2.0 Watershed Overview and Assessment

The Big Darby Creek watershed covers 555 square miles of central Ohio just west of the Columbus metropolitan area (see Figure 2.1.1) Big Darby Creek originates in Logan County and flows more than 80 miles before joining the Scioto River near Circleville, Ohio. Land use is predominately row crop agricultural, except for the watershed's suburbanizing eastern edge along the border of Madison and Franklin counties, and in Union County (see Figure 2.1.2).

Coarse glacial deposits (gravels and cobbles) are common in the valleys of lower Big Darby Creek and some of its tributaries. This material, combined with the natural stream gradient, creates excellent stream bed habitat for a wide diversity of plants and animals. Bottom land or flood plain forest of varying age is found adjacent to a significant length of both Big and Little Darby creeks, which is important for stream habitat and water quality. Collectively these features create the home for the diverse array of aquatic animal life in the watershed. Human impacts on these variables (flow, temperature, water chemistry, sediment, stream bed and riparian features) must be understood and properly controlled or managed to protect the ecosystem.

2.1 Chapter Organization

This chapter, and subsequent chapters of this report describe the Big Darby Creek watershed, starting in the headwaters of Big Darby Creek, and moving downstream. The report will organize information, data, and findings by ***watershed*** within the Darby Creek basin. From upstream to downstream, the Big Darby Creek watershed is broken into 4 major sub-watersheds; upper Big Darby Creek, middle Big Darby Creek, Little Darby Creek, and lower Big Darby Creek. These sub-watersheds can be divided further into minor (small) sub-watersheds. A map of the Big Darby Creek watershed showing the major and minor sub-watersheds is provided in Figure 2.1.1.

The sub-watershed names, the conventional numeric codes used to identify them, and the minor sub-watersheds associated with each major one are provided in Table 2.1.1. Figure 2.1.2 displays the land use for the entire watershed. Figures 2.1.3 and 2.1.4 provide a schematic representation of the watershed.

Please note there are two “Little Darby” creeks in the Big Darby Creek watershed. The first is the larger stream, and is the stream generally thought of as the Little Darby Creek and is a major sub-watershed. The second of the Little Darby creeks is in the

---

The Big Darby Creek ***watershed*** includes any portion of land that contributes runoff to the river system upstream of the mouth of the Big Darby Creek. Watersheds vary in scope depending on the streams being referenced. For example, the Hellbranch sub-watershed is a contributing area to the Big Darby Creek watershed, but is a smaller division and contains only the land area which contributes drainage to the Hellbranch Run.

upper Big Darby Creek major sub-watershed, and is referred to as “Little Darby Creek (Logan Co.)”.

This chapter is a summary of information gathered during the assessment phase of the Darby TMDL process. For a detailed description of the results of Ohio EPA’s water quality survey results and assessment findings please see the Biological and Water Quality Study of the Big Darby Creek Watershed, 2001/2002 (Ohio EPA, 2004).

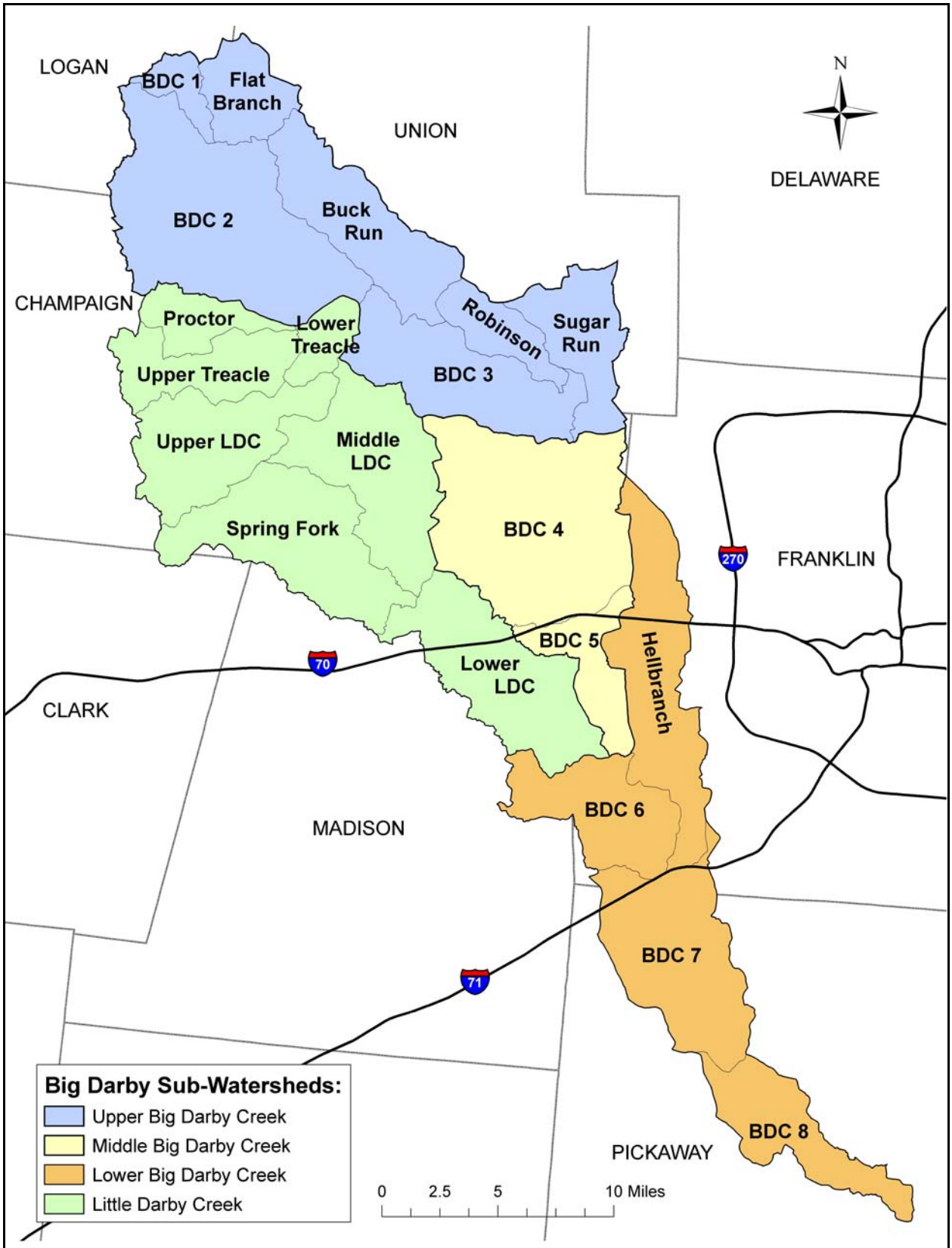

Figure 2.1.1 Sub-watersheds of the Big Darby Creek Watershed.

Table 2.1 Description of hydrologic units in the Big Darby Creek Watershed			
Major sub-watershed Description ***HUC* 11**	**Minor sub-watershed and streams in the sub-watershed**	**Reference Number (HUC 14)**	**Chapter section**
Upper Big Darby Creek From the headwaters to Sugar Run 05060001-190	BDC1: Big Darby Creek, Headwaters to Flat Branch	190-010	2.2.1
	Flat Branch	190-020	2.2.2
	BDC2: Big Darby Creek, from Flat Branch to Milford Center ; includes Little Darby Creek (Logan Co.), and Spain Creek	190-030	2.2.3
	BDC3: Big Darby Creek, Milford Center to Sugar Run	190-040	2.2.4
	Buck Run	190-050	2.2.5
	Robinson Run	190-060	2.2.6
	Sugar Run	190-070	2.2.7
Middle Big Darby Creek Sugar Run to Little Darby Creek 05060001-200	BDC4: Big Darby Creek, below Sugar Run to High Free Pike , includes Worthington, Ballenger-Jones, Powell, Yutzy and Fitzgerald Ditches.	200-010	2.3.1
	BDC5: Big Darby Creek, from High Free Pike to above Little Darby Creek	200-020	2.3.2
Little Darby Creek Headwaters to Big Darby Creek 05060001-210	Little Darby Creek Mainstem, headwaters to above Treacle Creek , includes Clover Run, Lake Run, Jumping Run.	210-010	2.4.1
	Treacle Creek, headwaters to above Proctor Run , includes Howard Run	210-020	2.4.2

A ***hydrologic unit code*** or ***HUC*** is the code used to represent an area designated by the United States Geological Survey as belonging to a certain watershed. The code is a series of numbers representing different levels of geographic scope. An 8 digit HUC indicates a region (leftmost two digits), sub-region (next two digits), accounting unit (next 2 digits), and cataloging unit (rightmost two digits). The cataloging unit can be further divided to represent different sub-watershed levels. The Big Darby Creek watershed is HUC 8 code 05060001. The HUC 11 codes in the table represent major sub-watersheds, and the HUC 14 codes identify minor sub-watersheds within each HUC 11 area. The HUC 14 column leaves off the first 8 digits and only specifies those digits that change within the Big Darby Creek watershed.

Table 2.1 Description of hydrologic units in the Big Darby Creek Watershed			
Major sub-watershed Description ***HUC*** **11**	**Minor sub-watershed and streams in the sub-watershed**	**Reference Number (HUC 14)**	**Chapter section**
	Proctor Run	210-030	2.4.3
	Treacle Creek (below Proctor Run to Little Darby Creek)	210-040	2.4.4
	Little Darby Creek, below Treacle Creek to above Spring Fork , includes Barron Creek and Wamp Ditch	210-050	2.4.5
	Spring Fork, includes Bales Ditch	210-060	2.4.6
	Little Darby Creek, below Spring Fork to Big Darby Creek	210-070	2.4.7
Lower Big Darby Creek Little Darby Creek to mouth 05060001-220	Hellbranch Run, includes Hamilton Ditch and Clover Groff Ditch	220-010	2.5.1
	BDC6: Big Darby Creek, below Little Darby Creek to above Hellbranch Run	220-020	2.5.2
	BDC7: Big Darby Creek, below Hellbranch Run to Darbyville, includes Springwater Run, Greenbrier Creek, and Georges Run	220-030	2.5.3
	BDC8: Big Darby Creek, from Darbyville to Scioto River, includes Lizard Run	220-040	2.5.4

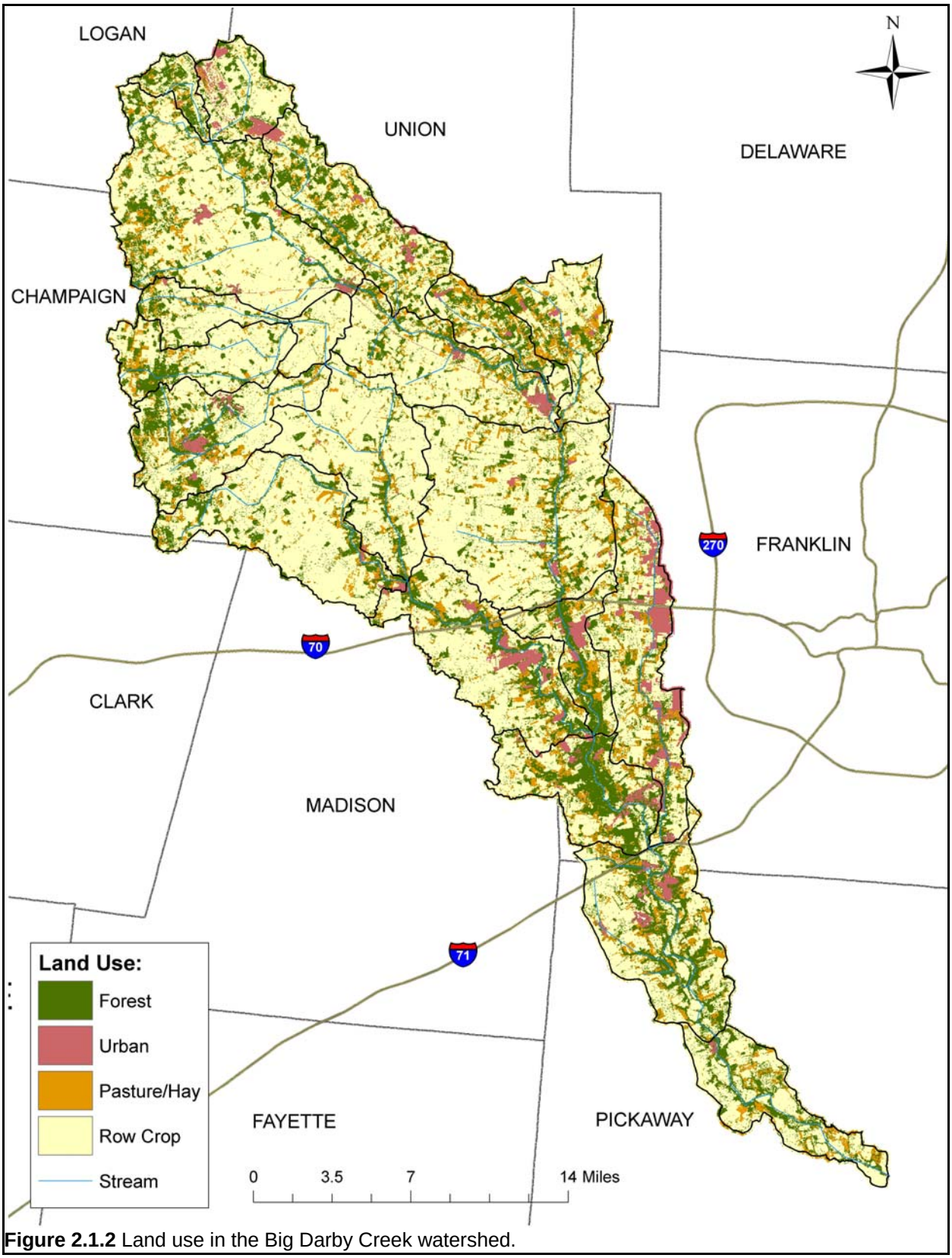

Figure 2.1.2 Land use in the Big Darby Creek watershed.

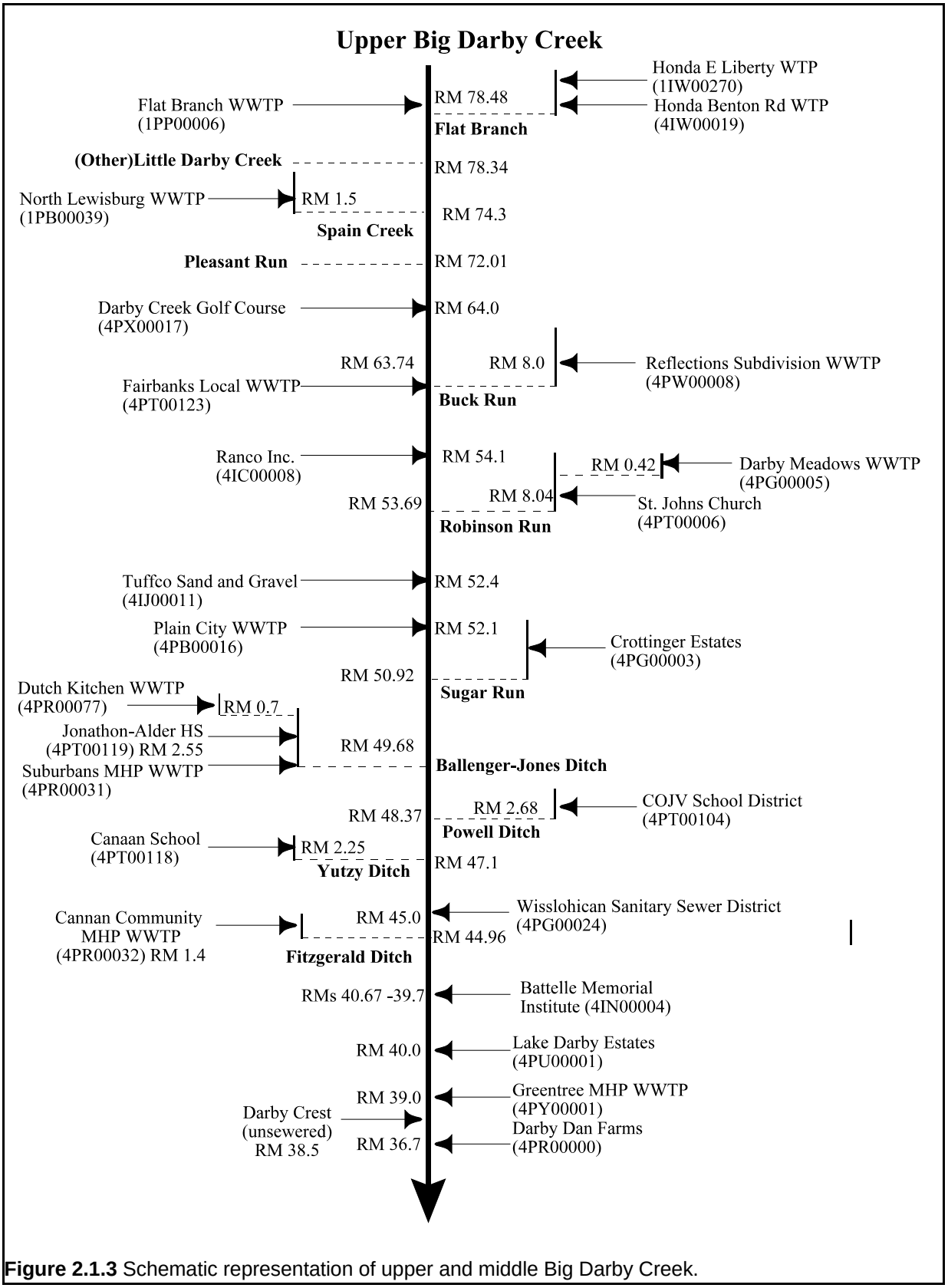

Figure 2.1.3 Schematic representation of upper and middle Big Darby Creek.

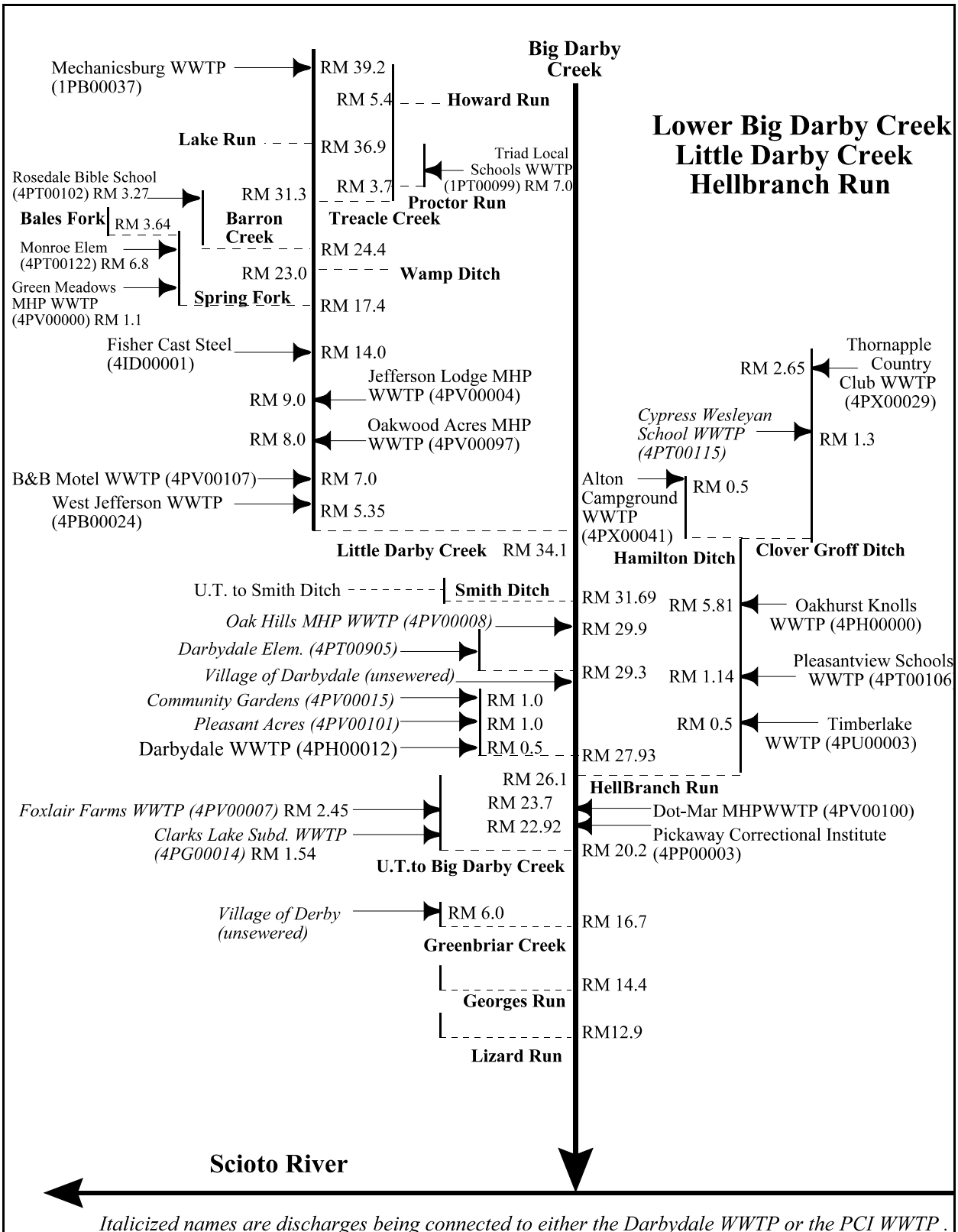

Figure 2.1.4 Schematic representation of lower Big Darby Creek and Little Darby Creek

2.2 Upper Big Darby Creek - (05060001 190)

The upper Big Darby Creek major sub-watershed contains a variety of streams, ranging from ground water fed, relatively pristine streams to highly modified streams. Results of the 2001, 2002 stream assessment indicate that aquatic life uses are impaired. Figure 2.2.1 shows the status of aquatic life use attainment in the upper Big Darby Creek major sub-watershed. As can be seen, aquatic life uses are impaired in parts of upper Big Darby Creek, particularly in the mainstem of Big Darby Creek downstream from Flat Branch. In the following sections, information about the minor sub-watersheds is provided, and they are reviewed with respect to assessment results, and the impairment of aquatic life uses shown in Figure 2.2.1.

