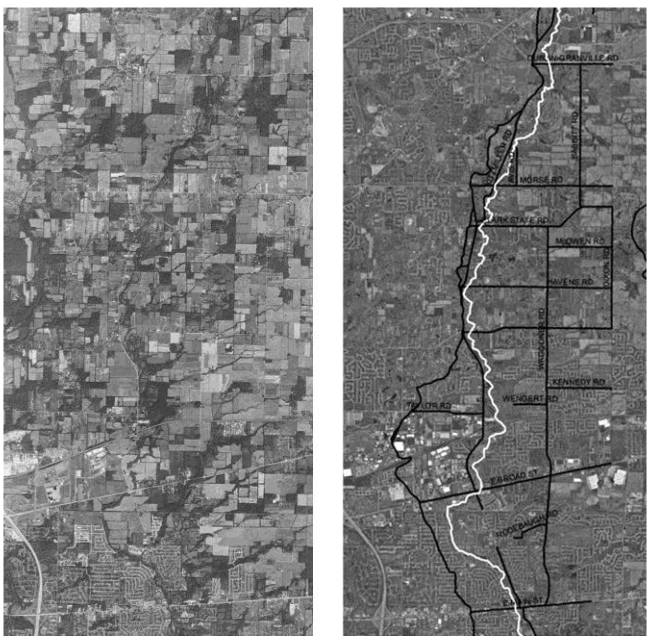

Figure 2: Aerials from 1980 (left) and 2015 (right), illustrating changes in land use in the middle section of Headwaters Blacklick Creek HUC-12

Human-caused pollution of Blacklick Creek began relatively early with the construction of slaughter houses that dumped their offal into the creeks, and raw sewage soon found its way into the creeks as well (Parkinson, 1980). Human waste has continued to present problems for the creeks, as HSTS effluent impairs significant reaches of stream. Small wastewater treatment plants (WWTPs) have also been an issue. The City of Reynoldsburg's WWTP used to discharge into Blacklick Creek as did Jefferson Township's. At the present time, there remain two

WWTPs that discharge to Blacklick Creek: Fairfield County - Tussing Rd. WWTP and the Blacklick Estates WWTP. The Tussing Rd. WWTP is at the southern end of the Headwaters Blacklick Creek HUC-12, while the Blacklick Estates WWTP is downstream in the Town of Brice-Blacklick Creek HUC-12.

While wastewater continues to be an issue in the watershed, its effects have decreased, and the significance of nonpoint pollution in the form of stormwater runoff has increased. As noted above, the percentage of impervious surface in the watershed has increased to the point that it has begun to impact water quality. Some subwatersheds have so much impervious surface that they are no longer able to sustain healthy streams.

With the rapid development that peaked in the late 1990s and early 2000s, sediment pollution from construction sites in the watershed became a major issue. Sediment and erosion control regulations were still relatively new to the construction industry and compliance failures became an issue in the Headwaters Blacklick Creek HUC-12.

Figure 3: Localized flooding due to drainage issues on Cole Ditch

Towns and cities have had their negative impact on Blacklick Creek and its tributaries, but flooding from the creeks has done its damage to properties in the watershed as well. Reynoldsburg is known to have experienced floods in 1956, 1959 and 1979 (Parkinson, 1981). The 1979 rain event also resulted in the flooding of 240 homes in Blacklick Estates ("Blacklick Mitigation Plan Ready").

There do not seem to have been any significant floods in the Headwaters Blacklick Creek HUC-12 since 1979, although the threat remains. Recent flooding has been quite localized, largely created by stormwater flows that exceed drainage capacities. Poorly infiltrating soils, undersized culverts, and major rain events that have overwhelmed stormwater systems have all contributed to this kind of flooding (see Figure 3).

The most common issue in the watershed at the present time is bank erosion. On the order of $2 million worth of bank protection projects have been implemented along the Blacklick Creek mainstem in Headwaters Blacklick Creek HUC-12 and Town of Brice-Blacklick Creek HUC-12 downstream. The erosion is a direct consequence of the accelerated stormwater runoff generated by the increase of impervious surfaces associated with the urbanization of the watershed.

Figure 4: Figure 4: Vanes (by yellow arrows) installed to reduce erosion along a 30' bank at ~RM 10.3 on the Blacklick Creek mainstem

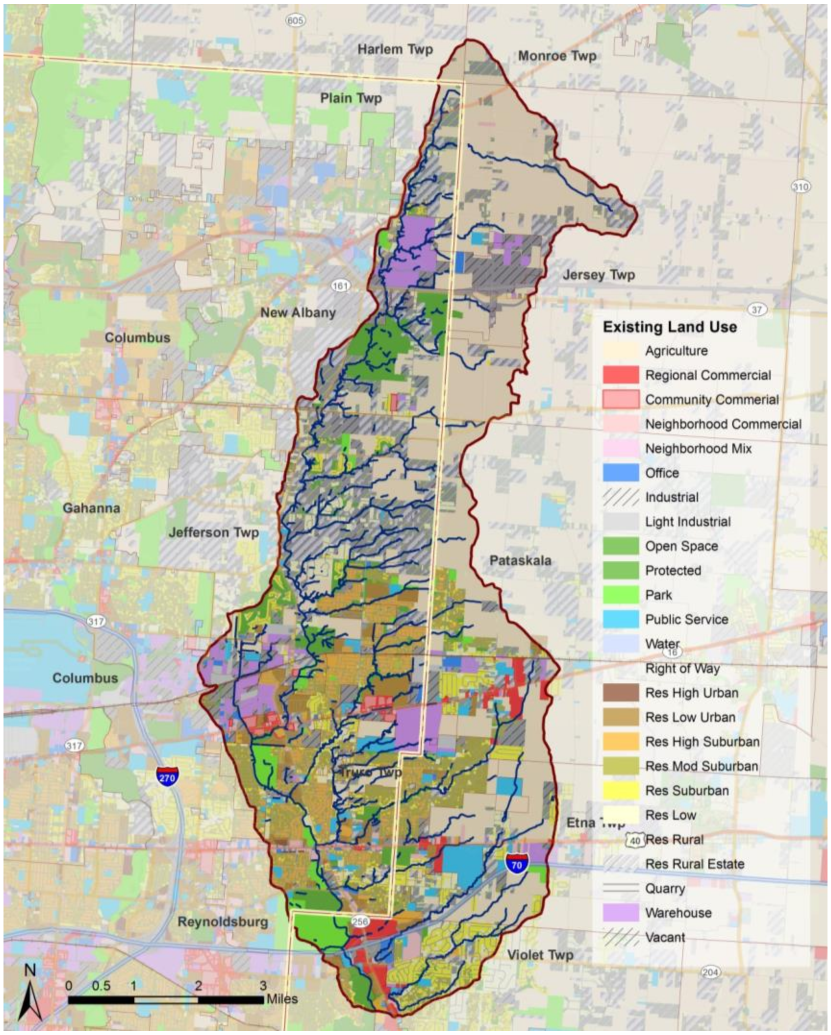

Figure 5: Land use in the Headwater Blacklick Creek HUC-12

1.3 Public Participation and Involvement

The development of the original Blacklick watershed action plan involved 29 individuals representing a cross section of citizens groups, jurisdictions and agencies. The final plan was presented to at least four city councils, four boards of township and the board of Franklin County Metro Parks. It was also presented at a public meeting. Elements of the plan have subsequently been presented to other community, school and jurisdictional groups.

Issues faced by landowners along the creek have already brought together citizens, a major business, jurisdictional staff and consultants to discuss issues in the watershed and propose possible solutions. Several projects from the initial plan have been implemented with the assistance of an HOA, private residents, Franklin Soil and Water Conservation District, the City of Reynoldsburg and the City of Columbus. A stormwater project will be undertaken by Meijer Inc. in partnership with Lawrence Technological University and Franklin Soil and Water Conservation District within the next year. Students and faculty from OSU and staff from OSU Extension have been involved in studies in the watershed and workshops for residents.

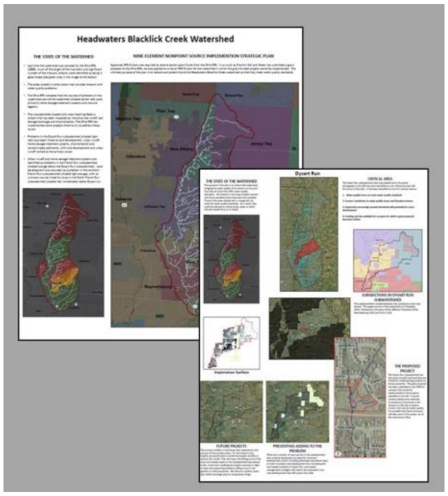

Figure 5: Figure 6: Posters for resident open houses

A watershed coordinator position for the Lower Big Walnut Creek was funded under a grants from the Ohio Department of Natural Resources at Franklin Soil and Water Conservation District from 2010 to 2014. While no longer funded by a grant, that watershed coordinator remains on staff and has done presentations on the dynamics affecting Headwaters Blacklick Creek to multiple audiences in the watershed, including a gardening group, an historical society, homeowners' associations, ad hoc citizen groups, high school classes, university classes and Columbus Department of Public Utilities.

In addition, Franklin Soil and Water has had ongoing partnerships with townships and municipalities in the watershed and has provided a variety of services that have included stormwater education, rain barrel and rain garden workshops, rain garden cost share program implementation, Illicit Discharge Detection and Elimination work, creek and outfall mapping, construction site inspection, construction plan review, landowner assistance, and streamside landowner workshops.

Franklin Soil and Water Conservation District has a solid base to build on in developing this plan, both by virtue of its engagement with the public and its experience in the watershed. In order to fully involve the jurisdictional stakeholders in the NPS-IS process, a meeting was held in Reynoldsburg on November 29, 2016 with representatives from multiple jurisdictions as well as other stakeholders in the watershed. Eighteen people attended, including representatives from Plain Township, New Albany, Gahanna, Reynoldsburg, Columbus, Franklin County and Franklin County Metro Parks. Three staff members from Franklin Soil and Water and two from Mid-Ohio Regional Planning Commission hosted the meeting.

Figure 6: Presentation at Greenways and Water Quality Working Group meeting

A follow-up meeting was held on December 22 with twelve in attendance, including representatives from Jersey Township, Jefferson Township, Pataskala, and Fairfield Soil and Water Conservation District (representing Violet Township and Pickerington). Stakeholders were also given access to the presentations from the meetings and the evolving planning document.

In order to get the general public directly involved in the shaping of the NPS-IS plan, an open house was held on December 13, 2016 at the Plain Township Fire Hall for residents in the watershed. Despite very inclement weather and the conflicts that come with the holiday season, twelve people attended. Following a presentation on the NPS-IS planning process and the issues in the watershed, the attendees had the opportunity to ask questions and make comments. A second open house was held on December 15 at a restaurant just north of Reynoldsburg. Eight residents attended that event.

Given the local resource people available and the amount of study that has been done on the watershed, a presentation was made to Mid-Ohio Regional Planning Commission's Greenways and Water Quality Working Group on December 2. We also held a meeting with professionals doing watershed work at the EMH&T offices. These professionals, John Mathews from Ohio EPA, Ed Rankin from Midwest Biodiversity Institute, and Anne Baird from OSU Extension provided useful feedback related to the plan. Ed Rankin also provided relevant data collected by Midwest Biodiversity Institute.

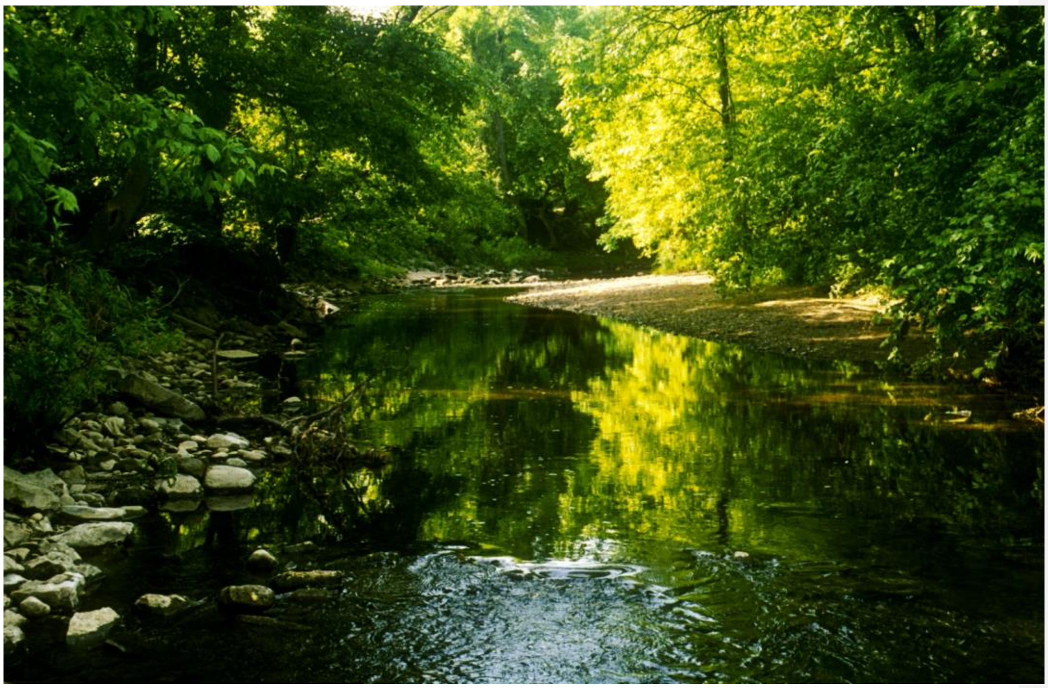

Figure 7: Blacklick Creek at RM 13.8 in Reynoldsburg

Chapter 2: Headwaters Blacklick Creek HUC-12 Watershed Characterization and Assessment Summary

2.1 Summary Watershed Characterization for Headwaters Blacklick Creek HUC-12

The Blacklick Creek basin is comprised mainly of small headwater streams flowing into the mainstem. Blacklick Creek is located in the Eastern Corn Belt Plains (ECBP) ecoregion of Ohio. The gently rolling glacial till plain comprising the ECBP ecoregion is broken by moraines, kames and outwash plains. Local relief is generally less than 50 feet. Soils derived from glacial till materials contain substantial amounts of clay and soil drainage are often poor. Many of the smaller streams in the ECBP ecoregion have been channelized to assist soil drainage.

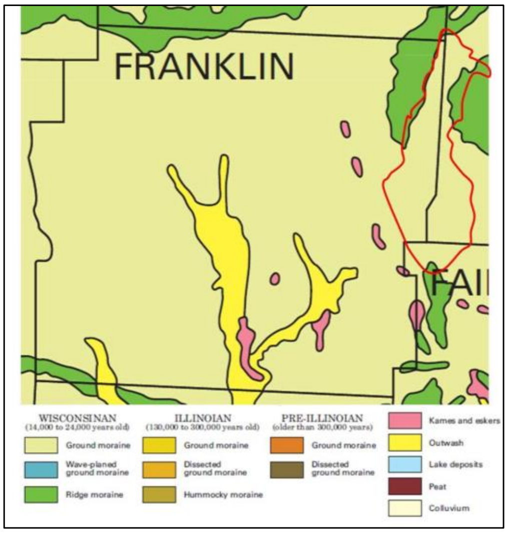

Figure 8: Franklin County with the Headwaters Blacklick Creek Superimposed in red from the Ohio Division of Geological Survey, 2005 , *Glacial Map of Ohio*

Blacklick Creek begins at the edge of an end moraine in Licking County, heading west and north across a ground moraine into Franklin County. Soon after entering Plain Township, it turns south along the edge of another end moraine, flowing south across the glacial till of a ground moraine for the remainder of its path in Headwaters Blacklick Creek HUC-12 (see Figure 8).

The subsurface geology is less uniform than this description would suggest. The creek crosses several buried valleys in Plain and Jefferson Townships, largely following one as it enters Reynoldsburg (Bates, 2007). Much of the bedrock is shale, although there are areas where Berea sandstone (see Figure 9) is close to the surface, as evidenced by old sandstone quarries in Reynoldsburg within the watershed. In contrast, the depth of glacial till can reach 300' in the northern part of the watershed (Schmidt and Goldthwait, 1958).

The interaction of bedrock geology, climate, slope-topography, flora, fauna, and the passage of time produced the soils of the Big Walnut Creek study area. Within the Franklin County portion of the Big Walnut system, the Bennington – Pewamo association, formed in glacial tills, predominates both east and west of the flood plain proper. Upstream of the Delaware County line, the Bennington-Pewamo association continues on upland areas to the Big Walnut's source in Morrow County. The Bennington soils are seen on flats, low knolls and ridges while the Pewamo soils are found in depressions and concavities of the landscape.

Figure 9: Exposed sandstone bedrock along a "Little Jordan Run" in Reynoldsburg

Land use on the Bennington - Pewamo association is limited by seasonal wetness, ponding, slow or moderately slow permeability, and low strength. Tiles and surface drains are commonly used to facilitate drainage. The *Soil Survey of Franklin County* (1980) notes that both Bennington and Pewamo soils are severely limited for sanitary facilities because of their slow permeability, seasonal wetness, and low strength. The survey states that in areas of this association, "Sanitary facilities should be connected to central sewers and treatment facilities." Bennington and Pewamo soils constitute 73% of the soils in the watershed (see Table 1).

Soil Type	Percent
Bennington	51%
Pewamo	22%
Celina	9%
Cardington	7%
Udorthents	3%
Condit	2%
Amanda	2%
Eel	1%
All others	4%

Table 1: Soils in Headwaters Blacklick Creek HUC-12

An Ohio Department of Natural Resources Natural Heritage Database search turned up only one identified endangered species in the Headwaters Blacklick Creek HUC-12. The golden-winged warbler (*Vermivora chrysoptera*), last identified in 1984, in the northern portion of the watershed around the location currently

occupied by the Abercrombie & Fitch facility on Smith's Mill Rd, New Albany. The database search also identified some high quality forests and forested wetlands including a Maple-ash-oak swamp, a Beech-sugar maple forest, and Beech-sugar maple forest. All of these areas are very close together in the headwaters of South French Run and Little Jordan Run* in western Licking County. These areas were last observed, according to the database, in 1982. A survey of 2015 aerials indicated that most of these woods still seem to be intact. The only portion seeming to have been lost is the northeastern portion of woods identified as Schmitt Swamp with the construction of a housing development in the late 1990s.

The National Wetland Inventory identifies 592 wetland areas in the Headwaters Blacklick Creek HUC-12 watershed, totaling 563 acres. A considerable number of these are actually stormwater ponds. There are 23 areas identified as wetlands in public parks, totaling 50 acres. The Ohio EPA has identified 23 sites as potentially suitable for high quality, vernal pool restoration. These sites cluster into 9 general areas. None of them are on public land.

Japanese honeysuckle (*Lonicera japonica*) is a prevalent invasive plant along the waterways in the watershed. Reed canary grass (*Phalaris arundinacea*), garlic mustard (*Allialaria petiolata*), and multiflora rose (*Rosa multiflora*) are also common. While it does not appear to be common, Japanese knotweed (*Polygonum cuspidatum*) has been found in the watershed as well. While other invasive plants are surely present as well, these are the most visible along the creeks and waterways. As has been the case throughout Ohio, the emerald ash borer (Agrilus planipennis) has laid waste to the ash trees in Headwaters Blacklick Creek HUC-12, impacting wooded riparian buffers and potentially contributing to logjams. Blacklick Creek has been prone to logjams, a major jam having formed in the early 2000s just west of Rte. 33 in Town of Brice-Blacklick Creek HUC -12.

While not known for its fishing, Blacklick is home to both smallmouth (*Micropterus dolomieu)* and largemouth bass (*Micropterus salmoides salmoides*). Blacklick has been home to three species of highly sensitive fish, but all are fairly common. No fish or macroinvertebrates with any unique status have been found in the watershed (Mishne, 2012).

Figure 10: A rainbow darter *Etheostoma caeruleum*) caught in Little Jordan Run, one of several darter species found in the Headwaters Blacklick Creek HUC-12

* – The tributary that joins Blacklick Creek at RM 12.9, listed as an unnamed tributary in Ohio EPA's technical study documents, is identified as "Little Jordan Run" on an 1872 map of Truro Township.