Within the discussion of each sub-watershed, there is a presentation of the results of the habitat analysis conducted by Ohio EPA during 2001 and 2002. Following that data collection effort, an independent inventory of the status of the riparian corridor was conducted by Ben Webb, the Darby Creek Watershed Coordinator at the time. The results of this work are presented with each major sub-watershed with permission of the Darby Creek Joint Board of Supervisors. As will be discussed in Chapter 3, the riparian corridor plays an important role in filtering pollutants from upland sources, and by providing shading to the stream to help control temperature and to inhibit algal production caused by excess phosphorus. Figure 2.2.2 shows the status of riparian buffers in the Upper Big Darby Creek major sub-watershed.

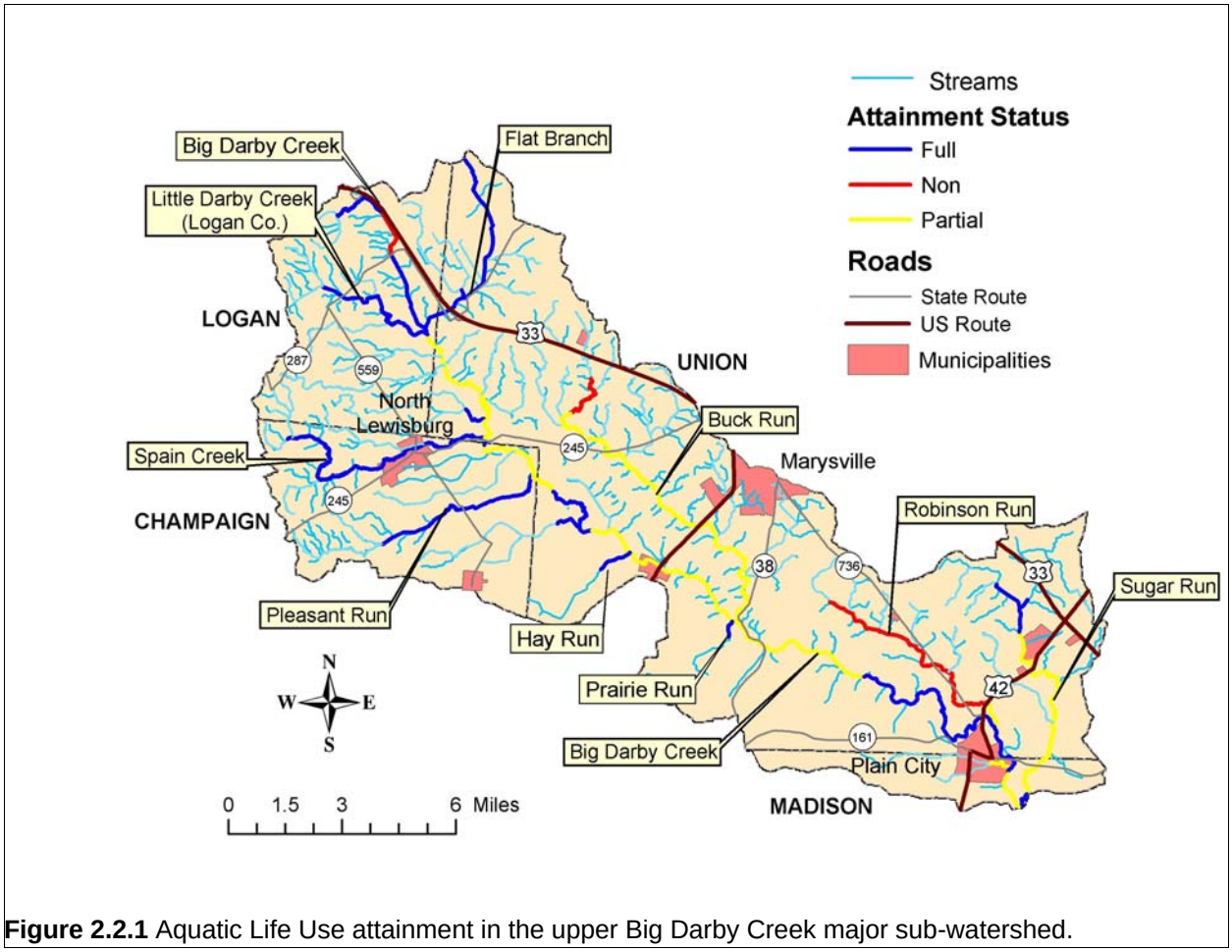

Figure 2.2.1 Aquatic Life Use attainment in the upper Big Darby Creek major sub-watershed.

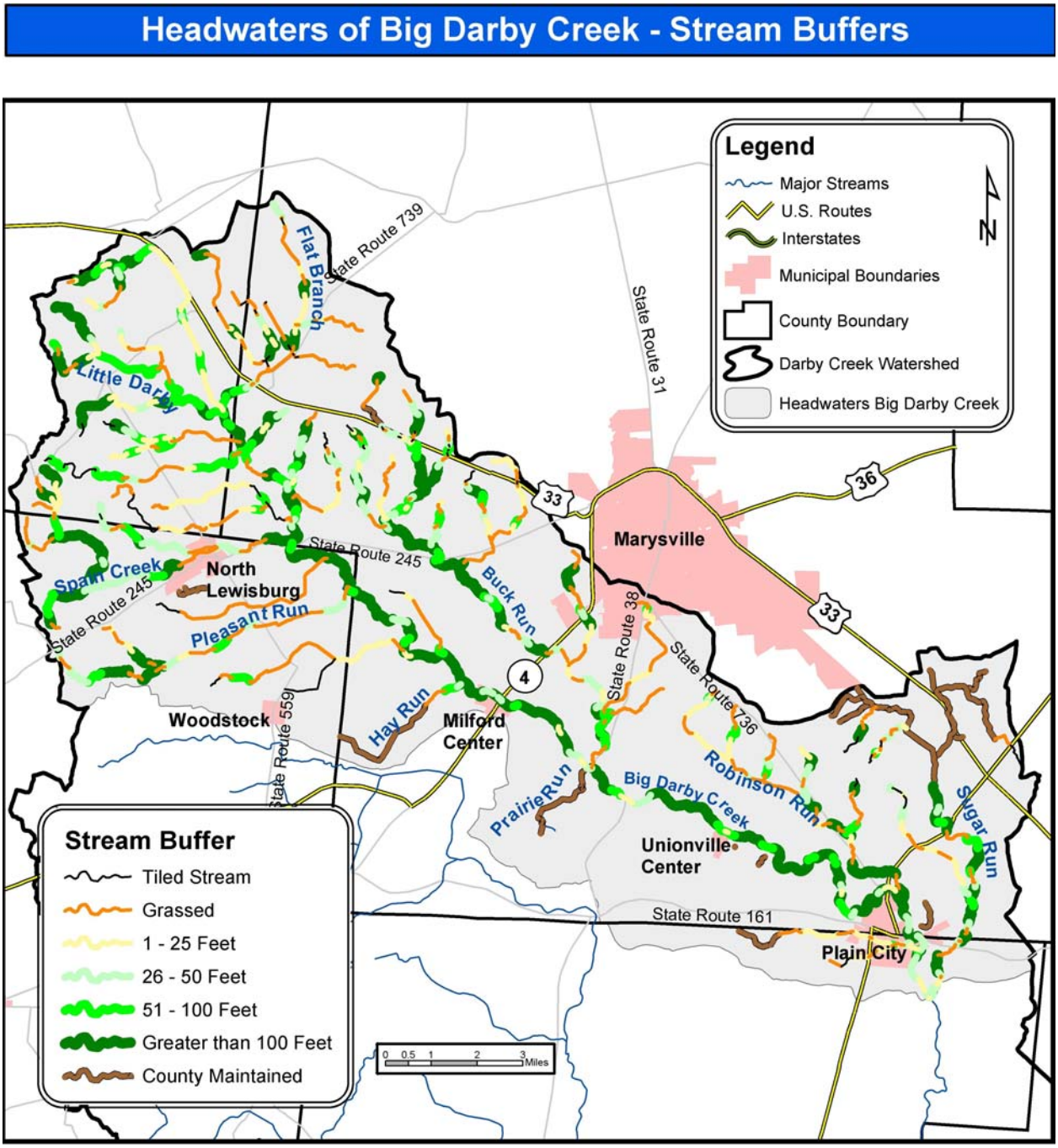

Figure 2.2.2 Riparian Corridor Status in the Upper Big Darby Creek major sub-watershed. Graphics courtesy Ben Webb.

2.2.1 Headwaters of Big Darby Creek (BDC1, 190-010)

The headwaters of Big Darby Creek are described in Box 2.2.1. Results of the habitat assessment are given in Table 2.2.1.

Box 2.2.1 Overview of the headwaters of Big Darby Creek (190-010)				
Area (acres)	3,757			
Streams	Big Darby Creek			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Logan County Flat Branch WWTP	1PP00006	0.1	0.062
Land Use	Figure 2.2.1.1			
Aquatic Life Use	**Designated Use**		**Impairment**	
	EWH, CWH		**Yes** - 25% of sites impaired	
			Deviation	IBI - 0 to 16%
Recreational Use	Primary Contact Recreation		**Yes**	
			Deviation (fecal coliform)	Av. = 18 %
				90^{th} % = 89%
Antidegradation Category	Big Darby Creek - Outstanding State Water			
Causes of impairment		**Sources of Impairment**		**Addressed in this TMDL?**
Direct Habitat Alteration		Channelization, riparian removal		√
Siltation		Road construction		√
Changes in hydrology		Channelization, hardening of the watershed		√
Nutrients		Domestic sewage, spills, land application of manure		√
Low dissolved oxygen, organic enrichment, low D.O.		Municipal Point Sources		√

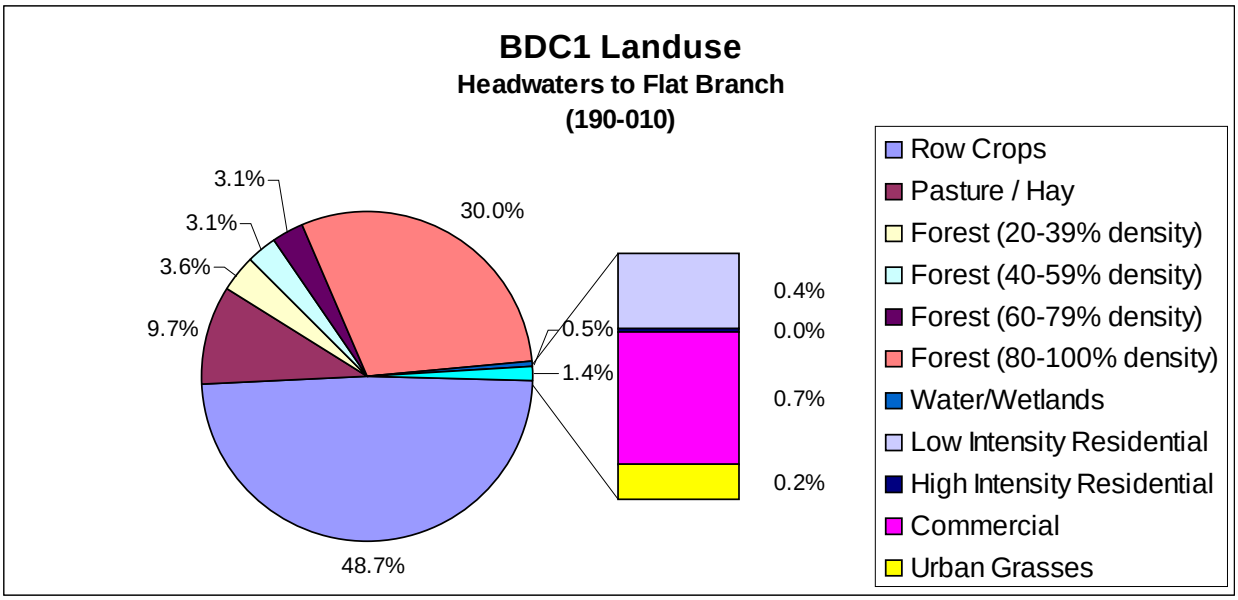

Figure 2.2.1.1 Land use in the headwaters of Big Darby Creek minor sub-watershed.

Big Darby Creek in this area has been subjected to channel modifications associated with the initial construction of U.S. Route 33 and subsequent relocations of portions of the stream to accommodate the widening of U.S. Route 33. The contribution of a significant sediment bed load to the stream channel from the lack of sediment erosion control BMPs during and after construction and the straightening of the channel resulted in declines in instream biological performance and habitat quality. Re-design and re-construction of the stream channel using natural stream channel design have subsequently resulted in improved local habitat quality.

Flushing of sediments downstream have resulted in gradually improving habitat scores in the immediate impact area. However, this movement of sediments downstream also has had the consequence of shifting impacts downstream causing declines in biological community performance. Based on the response pattern documented upstream, this should be a temporary situation with eventual improvement to close to pre-impact conditions.

Full attainment of EWH biological criteria was documented at RM 83.2 (in 1997 and 1999), Logan County Road 152 (RM 82.5) and Township Road 157 (RM 79.2) in 2001; therefore, it is recommended that the existing EWH designation be extended to include the very headwaters of Big Darby Creek. Obligate cold water fish and macroinvertebrate species present in this section of Big Darby Creek indicate the appropriateness of a Cold Water Habitat (CWH) use designation.

Table 2.2.1 Habitat Assessment Results for upper Big Darby Creek (05060001-190)						
Stream/River	**River Mile**	**Assessment Results**				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-010						
Big Darby Creek (EWH)	82.5	Channel	68	None	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	80.8	Substrate, channel	61	Silt or muck substrates	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	79.2	Substrate, channel	64.5	None	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	

Chemical water quality sampling occurred in upper Big Darby Creek five times during the 2001 survey period and was additionally sampled in 2004 in support of the water quality modeling survey. Water quality is generally very good in this part of the creek, and is reflective of a background condition of the soils in the upper watershed.

The recreational use of Big Darby Creek in this minor sub-watershed is impaired. Both measured geometric mean fecal coliform values of 1227 colony forming units/100ml(cfu) and 90th percentile of 19,961 cfu exceed the WQS criteria of 1000 cfu and 2000 cfu, respectively.

2.2.2 Flat Branch (190-020)

Flat Branch is a highly modified stream that primarily drains agricultural land and the Honda complex in western Union County. Description of the Flat Branch watershed is contained in Box 2.2.2. A description of the habitat assessment results is included in Table 2.2.2.

Box 2.2.2 Overview of Flat Branch (190-020)				
Area (acres)	8,686			
Streams	Flat Branch, Unnamed Tributary to Flat Branch			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Honda Benton Road WTP	4IW00019	N/A	0.0285
	Honda East Liberty WTP	1IW00270	N/A	0.0106
Land Use	see Figure 2.2.2.1			
Aquatic Life Use	MWH. The MWH aquatic life use of Flat Branch is not impaired. However, Flat Branch contributes to impairment of the downstream EWH aquatic life use. Targets will be established to protect that downstream aquatic life use.			
Recreational Use	**Designated Use**		**Impairment**	
	Primary Contact Recreation		**Yes**	
			Deviation (fecal coliform)	Av. = 29%
				90^{th} % = 91%

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Changes in hydrology	Channelization, hardening of the watershed	√
Metals	Industrial point source	√
Low dissolved oxygen, organic enrichment/D.O.	Industrial point sources	√

Water emanating from Flat Branch is generally very turbid, and has a marked visual influence on the water quality downstream of its confluence with Big Darby Creek (see Figure 2.2.2.2). Flat Branch also experiences violations of the MWH dissolved oxygen (DO) standard, and causes DO violations in Big Darby Creek downstream of the confluence of Flat Branch and Big Darby Creek.

Water quality sampling by Ohio EPA has revealed a complex chemical interaction emanating from Flat Branch. Analysis of chemical sampling revealed significantly elevated levels of iron, potassium, Total Kjeldahl Nitrogen (TKN) and manganese when comparing Flat Branch with the other minor sub-watersheds. Alkalinity, hardness, and

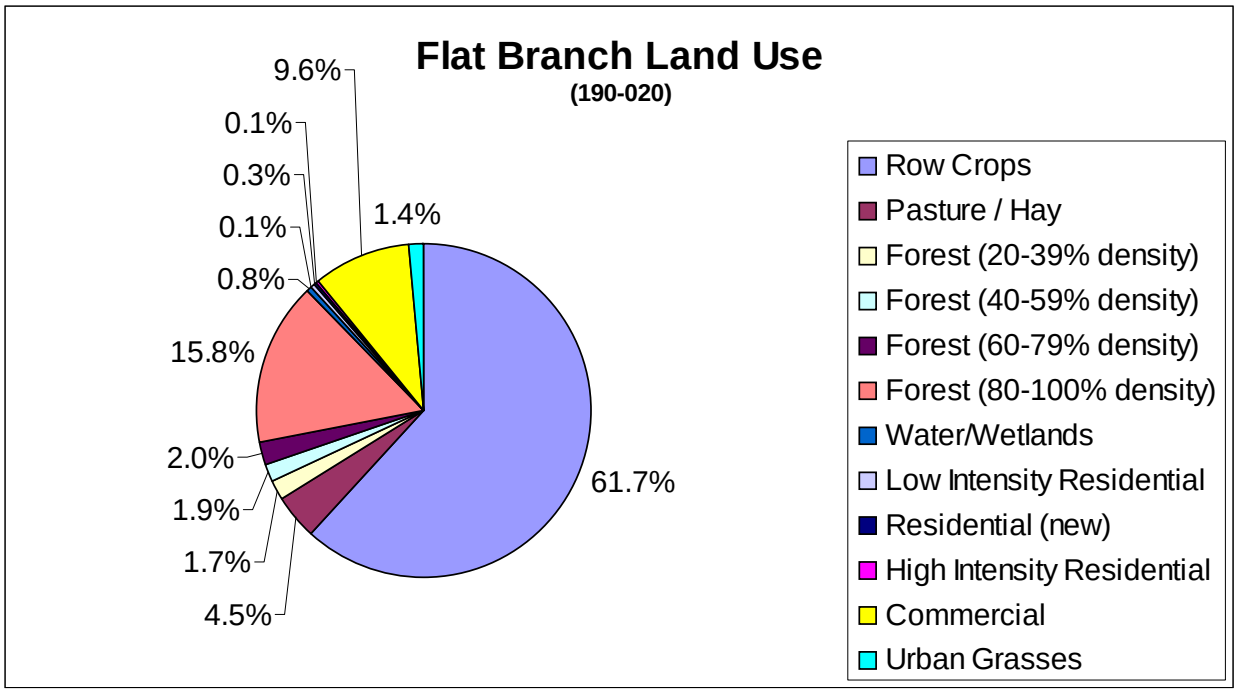

Figure 2.2.2.1 Land Use in the Flat Branch minor sub-watershed.

Figure 2.2.2.2 Confluence of Big Darby Creek (right) with Flat Branch (left). Notice that Flat Branch's turbidity overwhelms the clear water from Big Darby Creek.

magnesium were significantly lower than other minor sub-watersheds (See Chapter 4 discussion).

The recreational use of Flat Branch (HUC 14 190-020) is impaired. Both geometric mean fecal coliform (1419 cfu/100 ml) and 90th percentile (22,616 cfu/100 ml) exceed the WQS criteria.

Table 2.2.2 Habitat Assessment Results for Flat Branch (190-010)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-020						
Flat Branch (MWH)	3.2	Not applicable to MWH	25.5	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, Max. pool depth less than 40 cm	Sand substrate, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not Impaired, but contributes to downstream impairment
	0.8	Not applicable to MWH	36.5	silt or muck substrates, low sinuosity, sparse or no cover	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
UT to Flat Branch at RM 1.50 (MWH)	0.1	Not applicable to MWH	36.5	silt or muck substrates, low sinuosity, sparse or no cover	Channelized-recovering, hardpan substrate origin, intermittent or poor pool quality, no fast current, extensive/moderate substrate embeddedness	

2.2.3 Big Darby Creek Below Flat Branch to Milford Center (BDC2, 190-030)

Geographically this section of Big Darby Creek is defined as the mainstem from the confluence of Big Darby Creek and Flat Branch, downstream to about Milford Center, including several large tributaries, and is referred to as middle upper Big Darby Creek. A description of middle upper Big Darby Creek is included in Box 2.2.3. The results of the habitat assessment are given in Table 2.2.3.