2.1.2 Land Use and Protection

The Headwaters of Blacklick Creek HUC-12 land use figures (Tables 2 -5 and Figures 11-17) were derived using existing land use data compiled by MOPRC in combination with high resolution datasets (impervious, canopy, and open space) created by or for Franklin Soil and Water Conservation District. The alignment of these datasets allows for a highly accurate reflection of the land cover within the watershed that you would not find at this scale with the National Land Cover 30 meter datasets. These land use data were then categorized into four classes as seen in Table 2 and Figure 11: open space (grassland, turf grass, etc.), forested (land covered with canopy), agriculture (land currently in row crop cultivation), and impervious (developed land with an impervious surface).

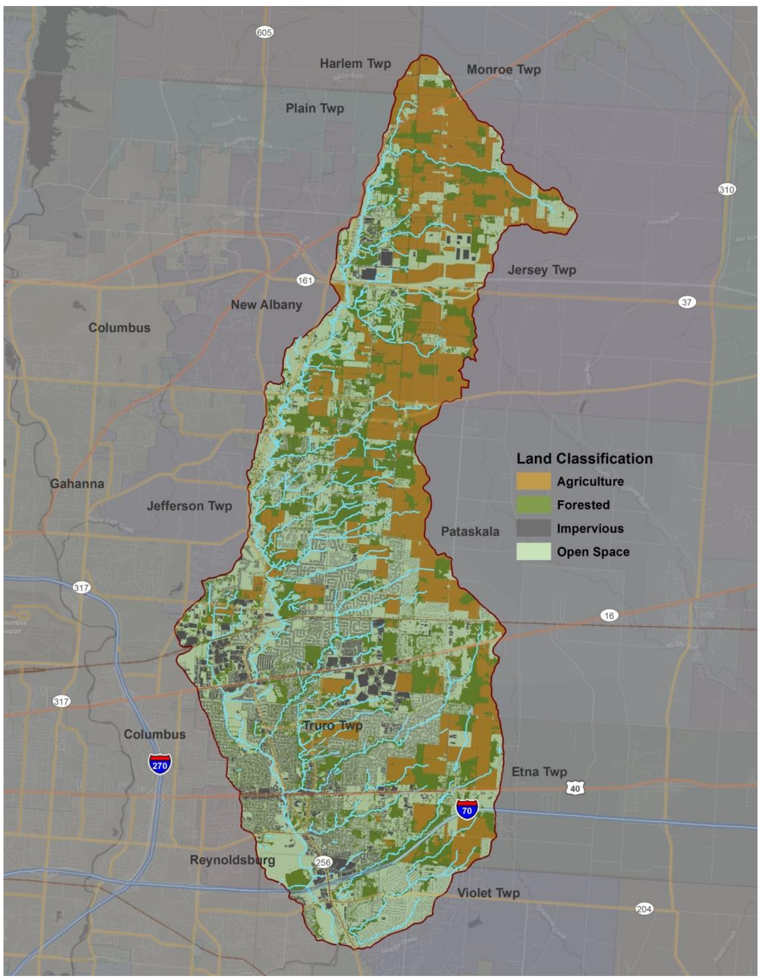

Figure 11: Land Use in the Headwaters Blacklick Creek HUC-12(All Maps Credit Franklin Soil and Water Conservation District)

Blacklick Headwaters (05060001 15 03)*		
Cover Classification	% Watershed Area	Area Acres
Open Space	40.40%	12657.3
Forested	24.50%	7663.1
Agriculture	23.40%	7307.1
Impervious	11.70%	3658.8
Total	100.00%	31286.3

*Numbers are approximate, taken from best available GIS data.

Table 2: Land use classifications for Headwaters Blacklick Creek HUC-12

Impervious Cover

Much of the watershed sits within NPDES regulated Municipal Separate Storm Sewer System communities. Development in these communities has increased the percentage of impervious cover in the watershed to 11.7%. Figure 12 illustrates the application of the "Impervious Cover Model" to the subwatersheds in the Blacklick Creek HUC-12. The Impervious Cover Model, developed by the Chesapeake Stormwater Network and Center for Watershed Protection (Schueler, 1994), provides a scale for assessing the impact of impervious cover (IC) on streams. IC is a useful indicator with which to measure the impacts of land development on aquatic systems, relating IC to changes in hydrology, habitat structure, water quality and biodiversity. Scientific evidence (Schueler. et al., 2009) indicates that the health of a stream can be forecast through IC percentage classes (see legend in Figure 12), finding that stream degradation occurs at moderately low level of IC (~10%) with sharp health declines with each successive interval. IC can be quantified and used to predict the attainment of water quality standards in the absence of sampling data. Conversely, IC percentages can be used to manage and control in land development to prevent, limit and/or reverse the impact of development on water quality.

A considerable amount of impervious cover sits within the southern reaches of the Headwaters Blacklick Creek HUC-12, and developing lands in the north and within the eastern headwaters of each tributary, where IC percentages are relatively low, will most likely increase the percentages of impervious cover in the watershed (Figures 13 and 14). This HUC-12 can be categorized as urbanized (impacted subwatersheds above the 10% IC threshold), and urbanizing (subwatersheds threatened by potential increases in IC and below the 10% threshold) (figure 14). Using these categories, urbanized and urbanizing, management schemes can be applied to each subwatershed for flow attenuation through the use of retrofits and hydrological mitigation, as well as hydrology protection measures through the use of zoning, utility fees, and a higher level of infiltration and storage during the development phase.

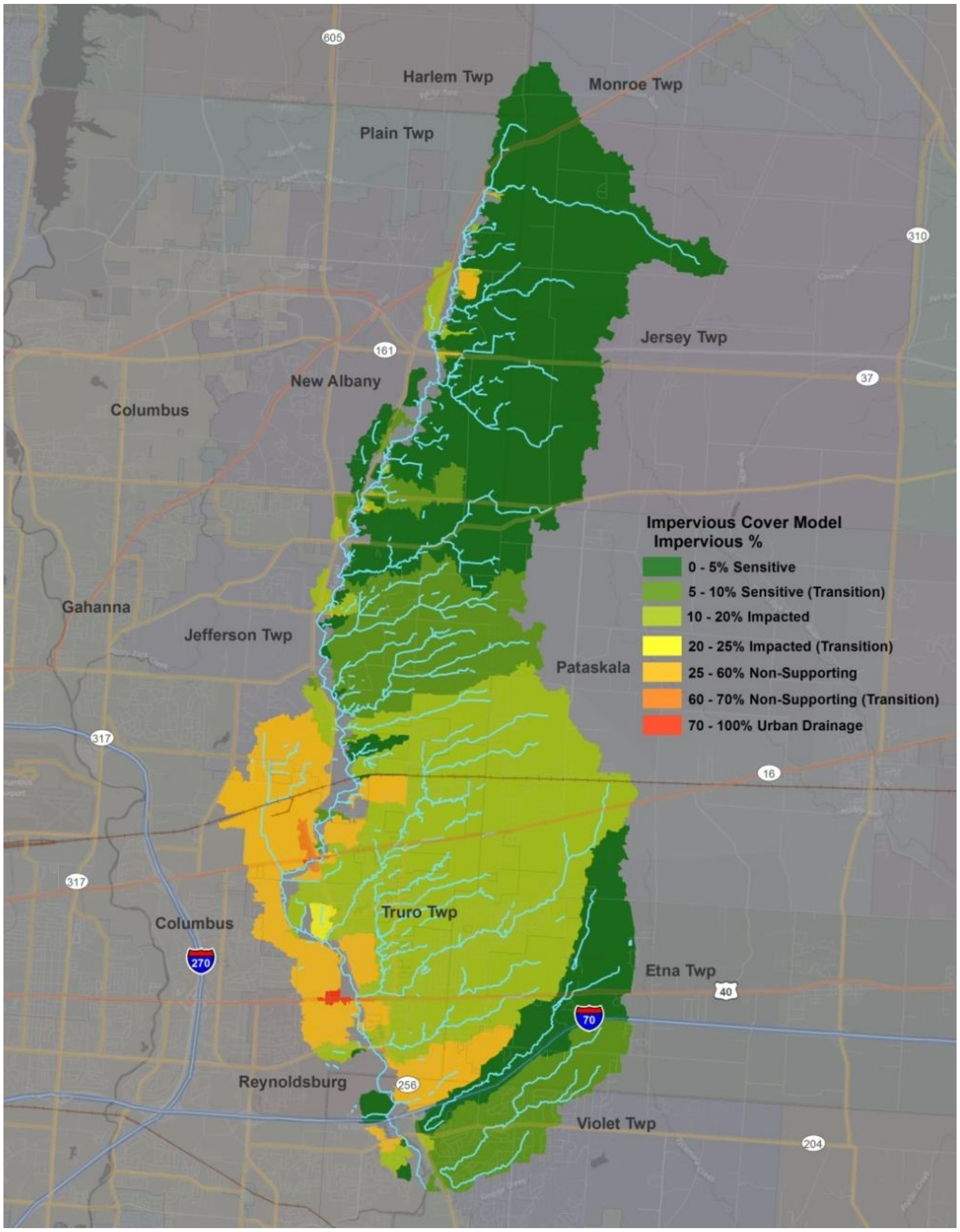

Figure 12: Impervious Cover Model, relating the health of the subwatersheds to the percentage of impervious cover

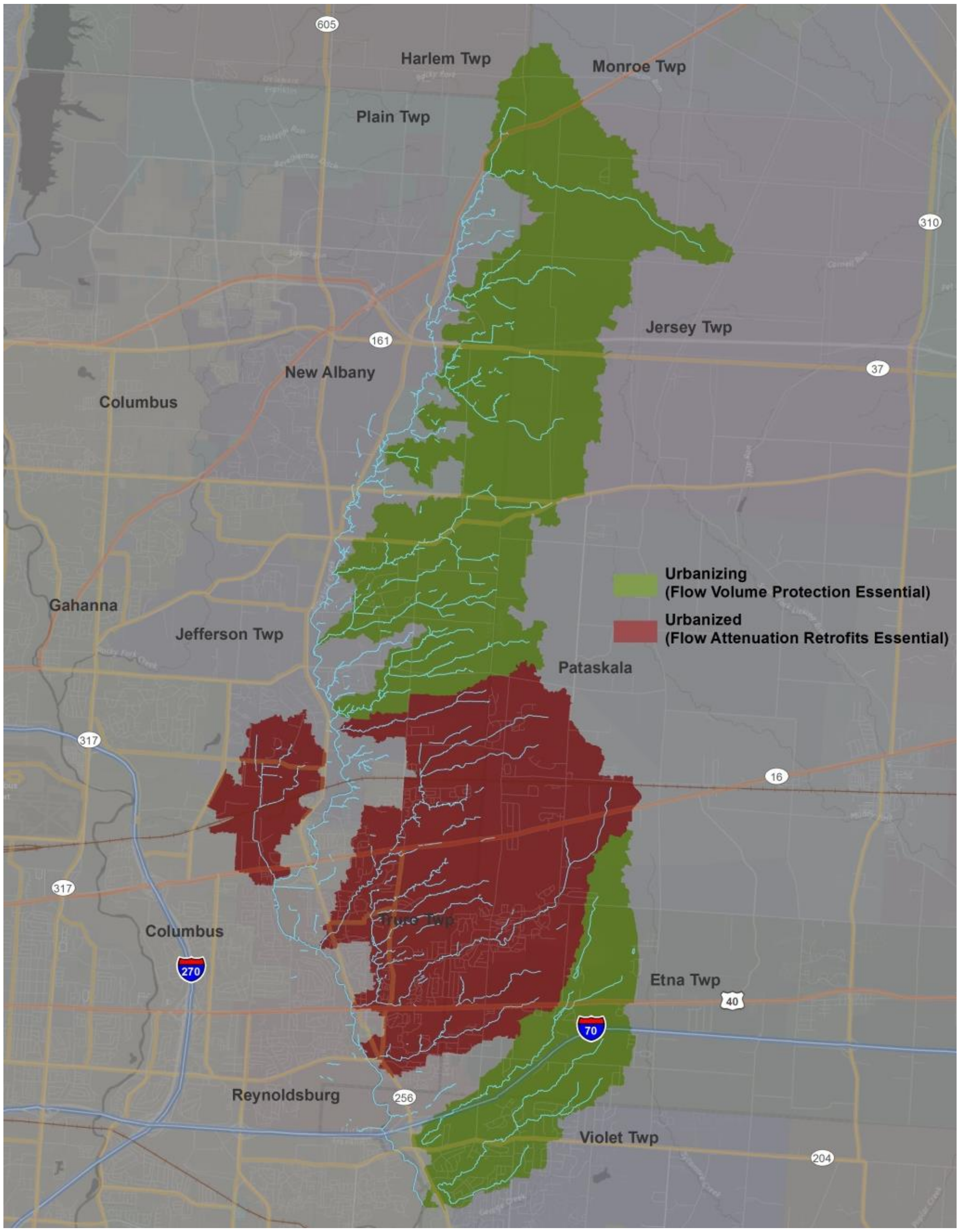

Figure 13: Urbanized and urbanizing subwatersheds in Headwaters Blacklick Creek HUC-12

Agricultural Cover

Agricultural land (23.4% of the watershed) is found mostly in the eastern headwaters of the tributaries that feed the main stem of Blacklick Creek (Figure 14). Future land use data developed by MORPC through the planning efforts of the surrounding communities demonstrate that most of that is slated for development in the future. A limited number of parcels have been protected from development. Given that an additional 21% of the watershed could be developed (Table 3), it is essential to find ways to develop standards to eliminate the potential impact increased IC on the watershed's streams as a result of future development. Where agricultural lands remain, implementing best management practices for water quality protection remains paramount.

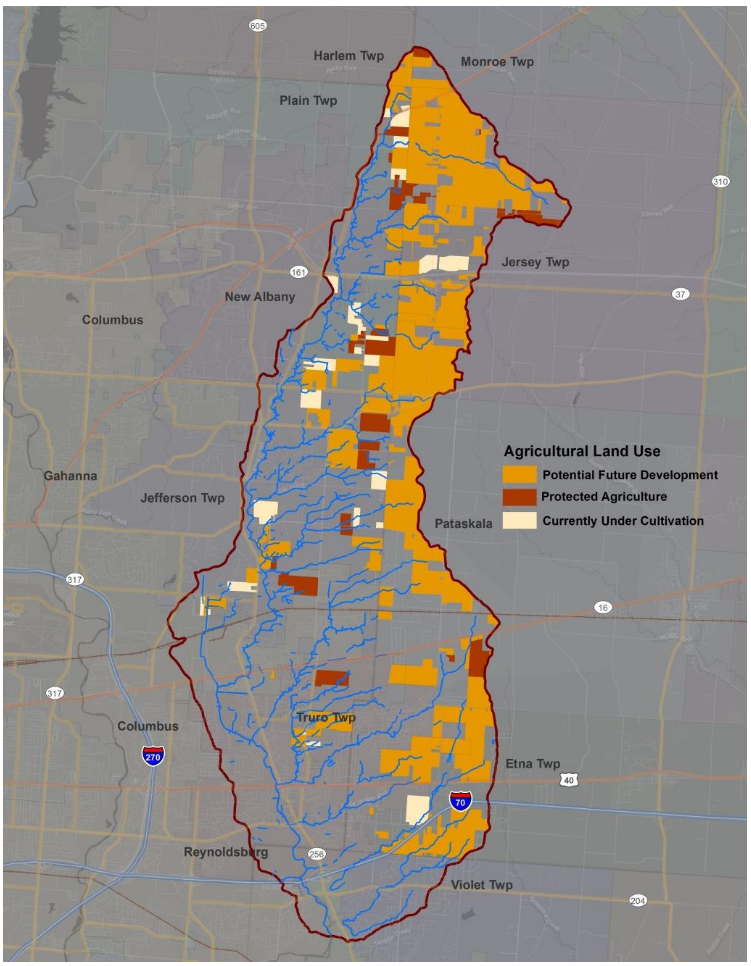

Figure 14: Agricultural land use in the Headwaters Blacklick Creek HUC-12

Urbanized Tributaries*		
Subwatershed**	**Acres > 10% Impervious Threshold**	**Potential Development Acres**
Dysart Run	200.16	472.52
Little Jordan Drainage	76.31	256.07
Utzinger Ditch	210.45	65.10
French Run	285.63	439.75
Jefferson Drainage	28.53	55.65
Total	**801.08**	**1289.09**

Urbanizing Tributaries*		
Subwatershed**	**Acres < 10% Impervious Threshold**	**Potential Development Acres**
Ackerburg Ditch	22.57	52.17
Ackerly Farms Drainage	21.10	85.4
Cole Ditch	41.62	20.26
Cook Tri. Co. Ditch	81.99	694.63
Fieldstone Drainage	30.62	297.60
Haines Ditch	78.34	629.98
Lees Creek	111.36	543.36
Rhodes Ditch	107.20	790.83
Swisher Creek	116.35	809.16
Tippet Drainage 1	103.71	843.11
Unknown 1	44.26	419.73
Total	**759.12**	**5186.22**

*Numbers are approximate. taken from best available GIS data.
**Subwatersheds only represent a subsection of the entire watershed HUC-12

Table 3: Urbanized and urbanizing tributaries, IC thresholds, and development potential for Headwaters Blacklick Creek HUC-12

Canopy Cover

Approximately one quarter (24.5%) of the landscape within the Blacklick Creek HUC-12 is covered by canopy, including sizable forested tracts within the center of the selected HUC-12 in Jefferson Township, and trees along the outskirts of existing developed land, the edges of farmland and open stream channels (Figure 15). Research data indicate that watershed forest cover of at least 45% to 65% is needed to fully protect stream health (Dwyer and Nowak, 2000). The selected HUC-12 and most of the subwatersheds fall well short of this cover threshold (Figure 15 and Table 4), indicating the importance of guarding existing trees and planting new ones as means for protecting the watershed.

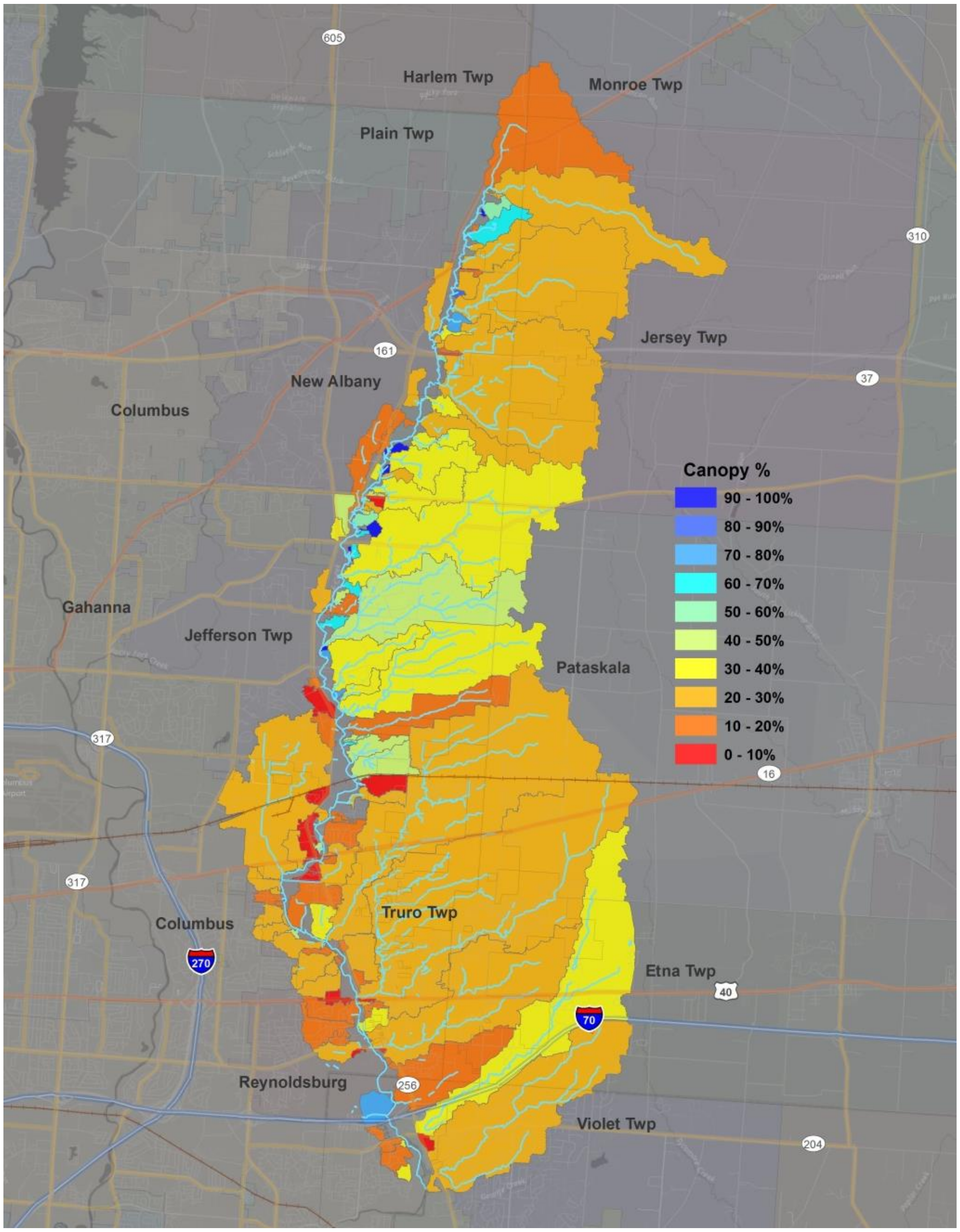

Figure 15: Canopy cover percentages in the Headwaters Blacklick Creek HUC-12

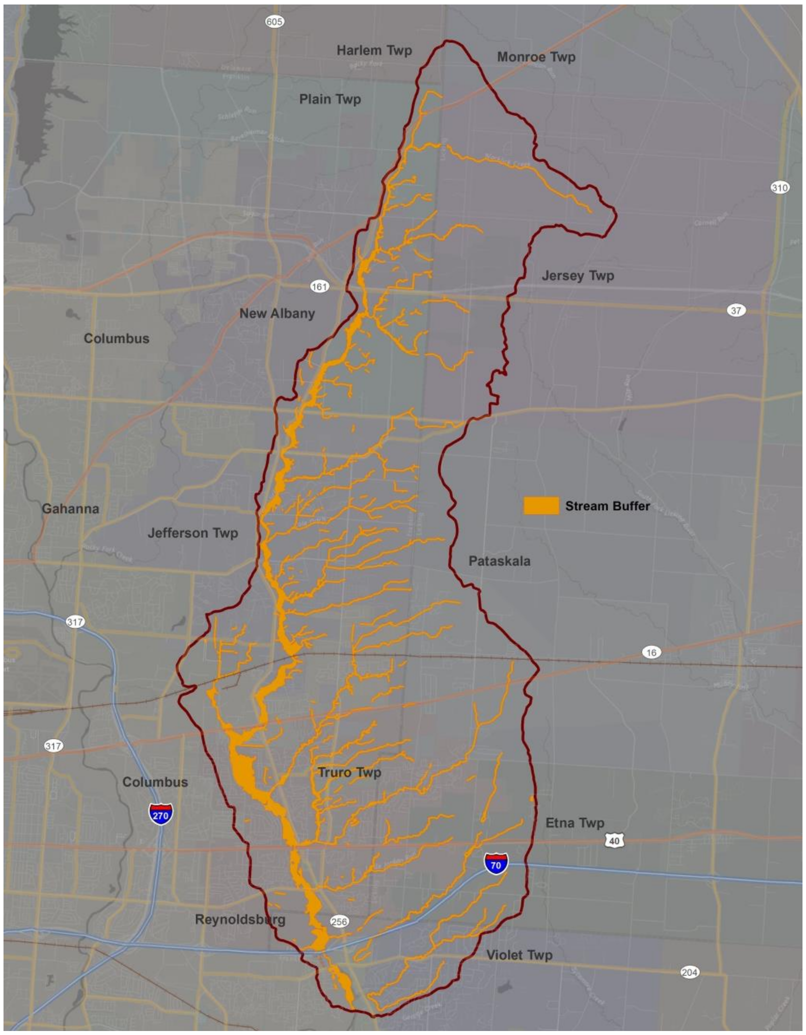

Figure 16: Stream buffers within the 100yr. floodplain and at Least 75 ft. from the center line of the channel within the Headwaters of Blacklick Creek HUC-12

Goetz et. al. (2003) found that at least a 45% streamside forest cover was required for streams to have a good health rating. This bodes well for stream buffers in the watershed as a whole (43.8% cover), the Blacklick main stem (54.6% cover) and most of the tributary systems to the main stem (Table4). Safeguarding these buffers (Figure 16) is a high priority for protecting water quality. Buffers are essential both for the well-being of creeks and for protecting streamside landowners from the very real threat of stream bank erosion.

Watershed	Stream Buffer Acres	Stream Buffer Canopy Acres	Canopy % of Buffer
Blacklick Headwaters (05060001 15 03)	3106.31	1360.76	43.81

Mainstem	Stream Buffer Acres	Stream Buffer Canopy Acres	Canopy % of Buffer
Mainstem Blacklick Creek	720.82	393.75	54.63

Urbanized Tributaries	Stream Buffer Acres	Stream Buffer Canopy Acres	Canopy % of Buffer
Dysart Run	232.34	134.78	58.01
Little Jordan Drainage	104.05	67.37	64.74
Utzinger Ditch	109.00	47.39	43.48
French Run	342.14	211.17	61.72
Jefferson Drainage	51.87	25.87	49.88

Urbanizing Tributaries	Stream Buffer Acres	Stream Buffer Canopy Acres	Canopy % of Buffer
Ackerburg Ditch	18.19	14.30	78.62
Ackerly Farms Drainage	7.01	2.98	42.54
Cole Ditch	126.80	78.62	62.01
Cook Tri. Co.Ditch	23.79	8.94	37.59
Fieldstone Drainage	150.71	101.14	67.11
Haines Ditch	70.50	51.56	73.13
Lees Creek	115.43	71.46	61.91
Rhodes Ditch	142.54	91.85	64.44
Swisher Creek	124.17	87.65	70.58
Tippet Drainage 1	63.89	30.45	47.66
Unknown 1	135.06	55.79	41.31

Table 4: Forested buffer by watershed, mainstem Blacklick Creek and within the urbanized and urbanizing tributaries

Open Space

A majority of the land (40.4%) falls under the classification of open space, which includes land that is covered in turf grass, shrub/scrub, and/or pasture, and open land that is considered undeveloped. The largest percentage of open space is found in the southern reaches of this selected HUC-12 within areas of development in the form of turf grass (Figure 17). This land use is important as an area for infiltration practices and limiting stormwater runoff.

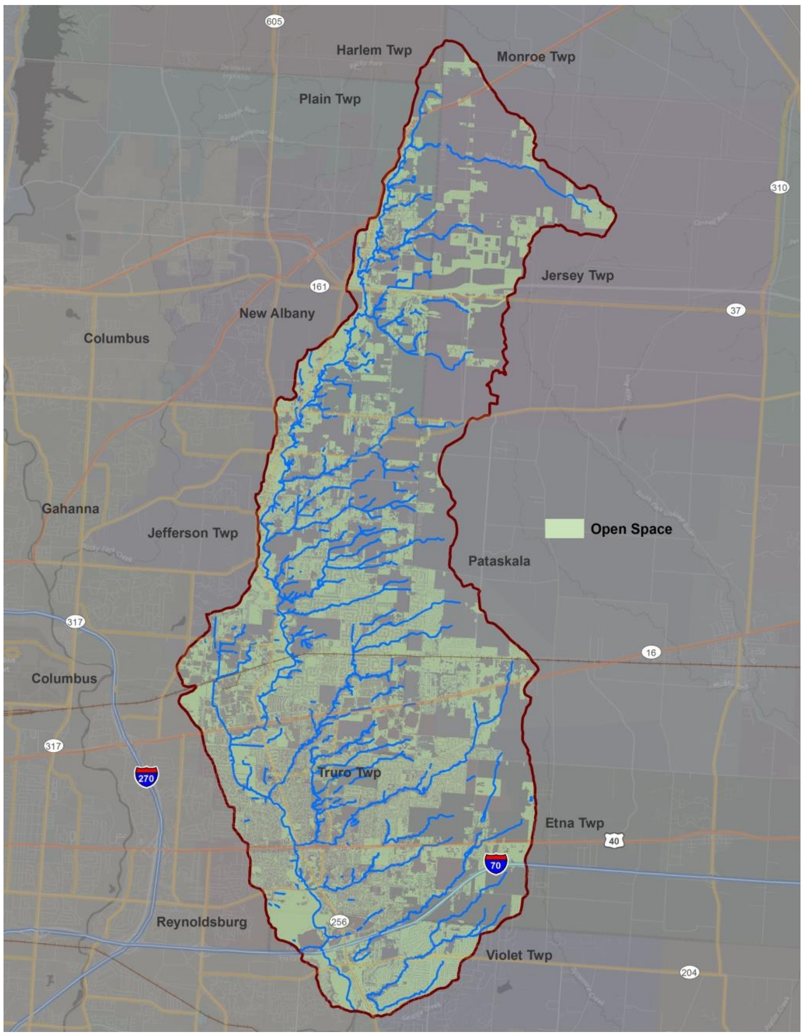

Figure 17: Open space in the Headwaters of Blacklick Creek HUC-12

Urbanized Tributaries			
Subwatershed	Cover Classification	% Watershed Area	Area Acres
Dysart Run	Open Space	44.34	1299.56
	Agriculture	16.12	472.52
	Impervious	16.83	493.32
	Forested	22.70	665.20
Little Jordan Drainage	Open Space	40.17	568.80
	Agriculture	18.09	256.07
	Impervious	15.39	217.95
	Forested	26.34	372.99
Utzinger Ditch	Open Space	45.79	548.19
	Agriculture	5.44	65.10
	Impervious	27.58	330.12
	Forested	21.19	253.67
French Run	Open Space	42.01	1528.60
	Agriculture	12.09	439.75
	Impervious	17.85	649.43
	Forested	28.05	1020.80
Jefferson Drainage	Open Space	59.85	271.04
	Agriculture	12.29	55.65
	Impervious	16.30	73.82
	Forested	11.56	52.36
Urbanizing Tributaries			
Subwatershed	**Cover Classification**	**% Watershed Area**	**Area Acres**
Ackerburg Ditch	Open Space	25.50	69.80
	Agriculture	37.70	103.17
	Impervious	1.75	4.80
	Forested	35.05	95.92
Ackerly Farms Drainage	Open Space	21.95	58.79
	Agriculture	54.61	146.26
	Impervious	2.12	5.69
	Forested	21.31	57.07
Cole Ditch	Open Space	32.39	342.15
	Agriculture	17.05	180.05
	Impervious	6.06	64.02
	Forested	44.50	470.05
Cook Tri. Co. Ditch	Open Space	15.03	152.86
	Agriculture	71.32	725.53
	Impervious	1.94	19.78
	Forested	11.71	119.13

Urbanizing Tributaries			
Fieldstone Drainage	Open Space	34.20	383.56
	Agriculture	26.53	297.60
	Impervious	7.27	81.53
	Forested	32.00	358.96
Haines Ditch	Open Space	30.38	463.95
	Agriculture	41.25	629.98
	Impervious	4.87	74.34
	Forested	23.50	358.85
Lees Creek	Open Space	30.51	530.12
	Agriculture	31.27	543.36
	Impervious	3.59	62.39
	Forested	34.62	601.50
Rhodes Ditch	Open Space	29.07	584.62
	Agriculture	39.32	790.83
	Impervious	4.67	93.88
	Forested	26.94	541.85
Swisher Creek	Open Space	17.01	312.65
	Agriculture	44.02	809.16
	Impervious	3.67	67.46
	Forested	35.30	648.80
Tippet Drainage 1	Open Space	17.75	200.76
	Agriculture	57.12	645.95
	Impervious	0.82	9.28
	Forested	24.31	274.93
Unknown 1	Open Space	53.84	866.60
	Agriculture	17.54	282.32
	Impervious	7.25	116.64
	Forested	21.37	343.99

Table 5: Land Use Classifications for Urbanized and Urbanizing Subwatersheds of the Headwaters of Blacklick Creek HUC-12

2.2 Summary of HUC-12 Biological Trends

Headwaters Blacklick Creek HUC-12 has not been sampled by the Ohio EPA since 2001. It was sampled in 1996, 1997, 2000 and 2001. The results of those sampling sets were published in the Ohio EPA's

Biological and Water Quality Study of Blacklick Creek and Selected Tributaries, Franklin and Fairfield Counties, Ohio, published in 1998, and *Biological and Water Quality Study of the Big Walnut Creek Basin 2000, Delaware, Fairfield, Franklin, Licking, Morrow, and Pickaway Counties*, published in 2003. These data are presented in Tables 6 and 7.

River Mile Fish[a]/Invert.	IBI	MIwb	ICI[b]	QHEI	Attainment Status	Comment
Blacklick Creek (02-130) WWH Use Designation (Existing)						
22.4(H)/22.7	35*	N/A	F*	65.5	NON	Kitzmiller/Morse Rd.
Eastern Corn Belt Plains - EWH/WWH Use Designation (Existing/Recommended)						
20.4(H)/20.4	49ns/49	N/A	G*/G	63	PARTIAL/FULL	Havens Rd.
18.2(W)/18.7	41*/41	7.8*/7.8ns	40*/40	79.5	NON/FULL	Ust. Jefferson WWTP
18.0(W)/17.9	44*/44	7.7*/7.7*	G*/G	75	NON/PARTIAL	Dst. Jefferson WWTP
16.6(W)/16.6	48ns/48	8.4*/8.4	40*/40	70.5	PARTIAL/FULL	Broad St.
Eastern Corn Belt Plains - WWH Use Designation (Existing)						
15.5(W)/15.2	43	8.5	34ns	68	FULL	Adj. Rose Hill Rd.
11.3(W)/11.3	38ns	7.8ns	G	74.5	FULL	Tussing Rd.
11.0(W)/11.1	39ns	8.6	G	63.5	FULL	Dst. Tussing Rd. WWTP
8.8(W)/8.9	41	8.3	46	62	FULL	Refugee Rd.
5.0(W)/5.6	43	8.7	50	78	FULL	Ust. Blacklick Est. WWTP
4.83(W)/4.83MZ	36	7.6	P/F	--	N/A	Blacklick Est. WWTP Mixing Zone
4.6(W)/4.5	45	8.2ns	52	64.5	FULL	Dst. Blacklick Est. WWTP
1.8(W)/1.4	38ns	7.6*	46	77	PARTIAL	SR 317

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

ns Nonsignificant departure from biocriterion (#4 IBI or ICI units, #0.5 MIwb units).

a Fish sampling methods: A=Boat, D=Wading, E=Longline.

b Narrative evaluation based on qualitative macroinvertebrate sample (E=Exceptional, VG=Very Good, G=Good, F=Fair, Low F=Low Fair, P=Poor, and VP=Very Poor).

c Macroinvertebrate sample was collected in 2001 and may be replacing a 2000 sample.

Table 6: Water quality data from 1996 and 1997, reported in 1998 TSD (sample data in shaded boxes are from samples collected Town of Brice-Blacklick Creek HUC-12)

Following the sampling done in 1996/1997, it was recommended that the use designation for the section of the stream between Broad St. and Havens Rd. be changed from EWH to WWH. This recommendation was based both on the transitional character of this reach between headwater and wading sample sites and what is described as " the true biological potential of this segment" (p. 8). By the time of the 2003 report, the recommended change had been accepted and the use designation for the mainstem of Blacklick Creek throughout the Headwater Blacklick Creek HUC-12 is WWH.

The samples taken in the mainstem of Blacklick, north of Morse Rd., indicated that the creek was in nonattainment at the sample sites during both sampling periods. With the exception of a sample taken just below the Jefferson Township WWTP, samples taken in the reach from Morse Rd. to Refugee Rd. indicated that the creek was in attainment of WWH aquatic life use at the sample sites during both sampling periods. Unfortunately, the creek was not sampled above the Blacklick Estates WWTP in 2000/2001, making it impossible to determine whether or not the stream remained in attainment at that point in 2000/2001, as it had in 1996/1997.

River Mile Fish[a]/Invert.	IBI	MIwb	ICI[b]	QHEI	Attainment Status	Comment
Blacklick Creek (02-130) WWH Use Designation (Existing)						
27.1E	20*	NA	P*	53.5	NON	Walnut St.
24.7E	34*	NA	Low F*	76	NON	SR 161
22.4E/23.0	32*	NA	F*	70.5	NON	Morse Rd.
20.4E	46	NA	G	63	FULL	Havens Rd.
16.6D	44	8.7	44	70	FULL	Broad St.
13.7D	46	8.5	MGns	71.5	FULL	Main St.
11.3D	39ns	8.0ns	48	76.5	FULL	Ust Tussing Rd.WWTP
11.14D/11.10	40	7	F/F	NA	NA	Tussing Rd. WWTP mixing zone
11.0D	44	8.6	38	70	FULL	Dst. Tussing Rd. WWTP
8.8D/8.9	46	9.4	40	70.5	FULL	Refugee Rd.
4.83D	39	8.5	F/F	NA	NA	Blacklick Estates WWTP mix zone
4.6D/4.5	46	8.9	26*	69	PARTIAL	Dst. Blacklick Estates WWTP
2.6D	43	8.4	42	78	FULL	Ust. Hamilton Rd.

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

ns Nonsignificant departure from biocriterion (#4 IBI or ICI units, #0.5 MIwb units).

a Fish sampling methods: A=Boat, D=Wading, E=Longline.

b Narrative evaluation based on qualitative macroinvertebrate sample (E=Exceptional, VG=VeryGood, G=Good, F=Fair, Low F=Low Fair, P=Poor, and VP=Very Poor).

c Macroinvertebrate sample was collected in 2001 and may be replacing a 2000 sample.

Table 7: Water quality data from 2000 and 2001, reported in 2003 TSD (sample data in shaded boxes are from samples collected in Town of Brice-Blacklick Creek HUC-12)

In 1996/1997 the Jefferson Township WWTP appeared to have had a negative impact on water quality. In 2000/2001 samples were not collected in the immediate proximity to that WWTP, and there was no impact on water quality attainment at the first site below the site location. In 1996/1997 the Blacklick Estates WWTP did not appear to have had a negative impact on water quality, while 2000/2001 indicated a decline in aquatic life below the plant. Conversely, there was a decline in water quality indicated in 1996/1997 at RM 1.8/1.4, while no such decline was suggested by the data in 2000/2001 at RM 2.6, recognizing that the two sampling locations are not the same.

River Mile Fish[a]/Invert.	IBI	MIwb	ICI[b]	QHEI	Attainment Status	Comment
Eastern Corn Belt Plains - Undesignated/WWH Use Designation (Existing/Recommended)						
Unnamed Trib.(Joins Blacklick Cr. at RM6.5)						
	36ns	N/A	--	56	(FULL)	Development Pressures
Unnamed Trib. (Joins Blacklick Cr. At RM10.4)						
	44	N/A	--	75.5	(FULL)	SR 256
Unnamed Trib. (Joins Blacklick Cr. At RM 11.3)						
	40	N/A	--	73.5	(FULL)	SR 256
Unnamed Trib. (Joins Blacklick Cr. At RM12.9)						
	46	N/A	--	74	(FULL)	Graham Rd.
Swisher Creek						
	40	N/A	--	47	(FULL)	Clark St. Rd.
Unnamed Trib. to Dysar Run						
	46	N/A	--	70.5	(FULL)	
French Run						
	38ns	N/A	--	68	(FULL)	Waggoner Rd.
Eastern Corn Belt Plains-Undesignated/EWH Use Designation (Existing/Recommended)						
North Br. French Run-1997						
	54	N/A	--	81.5	(FULL)	adj. Elementary School

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

ns Nonsignificant departure from biocriterion (#4 IBI or ICI units, #0.5 MIwb units).

a Fish sampling methods: A=Boat, D=Wading, E=Longline.

b Narrative evaluation based on qualitative macroinvertebrate sample (E=Exceptional, VG=VeryGood, G=Good, F=Fair, Low F=Low Fair, P=Poor, and VP=Very Poor).

c Macroinvertebrate sample was collected in 2001 and may be replacing a 2000 sample.

Table 8: Water quality data from 1996 and 1997, reported in 1998 TSD (sample data in shaded boxes are from samples collected in Town of Brice-Blacklick Creek HUC-12)

The samples taken on Blacklick Creek tributaries in 1997/1998 indicated that the streams were all in full attainment of WWH aquatic life use at the sampling sites. The sample in the north branch of French Run met EWH standards, and it was recommended that this creek be designated as EWH. By 2000/2001 North French Run was designated as EWH, while most of the remaining tributaries had been designated as WWH. A new stream was sampled in 2000/2001, a tributary to Dysart Run*, and it was recommended that it be designated as WWH.