Box 2.2.3. Overview of Big Darby Creek below Flat Branch to Milford Center (BDC2, 190-030).

Area (acres)	40,791				
Streams	Big Darby Creek, from below Flat Branch to Milford Center (RM 78.48 to RM 66.50), Little Darby Creek (Logan Co.), Unnamed Tributaries at RM 77.56, 77.32, 77.29, and 74.91, Spain Creek, Pleasant Run, Hay Run				
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)	
	North Lewisburg	1PB00039	0.170	0.188	
		Receiving stream: Spain Creek			
Land Use	see Figure 2.2.3.1				
Aquatic Life Use	**Name**		**Designated use**	**Impairment**	
	Big Darby Creek		EWH	**Yes** - 75% of sites impaired	
				Deviation	IBI 0-34% MIwb 0-12%
	Little Darby Creek (Logan Co.)		EWH + CWH	No	
	Spain Creek		WWH + CWH; EWH + CWH	No	
	Pleasant Run		EWH	No	
	Hay Run		EWH	No	
	Unnamed tributary to Big Darby Creek at RM:	74.91	EWH	No	
		69.4	WWH	No	

Box 2.2.3. Overview of Big Darby Creek below Flat Branch to Milford Center (BDC2, 190-030).

Recreational Use	Big Darby Creek		PCR	**Yes** - 90th percentile Fecal Coliform values exceed target WQ criteria by 36% (Informational note: *E. coli* values are highly elevated)
	Little Darby Creek (Logan Co.)		PCR	
	Spain Creek		PCR	
	Pleasant Run		PCR	
	Hay Run		PCR	
	Unnamed tributary to Big Darby Creek at RM:	74.91	SCR	
		69.4	SCR	
Antidegradation Category	Big Darby Creek - Outstanding State Water Spain Creek - Superior High Quality Water			

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Direct habitat alteration	Channelization, riparian removal	√
Changes in hydrology	Channelization, hardening of watershed	√
Nutrients	Domestic sewage, agriculture, spills, land application of manure	√
Metals	Municipal point sources, industrial point sources	√
Low dissolved oxygen, organic enrichment/D.O.	Municipal point sources, industrial point sources, spills sewage and agriculture products	√

Biological sampling results from 2001 and 2002 show that the mainstem of Big Darby Creek is impaired for most of its length within the middle upper Big Darby Creek minor sub-watershed. The exception to the impairment is the site just upstream of Collins Road. Below Flat Branch, the Big Darby Creek mainstem shows definite influences from Flat Branch.

Table 2.2.3 Habitat Assessment Results for upper Big Darby Creek (Flat Branch to Milford Center) (05060001-190-030)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-030						
Big Darby Creek (EWH)	78.4	Substrate, channel, riparian	63.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	76.6	None	73.5	None	Sand substrate, no fast current, substrate embeddedness,	
	69.5	Channel	70.5	Low sinuosity	Channelized-recovering, poor pool quality, no fast current, substrate embeddedness	
	66.0	Substrate	74.5	None	no fast current, substrate embeddedness	
Little Darby Creek (Logan County) (EWH/CWH)	3.5[1]	Channel	71.5	None	None	Not impaired (2001)
	3.5[1]	Substrate, cover, channel, riparian	32	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover	Hardpan substrate origin, fair or poor channel development, no fast current	
	0.4	Riparian	68	None	Poor pool quality	
UT to Big Darby Creek (74.91) (EWH)	0.2	Substrate, riparian	62.5	None	Sand substrate, no fast current, substrate embeddedness	Not Impaired
UT to Big Darby Creek (69.40) (WWH)	0.3	Substrate, cover, channel, riparian, pool, riffle, gradient	33.5	Silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired
Spain Creek (WWH[2]/EWH)	5.7[2]	None	66	None	Hardpan substrate origin, poor pool quality, substrate embeddedness	Not impaired
	3.7	Riparian	72	None	No fast current	
	0.1	Substrate	76	None	No fast current, substrate embeddedness	

Table 2.2.3 Habitat Assessment Results for upper Big Darby Creek (Flat Branch to Milford Center) (05060001-190-030)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
Pleasant Run (EWH)	4.6	Channel, riparian	72	None	Channelized-recovering, poor pool quality	Not impaired
	0.5	Substrate, channel, riparian	59.5	None	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
Hay Run (EWH)	0.3	Substrate, cover, channel, pool, riffle, gradient	52.5	Low sinuosity, max. pool depth less than 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired

[1] This sample site was evaluated in 2001 and 2002. In the intervening time frame, this stream was channelized under the Tulloch rule, thereby significantly reducing habitat quality.
[2] Denotes a Warm Water Habitat (WWH) site.

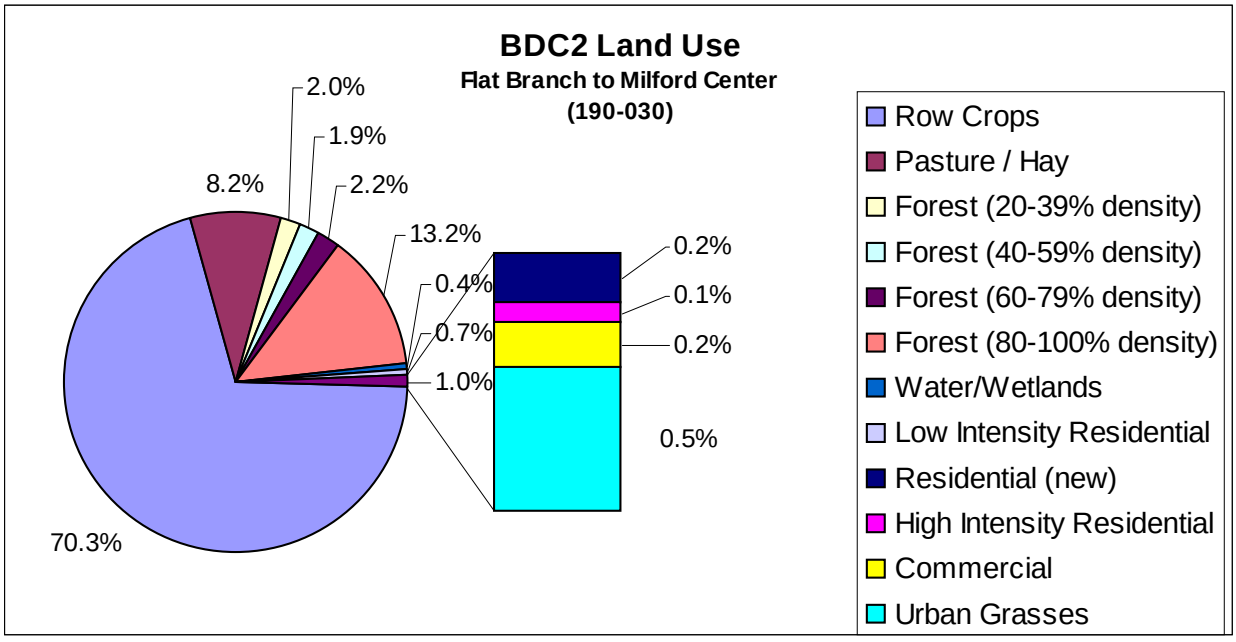

Figure 2.2.3.1 Land use in the middle upper Big Darby Creek minor sub-watershed.

Recreational use in this 14 digit HUC is impaired for both magnitude and frequency of fecal coliform values. The WQS criteria of a 90th percentile of no more than 2000 cfu is exceeded by the measured 90th percentile of 3163 cfu. *E. coli* values are highly elevated, with a geometric mean 800 cfu and a 90th percentile of 3770.

2.2.4 Big Darby Creek Below Milford Center to Sugar Run (BDC3, 190-040)

This part of the upper Big Darby Creek watershed is geographically defined as below Milford Center downstream to Sugar Run. A description of lower upper Big Darby Creek is provided in Box 2.2.4. Habitat assessment results are given in Table 2.2.4

<table>
<tr><th colspan="5">Box 2.2.4 Overview of Big Darby Creek below Milford Center to Sugar Run (BDC3, 190-040)</th></tr>
<tr><td>Area (acres)</td><td colspan="4">20,964</td></tr>
<tr><td>Streams</td><td colspan="4">Big Darby Creek, Milford Center to above Sugar Creek (RM 66.50 to RM 50.93), Prairie Run, Sweeney Run</td></tr>
<tr><td rowspan="7">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Plain City WWTP</td><td>4PB00016</td><td>0.500</td><td>0.444</td></tr>
<tr><td>Darby Creek Golf Course</td><td>4PX00017</td><td>0.0076</td><td>0.0007</td></tr>
<tr><td>Ranco</td><td>4IC00008</td><td>0.039</td><td>0.032</td></tr>
<tr><td>Tuffco Sand & Gravel</td><td>4IJ00011</td><td>N/A</td><td>2.16</td></tr>
<tr><td>Royster Clark</td><td colspan="2">Storm water General Permit</td><td>Potential contaminated storm water</td></tr>
<tr><td>Select Sires</td><td colspan="2">unpermitted AFO[1]</td><td>Contaminated storm water discharges from any significant rain.</td></tr>
<tr><td>Land Use</td><td colspan="4">see Figure 2.2.4.1</td></tr>
<tr><td rowspan="4">Aquatic Life Use</td><td>Name</td><td>Use Designation</td><td colspan="2">Impaired</td></tr>
<tr><td rowspan="2">Big Darby Creek</td><td rowspan="2">EWH</td><td colspan="2">Yes - 44% of sites impaired</td></tr>
<tr><td>Deviation</td><td>IBI - 14%
MIwb - 20%
ICI - 20%</td></tr>
<tr><td>Prairie Run</td><td>LRW</td><td colspan="2">No</td></tr>
<tr><td>Sweeney Run</td><td>WWH</td><td colspan="2">Yes - 100% of sites impaired (1/1)</td></tr>
</table>

Box 2.2.4 Overview of Big Darby Creek below Milford Center to Sugar Run (BDC3, 190-040)				
			Deviation	ICI - Fair ➜Good
Recreational Use	Big Darby Creek	PCR	**Yes** - 90th percentile fecal coliform values exceed maximum WQS by 2%.	
	Prairie Run	SCR		
	Sweeney Run	PCR		
Antidegradation Category	Big Darby Creek - Outstanding State Water			
Causes of impairment		**Sources of impairment**		**Addressed in this TMDL?**
Nutrients		Domestic Sewage, agriculture, spills, livestock breeding facility, land application of manure		√
Low dissolved oxygen, organic enrichment/D.O.		Municipal point source, spills - sewage and agriculture products		√

[1] Select Sires in an animal feeding operation just south of Unionville Center. A permit application has been requested.

Three minor sub-watersheds enter Big Darby Creek in this stretch, namely Buck Run (190-050), Robinson Run (190-060), and Sugar Run (190-070). Big Darby Creek in this area is impaired for most of its length. Part of this impairment is attributed to a major fish kill that occurred in response to a release of animal feed products from a mill in Milford Center. The 2001/2002 biological surveys did not document the expected recovery from this spill, and the effects on the aquatic biota seem to be lingering. In 2004 it was discovered that the Select Sires cattle operation in Unionville Center had a direct, uncontrolled discharge from the onsite storm water system. This system was not protected from contamination by manure. This discharge has the potential to contribute significant pollutant loads during storm events based upon its lack of controls (Figure 2.2.4.2).

At the downstream end of lower upper Big Darby Creek the Plain City Wastewater Treatment Plant discharges to Big Darby Creek. This wastewater load will be discussed further in the context of the water quality model that was developed to evaluate the discharge.

Recreational use in Big Darby Creek in this area is impaired by the magnitude and frequency of recorded fecal coliform values. The 90th percentile fecal coliform value of 2039 cfu exceeds the WQS criteria of 2000 cfu. This pattern suggests that runoff induced bacterial contamination is a factor in lower upper Big Darby Creek.

Figure 2.2.4.2. A storm water pond at Select Sires in Unionville Center. Grass in the swale is burned by high strength influent. Note manure piles on right.

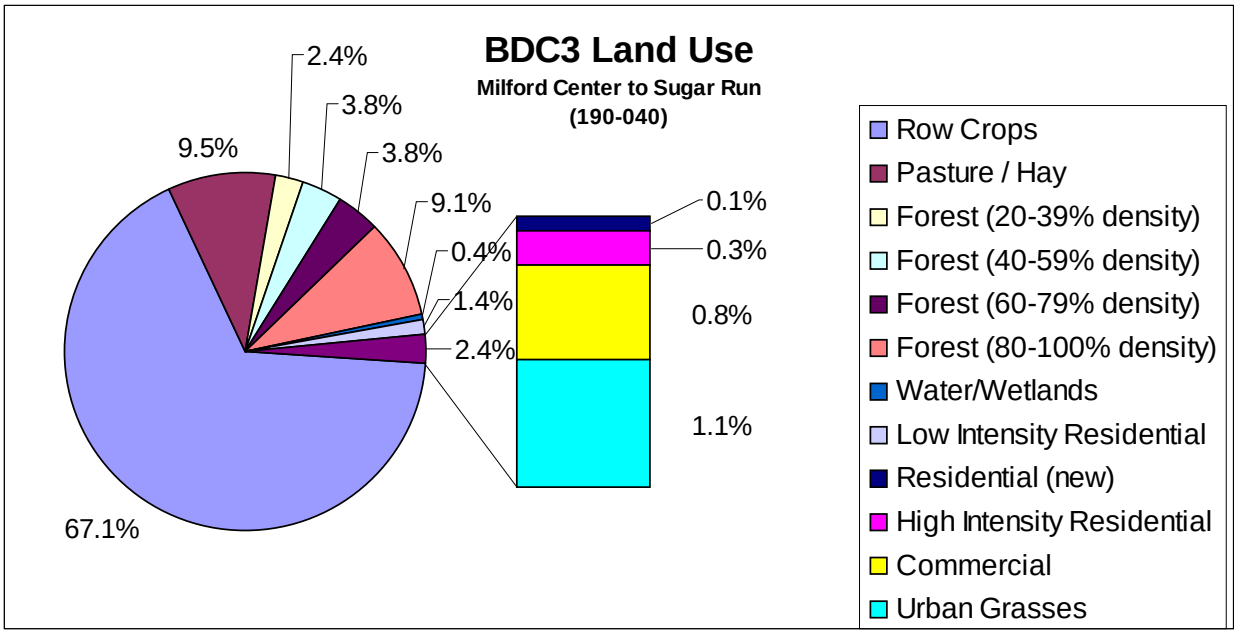

Figure 2.2.4.1 Land Use in the lower upper Big Darby Creek minor sub-watershed.

Table 2.2.4 Habitat Assessment Results for upper Big Darby Creek (Milford Center to Sugar Run) (05060001-190-040)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-040						
Big Darby Creek (EWH)	63.8	None	80.5	None	None	Impaired
	62.5	None	83.5	None	None	
	54.2	None	83.5	None	None	
	53.9	None	93	None	None	
	52	Channel	81	None	Channelized-recovering	
Prairie Run (LRW)	0.3	Not applicable to LRW	23	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not impaired
Sweeney Run (WWH)	0.1	Cover, channel	58	Low sinuosity, sparse or no cover	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	Impaired

2.2.5 Buck Run (190-050)

Buck Run drains into Big Darby Creek from the east. In the headwaters of Buck Run, an unnamed tributary drains storm water from the Honda site. Downstream, land use in the Buck Run basin is primarily agricultural, with additional residential land use.

Buck Run is described in Box 2.2.5. Habitat assessment results are given in Table 2.2.5.

Partial and non-attainment in the upstream reaches of Buck Run resulted from a combination of nutrient enrichment, sedimentation and livestock impacts. Mid reaches were stressed by high nitrogen and phosphorus, low dissolved oxygen (i.e., violations of the WWH minimum criteria) and TSS concentrations amongst the highest in the watershed. These impacts extended into Big Darby Creek and contributed to declines a short distance downstream in that watercourse.

Buck Run is impaired for its recreational use based upon magnitude and frequency of fecal coliform values measured. The 90th percentile value of 8009 cfu greatly exceeds the water quality standard of 2000 cfu.

Box 2.2.5. Overview of Buck Run (190-050).				
Area (acres)	19,052			
Streams	Buck Run			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Reflections Subdivision WWTP	4PW00008	N/A	0.0012
Land Use	see Figure 2.2.5.1			
Aquatic Life Use	**Designated Use**		**Impaired**	
	WWH		**Yes** - 75% of sites impaired	
			Deviation	IBI 0-53% MIwb 19%
Recreational Use	Primary Contact Recreation		**Yes** -90th percentile values of fecal coliform exceed maximum criteria by 75%	

Causes of impairment	**Sources of impairment**	**Addressed in this TMDL?**
Direct habitat alteration	Channelization, riparian removal	√
Nutrients	Domestic sewage, agriculture, spills, land application of manure	√
Metals	Industrial Point Source	√
Low dissolved oxygen, organic enrichment/D.O.	Industrial Point Source, spills - sewage and agricultural products	√

Table 2.2.5 Habitat Assessment Results for Buck Run (05060001-190-050)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-050						
Buck Run (WWH)	10.4	Substrate, cover, channel, riparian, pool, riffle, gradient	40	Channelized-no recovery, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Channelized-recovering, sand substrate, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired
	7.8	Substrate, pool, riffle, gradient	55.5	Sparse or no cover	Hardpan substrate origin, only one or two cover types, poor pool quality, no fast current, substrate embeddedness	
	0.1	Riparian	70.5	None	Hardpan substrate origin, poor pool quality, no fast current	

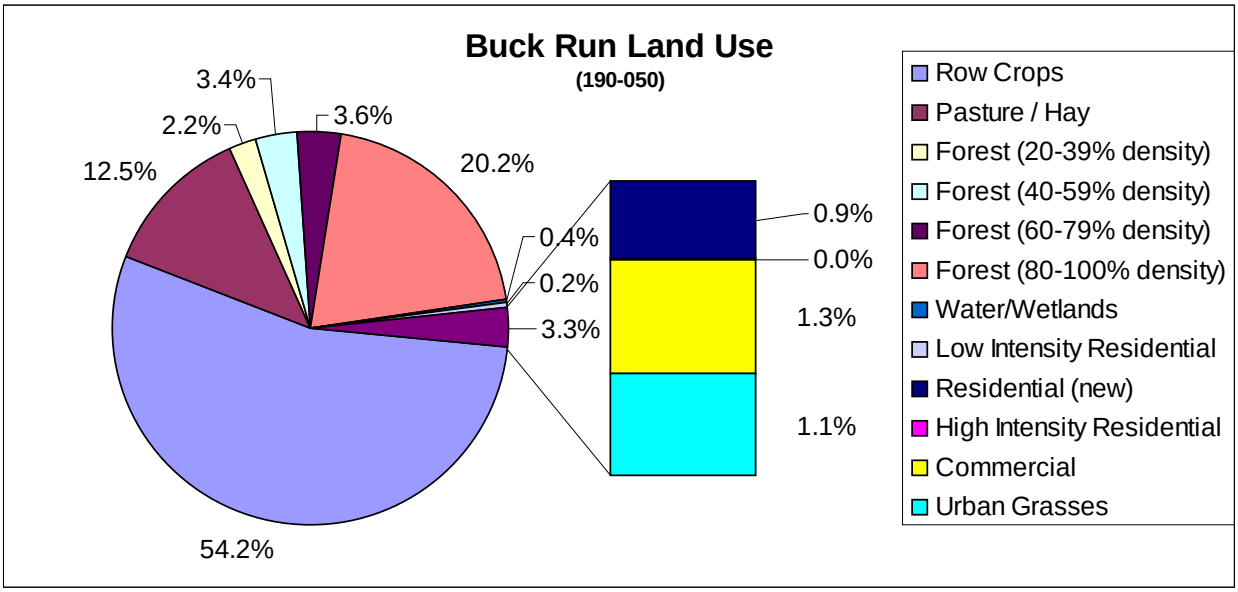

Figure 2.2.5.1. Land use in the Buck Run minor sub-watershed.

2.2.6 Robinson Run (190-060)

Robinson Run arises southeast of the City of Marysville, in Union County, and flows towards Plain City. Robinson Run is described in Box 2.2.6. Habitat assessment results for Robinson Run are given in Table 2.2.6.

Box 2.2.6. Overview of Robinson Run (190-060).				
Area (acres)	6,987			
Streams	Robinson Run			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	St. John's Church	4PT00006	0.0035	0.00097
	Union County Darby Meadows WWTP	4PG00005	0.010	0.014
Land Use	see Figure 2.2.6			
Aquatic Life Use	**Designated use**		**Impairment**	
	WWH		**Yes** - 100% of sites (3/3) impaired	
			Deviation	IBI - 25% ICI - Very Poor ➜ Good
Recreational Use	Primary Contact Recreation		**Yes** - 90th percentile fecal coliform values exceed maximum criteria by 42%	
Causes of Impairment		**Sources of Impairment**		**Addressed in this TMDL?**
Direct habitat alteration		Channelization, riparian removal		√
Changes in hydrology		Channelization, hardening of the watershed		√
Nutrients		Domestic sewage, agriculture, spills, land application of manure		√

Table 2.2.6 Habitat Assessment Results for Robinson Run (05060001-190-060)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-060						
Robinson Run (WWH)	2.1	Channel	64	Low sinuosity	Channelized-recovering, sand substrate, hardpan substrate origin	Impaired
	0.7	Channel	70	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	

The very poor results in the headwaters are due to very high nutrient concentrations which has led to low dissolved oxygen levels and black anoxic streambed sediments. Channelization has also contributed to the problems documented here. The depressed fish community scores seen at the site downstream from U.S. Route 42 are likely due to a combination of sediment contamination and water quality problems arising from Ranco Inc. One of the highest sediment ammonia concentrations (94 mg/kg) was found at this site. Arsenic and cyanide have been parameters of concern at this location. Further investigation needs to be conducted on Robinson Run bracketing Ranco Inc., the landfill and Chemfix piles with an expanded parameter list to pin down the causes and sources of this impairment.

Robinson Run is impaired for its recreational use. Magnitude and frequency of measured fecal coliform values exceed the WQS criteria of 2000 cfu with a 90^{th} percentile of 3457 cfu.

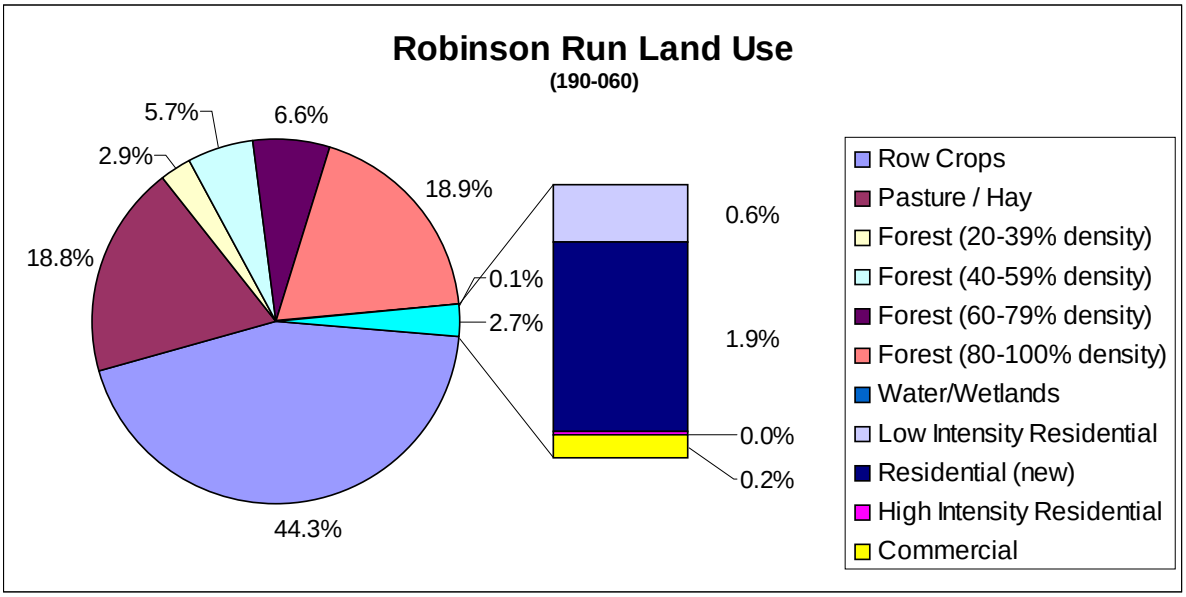

Figure 2.2.6.1. Land use in the Robinson Run minor sub-watershed.

2.2.7 Sugar Run (190-070)

Sugar Run is the most southerly major tributary to Upper Big Darby Creek that arises from the eastern side of the creek. Sugar Run is heavily influenced by agricultural practices along its length. Sugar Run is described in Box 2.2.7. Habitat assessment results for Sugar Run are given in Table 2.2.7.

The upstream reaches of Sugar Run are currently designated as WWH, but are recommended to be re-designated as MWH. Although biological samples met applicable biocriteria values for the recommended aquatic life use even this lower use is threatened in upper Sugar Run. Very high nutrients, degrading habitat, and spills have led to low dissolved oxygen concentrations (i.e, 2.88 mg/l) which do not achieve the MWH criterion, resulting in lowered biological community scores and exported stressors downstream.

The sampling site at the mouth of Sugar Run (RM 0.7) had one of the highest total phosphorus sediment concentrations in the watershed. Other Sugar Run sites had sedimentation, nutrient enrichment and low dissolved oxygen problems which yielded decreased biological community performance.

The most impacted stream locale for sediment contaminants was Sugar Run at RM 7.00. Here, arsenic concentrations were elevated as were chromium and iron. Copper, nickel, and zinc concentrations were slightly elevated. This was the only tributary that exhibited detectable concentrations of chromium and nickel as well as the highest values for copper, iron, and zinc. The Hershberger Landfill is probably source of these metals.

Box 2.2.7. Overview of Sugar Run (190-070).				
Area (acres)	12,443			
Streams	Sugar Run			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Union County Crottinger Estates	4PG00003	0.007	0.00825
Land Use	see Figure 2.2.7			
Aquatic Life Use	**Designated use**		**Impairment**	
	WWH		**Yes** - 50% of sites impaired	
			Deviation	IBI - 17%
	MWH		No	
Recreational Use	Primary Contact Recreation		No - Note: *E. coli* elevated.	

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Direct habitat alteration	Channelization, riparian removal	√
Changes in hydrology	Channelization, hardening of the watershed	√
Nutrients	Domestic sewage, agriculture, spills, land application of manure	√

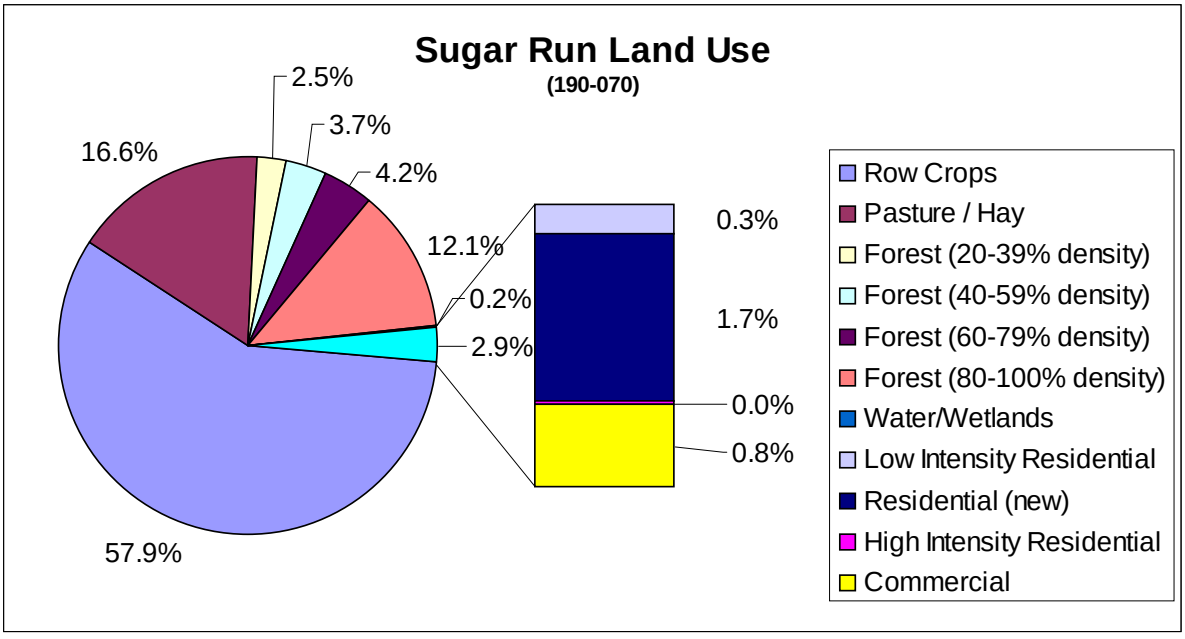

Figure 2.2.7.1. Land use in the Sugar Run minor sub-watershed.

Sugar Run is not impaired for its recreational use for fecal coliform bacteria measurements. Ohio WQS require attainment of only one of the two bacterial indicators. *E. coli* values in Sugar Run exceed WQS or other targets. Future implementation of an *E. Coli* only WQS could result in this stream being evaluated as impaired. Opportunities to reduce *E. Coli* loading to this stream should be pursued where practicable.

Table 2.2.7 Habitat Assessment Results for Sugar Run (05060001-190-070)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-190-070						
Sugar Run (MWH[1]/ WWH)	7.5[1]	Not applicable to MWH	31	Silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired
	7.0[1]	Not applicable to MWH	29.5	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Hardpan substrate origin, fair or poor channel development, poor pool quality, no fast current, riffle embeddedness	
	5.4	Substrate, cover, channel, riparian, pool, riffle, gradient	38.5	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover	Hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	
	0.5	Channel	65.5	None	Channelized-recovering, no fast current, substrate embeddedness	
UT to Sugar Run (RM 7.39) (MWH)	0.1[1]	Not applicable to MWH	27	Channelized-no recovery, silt or muck substrates, low sinuosity, sparse or no cover, max. pool depth less than 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not Impaired

[1] Denotes a Modified Warm Water Habitat (MWH) site.

2.3 Middle Big Darby Creek - (05060001 200)

The middle Big Darby Creek major sub-watershed extends from below Sugar Run to above Little Darby Creek. The Big Darby Creek mainstem is the predominant stream in middle Big Darby Creek, but there are also many streams flowing from the West in Madison County. Many of these streams have been influenced by channel modification.

Aquatic life uses in middle Big Darby Creek are impaired. Status of aquatic life uses is shown in Figure 2.3.1. The condition of the riparian corridor in this major sub-watershed is shown in Figure 2.3.2.

Figure 2.3.1 Status of Aquatic Life Uses in the middle Big Darby Creek major sub-watershed.

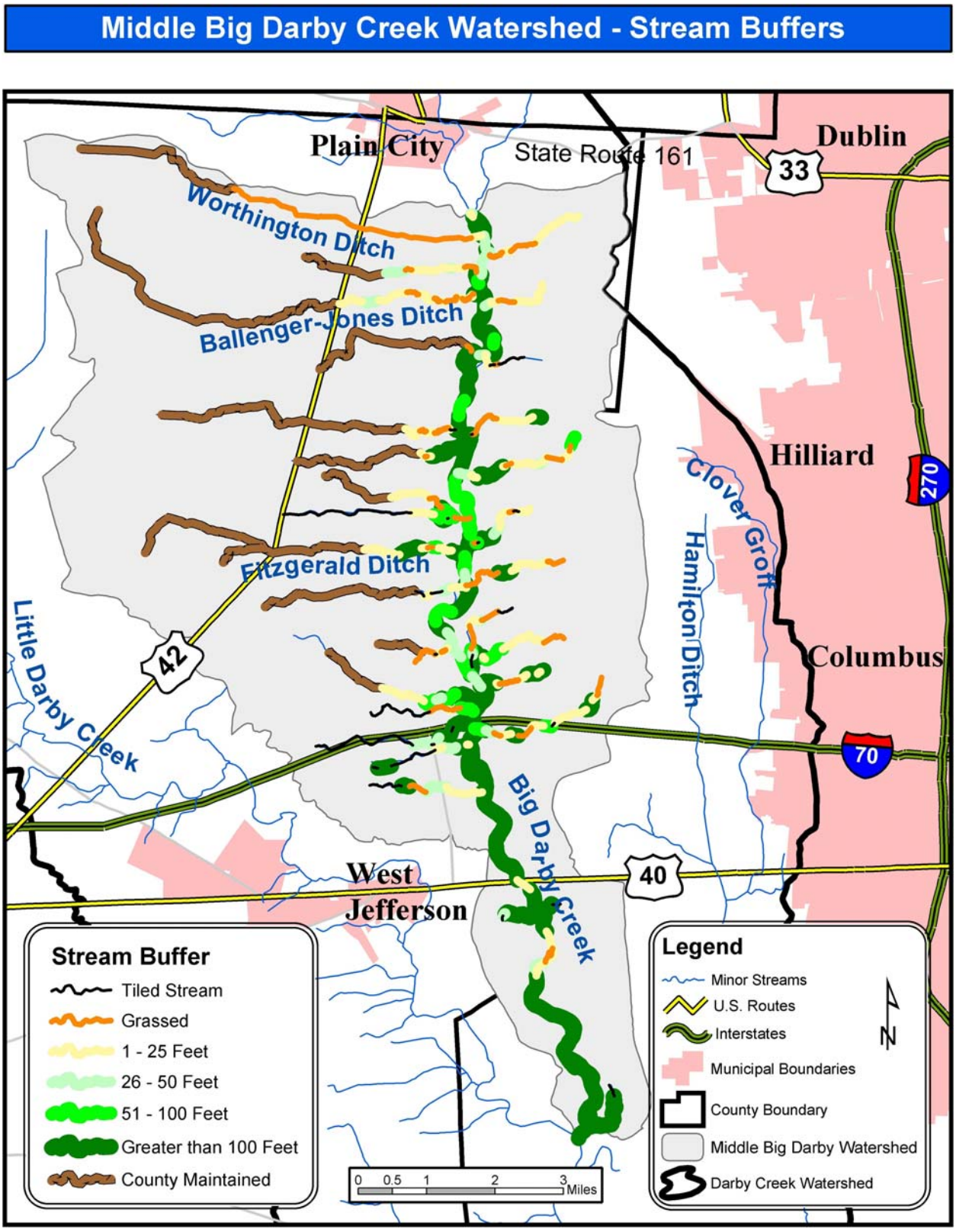

Figure 2.3.2. Riparian Corridor Status in Middle Big Darby Creek. Graphics courtesy Ben Webb.

The upstream reach of Big Darby Creek within middle Big Darby Creek (i.e., RM 49.5) has carryover impacts from the Plain City WWTP, Sweeney Run and Sugar Run. These include high TSS, biosolids, spills (primarily to Sweeney Run) and low dissolved oxygen. The pooled nature of this segment of the stream has a tendency to exacerbate the problems associated with nutrient enrichment due to extended retention times and lower re-aeration rates. However, this does have the benefit of reducing downstream transport of nutrients.

Full recovery to EWH levels of community performance in Big Darby Creek were evident from upstream of Interstate Route 70 (RM 42.1) to the downstream terminus of this major sub-watershed. This was due to a combination of factors. Several of the direct dischargers have been upgraded and documented to be operating within permit limits. One of the largest dischargers, Olen Corporation ceased operation in 2003. Another major potential source of stress, nonpoint source (NPS) inputs, was ameliorated by the relatively intact wide and wooded riparian buffers present throughout most of this reach (Figure 2.3.2). Instream gradient was adequate to flush contributed fines and the intact nature of the stream channel had the net result of a gradual improvement in habitat quality from upstream of exceptional to extraordinary downstream.

All sediment samples taken within middle Big Darby Creek revealed total organic carbon concentrations and total phosphorus concentrations exceeding the lowest effect level (LEL) to cause no harm. The sampling site at the mouth of Sugar Run (RM 0.7), which discharges directly to the BDC3 sub-watershed (Figure 2.1.1), had one of the highest total phosphorus sediment concentrations in the watershed.

2.3.1 Upper Middle Big Darby Creek (200-010)

The upper middle Big Darby Creek begins downstream of Sugar Run, and extends to High Free Pike, which crosses Big Darby Creek just south of the Interstate Route 70 crossing

A description of upper middle Big Darby Creek is given in Box 2.3.1.

<table>
<tr><th colspan="5">Box 2.3.1 Overview of upper middle Big Darby Creek (BDC4, 200-010)</th></tr>
<tr><td>Area (acres)</td><td colspan="4">40,108</td></tr>
<tr><td>Streams</td><td colspan="4">Big Darby Creek, below Sugar Run to High Free Pike (RM 50.92 to RM 41.75), including Worthington, Ballenger-Jones, Powell, Yutzy and Fitzgerald Ditches.</td></tr>
<tr><td rowspan="3">Point Source Dischargers</td><td>Name</td><td>Permit Number</td><td>Design flow (MGD)</td><td>Average flow (MGD)</td></tr>
<tr><td>Suburbans MHP</td><td>4PR00031</td><td>0.044</td><td>n/a - data unreliable</td></tr>
<tr><td rowspan="2">Jonathon Alder High School</td><td>4PT00119</td><td>0.0125</td><td>0.0024</td></tr>
<tr><td colspan="3">Receiving stream: Ballenger-Jones Ditch</td></tr>
</table>

Box 2.3.1 Overview of upper middle Big Darby Creek (BDC4, 200-010)				
	Dutch Kitchen	4PR00077	0.008	0.0014
		Receiving stream: UT to Ballenger-Jones Ditch		
	COJV School District	4PT00104	0.020	0.0107
		Receiving stream :Powell Ditch		
	Canaan School	4PR00032	0.003	0.0516
		Receiving stream: Yutzy Ditch		
	Wissolohican Sanitary Sewer District	4PG00048	0.0044	0.0028
	Canaan Community MHP	4PR00032		
		Receiving stream: Fitzgerald Ditch		
	Olen Corporation	4IJ00022	Discharge Eliminated	
Land Use	see Figure 2.3.1.1			
Aquatic Life Use	**Name**	**Designated use**	**Impairment**	
	Big Darby Creek	EWH	**Yes** - 50% of sites impaired	
			Deviation	MIwb - 15%
	Worthington Ditch	WWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 66%
	Ballenger-Jones Ditch	WWH	No	
	Yutzy Ditch	WWH	No	
	Fitzgerald Ditch	WWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 25%
Recreational Use	All	PCR	No	
Antidegradation Category	Big Darby Creek - Outstanding State Water			

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Nutrients	Spills, agricultural run-off, domestic sewage	√
Low dissolved oxygen	Spills, agricultural run-off, domestic sewage	√

Box 2.3.1 Overview of upper middle Big Darby Creek (BDC4, 200-010)		
Organic Enrichment	Non-irrigated crop production	√
Direct habitat alteration	Channelization, riparian removal	√
Sedimentation	Channelization, riparian removal	√

Big Darby Creek's aquatic life use is impaired through upper middle Big Darby Creek, with recovery occurring at the downstream edge of the sub-watershed. Recreational uses are not impaired in upper middle Big Darby Creek based upon sampling data collected in 2001. This is due to the fact that Ohio WQS require achieving only one of 2 bacterial criteria for the recreational use. *E. coli* values exceed existing targets, and should future WQS require a shift to *E. coli* only WQS, this sub-watershed could be re-evaluated as not being in attainment. Therefore, opportunities to reduce *E. coli* loading should be pursued where practicable.

Worthington Ditch is a stream that enters Big Darby Creek from the west just south of Plain City. Although channelized upstream from Plain City - Georgesville Road, groundwater influx and shading from a modest amount of wooded riparian vegetation in the lower reach downstream from State Route 142 has yielded cooler instream water temperatures and ameliorated some of the effects from nutrient enrichment introduced to the channelized open stream segment upstream. The macroinvertebrate communities marginally meet the WWH criterion for WWH between State Route 142 and the confluence with Big Darby Creek. As such, this is the recommended aquatic

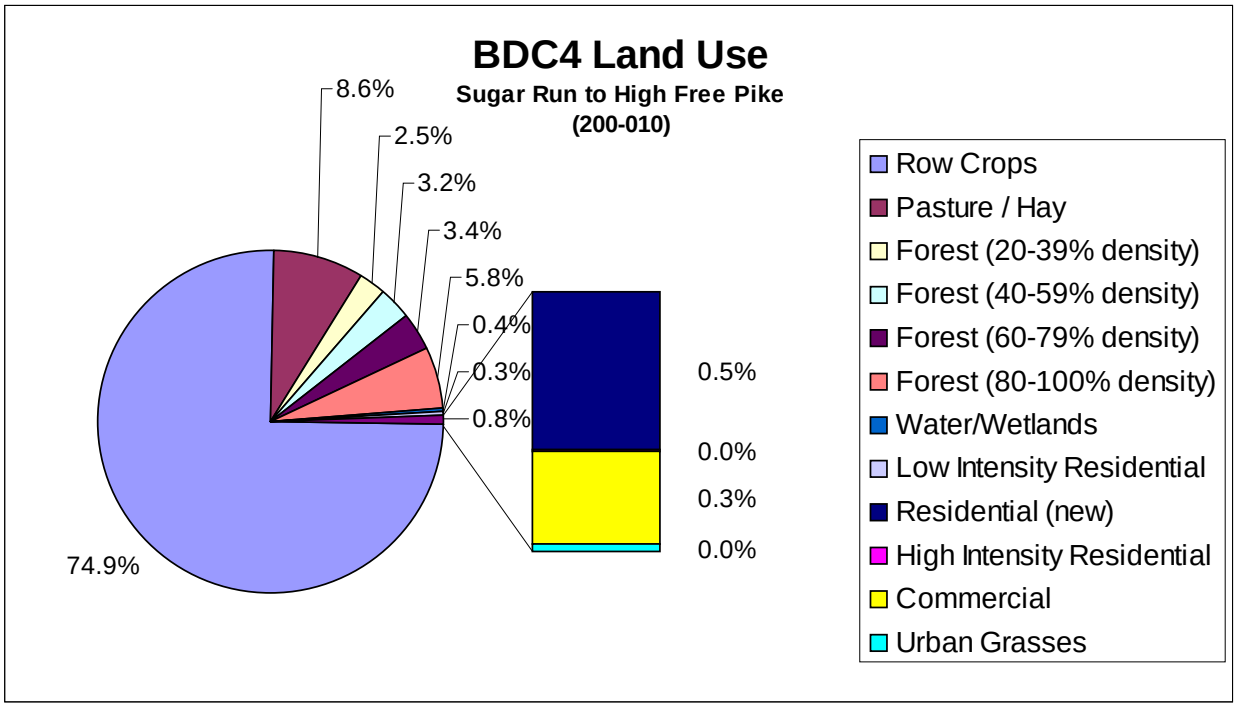

Figure 2.3.1.1 Land use in the upper middle Big Darby Creek minor sub-watershed.