In 2000/2001 Dysart Run, French Run, North French Run, and “Powell’s Ditch” were all in partial or nonattainment of their use designations. North French Run attained WWH standards but had been designated EWH since the 1996/1997 samples were taken. The change in attainment status did not necessarily reflect a change in water quality. In 2000/2001 macroinvertebrates were sampled in all of the creeks found to be in partial or nonattainment, while none of these creeks had been sampled for macroinvertebrates in 1996/1997.

* - Known as “Dysar” Run in Ohio EPA documents, this stream will be called “Dysart” Run, based on Franklin Soil and Water’s stream resource database which draws on the best available stream name resources

Utzinger* Ditch is a special case in this watershed, having been sampled independently of the aforementioned studies in 2000. The results of that study were reported in the Ohio EPA's Biological and Sediment Quality Study of Utzinger Ditch 2000, published in 2001. The results were summarized in the 2000 Big Walnut TSD, noted above. All sites in this stream were found to be in nonattainment of WWH standards, with the macroinvertebrate communities scoring from very poor to fair, and the fish from poor to fair. This heavily impacted stream has since been designated as Limited Resources Water (LRW).

River Mile Fish[a]/Invert.	IBI	MIwb	ICI[b]	QHEI	Attainment Status	Comment
Dysar Run (Trib. to Blacklick Cr. (RM 14.64)) (02-281) WWH Use Designation (Existing)						
3.0E/2.1c	40	NA	F*	49	PARTIAL	Railroad bridge/Waggoner Rd. bridge/Waggoner Rd.
1.9E/1.6	42	NA	P*	68	NON	SR 16
Tributary to Dysar Run (RM 1.67) (02-342) WWH Use Designation (Recommended)						
0.2E/	42	NA	-	52	(FULL)	Waggoner Rd.
French Run (Trib. to Blacklick Cr. (RM 13.66)) (02-290) WWH Use Designation (Existing)						
0.6E/0.7	48	NA	F*	55	PARTIAL	Waggoner Rd.
North Branch French Run (Trib. to French Run (RM 0.33)) (02-291) EWH Use Designation (Existing)						
/0.2	-	-	MG*	-	(NON)	Behind French Run Elem. Sch.
"Lees Creek" (Trib. to Blacklick Cr. (RM 11.25) (02-288) WWH Use Designation (Existing)						
0.3E/	48	NA	-	73.5	(FULL)	Ust. SR 256
Tributary to Blacklick Creek (RM 10.36) (02-287) WWH Use Designation (Existing)						
0.2E/	42	NA	-	70	(FULL)	Dst. SR 256
"Powell Ditch" (Trib. to Blacklick Cr. (RM 6.50)) (02-286) WWH Use Designation (Existing)						
0.8E/0.9	36ns	NA	P*	49.5	NON	Dst. Brice

* Significant departure from ecoregion biocriterion; poor and very poor results are underlined.

ns Nonsignificant departure from biocriterion (#4 IBI or ICI units, #0.5 MIwb units).

a Fish sampling methods: A=Boat, D=Wading, E=Longline.

b Narative evaluation based on qualitative macroinvertebrate sample (E=Exceptional, VG=VeryGood, G=Good, F=Fair, Low F=Low Fair, P=Poor, and VP=Very Poor).

c Macroinvertebrate sample was collected in 2001 and may be replacing a 2000 sample.

Table 9: Water quality data from 2000 and 2001, reported in 2003 TSD (sample data in shaded boxes are from samples collected in the HUC-12 watershed downstream from Headwaters Blacklick Creek HUC-12)

By way of summary, samples taken in the mainstem of Blacklick Creek from the south edge of Headwaters Blacklick Creek up to Morse Rd. were in full attainment of WWH standards in 2000/2001. With the exception of a single site impacted by a WWTP, this was true in 1996/1997 as well. Samples taken from Morse Rd. north on the mainstem were in nonattainment of WWH standards. The samples taken in tributaries in 1996/1997 and 2000/2001 were all in attainment of WWH standards for fish and one met EWH standards, except Utzinger Ditch. However, only one stream that was sampled in 2000/2001 for macroinvertebrates met WWH standards. Three streams were not sampled for macroinvertebrates in 2000/2001 and none were sampled for them in 1996/1997.

* - Known as "Unzinger" Ditch in some Ohio EPA documents, this stream will be referred to as "Utzinger" Ditch in this document, following Franklin Soil and Water's stream resource database

At least the first 7 miles of the mainstem of Blacklick Creek appear to be impaired so as to be in nonattainment of WWH standards. No tributary was identified as having water quality issues in 1996/1997. Two tributary streams were identified as being in nonattainment of WWH standards in 2000/2001. An additional tributary was in non-attainment of its EWH use designation.

2.3 Summary of HUC-12 Pollution Causes and Associated Sources

As noted above, Headwaters Blacklick Creek HUC-12 has not been sampled by the Ohio EPA since 2001 and is not scheduled for sampling until 2020. In 2001, the primary causes of impairment in the upper reaches of the mainstem were identified as ammonia, nutrients and organic enrichment. Pathogens, siltation and priority organics were listed as moderate contributors to impairment (see Table 10). These causes were attributed to the following sources: home sewage treatment systems (HSTSs), manure lagoons, contaminated sediments, and land development (see Table 11). Of these, HSTSs were named as the most significant sources, while the others were labeled as having moderate impact.

Causes:	Ammonia	Nutrients	Organic Enrichment	Pathogens	Siltation	Priority Organics
Blacklick Creek	H	H	H	M	M	M

Table 10: Causes of impairment in the upper reaches of Blacklick Creek

Sources:	HSTS	Manure Lagoons	Contaminated Sediments
Blacklick Creek	H	M	M

Table 11: Sources of impairment in the upper reaches of Blacklick Creek

In the impaired tributaries to Blacklick in this HUC-12, siltation was identified as the primary cause of impairment, with pathogens identified as the secondary cause, having an impact assessed as ranging from moderate to slight (see Table 12). It was not clear what the primary cause of impairment was in North French Run. Organic enrichment, priority organics, habitat alterations and metals were listed as having a slight impact on Dysart Run. HSTS, contaminated sediments, land development, channelization and urban runoff were listed as sources of impairment for these streams, with urban runoff identified as a primary source for Dysart and French Run, and a moderately significant source for North French Run (see Table 13). Land development was identified as a major source of impairment on Dysart Run. HSTSs were assessed as having a moderate impact on both branches of French Run and a slight effect on Dysart Run. Contaminated sediments and channelization were only associated with Dysart, and their impacts were judged to be slight. The primary source of impairment for North French Run was listed as unknown. In Utzinger Ditch, impairment was attributed to nutrients, priority organics, and habitat alterations, which were linked to contaminated sediments, industrial site runoff, raw sewage and channelization.

HSTSs are the only sources of impairment linked to Blacklick Creek's mainstem and all of the impaired tributaries in the HUC-12, except Utzinger Ditch. They are identified as having the largest impact on the upper reaches of the mainstem of Blacklick Creek. This is likely due to the density of these systems along the mainstem, the age of the systems and the low flow in the stream. There are on the order of 150 HSTSs discharging to the first 7 miles of Blacklick Creek. Approximately 50 of them discharge to the first 3 miles of the creek, where the flow is sufficiently low to make the stream intermittent for most intents and purposes. In Franklin County, 89% of these systems are installed at homes that are more than 30 years old, and 71% of them are more than 40 years old, suggesting that the systems are fairly old as well.

Causes:	Organic Enrichment	Pathogens	Siltation	Priority Organics	Habitat Alterations	Metals	Unknown
Dysart Run	S	S	H	S	S	S	
French Run		M	H				
N. Br. French Run		M					H

Table 12: Causes of impairment in the tributaries in Headwaters Blacklick Creek HUC-12

Sources:	HSTS	Contaminated Sediments	Land Development	Channelization	Urban Runoff	Unknown
Dysart Run	S	S	H	S	H	
French Run	M				H	
N. Br. French Run	M				M	H

Table 13: Sources of impairment in the tributaries in Headwaters Blacklick Creek HUC-12

All of the impaired tributaries have impervious cover exceeding 15% of the watershed. For Utzinger Ditch, that percentage is approximately 28%, which exceeds the threshold identified by the Center for Watershed Protection for a subwatershed that can support a healthy stream. The Dysart Run subwatershed has approximately 17% impervious surface, placing it in the category of impacted by impervious surface according to the Impervious Cover Model. For N. French Run, the percentage is approximately 20% and for French Run, 16%.

All of the impaired tributaries are significantly impacted by impervious surface and the resulting urban runoff. There has been more recent development in the Dysart Run subwatershed than there has been in the French Run watersheds, which would yield more impacts from land development in that subwatershed. Utzinger Ditch is further affected by raw sewage, industrial runoff and significant channelization.

The TMDL for the Big Walnut Creek watershed (*Total Maximum Daily Loads for the Big Walnut Creek Watershed,* 2005) identifies nutrients and pathogens as the pollutants of concern for Headwaters Blacklick Creek as a whole, with siltation listed as of particular concern in French Run. While agricultural practices, notably the failure of a manure lagoon, have had a significant impact on the uppermost reaches of the mainstem of Blacklick Creek, affecting pathogen levels in particular, this particular source seems to have been addressed. Discharging HSTSs are identified as the primary sources of bacteria both in Blacklick's mainstem and its tributaries. The impairments of the tributaries in the Headwaters Blacklick Creek HUC-12 are chiefly associated with the impacts of suburban development.

2.4 Additional Information for Determining Critical Areas and Developing Implementation Strategies

There have been several studies completed on the creeks in the Headwaters Blacklick Creek HUC-12 since the Ohio EPA's reports were published in 1998 and 2003. Most were undertaken by Ohio State University students, although there were two volunteer efforts and one professional study.

2.4.1 Level 2 Macroinvertebrate Sampling of the Blacklick Creek Watershed

In 2010, Kurt Keljo, a watershed coordinator at Mid-Ohio Regional Planning Commission, undertook a sampling Level 2 effort in the Blacklick Creek watershed, sampling at many of the locations sampled by the Ohio EPA in 1996/1997 and 2000/2001. The results are presented in graph form in Figure 18 and 19.

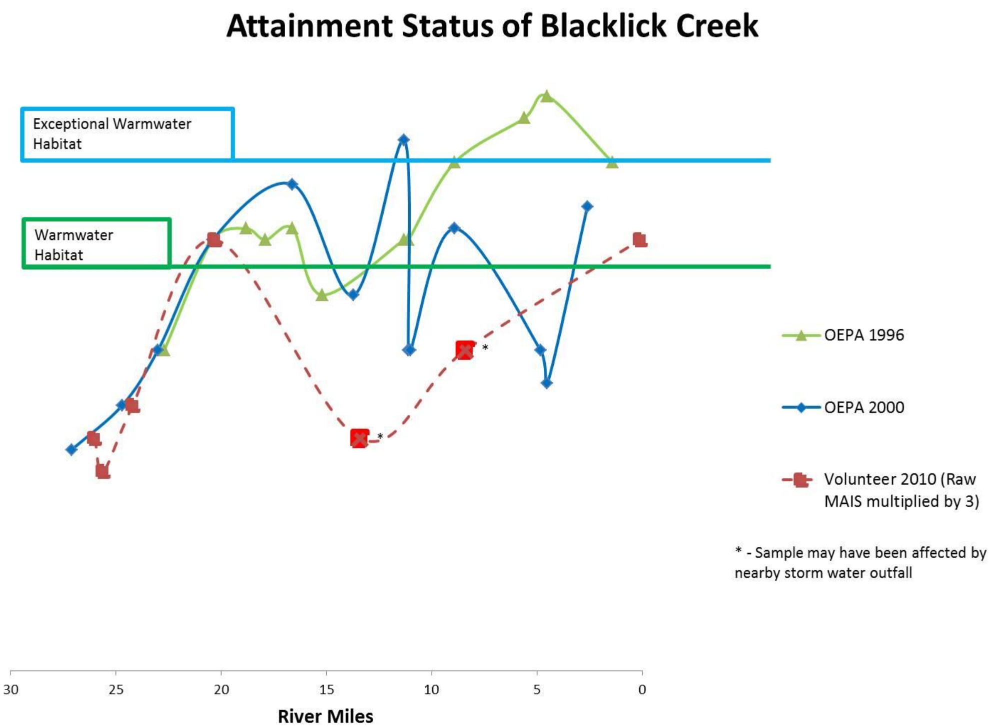

Figure 18: Data from volunteer sampling of Blacklick Creek mainstem in 2010, overlaid on Ohio EPA data.

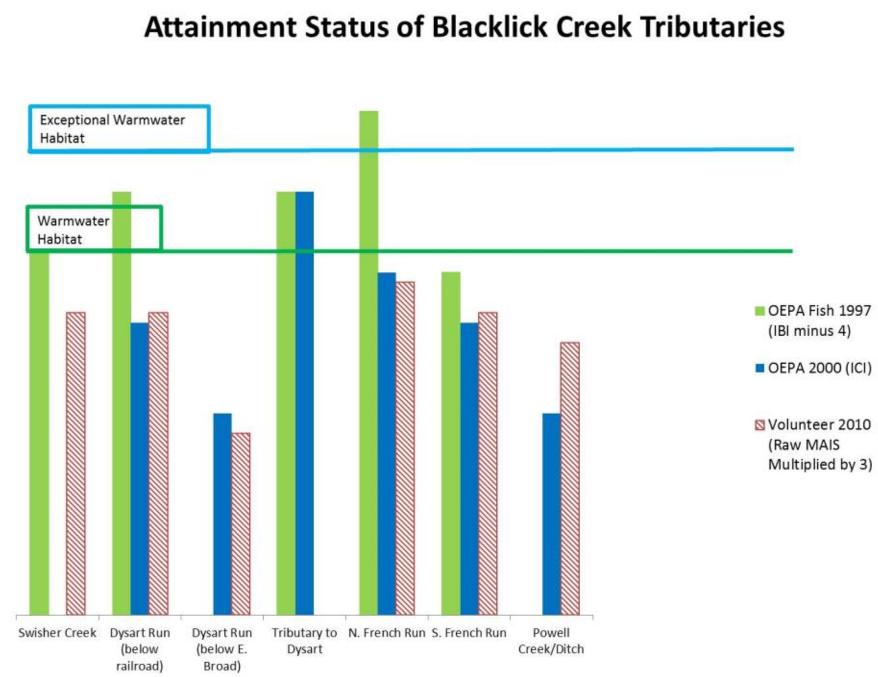

Figure 19: Data from volunteer Level 2 sampling of Blacklick Creek tributaries in 2010, overlaid on Ohio EPA data.

Inasmuch as Level 2 data is intended for trend analysis, it is difficult to make too much of the data. However, the trends reflected in the Ohio EPA data are roughly comparable to those found in the Level 2 data. There is nothing in the Level 2 data to suggest that water quality had improved in the watershed. There are some locations where the data suggest that water quality may have deteriorated, but further study would be needed to determine whether indeed that had happened.

2.4.2 EasyGel® Sampling of the Blacklick Creek Watershed from 2010

Volunteer bacteriological monitoring was also undertaken in 2010. Some of the sampling was done by Kurt Keljo in conjunction with the macroinvertebrate study described above. The remaining samples were taken by Ohio State University students as a part of a course project. The data appear in graphic form in Figures 20 and 21, combined with OEPA data from 2000. The volunteer bacteria count trends correlate reasonably well with the Ohio EPA data.

2.4.3 OSU Student Modeling of Newbury Riffles in Dysart Run

Adam Peterca (2010), a graduate student at Ohio State University, undertook a modeling study of Dysart Run using HEC-RAS software. His goal was to assess the potential impact of Newbury riffles on stream flow. His modeling study indicated that Newbury riffles could increase floodplain connectivity in Dysart Run, reducing bank erosion and downcutting in the stream.

2.4.4 OSU Class Assessment Studies of Hydrology of Dysart Run

Prof. Andy Ward's classes at Ohio State University have studied Dysart Run on two occasions, analyzing the hydrology of the creek. On both occasions, it was determined that the stream was not in equilibrium and was changing its channel to accommodate larger flows than those to which previously shaped the channel.

2.4.5 Student Thesis on Drivers of Stream Equilibrium

Matthew MacFarland (2012) wrote a master's thesis on the parameters most likely to predict instability in Central Ohio streams. Four tributaries in Headwaters Blacklick Creek HUC-12 were included in the study. Two of the streams are unnamed tributaries that the Ohio EPA has not sampled. Two are named, Cole Ditch and Dysart Run, one of which was sampled by the OEPA—Dysart Run. MacFarland developed a "Qualitative Stream Geomorphology Classification." The classification scores for the four streams in the Blacklick Creek watershed ranged from 26 for Cole Ditch (more stable) to 9 for Dysart Run (less stable). The unnamed tributaries had scores between these two, 11 and 12. A score of 13 was identified as the break point for equilibrium. Streams scoring above 13 were found to be in equilibrium, and those scoring below 13 were out of equilibrium. The percent of the watershed that had been developed and the characteristics of the flood plain width were the two parameters that could be used to accurately predict the equilibrium status of streams in all ten watersheds in the study.

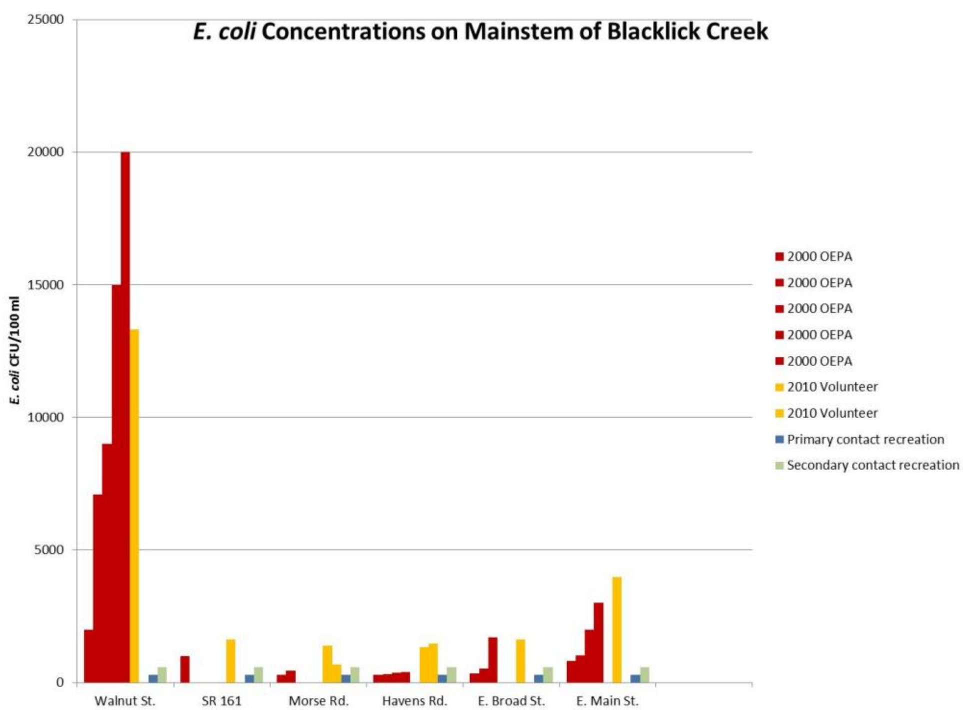

Figure 20: *E. coli* data collected by Ohio EPA in 2000 and volunteers in 2010 on Blacklick mainstem

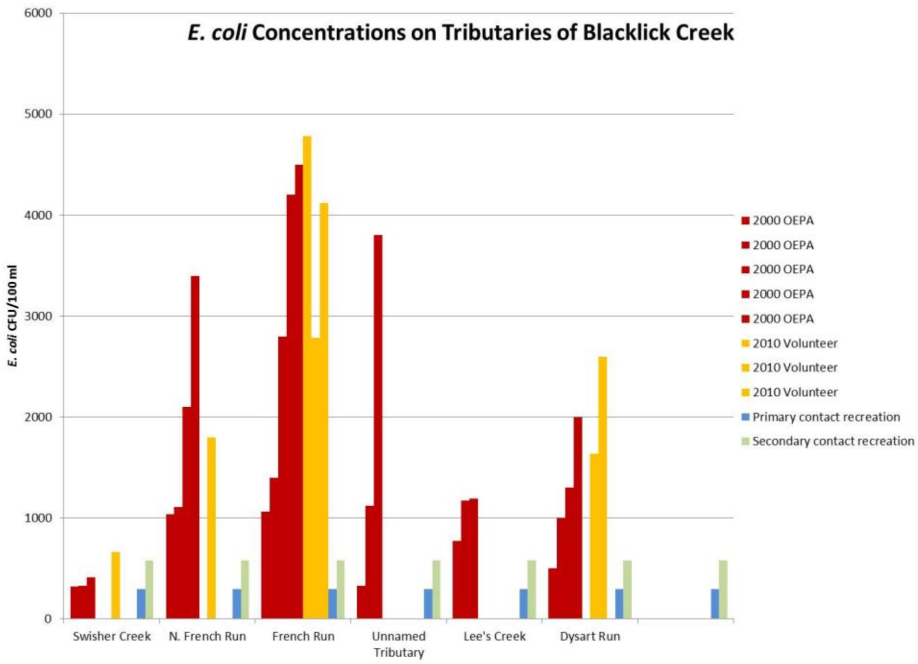

Figure 21: ***E. coli*** **data collected by Ohio EPA in 2000 and volunteers in 2010 on Blacklick tributaries**

2.4.6 Midwest Biodiversity Institute (MBI) Sampling

In the summer and early fall of 2016, MBI sampled two sites on Dysart Run, using Level 3 methods. The first site coincided with the Ohio EPA's sampling site in 2000 at RM 3.0. In 2016, the stream was found to be in attainment for both macroinvertebrates and fish (IBI – 44). The ICI score had improved from Fair to Marginally Good. The second site was on the Unnamed Tributary to Dysart sampled by the Ohio EPA in 2000 (see Figure 22). Here the fish continued to be in attainment (IBI – 48), while the macroinvertebrates were not (fair to poor (final narrative assessment not complete). In both cases, QHEI scores were acceptable, 65.5 for the first site and 76.5 for the second site.