Table 2.3.1 Habitat Assessment Results for upper middle Big Darby Creek (05060001-200-010)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-200-010						
Big Darby Creek (EWH)	49.5	Substrate	76	Low sinuosity	Hardpan substrate origin, no fast current, substrate embeddedness	Impaired
	42	None	81.5	None	Poor pool quality, substrate embeddedness	
Fitzgerald Ditch (WWH)	0.5	Cover, channel, pool, riffle, gradient	56.5	Low sinuosity, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
Ballenger-Jones Ditch (WWH)	0.4	Riparian	69	None	No fast current, substrate embeddedness	Not impaired
Worthington Ditch (WWH)	0.2	Cover, channel, riparian	46.5	Channelized-no recovery, low sinuosity, no cover	Hardpan substrate origin, fair/poor channel development, no fast current, substrate embeddedness	Impaired

life use for this segment (i.e., RM 0.4 to the mouth). Increasing the grass and/or wooded riparian buffer upstream from State Route 142 would improve water quality of Worthington Ditch and the water quality being delivered to Big Darby Creek at RM 50.62.

Although Ballenger -Jones Ditch has had much of the riparian vegetation removed from the stream bank upstream from State Route 142, the meander pattern of the stream channel and its instream habitat structure have been retained. Additionally, downstream from State Route 142, the wooded riparian vegetation has been retained as well. As a consequence instream habitat quality was judged as good (i.e., QHEI - 69.0) which was reflected in the instream biological community performance. County Ditch maintenance extends from RM 7.35 - 3.72

Yutzy Ditch was of marginally good quality at the site near State Route 142, RM 0.4, and met the recommended WWH aquatic life use biocriterion for macroinvertebrates. There was still some slight flow and groundwater recharge or supplemental interstitial flow and modest canopy in the lower reach that moderated water temperatures (~70^{o} F.). A more natural stream channel was present about 400-500 yards upstream from State Route 142 with riffles and functional pools comprised of predominately rocky

substrates. This pattern continued downstream to the mouth (confluence with Big Darby Creek at RM 47.1).

Much of the upper reaches of Fitzgerald Ditch have been channel modified. Lower reaches (i.e., ~RM 1.5 downstream) have been modified to a much lesser degree. The instream habitat evaluation conducted downstream from State Route142 yielded a QHEI of 56.4. Moderate influence negative habitat attributes were the main factors resulting in the slightly less than optimal habitat but were not judged to preclude eventual full attainment of the WWH use with improvements at the MHP WWTP. Fitzgerald Ditch is partially meeting the WWH aquatic life use designation in its lower reaches. The reasons for the partial departure from expectations are stream dessication, nutrient enrichment, inadequate dechlorination from point sources and modest habitat degradation.

Big Darby Creek and its tributaries from Sugar Run to High Free Pike are not impaired for their recreational uses.

2.3.2 Lower Middle Big Darby Creek (200-020)

The minor sub-watershed lower middle Big Darby Creek is comprised exclusively of the mainstem of Big Darby Creek, with no significant tributaries that were evaluated. Much of lower middle Big Darby Creek is owned by Metroparks, and has a well protected and extensive riparian corridor (Figure 2.3.2).

A description of lower middle Big Darby Creek is included in Box 2.3.2.

Big Darby Creek is in attainment of its aquatic life and recreational uses throughout lower middle Big Darby Creek. Continued compliance by smaller point source dischargers will be an important factor in maintaining this condition.

Box 2.3.2 Overview of lower middle Big Darby Creek (BDC5, 200-020)				
Area (acres)	9,183			
Streams	Big Darby Creek, from High Free Pike to above Little Darby Creek (RM 41.75 to 34.2)			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Battelle Memorial Institute	4IN00004	0.050	0.043
	Lake Darby Estates	4PU00001	0.500	0.411
	Greentree MHP	4PY00001	0.016	0.014
	Darby Dan Farms	4PR00000	0.004	0.002
Land Use	see Figure 2.3.2.1			
Aquatic Life Use	**Designated use**		**Impairment**	
	EWH		No	
Recreational Use	Primary Contact Recreation		No	
Antidegradation Category	Big Darby Creek - Outstanding State Water			
Deviation from target	☺ Full attainment in this minor sub-watershed			

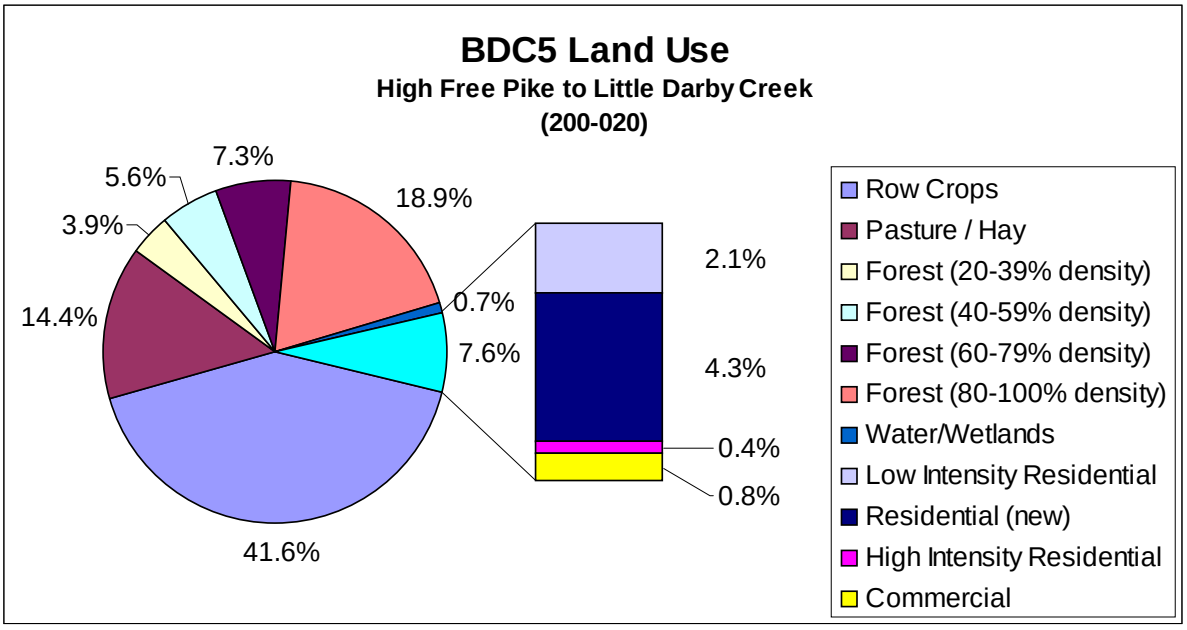

Figure 2.3.2.1. Land use in the lower middle Big Darby Creek minor sub-watershed.

Table 2.3.2 Habitat Assessment Results for lower middle Big Darby Creek (05060001-200-020)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-200-020						
Big Darby Creek (EWH)	38.9	None	82.5	None	No fast current, substrate embeddedness	Not impaired
	34.1	None	93.5	None	None	

2.4 Little Darby Creek - (LDC, 05060001 210)

The Little Darby Creek (LDC) major sub-watershed comprises the entirety of Little Darby Creek and it tributaries. Major tributaries to LDC are Treacle Creek and Spring Fork.

The Little Darby Creek sub-watershed has benefitted greatly by the contribution of ground water to a large percentage of its tributaries. Comparable instream habitat and equivalent concentrations of nutrients in this system without the ground water would have led to a much higher percentage of Warmwater Habitat streams with more widespread and more severe impairment. Thus, recovery can be much quicker if protective measures are taken. Additionally, every effort should be made to protect the aquifer that is supplying cool water to this unique oasis of biodiversity. Aquatic life use attainment in the LDC is shown in Figure 2.4.1. The condition of the riparian corridor in this major sub-watershed is shown in Figure 2.4.2.

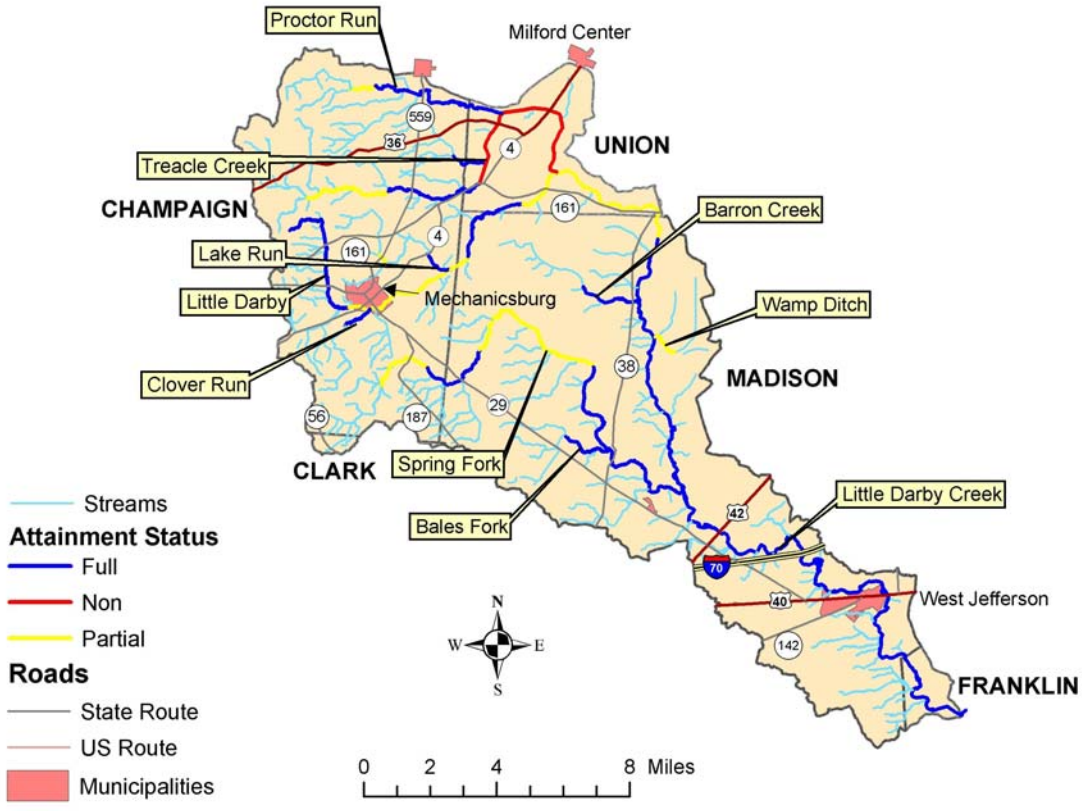

Figure 2.4.1. Status of aquatic life uses in Little Darby Creek (LDC) sub-watershed.

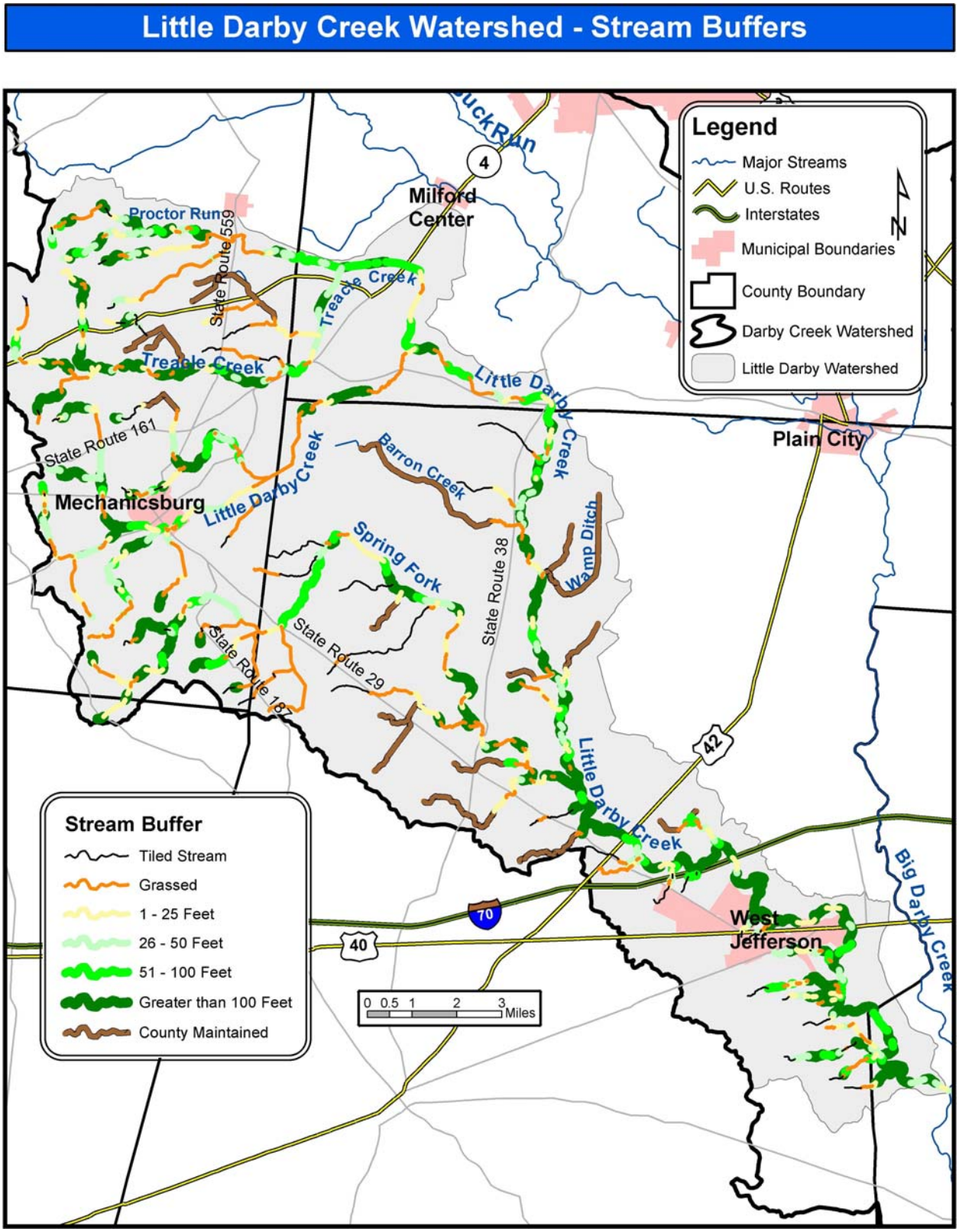

Figure 2.4.2. Status of Riparian Buffer in the Little Darby Creek sub-watershed. Graphics courtesy Ben Webb.

2.4.1 Upper Little Darby Creek (210-010)

The upper Little Darby Creek sub-watershed is comprised of Little Darby Creek mainstem, Clover Run, Lake Run, and Jumping Run. The mainstem section in upper Little Darby Creek extends to above the confluence with Treacle Creek.

A description of Upper Little Darby Creek is given in Table 2.4.1.

Box 2.4.1 Overview of Upper Little Darby Creek (210-010)				
Area (acres)	19,055			
Streams	Little Darby Creek from its headwaters to above Treacle Creek (RM 41.2 to RM31.4), including Clover Run, Lake Run, and Jumping Run.			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Mechanicsburg	1PB00037	0.23	0.275
	Champaign Landmark, Mechanicsburg Mill	unpermitted, unauthorized.	n/a	n/a
Land Use	see Figure 2.4.1.1			
Aquatic Life Use	**Name**	**Designated use**	**Impairment**	
	Little Darby Creek	EWH + CWH to RM 37.0	**Yes** - 60% of sites impaired	
			Deviation	IBI 2 - 42%
	Clover Run	WWH	No	
	Lake Run	EWH	**Yes** -100% of sites impaired	
			Deviation	IBI 19%
	Jumping Run	WWH	**Yes** - 100% of sites impaired	
			Deviation	IBI 33%
Recreational Use	Primary Contact Recreation		No	
Antidegradation Category	Little Darby Creek - Outstanding State Water			

Box 2.4.1 Overview of Upper Little Darby Creek (210-010)		
Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Unknown Toxicity	Spills - Note: this impairment is now attributed to the Champaign Landmark Feed Mill in Mechanicsburg.	√
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√
Low dissolved oxygen	Domestic sewage, pasture land agricultural run-off	√

The very headwaters of Little Darby Creek also appears to be suitable for co-designating as CWH. Several lines of evidence point to that conclusion including measured low mean water temperatures, the presence of the requisite number of coldwater macroinvertebrate taxa and the obligate coldwater mottled sculpin. The recommendation is being made to designate Little Darby Creek from its headwaters to RM 37.0 just upstream from the confluence with Lake Run. Although all macroinvertebrate sites on the Little Darby Creek mainstem met either the recommended or current EWH ICI biocriterion there were indications of challenges to this continued level of performance. Impairments to the fish communities were the main reason for partial attainment of the EWH use which was limited to the upper third of the mainstem.

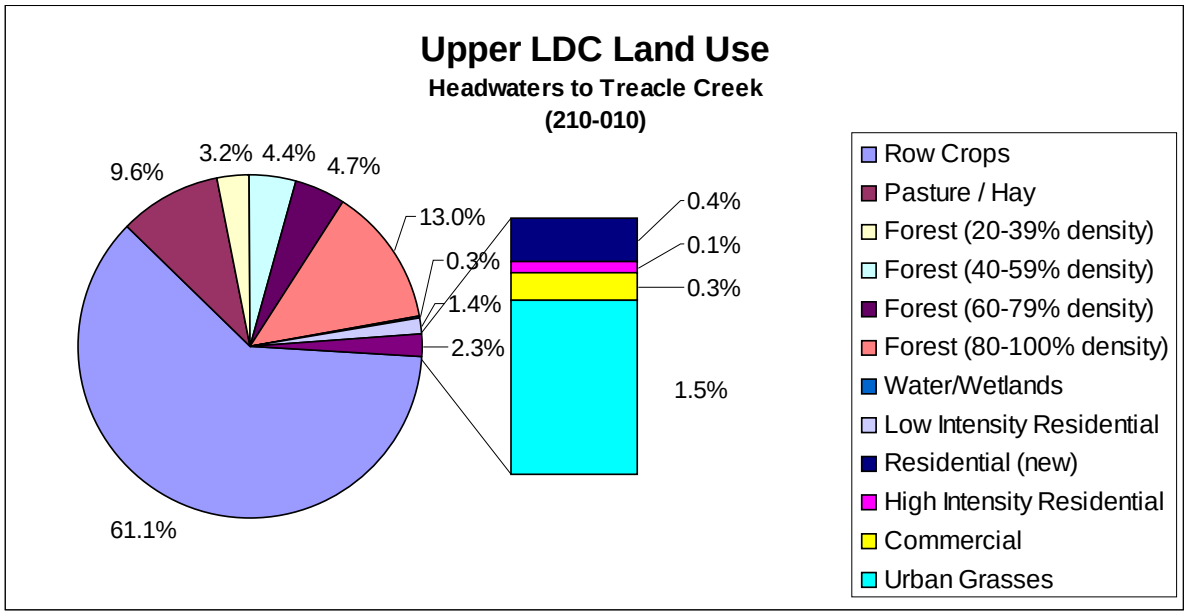

Figure 2.4.1.1. Land use in the upper Little Darby Creek minor sub-watershed.

Table 2.4.1 Habitat Assessment Results for upper Little Darby Creek (05060001-210-010)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-010						
Little Darby Creek (EWH)	41.2	None	80.5	None	None	Impaired
	41.2[1]	Substrate	70	None	Poor pool quality, no fast current, substrate embeddedness	
	39.6	Substrate, channel, riparian	69.5	No cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	38.8	None	82	None	Hardpan substrate origin, poor pool quality, no fast current	
	34.7	None	82.5	None	None	
Lake Run (EWH)	0.9	Channel	71	None	Channelized-recovering, poor pool quality, no fast current, substrate embeddedness	Impaired
Jumping Run (WWH)	0.3	Substrate	63	Silt/muck substrates	Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
Clover Run (WWH)	0.6	Pool, riffle, gradient	60	No cover	Poor pool quality, no fast current	Not Impaired

[1] Results are from the 2002 resampling of this site.

Little Darby Creek upstream from Mechanicsburg as mentioned above is strongly influenced by cool ground water. It is also strongly influenced by the upstream land use which is pasturage. Pasturage has led to false bank formation and the transport of silt and fines downstream smothering substrates and increasing embeddedness. This has led to variable sampling results over time and in the most recent sampling a fish community that did not meet the EWH criteria. The high gradient and strong influx of clean, cool ground water though provide the potential for swift recovery.

The next sampling site was downstream of State Route 29, RM 39.6, where Little Darby Creek winds southeast and east just south of most of Mechanicsburg. This site was also downstream from the confluence with Clover Run and just downstream from a fertilizer / feed distributor storage facility and an open pasture with unrestricted access of livestock to the stream. Fish community scores here appeared to be impaired as a

result of historic spills, nutrient enrichment and some sedimentation associated with pasturage.

Downstream from the Wing Road bridge, RM 38.8, untreated sewage discharged from an unpermitted bypass pipe was responsible for the impact to the fish community. The macroinvertebrates sampled just upstream from the pipe were not impacted clearly documenting the culpability of this discharge to the impact. Little Darby Creek should be re-evaluated after the bypass pipe has been sealed and the Mechanicsburg WWTP upgraded.

Clover Run is fully meeting the recommended WWH aquatic life use designation biocriteria for both fish and benthic macroinvertebrates. The significant presence of the obligate coldwater mottled sculpin and the facultative cool water blacknose dace as well as a handful of cold water macroinvertebrate taxa suggest that Clover Run might have been suitable for the Coldwater Habitat aquatic life use in the past. However the removal or thinning of the riparian buffer and sedimentation has lowered biological performance to the point that use designation is not currently being proposed.

Lake Run was designated in the 1978 WQS as EWH based on best professional judgement. Current sampling has revealed biological communities that are only partially meeting the current EWH biocriteria as a consequence of a recent and temporal impact (i.e., inadequate implementation of erosion and storm water BMPs that have delivered excess sediment to the stream channel). It is felt that given time for the disturbed land to stabilize with vegetation and the contributed sediment to be flushed downstream this high gradient stream should easily be able to fully meet the EWH criteria.

Siltation and episodic nutrient enrichment were judged to be the causes for the partial attainment of the recommended WWH biocriteria in Jumping Run.

Recreational uses are being attained in upper Little Darby Creek. This is due to the condition in the Ohio WQS that attainment of one of two bacterial criteria types is necessary for recreational use attainment. *E. coli* values exceed current and potential targets, especially 90th percentile *E. coli* values. In the event that the WQS shift to an *E. coli* only standard, this sub-watershed could be re-evaluated as in non-attainment. Therefore, opportunities to reduce *E. coli* loading should be pursued where practical.

2.4.2 Upper Treacle Creek (210-020)

The upper Treacle Creek minor sub-basin begins at the headwaters of Treacle Creek, and extends downstream to above Proctor Run. A description of upper Treacle Creek is given in Box 2.4.2.

Treacle Creek, currently is designated EWH its entire length and partially met criteria in its headwaters. Habitat although solidly in the very good range is less than generally found in streams that drain the Cable moraine, particularly those streams draining the boulder belt. One attribute that repeatedly appears is the cooler water temperatures

Box 2.4.2 Overview of upper Treacle Creek (210-020).			
Area (acres)	12,625		
Streams	Treacle Creek, from headwaters to above Proctor Run (RM 11.8 to RM 3.7), includes Howard Run.		
Point Source Dischargers	none		
Land Use	see Figure 2.4.2.1		
Aquatic Life Use	**Designated use**	**Impairment**	
	EWH	**Yes** - 33% of sites impaired	
		Deviation	IBI - 25%
Recreational Use	Primary Contact Recreation	No - Note: *E. coli* is highly elevated	

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√

found in these streams, including Treacle Creek. Siltation and elevated nutrients were thought to be the cause of the slightly lowered values in the headwaters.

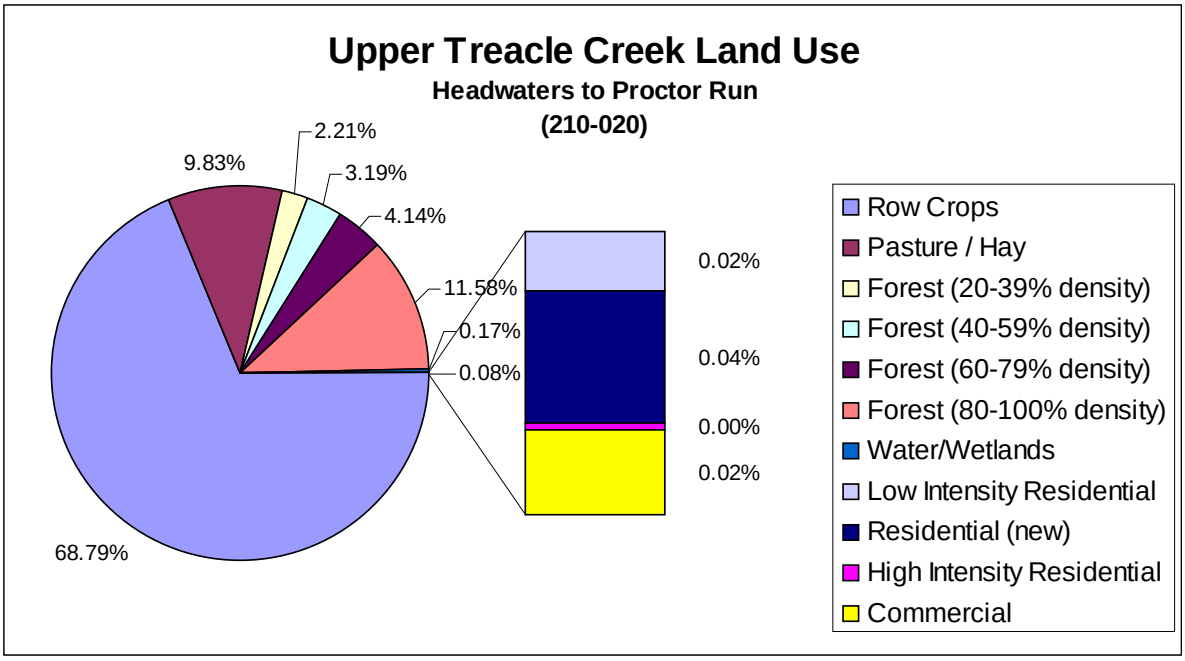

Figure 2.4.2.1. Land use in the upper Treacle Creek minor sub-watershed.

Howard Run, a small tributary to Treacle Creek, is fully meeting EWH biocriteria. Cooler water and a largely closed canopy helped to lessen the impacts from NPS inputs. Reducing siltation, widening the woody riparian corridor and permitting natural recovery from past channelization would improve the quality of Howard Run. These actions would also reduce sedimentation and nutrient inputs to Treacle Creek and in turn improve that receiving stream.

Table 2.4.2 Habitat Assessment Results for upper Treacle Creek (05060001-210-020)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-020						
Treacle Creek (EWH)	11.8	Channel	67.5	Low sinuosity	Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	8.3	None	67.5	None	Poor pool quality, no fast current	
	6	Substrate	66.5	None	Hardpan substrate origin, no fast current, substrate embeddedness	
Howard Run (EWH)	0.5	Substrate, channel, riparian, pool, riffle, gradient	55.5	Low sinuosity	Channelized-recovering, Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired
	0.5[1]	Substrate, channel, riparian	56	Channelized-no recovery, silt/muck substrates, low sinuosity	Hardpan substrate origin, no fast current, substrate embeddedness	

[1] Results from the 2002 resampling of this site.

2.4.3 Proctor Run (210-030)

Proctor Run is a major tributary to Treacle Creek, and is a minor sub-watershed in Little Darby Creek.

A description of Proctor Run is given in Box 2.4.3. The results of the habitat assessment are given in Table 2.4.3.

Box 2.4.3 Overview of Proctor Run (210-030).				
Area (acres)	9,659			
Streams	Proctor Run			
Point Source Dischargers	**Name**	**Permit number**	**Design Flow** (MGD)	**Average Flow** (MGD)
	Triad Local Schools	1PT00099	0.010	0.0072
Land Use	see Figure 2.4.3.1			
Aquatic Life Use	**Designated use**		**Impairment**	
	EWH		**Yes** - 33% of sites impaired	
			Deviation	IBI 19%
Recreational Use	Primary Contact Recreation		**Yes** - 90th percentile fecal coliform exceeds maximum criteria by 97%. *E. coli* values are extremely elevated.	
Antidegradation Category	Proctor Run - Superior High Quality Water			

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√

Proctor Run originates in Champaign County in the boulder belt of the Cable Moraine. It then flows almost directly east downslope through the rest of the Cable moraine and into ground moraine and Union County. Three sites were evaluated in Proctor Run in 2001 yielding QHEI scores ranging from 65 to 73. Positive warmwater habitat attributes predominated at all three sites. No high influence modified habitat attributes were found although moderate amounts of silt and embeddedness somewhat lowered habitat quality.

Bacteria levels in Proctor Run are elevated, and the recreational use is impaired. The magnitude and frequency of fecal coliform values exceed WQS with a 90th percentile value of 7074 cfu. *E. coli* values are extremely elevated, with a 90th percentile value of 6749 cfu. These values indicate run-off related problems with bacteria typically associated with agricultural inputs.

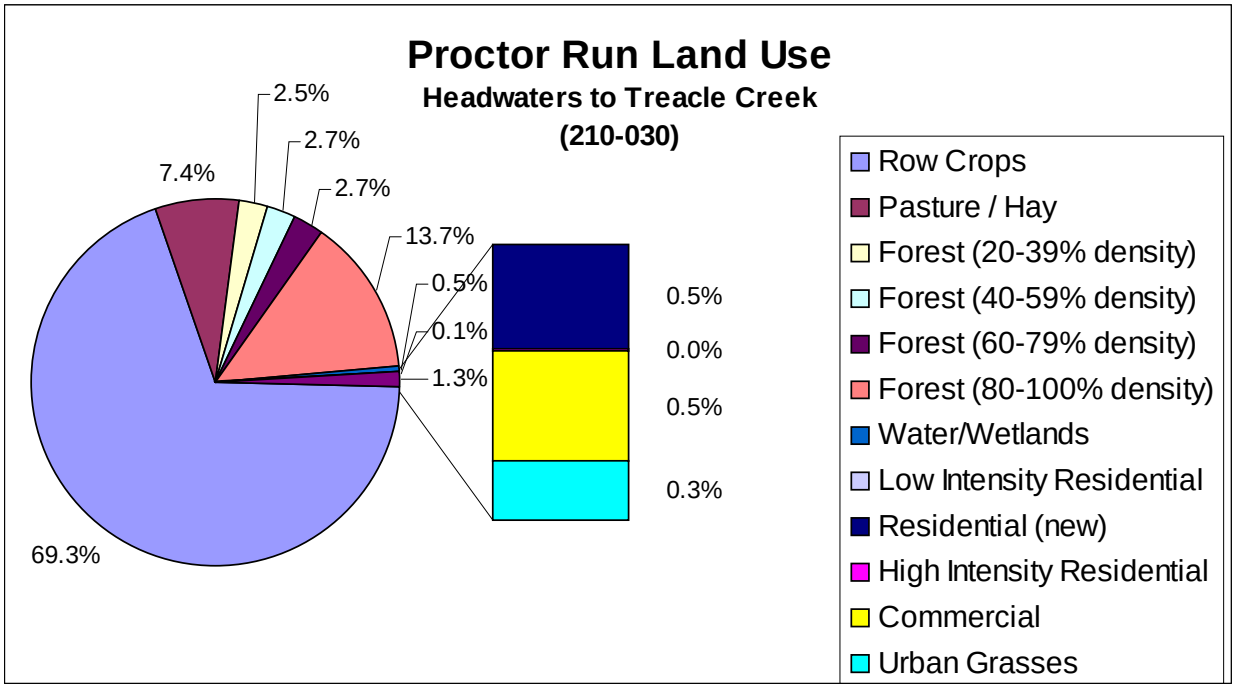

Figure 2.4.3.1. Land use in the Proctor Run minor sub-watershed.

Table 2.4.3 Habitat Assessment Results for Proctor Run (05060001-210-030)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-030						
Proctor Run (EWH)	4.9	None	71.5	None	Hardpan substrate origin, poor pool quality, no fast current	Impaired
	3.1	Channel, riparian	65	None	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	1.6	Substrate, channel, riparian	73	None	Channelized-recovering, sand substrate, poor pool quality, no fast current, substrate embeddedness	

2.4.4 Lower Treacle Creek (210-040)

The lower Treacle Creek minor sub-watershed extends from the confluence of Proctor Run and Treacle Creek to the confluence of Treacle Creek with Little Darby Creek.

A description of lower Treacle Creek is given in Box 2.4.4.

Box 2.4.4 Overview of lower Treacle Creek (210-040).			
Area (acres)	4,550		
Streams	Treacle Creek (RM 3.6 to mouth, RM 0.0)		
Point Source Dischargers	none		
Land Use	see Figure 2.4.4.1		
Aquatic Life Use	**Designated use**	**Impairment**	
	EWH	**Yes** - 100% of sites impaired (1/1)	
		Deviation	ICI - MG ➜E
Recreational Use	Primary Contact Recreation	**Yes** - both geometric mean (45% deviation) and 90th percentile (63% deviation) fecal coliform values exceed criteria. *E. coli* values are extremely elevated.	

Causes of Impairment	**Sources of Impairment**	**Addressed in this TMDL?**
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√
Low dissolved oxygen	Pasture land, agricultural run-off	√

Figure 2.4.4.2. Unrestricted livestock access to lower Treacle Creek.

Treacle Creek, currently designated EWH its entire length, partially met criteria in it headwaters and is in non-attainment towards its mouth. A wide variety of stressors were adversely affecting biological communities towards the mouth of Treacle Creek. Poor habitat resulting from channelization and free access livestock pasturage (Figure 2.4.4.2) has resulted in all native substrates being covered in a thick layer of soft, unconsolidated clays and silts. High fecal coliform bacteria and elevated nutrients also contributed to the decline which extended its reach into Little Darby Creek.

The recreational use of lower Treacle Creek is impaired. Both geometric mean and 90th percentile fecal coliform values of 1822 cfu and 5389 cfu, respectively, exceed the WQS criteria. *E. coli* geometric mean and 90th percentile values of 1063 cfu and 5720 cfu, respectively, are extremely elevated.

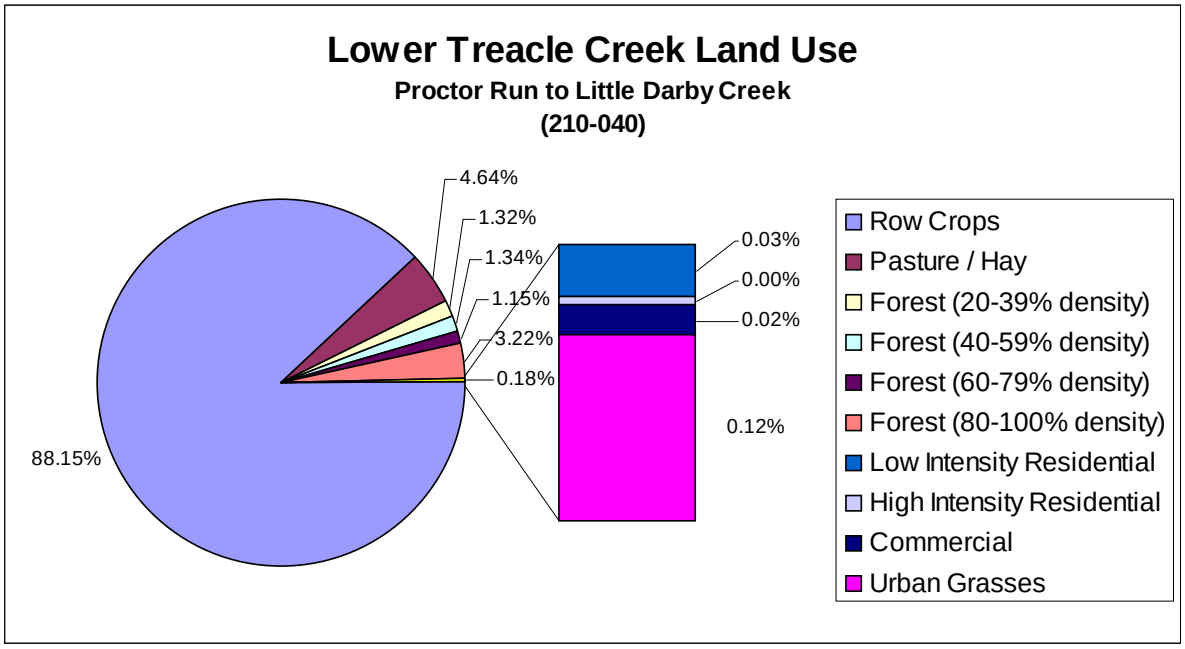

Figure 2.4.4.1. Land use in the lower Treacle Creek minor sub-watershed.

Table 2.4.4 Habitat Assessment Results for Lower Treacle Creek (05060001-210-040)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-040						
Treacle Creek (EWH)	0.8	Substrate, cover, channel, riparian, pool, riffle, gradient	29.5	Silt/muck substrates, low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired

2.4.5 Middle Little Darby Creek (210-050)

The middle Little Darby Creek minor sub-watershed extends from Little Darby Creek's confluence with Treacle Creek to above Spring Fork.

A description of middle Little Darby Creek is provided in Box 2.4.5. Habitat assessment results are presented in Table 2.4.5.

<table>
<tr><td colspan="6">Box 2.4.5 Overview of middle Little Darby Creek (210-050).</td></tr>
<tr><td>Area (acres)</td><td colspan="5">24,320</td></tr>
<tr><td>Streams</td><td colspan="5">Little Darby Creek, below Treacle Creek to above Spring Fork (RM 31.3 to RM 17.47), including Barron Creek and Wamp Ditch.</td></tr>
<tr><td rowspan="2">Point Source Dischargers</td><td>Name</td><td>Permit number</td><td>Design flow (MGD)</td><td colspan="2">Average flow (MGD)</td></tr>
<tr><td>Rosedale Bible College</td><td>4GS00001</td><td>0.009</td><td colspan="2">n/a</td></tr>
<tr><td>Land Use</td><td colspan="5">see Figure 2.4.5.1</td></tr>
<tr><td rowspan="6">Aquatic Life Use</td><td>Name</td><td>Designated use</td><td colspan="3">Impairment</td></tr>
<tr><td rowspan="2">Little Darby Creek</td><td rowspan="2">EWH</td><td colspan="3">Yes - 17% of sites impaired</td></tr>
<tr><td>Deviation</td><td colspan="2">IBI - 11%
MIwb - 7%</td></tr>
<tr><td>Barron Creek</td><td>WWH</td><td colspan="3">No</td></tr>
<tr><td rowspan="2">Wamp Ditch</td><td rowspan="2">WWH</td><td colspan="3">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td colspan="2">IBI - 33%</td></tr>
<tr><td rowspan="3">Recreational Use</td><td>Little Darby Creek -</td><td>PCR</td><td colspan="3" rowspan="3">Yes - geometric mean (35% deviation) and 90th percentile (90% deviation) fecal coliform exceed criteria. Note: E. coli is extremely elevated. Barron Creek is the source of this impairment.</td></tr>
<tr><td>Barron Creek</td><td>SCR</td></tr>
<tr><td>Wamp Ditch</td><td>SCR</td></tr>
<tr><td>Antidegradation Category</td><td colspan="5">Little Darby Creek - Outstanding State Water</td></tr>
<tr><td>Endangered Species</td><td colspan="5">Clubshell Mussel (Pleurobema clava)</td></tr>
<tr><td colspan="2">Causes of impairment</td><td colspan="3">Sources of impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Sedimentation</td><td colspan="3">Pasture land, habitat disruption, channelization</td><td>√</td></tr>
<tr><td colspan="2">Nutrients</td><td colspan="3">Pasture land, agricultural run-off</td><td>√</td></tr>
<tr><td colspan="2">Low dissolved oxygen</td><td colspan="3">Pasture land, agricultural run-off</td><td>√</td></tr>
</table>

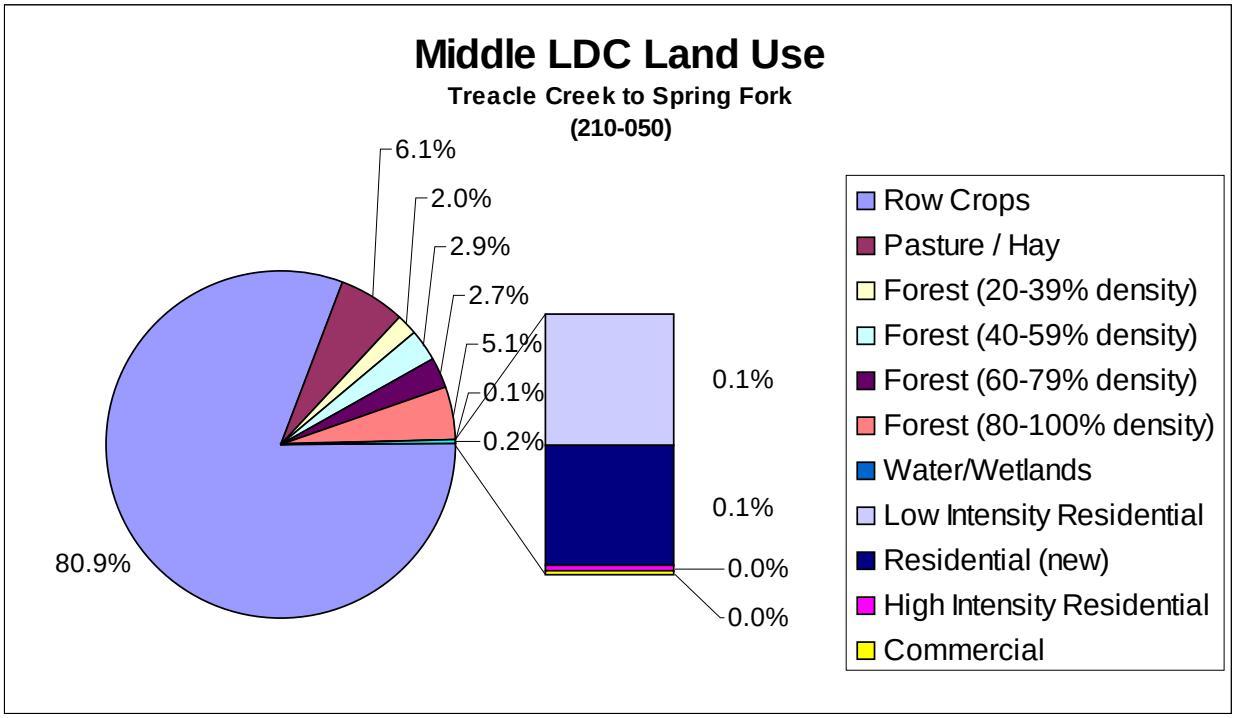

Figure 2.4.5.1. Land use in the middle Little Darby Creek minor sub-watershed.