Figure 22: Dysart Run Tributary near 2016 sampling site

Chapter 3: Critical Area Conditions & Restoration Strategies

3.1 Overview of Critical Areas

There are five streams/reaches of stream that were found to be in non-attainment in the Headwaters Blacklick Creek HUC-12: the headwaters of the Blacklick Creek mainstem, Utzinger Ditch, North French Run, French Run and Dysart Run (Figure 24). Of these, at least four have the potential to be selected for critical areas. Utzinger Ditch has been designated as Limited Use Water Resource (LWR) and is likely in attainment of those standards. Restoration efforts in this watershed have also already been undertaken by the Ohio EPA.

The primary sources of impairment of the reaches of Blacklick north of Morse Road are identified as HSTSs and a manure lagoon. The manure lagoon has been repaired, and addressing HSTSs is a long term project, already being undertaken by Franklin County Public Health. In the not-so-distant future, development in this part of the watershed could begin to impact water quality. Working to adopt development standards that would prevent impervious surfaces from having this impact would be an important task in this impaired section of the watershed (see relevant tables and figures in Section 2.1.2 above).

The impairments identified for French Run are identified primarily as urban runoff and land development, with HSTS contributing to a moderate degree. Urban runoff and HSTSs are also identified as sources of impairment in North French Run (see Figure 23). Looking for ways to address the effluent from discharging HSTSs is a challenge facing the entire Headwaters Blacklick Creek HUC-12. The strategies for the critical area to be focused on at this point in the development of the plan, Dysart Run, are all relevant to these subwatersheds as well.

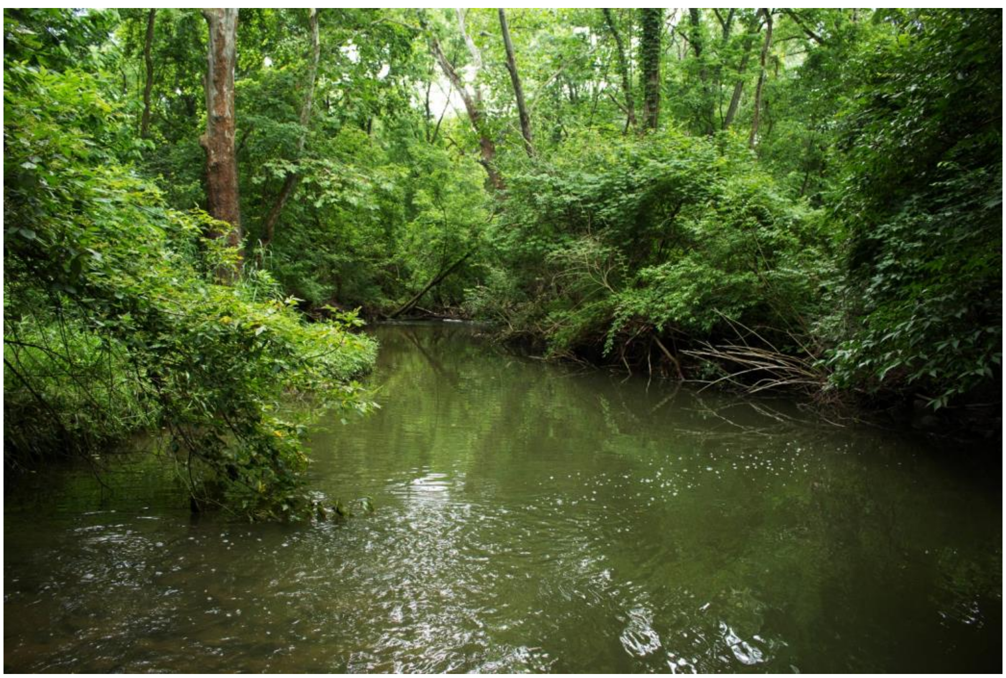

Figure 23: North French Run adjacent to French Run Elementary School

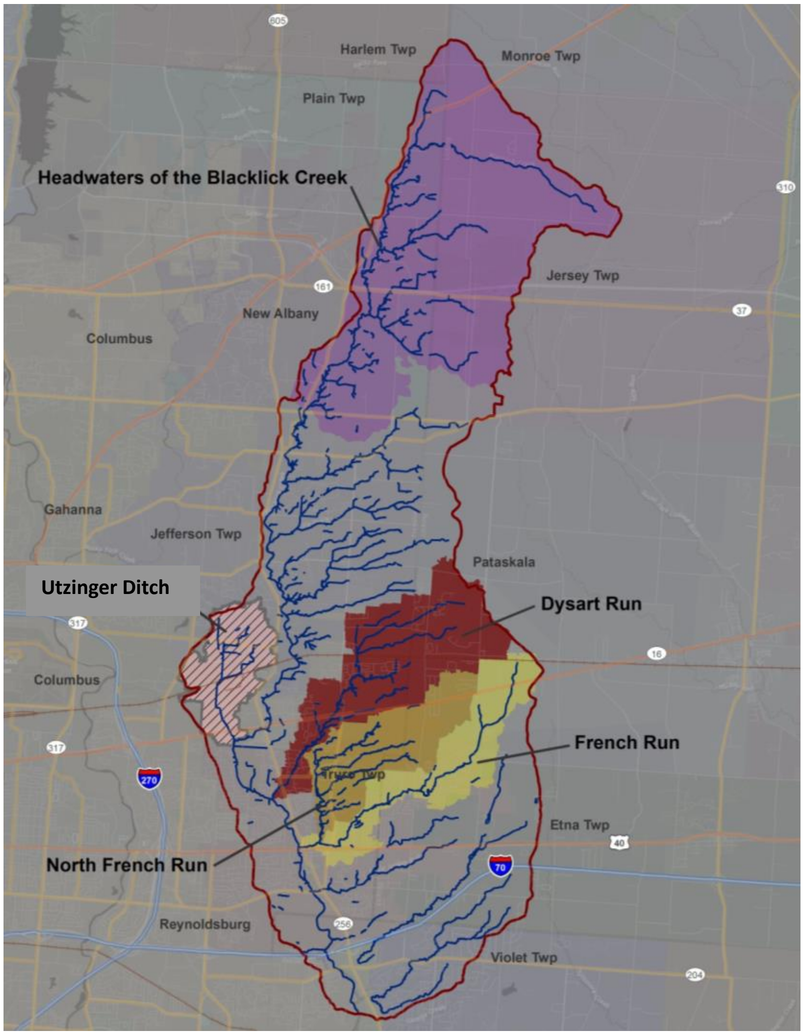

Figure 24: Overview of critical areas

The impairments of Dysart Run are attributed primarily to land development and urban runoff. Multiple hydrological studies have been done involving this watershed, indicating that the stream is out of equilibrium. Erosion problems are creating major problems for streamside landowners in Reynoldsburg. The sediment in this stream may well be degrading the mainstem of Blacklick Creek in Reynoldsburg. There are steps that have been taken and others that could be taken to both restore and protect the streams in the entire subwatershed, including implementing a creek restoration project. In addition, there is also potential funding support for that project. A commercial entity, Meijer Inc., has been a partner in looking at ways to restore the watershed and will be implementing a demonstration project in the near future. In sum, Dysart Run is an impaired creek that may well be degrading the mainstem on Blacklick, but could be both restored and protected. Dysart also has a group of invested stakeholders. As a result, Dysart Run has been selected as the first critical area to focus on in the Headwaters Blacklick Creek HUC-12 (see Figure 25).

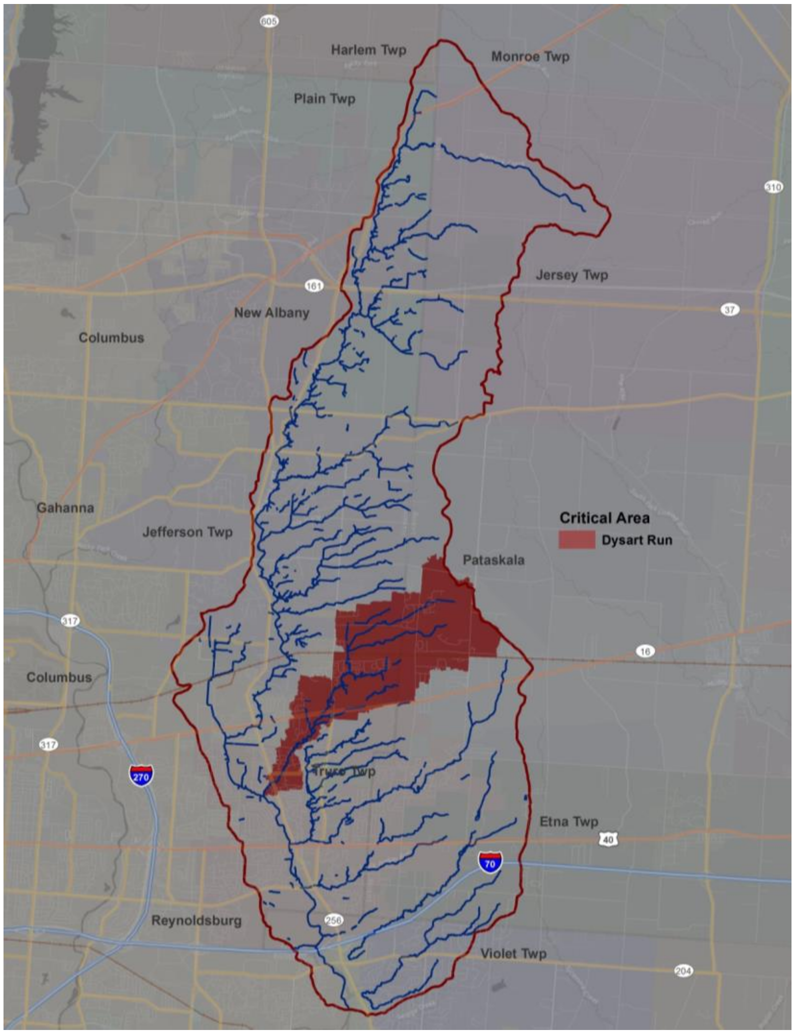

Figure 25: Dysart Run within Headwaters of Blacklick Creek HUC-12

3.2 Critical Area 1: Conditions, Goals & Objectives for Dysart Run

3.2.1 Detailed Characterization

The Dysart Run subwatershed is a 4.58 mi^2 in size, located in the heart of Headwaters Blacklick Creek HUC-12. The watershed extends from 82°45'41.538"W 40°1'14.763"N in the northeast corner to 82°48'41.566"W 39°58'0.729"N, where Dysart Run enters the mainstem of Blacklick Creek at RM 14.64. Five jurisdictions, Columbus, Jefferson Township, Pataskala, Reynoldsburg , and Truro Township, contain portions of the watershed. Columbus contains the largest portion of the watershed (42%) followed by Pataskala (32%), Jefferson Township (13%), Reynoldsburg (12%) and Truro Township (<1%). MacFarland (2012) estimated that 65% of the watershed had been developed by 2012, 63% of that total having been developed since 2001. Franklin Soil and Water's analysis indicates that the percentage of impervious cover in the watershed is on the order of 18-20% (see Figure 26). Based on the Impervious Cover Model described above, this figure places the watershed above the threshold for being impacted by impervious surface.

Land development and urban runoff are identified as the primary sources of impairment for the stream, with HSTSs playing a minor role. While the percentage of impervious surface is already over the threshold for stream impact, on the order of 35% of the watershed has not yet been developed, and most of this remaining acreage is expected to be developed in the future.

There is major bank erosion along the stream in Reynoldsburg. At the site of two properties along the stream on the order of 250 yd^3 of stream bank has eroded each year during the past ten years (see Figure 26). This erosion has taken place below the Ohio EPA's sample site and therefore is not reflected in any data that has been collected.

Figure 26: Major bank erosion along Dysart Run in Reynoldsburg

QHEI scores seem to reflect urbanization in the watershed. The sites furthest upstream in heavily urbanized sections of the watershed are those with the lowest QHEI scores (RM 3.0 on the mainstem and RM 0.2 on the tributary at RM 2.52). At both of these sites there has been significant development just upstream, including channelization of the streams. Higher QHEI scores at the other two Dysart Run sites likely reflect the protection of the stream corridor at those sites and for extended reaches upstream. By 2016, the QHEI score at RM 3.0 had increased from 49 (in 2000) to 67.5, suggesting that this reach of stream had begun to recover from the impacts of urbanization.

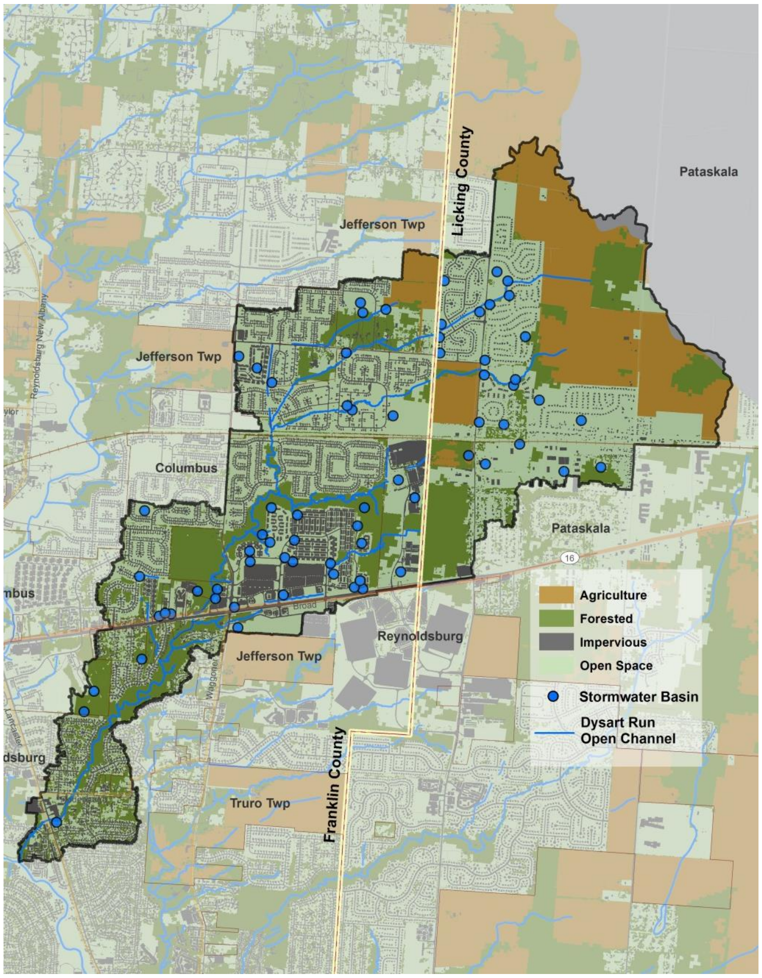

Figure 27: Land use and stormwater basins in the Dysart Run subwatershed

3.2.2 Detailed Biological Conditions

Four sites in the watershed have been sampled by the Ohio EPA, two on the mainstem of the creek (RM 3.0 and 1.9) and two on tributaries to the mainstem, one at RM 2.52 (RM 0.1 on the tributary) and a second at RM 1.67 (RM 0.2 on the tributary). The tributaries were never sampled for macroinvertebrates, but the IBI scores in 1997 at the first site (46) and in 2000 at the second site (42) placed the streams in full attainment of WWH standards. The mainstem of Dysart was only sampled in 2000, and was found to be in partial attainment at RM 3.0 (IBI – 40, ICI – Fair) and non-attainment at RM 1.9 (IBI – 42, ICI – Poor).

Impairment in the Dysart Run watershed is not reflected in IBI scores. All of the fish samples taken in the watershed were in attainment of WWH standards. Conversely, in 2000 all of the ICI scores failed to meet WWH standards (see Tables 9 and 14). The 2000 Big Walnut TSD notes with regard to Dysart and a number of other tributaries in the Blacklick Creek watershed, "Diversity of EPT taxa and sensitive taxa were low and the riffle habitats were at least in part predominated by pollution facultative taxa like blackflies, *Tipula* craneflies, and flatworms. One likely source of impairment in these streams was the urbanized nature of the surrounding area." (p. 188) By 2016, the macroinvertebrate community at RM 3.0 on Dysart Run had improved to the point of achieving a marginally good rating, reflecting some recovery from the impacts of urbanization and mirroring the improvement in the QHEI score noted above. However, it is important to note that the macroinvertebrates collected in 2001 for the site at RM 3.0 were actually collected well downstream at RM 2.1. As a result, it is not possible to determine whether or not the macroinvertebrate population scored as Fair in 2001 has come into attainment of WWH standards since that site was not sampled in 2016.

In 2016, the tributary site sampled in 1997 continued to have a robust IBI score (48), but the macroinvertebrate population was in much poorer shape than expected with only one EPT taxon present. The cause of this degradation of the macroinvertebrate community is unknown.

Qualitative Evaluation[b]						
Stream River Mile	No. Taxa	No. EPT[a]	I&MI Taxa[e]	Relative Density	Predominant Organisms	Narrative Evaluation
Dysar Run (Trib. to Blacklick Cr. (RM 14.64)) (02-281) Eastern Cornbelt Plains (WWH - Existing)						
3.1[d]	29	4	8	Low-Mod.	Blackflies, hydropsychid caddisflies	Fair
1.6	10	0	2	Low	Tipula craneflies	Poor

a EPT = total Ephemeroptera (mayflies), Plecoptera (stoneflies) and Trichoptera (caddisflies) taxa richness.
b A qualitative narrative evaluation based on best professional judgement is used when quantitative data is not available to calculate the Invertebrate Community Index (ICI) scores.
d Sample was collected in 2001 and may be replacing a 2000 sample.
e Sensitive taxa include I=intolerant taxa and MI=moderately intolerant taxa.

Table 14: Detailed macroinvertebrate data for Dysart Run samples

3.2.3 Detailed Causes and Associated Sources

The primary sources of impairment in the Dysart Run watershed are land development and urban runoff. MacFarland's data indicate that 65% of the watershed was developed by 2012 and at least 65% of the development in the watershed had taken place since 2001. The OEPA sampled the RM 3.0 site on Dysart in 2001. Urban runoff has likely increased at this site over the years since 2001, but the amount of land development occurring immediately upstream from RM 3.0 in 2001 has significantly has decreased. In addition, erosion and sediment control practices have improved significantly in the years since the developments just north of RM 3.0 were put in. This suggests that land development and the associated sediment discharge has a more significant impact on the QHEI RM 3.0 than did urban runoff. It is impossible to say whether or not the impact on the macroinvertebrate population over the years had decreased or increased, since they were not samples at RM 3.0 in 2001.

The percentage of impervious surface is on the order of 18-20%, exceeding the impact threshold identified the Impervious Cover Model, indicating that impervious surfaces would be expected to have a negative impact on Dysart Run. The percentage is approaching the transition zone from "impacted" to "non-supporting." The amount of impervious surface would seem to be directly linked to the disequilibrium of the stream. The major cause of impairment—sediment—would be logically connected to the significant urban runoff coming off of the hard surfaces in the watershed.