The next stream segment suffering declines was immediately downstream from the confluence with Treacle Creek and upstream from Axe Handle Road. This segment had previously supported EWH communities and habitat quality had not significantly declined. In 2001 this site dropped below the EWH range. The loss of intolerant species and the fairly low number on non-tolerant individuals were the metrics showing the greatest deviation from expectations. Problems associated with nutrient enrichment and its consequent effects on dissolved oxygen appear to be strong candidates for the depressed fish community results. Continuous dissolved oxygen monitoring has revealed dissolved oxygen dropping below EWH minimums upstream from the bridge and in the downstream reaches of Treacle Creek, whose confluence is immediately upstream.

Barron Creek performed much better than would be predicted based on a cursory evaluation of channel morphology and instream habitat quality. Barron Creek is currently under ongoing maintenance by the Madison County Engineer's Office. A large percent of the watercourse has been channelized yielding an open canopy and groomed grass buffer strips. Excess nutrient inputs caused enrichment with gross algal production and large stands of emergent aquatic macrophytes. Substrates in the bottom of shallow pools were black and anoxic from the accumulated decaying detritus. Cool ground water inputs appear to have ameliorated the impacts that would normally be associated with the elevated levels of nutrients documented in Barron Creek. Establishing a wooded riparian buffer along Barron Creek would benefit the aquatic communities locally and Little Darby Creek downstream from the confluence.

Bacterial sampling of Barron Creek shows it to be grossly polluted, and not attaining the recreational use of secondary contact recreation (2000 cfu average, 5000 cfu maximum). Bacteria levels for both fecal coliform and *E. coli* are extremely elevated. Geometric mean fecal coliform bacteria levels in Barron Creek are 22,000 cfu and 90th percentile of fecal coliform values is 39,952 cfu.

Table 2.4.5 Habitat Assessment Results for middle Little Darby Creek (05060001-210-050)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-050						
Little Darby Creek (EWH)	29.5	Channel, riparian	66.5	Silt/muck substrates	Channelized-recovering, no fast current	Impaired
	26.6	Substrate, riparian, pool, riffle, gradient	58	None	No fast current, substrate embeddedness	
	24.5	Substrate, channel	62.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	23.1	Substrate, channel	55.5	Silt/muck substrates, low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	20.5	Substrate, channel	64.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	
Barron Creek (WWH)	2.1	Cover, channel, riparian, pool, riffle, gradient	44.5	Low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not impaired
Wamp Ditch (WWH)	0.1	Cover, channel, riparian, pool, riffle, gradient	45.5	Channelized-no recovery, silt/muck substrates, no cover, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired

Wamp Ditch, a small direct tributary to Little Darby Creek, is one of the few that drain into Little Darby Creek from the east. A significant portion of Wamp Ditch is under maintenance by the Madison County Engineer's Office. However, in this case the

ameliorating effects of ground water augmentation did not appear to be as effective in reducing the impacts associated with the adjacent land use, instream habitat degradation and nutrient enrichment as it had been in Barron Creek. Wamp Creek possessed similar habitat, and also had significant ground water contribution leading to the conclusion that the water chemistry was probably more severely impacted. Unfortunately no water chemistry samples were taken. In view of the partially meeting of the WWH criteria the stream is being recommended to be designated as WWH. Future monitoring should include water chemistry sampling in addition to the biological and habitat quality monitoring. Restoration of a woody riparian buffer would also benefit Wamp Ditch and the sensitive portion of Little Darby Creek which receives Wamp Ditch water.

2.4.6 Spring Fork (210-060)

The Spring Fork minor sub-watershed is described in Box 2.4.6. Habitat assessment results for Spring Fork are given in Table 2.4.6.

Spring Fork had a mix of full and partial attainment of the EWH use along its length. As was the case in many of the Little Darby Creek tributaries nutrient enrichment was a significant contributor to the lessened performance and partial attainment seen. Although habitat quality was in the good range throughout most of the reach sampled siltation and sedimentation were felt to have reduced overall performance. Lack of access downstream from the Green Meadows Mobile Home Park WWTP limited the ability to accurately assess the full impact of that point source. However, it was possible to determine that the WWTP was responsible for some of the highest nutrient concentrations in the sub-watershed (including ammonia) and that there was a dissolved oxygen sag downstream from the WWTP which lead to failing to achieve EWH minimum DO instream. Efforts to improve the quality of effluent leaving this WWTP will benefit the downstream reaches of Spring Fork and the sensitive reach of Little Darby Creek that receives water from Spring Fork.

Bales Ditch possessed very good instream habitat (QHEI - 70). Gradient in the moderate - high range indicates the potential energy to recover from habitat disruptions and to transport and expel fine sediments and thus improve. A moderately wide to wide riparian buffer coupled with an undisturbed stream channel, moderately high gradient and glacial till yielded a diverse and moderately stable stream channel. The habitat was judged to be easily capable of supporting a WWH aquatic biological community and yielded an excellent fish community and a good macroinvertebrate community. Again, cool ground water inflow appeared to have ameliorated the effects of elevated nutrient concentrations.

Frequency and magnitude of recorded bacteria levels were elevated in the Spring Fork watershed. The 90^{th} percentile fecal coliform value of 4014 cfu exceeds the criteria (2000 cfu). *E. coli* levels were also elevated.

Box 2.4.6 Overview of Spring Fork (210-060).				
Area (acres)	24,320			
Streams	Spring Fork, including Bales Ditch			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Monroe Elementary School	4PT00122	0.005	0.004
	Green Meadows MHP	4PV00000	0.081	0.114
Land Use	see Figure 2.4.6.1			
Aquatic Life Use	**Name**	**Designated use**	**Impairment**	
	Spring Fork	EWH	**Yes** - 60% of sites impaired	
			Deviation	IBI - 25% ICI G ➜E
	Bales Ditch	WWH	No	
Recreational Use	Spring Fork	PCR	**Yes** - 90th percentile fecal coliform values exceed maximum criteria (50% deviation). Note: *E. coli* is elevated as well.	
	Bales Ditch	SCR		
Antidegradation Category	Spring Fork - Superior High Quality Water			

Causes of impairment	**Sources of impairment**	**Addressed in this TMDL?**
Sedimentation	Pasture land, habitat disruption, channelization	√
Nutrients	Pasture land, agricultural run-off	√
Low dissolved oxygen	Domestic sewage, pasture land, agricultural run-off	√

Table 2.4.6 Habitat Assessment Results for Spring Fork (05060001-210-060)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-060						
Spring Fork (EWH)	15.8	Substrate, channel	60.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality	Impaired
	13.7	Substrate, channel, riparian	62.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	13.4	Cover, channel, riparian	53	Low sinuosity, no cover	Hardpan substrate origin, substrate embeddedness	
	10.1	Substrate, riparian	69	None	No fast current, substrate embeddedness	
	7.8	Substrate, channel, riparian	54.5	Low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	
	3.3	Channel, riparian	67.5	None	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	
Bales Ditch (WWH)	0.4	None	70	None	Hardpan substrate origin, poor pool quality	Not Impaired

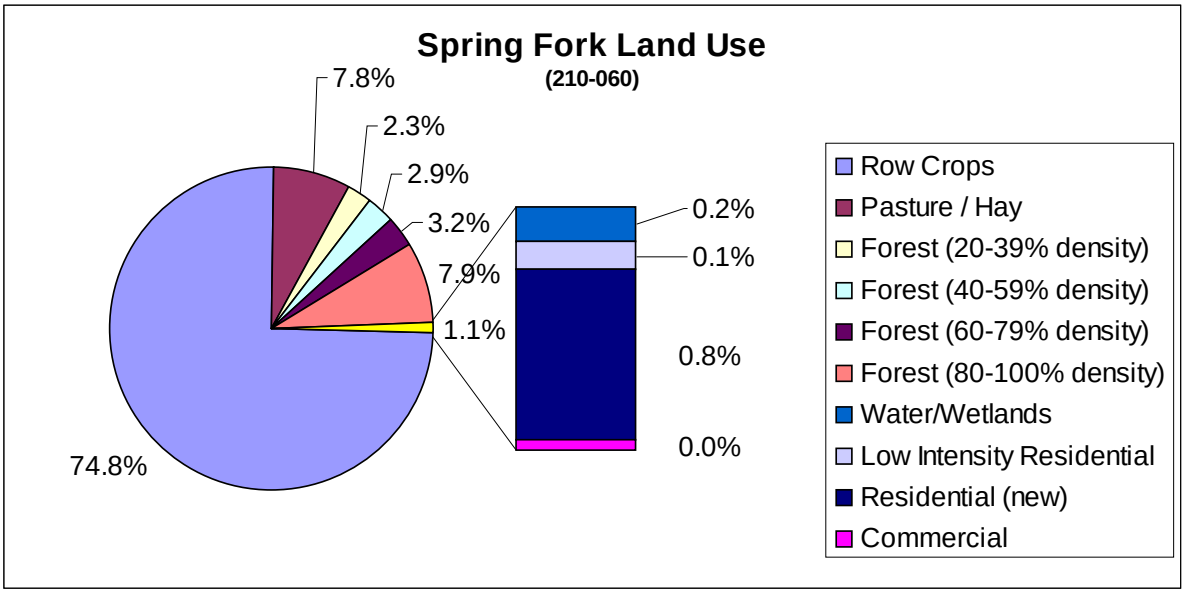

Figure 2.4.6.1. Land use in the Spring Fork minor sub-watershed.

2.4.7 Lower Little Darby Creek (210-070)

The lower Little Darby Creek minor sub-watershed includes the Little Darby Creek mainstem from below Spring Fork to Big Darby Creek.

A description of lower Little Darby Creek is given in Box 2.4.7. Habitat assessment results for lower Little Darby Creek are presented in Table 2.4.7.

Fish community scores in general gradually increased with increasing downstream distance towards the mouth. The major exception to this pattern was the site just upstream from the confluence with Big Darby Creek which is marginally meeting EWH criteria. This site is located in an area that prior to the mid 1990s was impounded by a dam across the mouth of Little Darby Creek. As sediments are flushed and more natural features develop this portion of Little Darby Creek is expected to perform at levels comparable to those found just upstream.

Recreational uses are being attained in lower Little Darby Creek.

Box 2.4.7 Overview of lower Little Darby Creek (210-070).				
Area (acres)	23,514			
Streams	Little Darby Creek, from below Spring Fork to its confluence with Big Darby Creek (RM 17.46 to mouth, RM 0.0).			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Fisher Cast Steel	4ID00001	0.001	n/a
	Jefferson Lodge MHP	4PV00004	0.040	0.047
	Oakwood Acres MHP	4PV00097	0.010	0.006
	B & B Motel	4PV00107	0.0022	0.0014
	West Jefferson WWTP	4PB00024	1.2	0.692
Land Use	see Figure 2.4.7.1			
Aquatic Life Use	**Designated use**		**Impairment**	
	EWH		No	
Recreational Use	Primary Contact		No	
Antidegradation Category	Little Darby Creek - Outstanding State Water			
Endangered species	Clubshell mussel (*Pleurobema clava)*			
Causes and Sources of Impairment	☺ There is no impairment in the lower Little Darby Creek minor sub-watershed.			

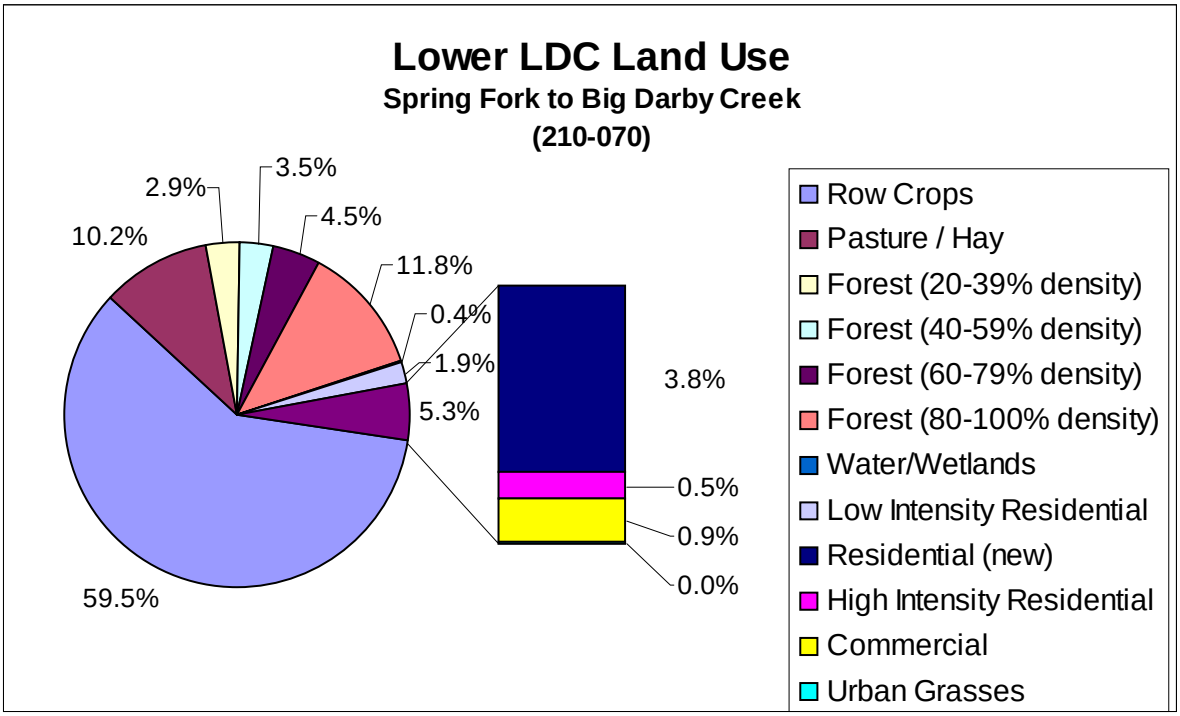

Figure 2.4.7.1. Land use in the lower Little Darby Creek minor sub-watershed.

Table 2.4.7 Habitat Assessment Results for lower Little Darby Creek (05060001-210-017)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-210-070						
Little Darby Creek (EWH)	15.3	None	95.5	None	None	Not impaired
	6.5	None	95.5	None	None	
	4.1	None	99	None	None	
	0.7	Cover, channel	63.5	Low sinuosity, no cover	Hardpan substrate origin, no fast current, substrate embeddedness	
	0.2	Channel	77.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	

2.5 Lower Big Darby Creek (05060001 220)

Lower Big Darby Creek is the major sub-watershed that extends from downstream of Little Darby Creek, to Big Darby Creek's confluence with the Scioto River. Within lower Big Darby Creek, the mainstem of Big Darby Creek is in attainment, though there are some areas that are showing signs of stress. Most non-attainment occurs in the minor sub-watershed that includes Hellbranch Run. A map showing aquatic life use attainment is provided in Figure 2.5.1. The condition of the riparian corridor in this major sub-watershed is shown in Figure 2.5.2.

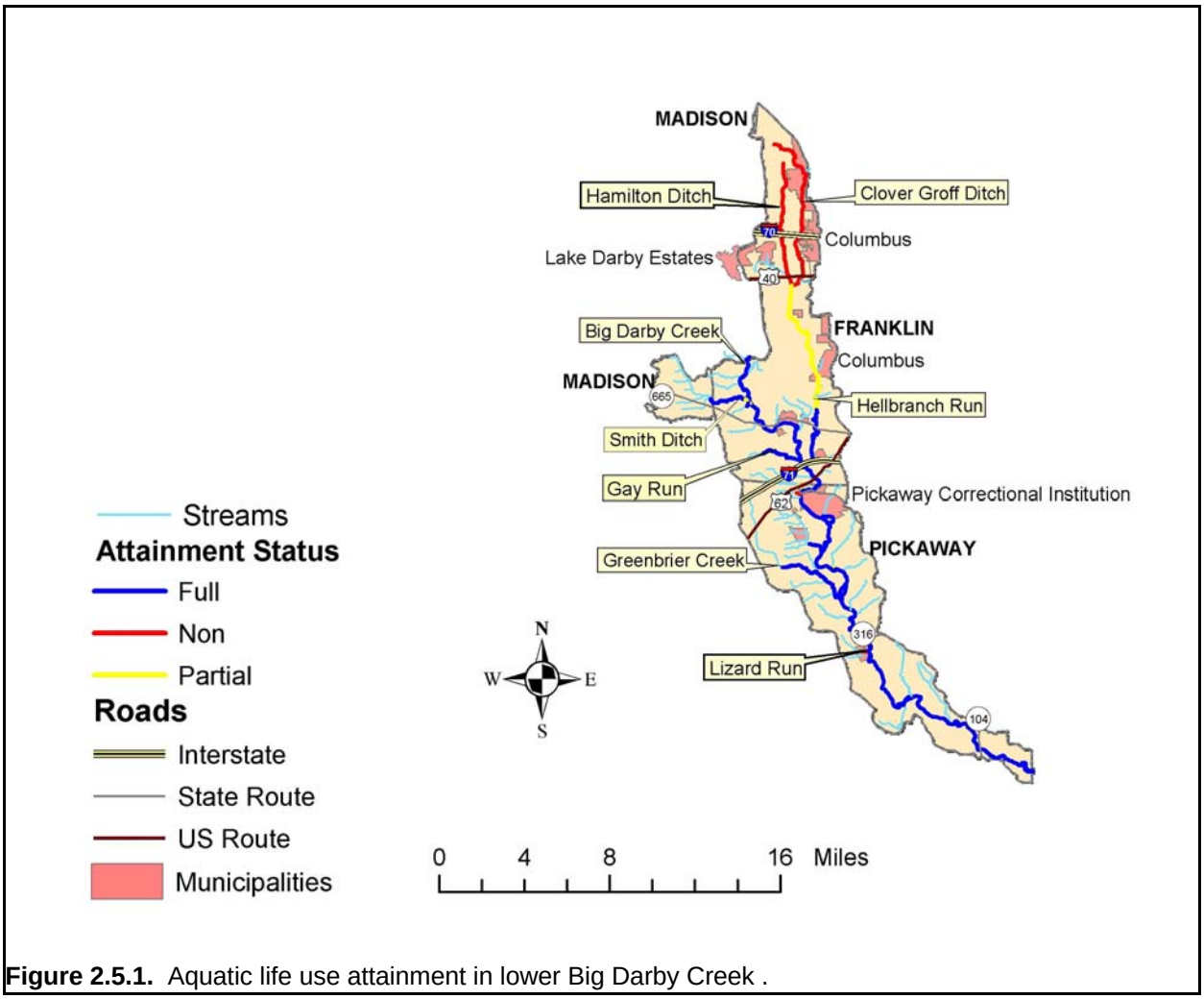

Figure 2.5.1. Aquatic life use attainment in lower Big Darby Creek .