Minor sources of impairment in the watershed are listed as HSTSs, channelization and contaminated sediments. There are 56 known discharging HSTSs in the Dysart Run watershed—a significant number. However, the bacteria counts are not commensurate with that concentration of HSTSs, and the Ohio EPA assessed pathogens as only a slight contributor to impairment of the stream. Similarly, the impairments caused by metals and priority organics which are associated with contaminated sediment, and those resulting from modified habitat (i.e. channelization) were also assessed as slight.

Of the causes and sources of impairment in the watershed, urban runoff is likely to increase in the foreseeable future, with further development expected in the wayershed. While the intensity of land development is not expected to parallel that realized in the late 1990s and early 2000s, the increase in impervious surface would have a significant impact on the stream, unless significant changes to stormwater management strategies are made in any new developments (see Tables 15 -18, The appendix has details regarding the generation of these tables.).

Subwatershed	Area (ac)	Land Cover (%)				Composite RCN	Time of Concentration
		Row Crop	Open Space	Woods	Impervious*		
Dysart Run	2,925	11	50	22	17	76	4 hrs 58 min

*Hard surface (e.g., roads, parking lots, sidewalks, rooftops, etc.)

Table 15: Subwatershed existing condition

Design Storm (recurrence interval)	Dysart Run	
	PFR[1] (cfs)	RV[2] (ac-ft)
1-yr	200	130
2-yr	320	190
5-yr	500	290
10-yr	670	380
25-yr	920	510
50-yr	1,140	630
100-yr	1,380	750

1. PFR – Peak Flow Rate
2. RV – Runoff Volume

Table 16: Existing peak flow rates and runoff volumes

Design Storm (recurrence interval)	Existing Condition		10% Increased Imperviousness				20% Increased Imperviousness			
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]
1-yr	200	130	260	29	160	24	310	50	180	41
2-yr	320	190	390	23	230	20	450	41	250	34
5-yr	500	290	600	19	340	16	660	32	370	27
10-yr	670	380	780	16	430	14	850	27	470	24
25-yr	920	510	1,050	14	570	12	1,130	23	610	20
50-yr	1,140	630	1,280	12	690	10	1,370	20	740	18
100-yr	1,380	750	1,530	10	820	9	1,630	17	870	16

1. PFR – Peak Flow Rate
2. RV – Runoff Volume
3. %Δ - Percent change as compared to existing condition

Table 17: Dysart Run peak flow rates and runoff volumes – future development

	Existing Condition			10% Increased Imperviousness			20% Increased Imperviousness		
	TSS	TP	TKN	TSS	TP	TKN	TSS	TP	TKN
Load[1]	230	2,090	9,340	310	3,000	14,010	400	3,910	18,690
Yield (lbs/ac/year)	156	0.7	3.2	213	1.0	4.7	270	1.3	6.3
%Δ[2]	--	--	--	37%	43%	50%	73%	87%	100%

1. Load is expressed as tons/year for TSS and pounds/year for TP and TKN
2. %Δ - Percent change as compared to existing condition

Table 18: Dysart Run estimated annual pollutant loads and yields – future development

3.2.4 Outline Goals and Objectives for Critical Area 1

As explained in detail above, Critical Area 1 is primarily impaired by sediment due to land development and urban runoff, with minor impacts from HSTS effluent, channelization and contaminated sediments.

Goals

The overarching goal for this NPS-IS plan is to improve the IBI, MIwb, ICI, and QHEI scores in the Dysart Run subwatershed so that sites in partial or non-attainment status can reach full attainment of the designated WWH aquatic life use. Dysart Run is in non-attainment at the site farthest downstream. The fish community meets WWH standards, but the macroinvertebrate community does not. There is considerable erosion downstream from that sample site (see Figure 28) which reflects a stream in disequilibrium. In other words, downstream reaches of Dysart Run are likely further impaired and threaten the mainstem of Blacklick Creek in Headwaters Blacklick Creek HUC-12. The primary goal for Critical Area 1 is to bring its ICI scores into full attainment of WWH standards at the established sampling sites. A secondary goal, which will likely be met via achieving the primary goal, is to restore the stream to a state of dynamic equilibrium. Specific goals:

Goal 1. Achieve an ICI rating of good at RM 3.0 on Dysart Run.
- NOT ACHIEVED: Site currently has a rating of marginally good

Goal 2. Achieve an ICI rating of at least marginally good at RM 2.1 on Dysart Run.
- NOT ACHIEVED: Site had a rating of fair in 2001 and has not been sampled since

Goal 3. Achieve an ICI rating of at least marginally good at RM 1.6 on Dysart Run.
- NOT ACHIEVED: Site had a rating of poor in 2000 and has not been sampled since

Goal 4. Achieve an ICI rating of at least marginally good at RM 0.1 on the tributary joining Dysart Run at RM 2.52.
- NOT ACHIEVED: Site currently has a rating of fair-poor

Goal 5. Restore the stream to a state of dynamic equilibrium below E. Broad St.
- NOT ACHIEVED: Using a weight of evidence approach the stream has been assessed as in disequilibrium at all three sites studied below E. Broad St.


Figure 28: Erosion and high flows on Dysart Run

Objectives

In order to achieve the overall nonpoint source restoration goal of restoring full attainment to the Headwaters Blacklick Creek HUC-12, the following objectives need to be achieved within Critical Area 1.

Objective 1. Increase stream access to its flood plain, reduce erosion and stream instability, and reduce sediment, nutrient and pathogen loads in the stream reaches north of the Pennsylvania Baltimore Railroad tracks.

- Install stream inserts that function like Newbury riffles in at least 1000' of stream (see Figure 29).
- Enhance stream buffer by planting trees along 200' of stream.

Objective 2. Reduce the rate of stormwater runoff and improve the water quality of that runoff from hard surfaces in the entire watershed.

- Retrofit the stormwater features handling the runoff from approximately 200 acres of impervious so as to slow their release rates and increase retention time.

Objective 3. Eliminate stormwater impacts from any future development in the subwatershed.

- Establish stormwater management standards in the Dysart Run subwatershed that would require green infrastructure and/or stormwater release rates that would prevent future degradation of the streams in the watershed by any new development from.

Objective 4. Protect the mainstem of Blacklick Creek from degradation in the City of Reynoldsburg.

- Implement any feasible bank stabilization projects along major eroding banks in Reynoldsburg.

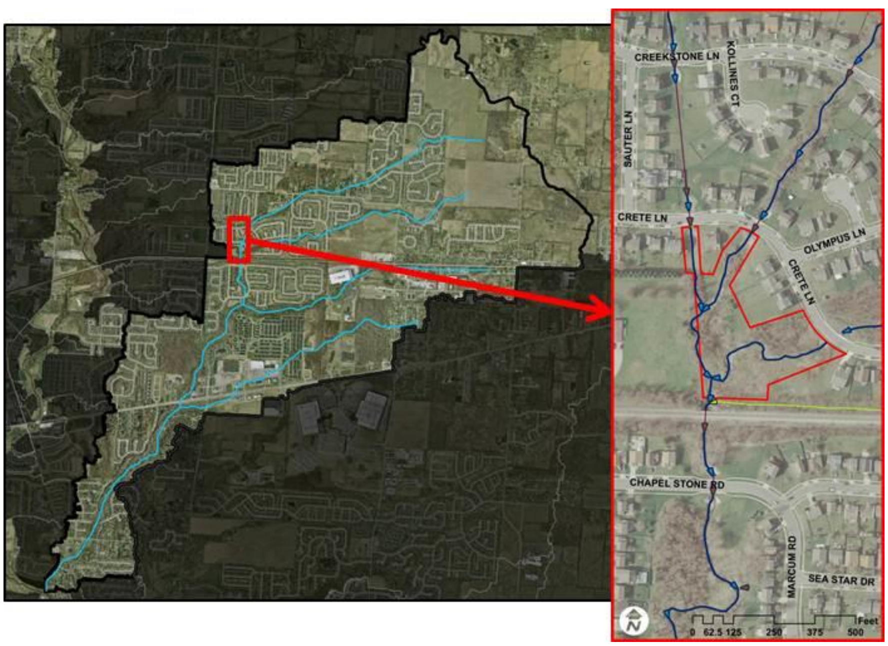

Figure 29: Stream restoration project location in Dysart Run subwatershed

Chapter 4: Projects and Implementation Strategy

4.1 Overview Tables and Project Sheets for Critical Areas

The projects believed to be needed to restore the creeks in Critical Area 1, the Dysart Run subwatershed, to full attainment and keep in in attainment are outlined below. The effect of these projects will not be immediate. In the case of the stream restoration project, the effectiveness of the stream inserts at improving water quality is expected to increase over time. Similarly, the stream habitat will take time to recover. It may be discovered that additional projects are needed. Some potential projects are identified in the report in the Appendix provided by EMH&T. Any projects requiring grant funding in particular would be submitted to the Ohio EPA for approval.

Additional critical areas will need to be identified and projects developed to fully remove the impairments resulting from nonpoint source pollution in the entire Headwaters Blacklick Creek HUC-12. Potential critical areas have been identified above, based on past sampling of the entire watershed, along with some potential strategies for addressing the impairments in those areas. As additional critical areas are identified, appropriate sections will be added to this plan, including summary tables and project sheets. Any changes/additions to the plan will be submitted to the Ohio EPA for approval.

4.2 Critical Area 1: Overview Table and Project Sheet(s) for Dysart Run Subwatershed

The Critical Area 1 Overview Table provided an abbreviated overview of all the projects identified for addressing nonpoint source pollution and he restoring the streams in Critical Area 1 for Headwaters Blacklick Creek HUC-12. Project Summary Sheets are included for short term projects or any project for which grant funding is needed in the near future. Only those projects with complete Project Summary Sheets will be considered for state and federal nonpoint source program funding.

4.2.1 Critical Area 1: Project and Implementation Strategy Overview Table

The Headwaters Blacklick Creek HUC-12 Critical Area 1 was determined based on the partial attainment status of WWH aquatic use standards at RM 3.0/2.1 of Dysart Run and the non-attainment status at RM 1.9/1.6. The Critical Area 1 Overview Table provides a quick summary of what needs to be done, where, and what problem (cause/source) will be addressed and includes projects at all levels of development (i.e. concept, need funding, in progress). This Overview Table is intended to show a prioritized path toward the restoration of Dysart Run subwatershed, which is a step towards the full restoration of the Headwaters Blacklick Creek HUC-12.

Critical Area 1: Project Overview Table for Headwaters Blacklick Creek HUC-12 (05060001 15 03)							
Goal	**Objective**	**Project #**	**Project Title**	**Lead Organization**	**Time Frame**	**Estimated Cost**	**Potential/Actual Funding Source**
Urban Sediment and Nutrient Reduction Strategies (Ohio EPA, 2013)							
1,2,3,4,5	2,4	3	Dysart Run Stormwater Basin Retrofits	Franklin Soil and Water Conservation District	Short-Medium	$500,000 to $2.3 million	Homeowners' Associations, Individuals, Jurisdictions, Commercial entities, WRRSP
1,2,3,4,5	3,4	4	Stormwater Management Standards Establishment	Franklin Soil and Water Conservation District	Short-Medium	$5,000	Franklin Soil and Water Conservation District and its partners
Altered Stream and Habitat Reduction Strategies (Ohio EPA, 2013)							
1, 2, 3, 4	1	1	Dysart Run Stream Insert Restoration	Franklin Soil and Water Conservation District	Short	$50,000	Ohio EPA §319, City of Reynoldsburg

			– Crete Ln. to Railroad				

Critical Area 1: Project 1		
Nine Element Criteria	**Information Needed**	**Explanation**
n/a	Title	Dysart Run Stream Insert Restoration – Crete Ln. to Railroad
criterion d	Project Lead Organization and Partners	Franklin Soil and Water Conservation District, Columbus Recreation and Parks, and the City of Reynoldsburg
criterion c	HUC-12 & Critical Area	Headwaters Blacklick Creek HUC-12 (050600011503) in the Dysart Run subwatershed
criterion c	Project Location	On headwater streams between Crete Ln. and railroad tracks,
n/a	Which strategy is being addressed by this project?	Altered Stream and Habitat Restoration Strategy
criterion f	Time Frame	Short (1-3 years)
criterion g	Short Description	Install 15-20 stream inserts (modified Newbury Riffles/cross vanes) within 1300' of headwater stream
criterion g	Project Narrative	Three streams come together in this area to form the mainstem of Dysart Run. They are causing bank erosion, reflecting the instability of this creek, and lack adequate vegetated buffer in some locations. The project will redirect flow to address bank erosion, create new riffle and pool habitat, increase the streams pollutant processing capacity and increase the stream buffer.
criterion d	Estimated Total Cost	$50,000
criterion d	Possible Funding Source	Ohio EPA §319, the City of Reynoldsburg
criterion a	Identified Causes and Sources	Causes: TSS and Nutrients Sources: Urban Runoff, Land Development and HSTSs
Criteria b & h	Part 1: How much improvement is needed to remove the NPS impairment associated with this Critical Area?	The ICI on a mainstem site was only rated as marginally good (MG). At a second, downstream site, the ICI was rated as fair (F). At the site furthest downstream, the ICI was rated as poor (F). On a tributary, the ICI was rated at fair to poor. The goal is to raise all of these ICI narrative ratings to good.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	This project could result in as much as 25% of the improvement needed for the whole critical area. It could raise the ICI of the first site from marginally good to good, the second site from fair to marginally good and the third site from poor to low fair.
	Part 3: Load reduced?	Nitrogen (pounds/year): 180 Pathogen load reduction is also expected. Phosphorus (pounds/year): 46 Sediment (tons/year): 38
criterion i	How will the effectiveness of this project in addressing the NPS impairment be measured?	If the project is funded by the Ohio EPA, the Ohio EPA will monitor the project before and after implementation. Level 2 volunteer monitoring will also be used to track trends associated with project implementation.
criterion e	Information and Education	Signage will be placed at the project site. Volunteers will be provided information on the project and learn firsthand about its impacts. A workshop on the project will be held. Residents concerned about the creek will be provided information about the project. The project will be described in Franklin Soil and Water newsletters and on the agency's website. There will be press releases on the project and a fact sheet will be developed and distributed. The results of the project will be presented at relevant conferences as appropriate.

Deleted: ¶

Critical Area 1: Project 2		
Nine Element Criteria	**Information Needed**	**Explanation**
n/a	Title	Dysart Run Stormwater Basin Retrofits
criterion d	Project Lead Organization and Partners	Franklin Soil and Water Conservation District, Reynoldsburg, Columbus, Pataskala
criterion c	HUC-12 & Critical Area	Headwaters Blacklick Creek HUC-12 (050600011503) in the Dysart Run subwatershed
criterion c	Project Location	Throughout the Dysart Run watershed
n/a	Which strategy is being addressed by this project?	Urban Sediment and Nutrient Reduction Strategy
criterion f	Time Frame	Short (1-3) to Medium (3-7) This project would likely be broken into multiple subprojects. Timing hinges on funding and site availability
criterion g	Short Description	Retrofit stormwater basins receiving runoff from 200 acres of impervious surface
criterion g	Project Narrative	Priority stormwater basins will be identified in the watershed, based on amount of stormwater treated, capacity for retrofitting, cost of retrofitting and availability for retrofitting. As funding and sites become available, basins will be retrofitted in the most cost effective ways possible, according to the priorities established above.
criterion d	Estimated Total Cost	$500,000 to $2.3 million
criterion d	Possible Funding Source	Homeowners' Associations, Individuals, Jurisdictions, Commercial entities, WRRSP
criterion a	Identified Causes and Sources	Causes: TSS and Nutrients Sources: Urban Runoff
Criteria b & h	Part 1: How much improvement is needed to remove the NPS impairment associated with this Critical Area?	The ICI on a mainstem site was only rated as marginally good (MG). At a second, downstream site, the ICI was rated as fair (F). At the site furthest downstream, the ICI was rated as poor (F). On a tributary, the ICI was rated at fair to poor. The goal is to raise all of these ICI narrative ratings to good.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	This project could result in as much as 100% of the improvement needed for the whole critical area.
	Part 3: Load reduced?	Nitrogen (pounds/year): 1,000 Phosphorus (pounds/year): 500 Sediment (tons/year): 100 Load reduction will vary based on the selection and number of stormwater basin retrofits completed, the existing sediment and nutrient load in the tributary area to each stormwater basin, and the effectiveness of the retrofit. In general terms, such retrofits may be expected to have removal rates of approximately 25%, 35% and 75% for total nitrogen, total phosphorus and total suspended solids, respectively. Based upon the estimated current pollutant loading for the Dysart subwatershed, and assuming approximately 50% of the subwatershed is tributary to a stormwater basin, implementing stormwater basin retrofits across the entire subwatershed may provide approximate load reductions as listed above.
criterion i	How will the effectiveness of this project in addressing the NPS impairment be measured?	If any retrofit projects overlap with the Ohio EPA stream monitoring for Project 1, that monitoring could provide some information related to this project. Ongoing volunteer monitoring will also provide some trend data vis a vis macroinvertebrate populations.
criterion e	Information and Education	Residents concerned about the creek will be provided information about the project. The project will be described in Franklin Soil and Water newsletters and on the agency's website. The results of the project will be presented at relevant conferences as appropriate.

Critical Area 1: Project 3		
Nine Element Criteria	**Information Needed**	**Explanation**
n/a	Title	Stormwater Management Standards Establishment
criterion d	Project Lead Organization and Partners	Franklin Soil and Water Conservation District
criterion c	HUC-12 & Critical Area	Headwaters Blacklick Creek HUC-12 (050600011503) in the Dysart Run subwatershed
criterion c	Project Location	
n/a	Which strategy is being addressed by this project?	Urban Sediment and Nutrient Reduction Strategy
criterion f	Time Frame	Short (1-3 years) to medium (3-7 years)
criterion g	Short Description	Establish stormwater standards to minimize stormwater runoff from new development in the watershed
criterion g	Project Narrative	Franklin Soil and Water Conservation District will work with jurisdictions in the watershed to establish stormwater management standards that will minimize stormwater runoff from new development in the watershed.
criterion d	Estimated Total Cost	$5,000
criterion d	Possible Funding Source	Franklin Soil and Water and its partners.
criterion a	Identified Causes and Sources	Causes: sediment Sources: land development
Criteria b & h	Part 1: How much improvement is needed to remove the NPS impairment associated with this Critical Area?	The ICI on a mainstem site was only rated as marginally good (MG). At a second, downstream site, the ICI was rated as fair (F). At the site furthest downstream, the ICI was rated as poor (F). On a tributary, the ICI was rated at fair to poor. The goal is to raise all of these ICI narrative ratings to good.
	Part 2: How much of the needed improvement for the whole Critical Area is estimated to be accomplished by this project?	The project will not address the impairments identified above but it will address future impairments.
	Part 3: Load reduced?	There are too many variable to assess with any precision. Without these new measures, TSS could increase by as much as 170 tons/yr., TP by 1,820 lbs./yr. and TKN by 9,350 lbs./yr.
criterion i	How will the effectiveness of this project in addressing the NPS impairment be measured?	Ongoing volunteer monitoring will also provide some trend data vis a vis macroinvertebrate populations.
criterion e	Information and Education	Franklin Soil and Water will provide information on the project on its website and in its newsletters.

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Appendix: Project Report – EMH&T

INTRODUCTION

EMH&T was engaged by the Franklin Soil and Water Conservation District (FSWCD) to provide professional consulting services in regard to FSWCD's Blacklick Creek 319 Planning Grant. Blacklick Creek is a tributary of Big Walnut Creek located primary in eastern Franklin County and western Licking County, Ohio. These services included:

- As assessment of the impact of existing impervious surface within specific critical subwatersheds of Blacklick Creek;
- A discussion of the likely implications of future development on watershed hydrology and water quality within critical subwatersheds;
- A proposed strategy for preventing the degradation of Blacklick Creek and its tributaries as a result of future development; and
- Strategies for restoring the Dysart Run subwatershed and the Blacklick Creek mainstem, including potential costs.

At the request of FSWCD, the six critical subwatersheds examined include Dysart Run, French Run, Little Jordan Tributary, Utzinger Ditch, Fieldstone Tributary,* and Jefferson Tributary.** The requested information is presented herein, for the use of FSCWD in the larger watershed planning document.

HYDROLOGIC ANALYSIS

Existing Conditions

In order to assess the impact of existing impervious surface within each of the six critical subwatersheds, peak flow rates and runoff volumes were estimated using Natural Resources Conservation Service (NRCS) methodology and the HydroCAD computer program. Using standard NRCS methodology, the existing land cover and soil types within each subwatershed were utilized to determine hydrologic parameters, such as the Runoff Curve Number (RCN) and Time of Concentration.

Table 1. Subwatershed Existing Conditions

Subwatershed	Area (ac)	Land Cover (%)				Composite RCN	Time of Concentration
		Row Crop	Open Space	Woods	Impervious *		
Dysart Run	2,925	11	50	2	17	76	4 hrs 58 min
French Run	3,648	7	47	3	18	77	4 hrs 39 min
Little Jordan	1,416	15	43	26	15	77	2 hrs 47 min
Utzinger Ditch	1,237	1	51	21	28	77	4 hrs 26 min
Fieldstone	1,136	31	29	2	7	74	3 hrs 5 min
Jefferson	453	16	51	12	16	77	1 hr 40 min

*Hard surface (e.g., roads, parking lots, sidewalks, rooftops, etc.)

* - Fieldstone Tributary is an unnamed tributary entering Blacklick Creek at RM 18.77.
** - Jefferson Tributary is an unnamed tributary entering Blacklick Creek at RM 18.5.

As shown in Table 1, Dysart Run and French Run have the largest subwatershed areas with a similar percentage of impervious area. The calculated RCNs presented in Table 1 are indicative of watersheds impacted by some amount of urbanization. Even though the majority of each subwatershed is not impervious, there is the potential for hydrologic impacts associated with the existing level of urbanization.

Using this information, the peak flow rate of stormwater runoff for each subwatershed was calculated for the 1-, 2-, 5-, 10-, 25-, 50-, and 100-year design storm events using the NRCS TR-55 methodology. This analysis reflects the NRCS Type II distribution, 24-hr storm duration. Rainfall depths were obtained from NOAA Atlas 14, Volume 2, Version 3, 2004. The peak flow rates were computed using HydroCAD 10.0. The results of this analysis are presented in Table 2.

Table 2. Existing Peak Flow Rate & Runoff Volume

Design Storm (recurrence interval)	Subwatershed Area											
	Dysart Run		French Run		Little Jordan		Utzinger		Fieldstone		Jefferson	
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	RV[2] (ac-ft)
1-yr	200	130	300	170	170	70	100	60	90	40	80	20
2-yr	320	190	460	250	260	100	160	80	150	60	120	30
5-yr	500	290	710	380	410	150	250	130	250	100	190	50
10-yr	670	380	940	490	540	190	330	170	340	130	260	60
25-yr	920	510	1,280	660	740	260	450	220	480	180	350	80
50-yr	1,140	630	1,570	800	910	310	550	270	600	230	430	100
100-yr	1,380	750	1,890	960	1,090	370	660	330	730	270	520	120

1. PFR – Peak Flow Rate
2. RV – Runoff Volume

The results presented in Table 2 are based upon a simplified hydrologic modeling approach that does not take into account the influence of existing stormwater BMPs (e.g., detention basins), stormwater piping or culverts on the peak flow rates. Actual peak flow rates may be higher or lower depending on the influence of these factors on stormwater conveyance. The purpose of these results is only to create a relative comparison against future development conditions, as described below.

Impact of Future Development

In order to assess the impact of future development on the peak flow rates and runoff volumes in each critical subwatershed, the HydroCAD analysis was repeated based on an assumed increase in impervious area of 10 percent and 20 percent. It was assumed that with the increase in impervious area, the pervious land uses in each subwatershed would each decrease commensurately, such that the proportion of row crop, open space and woodland within the remaining pervious cover would be maintained. The results of this analysis are presented in Tables 3a-3f.

Table 3a. Dysart Run Peak Flow Rates & Runoff Volumes – Future Development

Design Storm (recurrence interval)	Existing Condition		10% Increased Imperviousness				20% Increased Imperviousness			
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]
1-yr	200	130	260	29	160	24	310	50	180	41
2-yr	320	190	390	23	230	20	450	41	250	34
5-yr	500	290	600	19	340	16	660	32	370	27
10-yr	670	380	780	16	430	14	850	27	470	24
25-yr	920	510	1,050	14	570	12	1,130	23	610	20
50-yr	1,140	630	1,280	12	690	10	1,370	20	740	18
100-yr	1,380	750	1,530	10	820	9	1,630	17	870	16

Table 3b. French Run Peak Flow Rates & Runoff Volumes – Future Development

Design Storm (recurrence interval)	Existing Condition		10% Increased Imperviousness				20% Increased Imperviousness			
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]
1-yr	300	170	380	28	210	23	450	49	240	40
2-yr	460	250	560	23	300	19	640	39	330	33
5-yr	710	380	840	18	440	16	930	30	480	27
10-yr	940	490	1,080	15	560	14	1,180	26	600	23
25-yr	1,280	660	1,440	12	730	11	1,550	21	790	19
50-yr	1,570	800	1,740	11	880	10	1,860	18	940	17
100-yr	1,890	960	2,070	10	1,050	9	2,190	16	1,110	16

Table 3c. Little Jordan Peak Flow Rates & Runoff Volumes – Future Development

Design Storm (recurrence interval)	Existing Condition		10% Increased Imperviousness				20% Increased Imperviousness			
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]
1-yr	170	70	220	30	80	23	250	52	90	40
2-yr	260	100	320	23	120	19	360	40	130	33
5-yr	410	150	480	18	170	16	530	31	190	27
10-yr	540	190	620	16	220	14	680	26	230	23
25-yr	740	260	830	13	280	11	890	21	300	19
50-yr	910	310	1,010	11	340	10	1,070	19	370	17
100-yr	1,090	370	1,200	10	410	9	1,270	16	430	16

1. PFR – Peak Flow Rate
2. RV – Runoff Volume
3. %Δ - Percent change as compared to existing condition

Table 3d. Utzinger Ditch Peak Flow Rates & Runoff Volumes – Future Development

Design Storm (recurrence interval)	Existing Condition		10% Increased Imperviousness				20% Increased Imperviousness			
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]
1-yr	100	60	130	28	70	23	170	61	90	49
2-yr	160	80	200	23	100	19	240	48	120	40
5-yr	250	130	300	19	150	16	340	37	170	32
10-yr	330	170	380	15	190	14	430	31	210	28
25-yr	450	220	510	12	250	11	560	25	280	24
50-yr	550	270	610	11	300	10	680	22	330	21
100-yr	660	330	730	10	360	9	790	20	390	19

Table 3e. Fieldstone Peak Flow Rates & Runoff Volumes – Future Development

Design Storm (recurrence interval)	Existing Condition		10% Increased Imperviousness				20% Increased Imperviousness			
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]
1-yr	90	40	120	33	50	25	150	58	60	44
2-yr	150	60	190	27	80	21	220	46	90	36
5-yr	250	100	300	20	120	17	340	35	130	28
10-yr	340	130	400	18	150	14	440	30	170	25
25-yr	480	180	540	14	200	12	590	24	220	21
50-yr	600	230	670	12	250	11	720	21	270	18
100-yr	730	270	810	11	300	10	860	18	320	17

Table 3f. Jefferson Peak Flow Rates & Runoff Volumes – Future Development

Design Storm (recurrence interval)	Existing Condition		10% Increased Imperviousness				20% Increased Imperviousness			
	PFR[1] (cfs)	RV[2] (ac-ft)	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]	PFR[1] (cfs)	%Δ[3]	RV[2] (ac-ft)	%Δ[3]
1-yr	80	20	100	32	30	23	120	55	30	40
2-yr	120	30	150	24	40	19	170	42	40	33
5-yr	190	50	230	19	50	11	260	32	60	21
10-yr	260	60	300	16	70	14	330	26	70	23
25-yr	350	80	400	13	90	11	430	21	100	19
50-yr	430	100	480	11	110	10	510	18	120	17
100-yr	520	120	570	10	130	9	610	16	140	16

1. PFR – Peak Flow Rate
2. RV – Runoff Volume
3. %Δ - Percent change as compared to existing condition

As shown in Tables 3a-3f, estimated peak flow rates and runoff volumes will increase significantly with future development. In the Dysart Run subwatershed, the model results indicate a 10% increase in impervious area will lead to an estimated 29% increase in the peak flow rate and 24% increase in runoff volumes for the 1-year design storm event. Assuming a 20% increase in impervious area in the Dysart Run subwatershed, the model results indicate a 50% increase in peak flow rate and 41% increase in runoff volume for the 1-year design storm event. Similar results were calculated for the other critical subwatersheds. This increase in runoff will exacerbate issues within these critical subwatersheds, potentially resulting in increased channel erosion, water quality impairments and flooding. As noted previously, these model results do not take into account the hydrologic impacts of existing stormwater detention basins, culverts and other stormwater infrastructure.

POLLUTANT LOADING ANALYSIS

Existing Conditions

Utilizing the calculated runoff volumes summarized above, annual pollutant loading in each subwatershed was estimated using the *Simple Method to Calculate Urban Stormwater Loads* (Schueler 1987). The Simple Method estimates stormwater pollutant loads for urban areas based upon stormwater runoff pollutant concentrations for given land uses, as the type of development generally influences the pollutant constituency of storm water runoff. Generally, pollutant concentrations tend to increase as the level of development and impervious cover increases, unless water quality-specific stormwater BMPs are successfully implemented. A variety of published resources are available that estimate stormwater pollutant concentrations, based on local, regional and/or national data sources, including the National Stormwater Quality Database and the National Urban Runoff Program. Table 4 presents the summary of pollutant concentrations for Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Kjeldahl Nitrogen (TKN) that were utilized to estimate pollutant loads in each of the six critical subwatersheds.

Table 4. Pollutant Concentrations in Runoff from Various Land Uses

Land Use	TSS (mg/L)	TP (mg/L)	TKN (mg/L)
Row Crop	762	2.35	2.9
Open Space	40	0.12	0.97
Woods	34	0.15	0.61
Impervious	73	0.38	1.90

Source: Based on the Lower Grand River Watershed TMDL (Ohio EPA, 2012)

Using these pollutant concentrations, an analysis of annual pollutant loads and yields from each of the six critical subwatersheds was completed using the Simple Method in HydroCAD. The results of this analysis are presented in Table 5.

Table 5. Estimated Annual Pollutant Loads and Yields

Subwatershed	TSS		TP		TKN	
	Load (tons/year)	Yield (lb/ac/yr)	Load (lbs/year)	Yield (lb/ac/yr)	Load (lbs/year)	Yield (lb/ac/yr)
Dysart	230	156	2,090	0.7	9,340	3.2
French	270	64	2,570	0.3	12,000	1.6
Little Jordan	110	386	1,000	1.8	4,220	8.5
Utzinger	120	184	1,180	0.8	5,950	3.4
Fieldstone	90	164	690	0.6	2,050	1.8
Jefferson	40	185	360	0.8	1,450	3.2

As shown in Table 5, the annual pollutant loads are highest within the Dysart Run and French Run subwatersheds, followed by Little Jordan, Utzinger, Fieldstone and Jefferson. This is expected based on the larger size of the Dysart Run and French Run subwatersheds. However, pollutant yields (lbs/acre/year) vary within the subwatersheds based upon the distribution of impervious and row crop land uses.

Impact of Future Development

In order to assess the impact of future development on the pollutant loading in each critical subwatershed, this analysis was repeated based on the change in land use as well as the accompanying increase in peak flow rates and runoff volumes modeled under the future development scenarios described above (i.e., an increase in impervious area of 10 percent and 20 percent). The results of this analysis are presented in Tables 6a-6f.

Table 6a. Dysart Run Estimated Annual Pollutant Loads and Yields – Future Development

	Existing Condition			10% Increased Imperviousness			20% Increased Imperviousness		
	TSS	TP	TKN	TSS	TP	TKN	TSS	TP	TKN
Load[1]	230	2,090	9,340	310	3,000	14,010	400	3,910	18,690
Yield (lbs/ac/year)	156	0.7	3.2	213	1.0	4.7	270	1.3	6.3
%Δ[2]	--	--	--	37%	43%	50%	73%	87%	100%

1. Load is expressed as tons/year for TSS and pounds/year for TP and TKN
2. %Δ - Percent change as compared to existing condition

Table 6b. French Run Estimated Annual Pollutant Loads and Yields – Future Development

	Existing Condition			10% Increased Imperviousness			20% Increased Imperviousness		
	TSS	TP	TKN	TSS	TP	TKN	TSS	TP	TKN
Load[1]	120	1,180	5,950	150	1,580	7,930	190	1,970	9,900
Yield (lbs/ac/year)	64	0.3	1.6	84	0.4	2.2	105	0.5	2.7
%Δ[2]	--	--	--	31%	34%	33%	64%	67%	66%

Table 6c. Little Jordan Estimated Annual Pollutant Loads and Yields – Future Development

	Existing Condition			10% Increased Imperviousness			20% Increased Imperviousness		
	TSS	TP	TKN	TSS	TP	TKN	TSS	TP	TKN
Load[1]	270	2,570	12,000	380	3,710	17,800	490	4,850	23,600
Yield (lbs/ac/year)	386	1.8	8.5	536	2.6	12.6	686	3.4	16.7
%Δ[2]	--	--	--	39%	44%	48%	78%	89%	97%

Table 6d. Utzinger Estimated Annual Pollutant Loads and Yields – Future Development

	Existing Condition			10% Increased Imperviousness			20% Increased Imperviousness		
	TSS	TP	TKN	TSS	TP	TKN	TSS	TP	TKN
Load[1]	110	1,000	4,220	150	1,430	6,460	190	1,860	8,700
Yield (lbs/ac/year)	184	0.8	3.4	247	1.2	5.2	311	1.5	7.0
%Δ[2]	--	--	--	34%	43%	53%	69%	86%	106%

1. Load is expressed as tons/year for TSS and pounds/year for TP and TKN
2. %Δ - Percent change as compared to existing condition

Table 6e. Fieldstone Estimated Annual Pollutant Loads and Yields – Future Development

	Existing Condition			10% Increased Imperviousness			20% Increased Imperviousness		
	TSS	TP	TKN	TSS	TP	TKN	TSS	TP	TKN
Load[1]	90	690	2,050	120	1,020	3,830	150	1,340	5,610
Yield (lbs/ac/year)	164	0.6	1.8	214	0.9	3.4	264	1.2	4.9
%Δ[2]	--	--	--	30%	47%	87%	61%	95%	174%

Table 6f. Jefferson Estimated Annual Pollutant Loads and Yields – Future Development

	Existing Condition			10% Increased Imperviousness			20% Increased Imperviousness		
	TSS	TP	TKN	TSS	TP	TKN	TSS	TP	TKN
Load[1]	40	360	1,450	50	490	2,160	70	630	2,870
Yield (lbs/ac/year)	185	0.8	3.2	238	1.1	4.8	291	1.4	6.3
%Δ[2]	--	--	--	29%	37%	49%	57%	75%	98%

1. Load is expressed as tons/year for TSS and pounds/year for TP and TKN
2. %Δ - Percent change as compared to existing condition

As shown in Tables 6a-6f, pollutant loading will increase significantly with future development. In the Dysart Run subwatershed, a 10% increase in impervious area will lead to an estimated 37% increase in loading of TSS, 43% increase in loading of TP, and 50% increase in loading for TKN on an annual basis. Assuming a 20% increase in impervious area in the Dysart Run subwatershed, TSS, TP and TKN loading is expected to increase 73%, 87% and 100%, respectively, as compared to existing conditions. Similar results were modeled for the other critical subwatersheds. These increases in pollutant loading will degrade water quality within these critical subwatersheds, without the implementation of water quality-specific stormwater BMPs.

Limitations

The Simple Method provides reasonable estimates in changes in pollutant export resulting from urban development; however, some caveats apply. First, the Simple Method provides a general planning estimate of likely storm pollutant export and is most appropriate for assessing and comparing the *relative* stormflow pollutant load changes of different land use scenarios. Second, the Simple Method only estimates pollutant loads generated during storm events.

LOW IMPACT DEVELOPMENT STRATEGIES

As demonstrated via the hydrologic and pollutant loading analyses presented above, future development in the critical subwatersheds of Blacklick Creek has the potential to significantly impact hydrologic conditions and water quality. Implementation of a Low Impact Development (LID) approach to stormwater management may mitigate these potential impacts. The goal of LID is to mimic a site's pre-development hydrology by using design techniques that infiltrate, filter, store, evaporate and detain stormwater runoff close to its source. Instead of conveying and managing stormwater in large, end-of-pipe facilities, LID addresses stormwater through smaller, cost-effective features known as Integrated Management Practices (IMP). As described by the Low Impact Development Center, Inc., the LID approach includes five basic tools:

1. Encourage conservation measures and low-density design as part of site planning;
2. Promote impact minimization techniques such as impervious surface reduction;
3. Provide for strategic runoff timing by slowing flow using the landscape;
4. Use an array of integrated management practices to reduce and cleanse runoff; and
5. Advocate pollution prevention measures to reduce the introduction of pollutants.

LID practices may apply to new development, urban retrofits and redevelopment projects. Typical IMPs include bioretention basins/swales, green rooftops, permeable pavement, rain gardens, rain barrels and cisterns, right-of-way and median infiltration trenches, and tree planters. There is a wealth of publicly available information regarding these practices, most notably the Center for Watershed Protection's Urban Subwatershed Restoration Manual Series (www.cwp.org) and the U.S. EPA Watershed Academy (www.epa.gov/watershedacademy).

LID standards may be encouraged by municipalities via local incentives. Incentives may include stormwater fee discounts or credits (where a stormwater utility is present), development incentives (such as waived or reduced permit fees or exemptions from local permitting requirements), subsidies for the installation of IMPs, and award/recognition programs. These incentives are intended to encourage voluntary use of LID methods by local developers.

In contrast, LID may also be implemented via adoption of local ordinances or zoning regulations. Such regulations are the most cost-effective and far-reaching means by which LID practices can be implemented because, once adopted, they apply uniformly to all land development in a community. The Chagrin River Watershed Partners, Inc. have developed an adoption process for such regulations, including models for comprehensive stormwater management, establishment of a conservation development district, riparian setback zoning, and wetland setback zoning. The *Adoption Process for Best Land-Use Regulations*, as well as model regulations, are provided online at www.crwp.org. The adoption process generally follows the following steps:

1. Tailor model regulation to the community;
2. Introduction and initial review of regulation;
3. Intra-community review, education and training;
4. Review by law director;
5. Recommendation for adoption;
6. Presentation to legislative body;

7. Regulation readings and adoption;
8. Public education; and
9. On-going implementation support.

Under either scenario, providing incentives or adoption of local codes/regulations, strong local buy-in is essential for the success of measures to promote LID. Local officials must recognize the potential adverse impact of development on stormwater management and water quality, and provide leadership in either encouraging or requiring LID practices.

PROJECT CONCEPTS FOR DYSART RUN SUBWATERSHED

Stormwater Basin Retrofits

Based on a review of available mapping information, there are estimated to be 45 existing stormwater detention basins located within the Dysart Run subwatershed. Approximately 32 of these basins are wet basins, with permanent pools, and 13 are dry basins. The majority of these detention basins are traditional stormwater basins that were constructed prior to requirements for post-construction water quality treatment. Water quality treatment was required by Ohio EPA in 2003, when the requirement for a specific post-construction treatment stormwater runoff volume was added to the state's construction general permit, and by the City of Columbus via the 2006 Stormwater Drainage Manual.

Traditional basins were designed to reduce the peak flows from large storms caused by development of a site. They do little or nothing to filter pollutants or slow the velocity of the discharge from smaller storm events, which may pass through the basin quickly. However, it is now generally understood that it is the smaller, more frequent storms that result in streambank erosion and generate pollutants in stormwater runoff, which is then transported to receiving streams. Thus, the goal of retrofitting these stormwater basins is to make them more efficient at slowing and filtering runoff from smaller storm events, while not diminishing their original design intent of reducing flooding potential from larger storm events.

Stormwater basin retrofits include a spectrum of modifications, ranging from simple planting enhancements to complex engineering retrofits. Simple retrofits may include removal of a concrete-lined pilot channel or outlet structure modification to increase residence time in the detention basin. Moderate retrofits may entail the installation of a forebay for debris and sediment collection, or grading to create longer flow paths. At the far end of the scale, complex retrofits may involve excavation and/or expansion of the basin to increase storage volume for both water quality and flood control enhancements.

Generally the more complex retrofit projects, while the most expensive, will provide a greater level of water quality improvement and peak flow rate reduction. However, any level of these improvements has the potential to improve water quality incrementally.

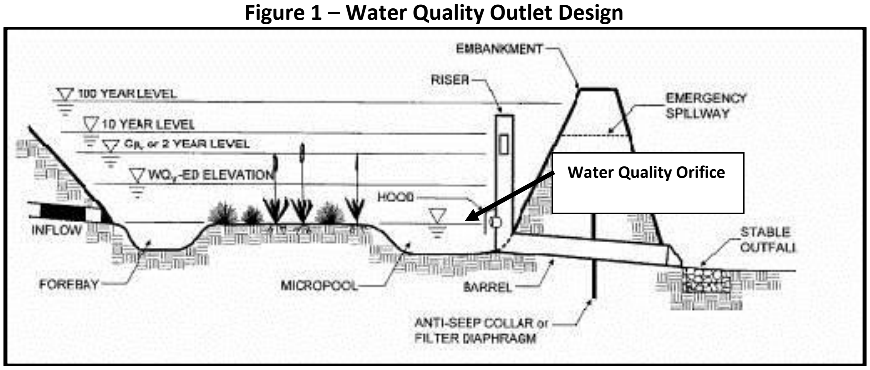
Given the number of existing detention basins in the Dysart subwatershed, modification of the outlet structures, along with some limited excavation in dry basins, may provide the most cost-effective retrofit solution for water quality improvements. Modification of the outlet structure creates a staged release that serves to detain low flows within the basin longer, while still controlling the larger storms.

The outlet structure modification on wet basins takes advantage of existing 'dead' storage (below the normal pool level) to provide capture storage for pollutants associated with the volume of water from smaller storms (the water quality volume). Retention of this runoff within the basin promotes reduction in peak flow rates and settling of sediment and other common pollutants. The outlet structure is modified to increase the residency time in the detention basin, typically by constructing a riser (e.g., a catch basin or manhole structure) at the outlet with a small diameter orifice at the bottom. This first-stage orifice, sometimes referred to as the water quality orifice, is typically designed to retain the calculated water quality volume for either 24-hours (wet basins) or 48-hours (dry basins). The modified outlet structure will also include a second, and maybe a third, stage to ensure the design function of the detention basin during larger storm events is not adversely impacted.

Figure 1 below demonstrates a typical water-quality outlet design. In retrofit situations, the outlet structure modifications may not meet the minimum requirements of the Ohio EPA or the local community. In this case, the goal is to enhance water quality performance to the extent possible, and to the extent practical given potential costs of detention basin retrofits applied on a watershed scale.

In the retrofit of a dry detention basin for water quality, some excavation may be required within the basin to provide for capture and storage of debris and stormwater pollutants. Typically, a forebay (a settling basin) is excavated at the inflow to the basin and a micropool (a small permanent pool) is excavated near the outlet structure. Figure 1 also demonstrates these features. Similar modifications are made to the outlet structure, as described for a wet basin, in order to maximize residency time of stormwater runoff within the dry basin.

Figure 1 – Water Quality Outlet Design



As retrofitting of wet basins does not require any excavation of the basin, typical construction costs may range from $20,000 to $30,000 per basin to retrofit the outlet structure. For dry basins, where excavation of the forebay and micropool is needed, construction costs would likely exceed $50,000, and may be as high as $100,000. Planting enhancements may be completed in conjunction with the retrofits, but this will add to these estimated construction costs. Additional costs may be incurred for design and engineering, particularly if local plan approval and permitting is required for the modification.

Given the number of wet basins (32) and dry basins (13) in the Dysart Run subwatershed, the construction cost to retrofit all of them may range from $1.3 million to $2.3 million or more. Accordingly, creation of an inventory to prioritize the basins should be completed. This prioritization should account for whether or not the detention basin is publicly owned, the ease of access to the basin, and any regulatory constraints associated with performing the basin improvements.

For a detailed analysis to determine the retrofit opportunities for each detention basins in the subwatershed, it will be necessary to determine the tributary area to each detention basin and perform calculations to determine the water quality volume and evaluate options for retrofitting the outlet structure, and then prioritize individual basins according to potential water quality benefits versus costs.

Green Street BMP

Many LID-based, structural and non-structural BMPs are available to provide stormwater management in conjunction with existing and future urbanization, as discussed previously herein. These practices typically include rain gardens, permeable pavement, and tree planters, that are intended to provide infiltration and/or enhance evapotranspiration for *low volumes* of stormwater runoff. The "green street" BMP described below, however, provides an option for treating tributary areas between 2 and 15 acres, within existing developed areas with insufficient stormwater detention.

The Green Street BMP combines permeable pavement with subsurface storage and infiltration, which is installed within the low spot (sump) of a roadway. In general, the design involves removal of the existing pavement and installation of a subgrade infiltration bed of stone aggregate beneath a combination of permeable and traditional pavement. This aggregate layer provides detention storage volume for peak flow rate control and promotes infiltration (exfiltration) to the surrounding native soils. The permeable pavement and aggregate layer also provide water quality treatment for runoff from the tributary area. Each of the design components are shown on Exhibit 1 and described below:

> **Outfall Flow Control Structure:** This is a manhole structure including an Agri-drain insert with a low-flow orifice sized to control (reduce) the peak flow rate to the outfall. The reduced outlet capacity forces flow from larger rainfall events to 'back-up' into the infiltration and storage components of the BMP (described below). The Agri-drain includes stop logs that allow the user to adjust and optimize the amount of storage that is used.

> **Permeable Pavement:** Existing curb and gutter along both sides of the street is replaced by a conventional curb and 2.5-foot wide extended gutter constructed of concrete permeable pavers. To address maintenance concerns, sediment trap catch basins can be installed upstream of the permeable pavement to capture material that would otherwise present a clogging risk. These catch basins include overflow pipes that carry the intercepted runoff directly into the stone sub-grade layer for purposes of water quality treatment and detention (peak flow reduction). The extent of the permeable pavement on any given project can change based on street geometry, usage and aesthetic preferences.

> **Stone Aggregate Sub-grade:** High-porosity road base material is placed beneath the roadway where permeable pavement is proposed. The stone sub-grade is approximately four feet (or more, depending on tributary area) and includes stormwater infiltration chambers which

increase the total detention storage volume and improve the water quality treatment capability. The design of the stormwater infiltration chambers includes an 'isolator row' to promote the capture and confinement of solids within a portion of the system where there is easy access for maintenance purposes. The design of the stone subgrade layer extends up to 12-inches beneath the embedded stormwater infiltration chambers, including a 6-inch deep sump beneath the underdrain to promote the exfiltration process.

Existing catch basins within the sump area are maintained as part of the improvement to capture excessive rainfall events which would otherwise overwhelm the BMP and lead to localized flooding. As some portion of the runoff will bypass the BMP, the expected reduction in the annual load of TSS as a result of the BMP is approximately 70%. In addition, the BMP can significantly reduce peak flow rates, which has significant benefits to the downstream receiving channel in terms of reduced flooding and erosion potential.

The estimated construction cost for the Green Street BMP, assuming a tributary area of approximately 8 acres, is approximately $250,000. These costs would scale up or down depending on the tributary area and required size of the BMP; however, there is an economy of scale that favors larger projects. In addition, the cost of long-term operation and maintenance must be considered, including:

- Street sweeping every other month during the non-winter months (3-4 times per year).
- Scheduled inspections at least two times per year.
- Cleaning out sediment trap catch basins via vacuum truck at least four times per year.
- Jet-vac the isolator row of the underground infiltration chambers up to two times a year.
- Monitoring and adjusting the stop logs in the outflow structure to optimize performance.

A total of 10 potential locations have been identified where this practice could be implemented in the Dysart Run watershed. These locations, and their respective tributary areas, are listed below. All of these locations are located within subdivisions that are lacking stormwater detention basins, in particular The Woods at Jefferson and Creekstone subdivisions, which are located south of Kennedy Road and east of Waggoner Road.

1. Kestrel Drive (7.1 acres)
2. Sandmar Drive (5.1 acres)
3. Old Ivory Way (15.3 acres)
4. River Pebble Drive (2.5 acres)
5. Windsome Drive (8.0 acres)
6. Crete Lane (7.6 acres)
7. Olympus Lane at Crete Lane (2.5 acres)
8. Olympus Lane at Creekstone Lane (8.1 acres)
9. Parori Lane (3.8 acres)
10. Timbercreek Road (16.2 acres)

By way of example, Exhibit 2 shows the potential tributary area that could be treated via installation of a Green Street BMP on Kestrel Drive. Based on the estimated tributary area of 7.1 acres, it is foreseeable that the construction cost for a Green Street BMP at this location would be approximately $250,000. As shown on Exhibit 2, this would manage and treat stormwater from approximately 62 residential lots within The Woods at Jefferson subdivision.

Stream Stabilization / Restoration

Stream channel stabilization and restoration includes a continuum of practices, including two stage channel construction, bioengineering or "soft" bank stabilization techniques, hard armoring, and full-scale stream restoration, that could be employed in the Dysart Run subwatershed. Each of these is discussed briefly below.

Two-stage ditch design incorporates a floodplain bench along one or both sides of a traditional ditched waterway, or a channel that has become incised within the surrounding landscape. This is accomplished by excavating the land adjacent to the channel, to or below the bankfull channel depth. The total width of the excavated channel on both sides of the channel should be a minimum of 5-times the bankfull channel width. The excavated floodplain benches are stabilized with erosion control matting and seeded with native grasses or woody vegetation. The two-stage channel design provides the stream with an accessible floodplain, allowing water to spread out on the excavated benches, thereby increasing flood-carrying capacity, decreasing flow velocity and providing for the capture of sediment.

This in turn improves channel stability and ecological function. The floodplain benches reduce sediment and nutrient loads by promoting sediment settling, and improving water quality via nutrient assimilation by the floodplain vegetation. Two-stage ditch design is best suited to smaller channels, with drainage areas of 1 to 10 square miles, where natural drainage patterns have been altered. The practice is commonly employed in agricultural settings, but may also be utilized on urban ditches, particularly in areas where space constraints may prohibit more extensive restoration techniques.

Bioengineering is the use of natural material (vegetation, matting and boulders) to stabilize slopes and stream banks rather than conventional hard armoring with rip rap or concrete. The use of vegetation serves to fortify eroding stream banks, re-establish riparian cover, and provide wildlife habitat. As such, bioengineering approaches are typically more beneficial to the natural environment and aesthetically pleasing, as compared to hard armoring, and can be less expensive to implement. Bioengineering bank stabilization techniques may include:

- Vegetated buffer strips: Planted buffers help to reduce erosion, filter pollutants during periods of overbank flow, shade the stream, and provide woody debris for habitat.
- Live fascines: Long bundles of live woody vegetation buried in the streambank in shallow trenches parallel to the stream flow; they quickly establish to control channel bank erosion and enhance aquatic habitat.
- Live stakes: Hardwood cuttings, typically of fast growing species (such as willows) that are inserted into the stream banks; they quickly establish to control channel bank erosion and enhance aquatic habitat.
- Streambank grading: Excavation to create shallower and more stable stream bank slopes; may be used in combination with rock toe protection and vegetation to increase channel stability.
- Cross vanes, j-hooks and other deflectors: Rock structures placed in the stream to redirect stream flow away from unstable banks toward the center of the channel; may be used in combination

with other bank stabilization techniques; provides in-stream habitat for fish and macroinvertebrates.

Hard armoring of the stream banks may be required in some cases due to site constraints. Hard armoring may be necessary to withstand high stream flows and/or in locations where space to implement other stabilization practices is restricted. Armoring techniques include riprap revetments, rock gabions, bulkheads and retaining walls. Some of these armoring practices, such as with rock or rip rap, may be used in combination with bioengineering techniques. For instance, live stakes can be tamped through openings in rock revetments or rock gabion in a practice known as joint planting. As noted, the exclusive use of hard armoring is not beneficial to healthy stream function or water quality and may not enhance aquatic habitat.

Full-scale stream restoration seeks to reestablish the structure and function of the natural, stable stream system by restoring the appropriate morphology (i.e., dimension, pattern and profile) using a natural channel design approach. Stream restoration typically involves reshaping the stream channel to bankfull dimensions with an adjacent constructed floodplain, installing in-stream structures such as riffles, cross vanes and j-hooks, and stabilizing the newly formed banks with natural materials such as matting and native vegetation. The end result is a stream channel that is fully connected to its floodplain, with an appropriate meander pattern, riffle-pool sequences, and riparian vegetation.

In general, a cost of approximately $150 to $200 per linear foot may be assumed for planning purposes for any significant stream channel stabilization/restoration measures. Two-stage ditch projects may be less expensive, in the range of $25 to $75 per linear foot, depending on the quantity of excavation. Simple bank stabilization measures involving solely vegetation (i.e., installation of vegetated buffer strips, live stakes and/or bare root trees and shrubs) are the least expensive, typically in the range of $10 to $25 per linear foot, depending on the buffer width to be planted and the planting density. These costs are exclusive of any necessary engineering, design or permitting.

Based on the total length of stream in the Dysart Run subwatershed (approximately 64,815 linear feet), and assuming that approximately 20% of this length may require stabilization and/or restoration, the cost of full-scale stream restoration in the Dysart Run subwatershed may be estimated at upwards of $2 million. Utilizing less expensive stabilization techniques where possible, such as vegetative bank stabilization or two-stage ditch design, will help to reduce this total cost. Providing accurate cost estimates for specific stream stabilization/restoration projects will require looking at site-specific conditions for potential project areas, including accessibility, stabilization/restoration techniques to be utilized, stream size and stream conditions.

EROSION-RELATED PROJECTS ON BLACKLICK MAINSTEM

The main stem of Blacklick Creek has numerous locations of profound erosion, some of which have been addressed through previous projects. The geography of the Blacklick Creek corridor includes steep embankments and the on-going urbanization of the surrounding watershed has placed utilities, buildings and public infrastructure in close proximity to areas where there is active erosion. Some notable channel stabilization projects which have been completed in the watershed are noted below.

- **Fairfield Square Apartments, City of Pickerington:** This project provided toe of slope stabilization consisting of a reinforced bankfull bench, with offsetting excavation on the opposing channel bank to maintain a stable bankfull channel dimension. By restoring the toe of an eroding steep slope along Blacklick Creek, the active erosion was arrested without the need for constructing more extensive and costly embankment protection measures. The construction cost for this project was approximately $200,000.

- **Target Store Site, City of Pickerington:** This project provided stabilization of an entire steep embankment along Blacklick Creek using a reinforced bankfull bench and a green-wall vertical retaining wall system extending to the top of the embankment. The extensive nature of this stabilization project was necessary due to the close proximity of a public sewer line and a building site. The approximate construction cost for this project was over $1 Million.

- **Stoney Creek Apartments, City of Reynoldsburg:** This project provided armoring of the toe of a steep embankment adjacent to Blacklick Creek, re-grading to provide a more stable embankment slope, revegetation, and segments of a retaining wall system due to horizontal grading constraints. The construction cost of this project was approximately $700,000.

- **Blacklick Trail Protection, City of Columbus:** This project was implemented to restore the main stem channel where bank erosion had led to the diversion of the upstream watershed to an adjacent off-line detention basin, directly impacting the Metro Parks' trail system along Blacklick Creek. The restoration included re-construction of the eroded channel bank, rock armoring and revegetation. The project also includes in-stream flow re-direction features such as single-arm rock vanes and a cross-vane. The construction cost of this project was approximately $250,000.

Each of these projects required a Section 404 Nationwide Permit from the U.S. Army Corps of Engineers and approval from the local municipality. The varying costs of these projects reflects the different types and extents of measures which may be required to restore eroding channel banks/embankments along the Blacklick Creek main stem. The total length of additional bank stabilization that is required along the main stem has not been determined; however, the need to continue implementing these projects is evident as much of the channel flows through urbanized areas of the watershed and in close proximity to public and private infrastructure. In addition, stabilization of the main stem channel and major tributaries will significantly reduce mass-loading of sediment to the downstream watershed, and provides an opportunity for the restoration projects to enhance aquatic habitat.

It is not easy to estimate the total cost of implementing all of the remaining required channel stabilization along Blacklick Creek, due to highly variable project costs depending on the geography and geology of the future project areas. For this reason, a watershed-scale investigation is necessary to identify future projects along the main stem and some of the major tributaries with the goal of developing conceptual restoration plans sufficient to estimate construction costs and develop a prioritization of these projects based on a quantifiable measure of benefits and costs.

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Ohio EPA. 2012. Total Maximum Daily Loads for the Grand River (lower) Watershed. Ohio Environmental Protection Agency, Columbus, OH.


1. Conventional Pavement
2. Outlet Flow Control Structure
3. Permeable Pavement System with Setting Bed
4. Stormwater Infiltration Chambers
5. Sump below Underdrain
6. Stone Aggregate Subgrade
7. Underdrain
8. Existing Catch Basin
9. Existing Storm Sewer
Detention Storage
Outfall
CROSS SECTION SCHEMATIC OF GREEN STREET BMP
EXHIBIT 1
FOR
BLACKLICK CREEK WATERSHED PLAN
EMH&T
emht.com

Exhibit 1

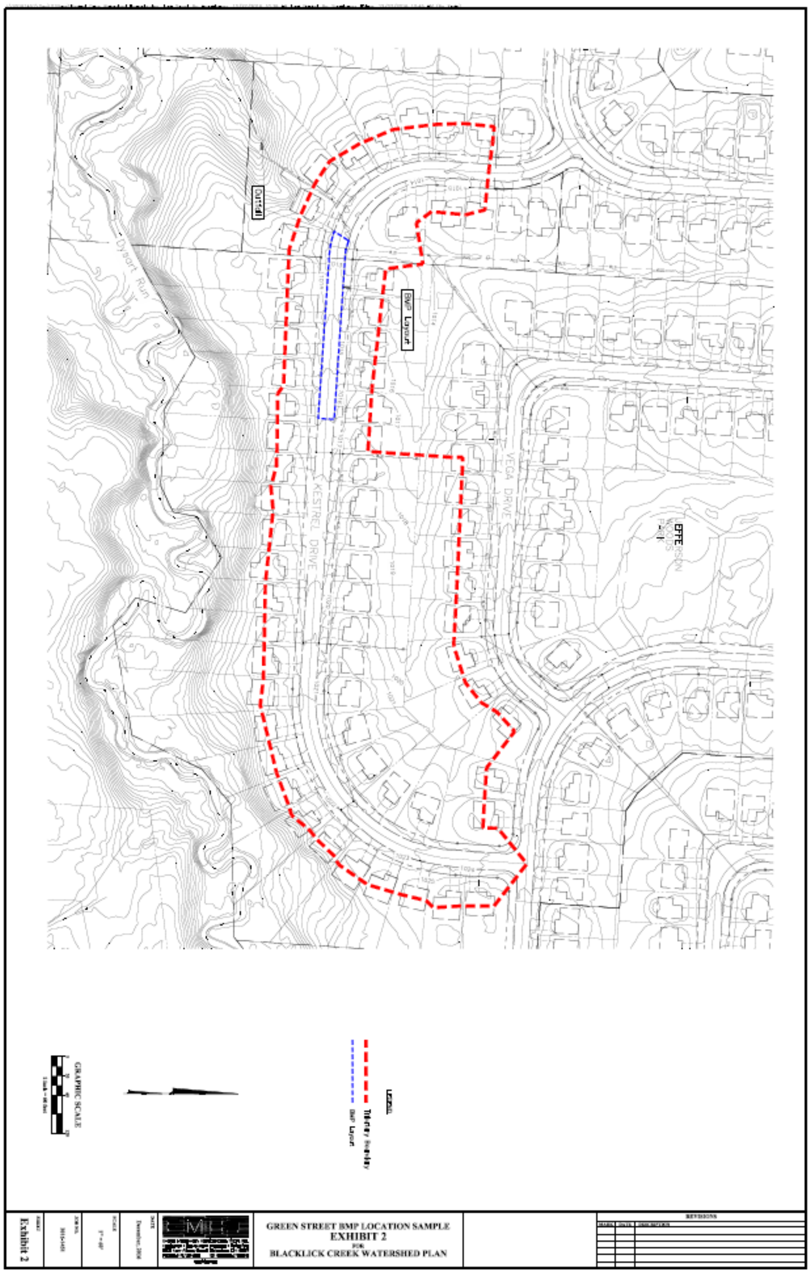
Outfall
BMP Layout
KESTREL DRIVE
VEGA DRIVE
GRAPHIC SCALE
REVISIONS
GREEN STREET BMP LOCATION SAMPLE
EXHIBIT 2
FOR
BLACKLICK CREEK WATERSHED PLAN
Exhibit 2

Exhibit 2