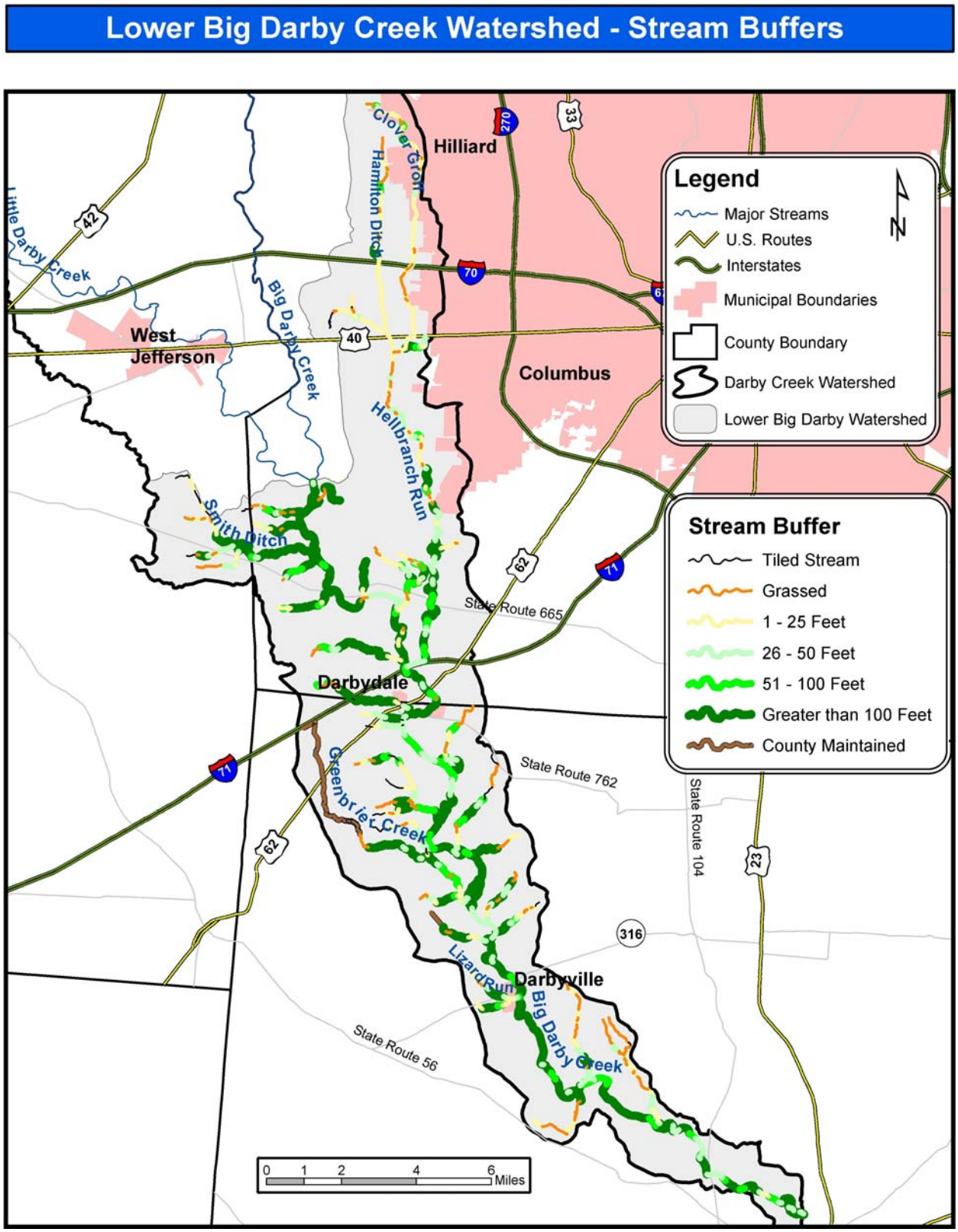

Figure 2.5.2 Status of Riparian Buffers in the lower Big Darby Creek Sub-watershed. Graphics courtesy Ben Webb.

2.5.1 Hellbranch Run (220-010)

The Hellbranch Run minor sub-watershed contains most of the impaired waters in the lower Big Darby Creek major sub-watershed. A description of Hellbranch Run in given in Box 2.5.1. Habitat assessment results are given in Table 2.5.1.

Box 2.5.1 Overview of Hellbranch Run (220-010).				
Area (acres)	24,180			
Streams	Hellbranch Run, including Hamilton Ditch and Clover Groff Ditch.			
Point Source Dischargers	**Name**	**Permit number**	**Design Flow** (MGD)	**Average flow** (MGD)
	Alton Campground	4PX00041	0.0032	0.0011
		Receiving stream: Hamilton Ditch		
	Thornapple Country Club	4PX00029	0.002	0.0004
		Receiving stream: Clover Groff Ditch		
	Cypress Wesleyan School	4PJ00115	0.002	n/a
		Receiving stream: Clover Groff Ditch		
	Oakhurst Knolls	4PH00000	0.100	0.070
	Pleasantview School	4PT00106	0.020	0.0125
	Lakeland Utilities, Timberlake	4PU00003	0.050	0.052
Land Use	see Figure 2.5.1.1			
Aquatic Life Use	**Name**	**Designated use**	**Impairment**	
	Hellbranch Run	WWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 25% MIwb - 26%
		EWH	**Yes** - 33% of sites impaired	
			Deviation	IBI - 22%
	Clover Groff Ditch	MWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 55% ICI - VP ➜ F
		WWH	**Yes** - 100% of sites impaired	

			Deviation	IBI - 43% ICI - 80%
	Hamilton Ditch	MWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 75%
		WWH	**Yes** - 100% of sites impaired	
			Deviation	IBI - 67%
Recreational Use		PCR	**Yes** - 90th percentile fecal coliform values exceed maximum criteria.	
Antidegradation Category	Hellbranch Run - Superior High Quality Water - Kropp Rd. to mouth.			
Applicable 208 Plan	Central Scioto Plan Update (CSPU)			

Causes of impairment	**Sources of impairment**	**Addressed in this TMDL?**
Low dissolved oxygen	Ground water, septic systems, package plants	√
Nutrients	Septic systems, rowcrop agriculture, suburban run-off, package plants	√
Unionized ammonia	Package plants, septic systems	√
Siltation	Construction, hydromodification	√
Sediment metals	unknown source	no

Biological condition at the three upstream sites of Hellbranch Run, although improved from values recorded at the downstream sites in its source tributaries (Hamilton and Clover Groff Ditches), still only marginally and partially met WWH criteria. Habitat quality was obviously a factor in the suppressed performance at the upstream site with a QHEI of only 39.5 recorded there. Habitat quality in general improved with downstream distance and quickly became less of a factor. The improved biological performance did indicate an improved water quality condition and perhaps ground water augmentation given that the biological performance was higher than the improved habitat would normally deliver. The presence of mottled sculpins, an obligate coldwater taxa, not only here but in increased numbers at all sites downstream support this observation. However, there were water column indications of modest nutrient enrichment which extend at least downstream to RM 5.8, downstream from the Oakhurst Knolls WWTP.

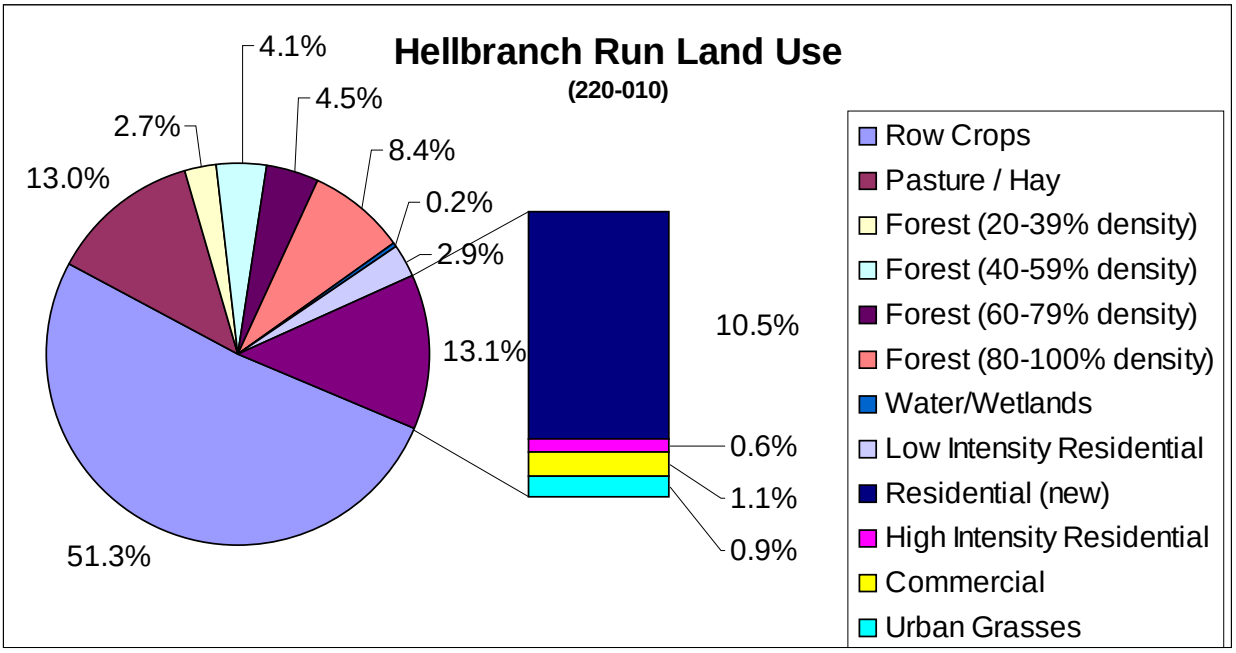

Figure 2.5.1.1. Land use in the Hellbranch Run minor sub-watershed.

Habitat quality in the lower five miles of Hellbranch Run exceeds that necessary to support Exceptional Warmwater Habitat biological communities and marginally meets those criteria at RM 3.7 and 1.0. Hellbranch Run partially attains the EWH use at RM 0.5, downstream from the Timberlake WWTP. This WWTP has a history of operational problems and consistently violates permit limits with sludge frequently detected in stream and very high ammonia concentrations and other nutrient parameters in evidence. The influent to this WWTP is being redirected to a regional WWTP by 2005, which should lead to significant improvement in the lower reach of Hellbranch Run.

Hamilton Ditch and Clover Groff Ditch are both severely impaired in their headwaters with very slight improvement with downstream distance. Hamilton Ditch is the more rural western tributary forming Hellbranch Run. Upstream adverse influences include historical channelization that has resulted in very poor instream habitat. The straightening of the channel has greatly reduced habitat diversity and increased entrenchment, which is particularly harmful because the streambed's low gradient has trapped sediment within the stream channel. Recently, residential construction run-off is delivering silt from sites with inadequate storm water BMPs. Significant suppression of the instream biological community would be expected with the poor habitat but not to the levels evident here. This indicates that poor water quality was contributing to the toxic response observed. Hamilton Ditch was documented to be extremely nutrient enriched with ammonia, TKN and total phosphorus in the 90 to 95th percentile versus ecoregional (ECBP) background concentrations. This enrichment resulted from a mix of agricultural and residential sources.

Table 2.5.1 Habitat Assessment Results for Hellbranch Run (05060001-220-010)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-220-010						
Hellbranch Run (WWH[1]/EWH)	10.3[1]	Substrate, cover, channel, pool, riffle, gradient	39.5	Silt/muck substrates, low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Impaired
	7.4[1]	Cover, channel	51	Low sinuosity, no cover	Channelized-recovering, hardpan substrate origin, poor pool quality, substrate embeddedness	
	5.8[1]	Channel	65.5	Low sinuosity, no cover	Hardpan substrate origin, poor pool quality, substrate embeddedness	
	3.7	None	83.5	None	None	Not impaired
	1	None	84.5	Low sinuosity	None	
	0.5	None	83.5	None	None	
Clover Groff Ditch (MWH/ WWH[1])	4.7	Not applicable to MWH	22	Channelized-no recovery, silt/muck substrates, low sinuosity, no cover, max. pool depth <40 cm	Hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
	0.8[1]	Channel	61.5	Low sinuosity	Channelized-recovering, hardpan substrate origin, no fast current, substrate embeddedness	
Hamilton Ditch (MWH/ WWH[1])	3.4	Not applicable to MWH	21	Channelized-no recovery, silt/muck substrates, low sinuosity, no cover, max. pool depth <40 cm	Poor channel development, no fast current, poor pool quality, substrate embeddedness, riffle embeddedness,	Impaired
	0.5[1]	Substrate, cover, channel, riparian, pool, riffle, gradient	36.5	Channelized-no recovery, silt/muck substrates, low sinuosity, no cover, max. pool depth <40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness,	

[1] Denotes a Warm Water Habitat (WWH) use.

Clover Groff Ditch is the easternmost tributary and is being encroached upon by Hilliard and metropolitan Columbus. Clover Groff Ditch has also been channelized historically with accumulated sediment trapped in the modified, entrenched channel. These sediment deposits cover the mostly rocky substrates and have neutralized most of the habitat. Sedimentation has become a more pronounced problem in recent years due to inadequate implementation of construction site erosion control BMPs. Gray septic storm water inputs from the adjacent suburban area as well as inadequately treated sewage have collectively caused enriched conditions that were likely periodically toxic. Supporting this conclusion were measured concentrations of ammonia, nitrite and total phosphorus in the 90 to 95th percentile range of ecoregional (ECBP) background conditions. Fecal coliform counts were also elevated.

The Hellbranch Run watershed (220-010) collectively exceeds fecal coliform criteria (2000 cfu) with a 90th percentile value of 2058 cfu. However, if individual tributaries are examined, Clover Groff Ditch significantly exceeds the criteria with a 90th percentile value of 5266 cfu. Hamilton Ditch exceeds average criteria (1000 cfu) with a value of 1661 cfu, as well as maximum criteria with a value of 4633 cfu. Hellbranch Run on the other hand meets the criteria. Efforts at reduction of bacteria should focus on Clover Groff Ditch and Hamilton Ditch.

2.5.2 Upper Lower Big Darby Creek (220-020)

The upper lower Big Darby Creek minor sub-watershed extends from below Little Darby Creek to above Hellbranch Run. A description of upper lower Big Darby Creek is included as Box 2.5.2.

All sites sampled on the mainstem of Big Darby Creek fully met all applicable biocriteria within this major sub-watershed. There were, however, indications that certain segments are currently under stress and starting to decline.

A short distance downstream from the community of Darbydale nutrient enrichment and low dissolved oxygen have led to several negative macroinvertebrate community attributes including a 300% increase in relative abundance, a 20% drop in sensitive EPT taxa, and the disappearance of viable bivalves. Construction of the planned Darbydale WWTP should eliminate this problem by incorporating all of the existing septic systems and unsewered portions of Darbydale as well as several small package WWTPs. Due to the potential for construction of WWTPs to foster increased development and higher population density the Darbydale WWTP service area has been delineated to keep these problems in check. Ensuring optimum performance of this WWTP will be important to maintaining the very high quality nature of this portion of Big Darby Creek.

Smith Ditch is a high quality direct tributary to Big Darby Creek. Field notes indicate that this site should have been a classic good intermittent stream with very deep pools, strong ground water influence and a wooded riparian corridor. The low number of fish at the downstream site was noteworthy with low D.O. from groundwater a suspected source.

Box 2.5.2 Overview of upper lower Big Darby Creek (BDC6, 220-020).					
Area (acres)	16,040				
Streams	Big Darby Creek, below Little Darby Creek to above Hellbranch Run (RM 34.1 to RM 26.2), including Smith Ditch, unnamed tributary to Smith Ditch and Gay Run.				
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)	
	Oak Hills MHP	4PV00008	0.069	0.100	
	Darbydale Elementary	4PT00105	0.0075	0.0075	
	Pleasant Acres MHP	4PV00101	0.039	0.038 Planned to tie into new Darbydale Plant	
	Community Gardens MHP	4PV00015	0.030	0.0143 Planned to tie into new Darbydale Plant	
	Darbydale WWTP	4PH00012		Under Construction	
Land Use	see Figure 2.5.2.1.				
Aquatic Life Use	**Name**		**Designated use**	**Impairment**	
	Big Darby Creek		EWH	No	
	Smith Ditch		EWH	**Yes** - 50% of sites impaired	
				Deviation	IBI -78%
	Unnamed Tributary to Smith Ditch		EWH	No	
	Gay Run		WWH	No	
Recreational Use	All		PCR	No	
Antidegradation Category	Big Darby Creek - Outstanding State Water				
Causes of impairment		**Sources of impairment**		**Addressed in this TMDL?**	
Low dissolved oxygen		groundwater		no	

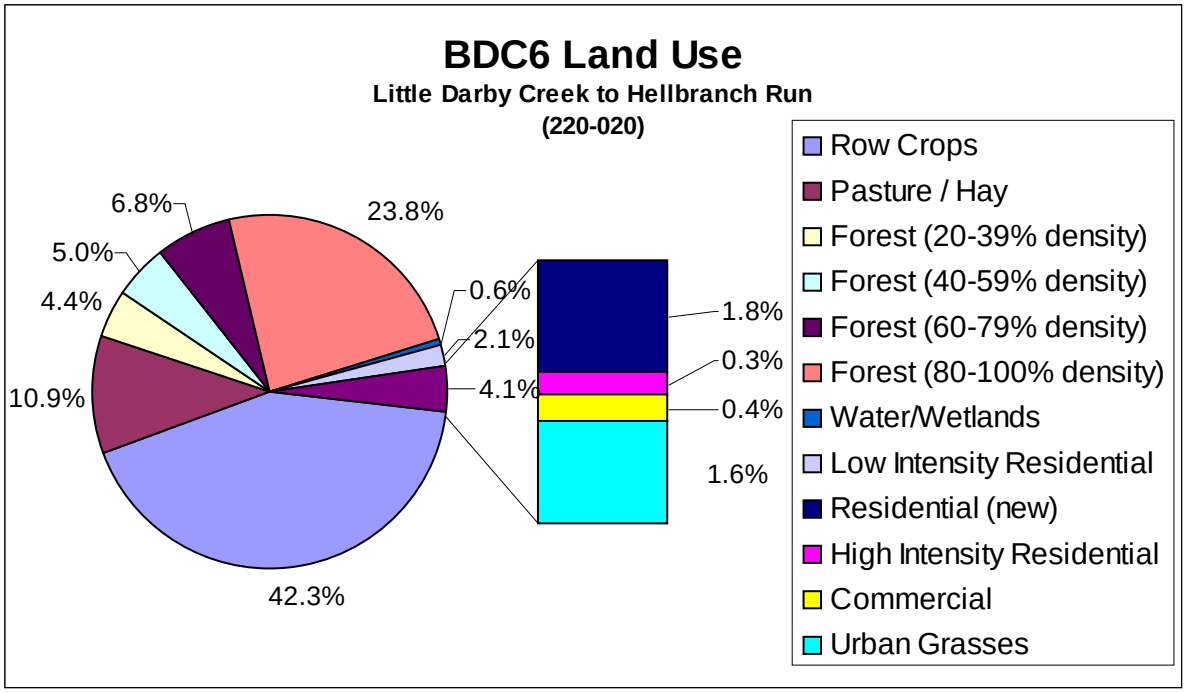

Figure 2.5.2.1. Land use in the upper lower Big Darby Creek minor sub-watershed.

Table 2.5.2 Habitat Assessment Results for upper lower Big Darby Creek (05060001-220-020)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-220-020						
Big Darby Creek (EWH)	29.1	None	86	None	None	Not Impaired
Gay Run (WWH)	2.2	Pool, riffle, gradient	66.5	None	No fast current, substrate embeddedness	Not Impaired
Smith Ditch (EWH)	2.1	None	77.5	None	Poor pool quality, no fast current, substrate embeddedness	Impaired
	0.3	Pool, riffle, gradient	73	None	1 or 2 cover types, poor pool quality, riffle embeddedness	
UT to Smith Ditch (EWH)	0.2	Pool, riffle, gradient	67	No cover	Poor pool quality, no fast current	Not Impaired

2.5.3 Middle Lower Big Darby Creek (220-030)

The middle lower Big Darby Creek minor sub-watershed extends from below Hellbranch Run to Darbyville. A description of middle lower Big Darby Creek is given in Box 2.5.3.

Box 2.5.3 Overview of middle lower Big Darby Creek (BDC7, 220-030).				
Area (acres)	25,099			
Streams	Big Darby Creek, from below Hellbranch Run to Darbyville (RM 26.1 to RM 13.1), including Springwater Run, unnamed tributaries to Big Darby Creek at RM 23.77, 20.2, and 18.41, Greenbrier Creek and Georges Run.			
Point Source Dischargers	**Name**	**Permit number**	**Design flow** (MGD)	**Average flow** (MGD)
	Dot-Mar MHP	4PV00100	0.004	0.006
	Pickaway Correctional Institute	4PP00003	2.340	0.903
	Foxlair Farms	4PV00007	0.050	0.042
		Receiving stream: UT to BDC @ RM 20.2		
	Clark's Lake Subdivision	4PG00014	0.100	not reported
		Receiving stream: UT to BDC @ RM 20.2		
Land Use	see Figure 2.5.3.1.			
Aquatic Life Use	**Name**		**Designated use**	**Impaired**
	Big Darby Creek		EWH	No
	Springwater Run		WWH	**Yes** - 100% of sites impaired
				Deviation: ICI F ➜ G
	Unnamed Tributary to BDC RM:	23.77	WWH	**Yes** - 100% of sites impaired
				Deviation: IBI - 33%
		20.2	WWH	No
		18.41	WWH	No
	Greenbrier Creek		WWH	No
	Georges Run		WWH	No

Box 2.5.3 Overview of middle lower Big Darby Creek (BDC7, 220-030).				
Recreational Use	Big Darby Creek		PCR	No
	Springwater Run		PCR	
	Unnamed Tributary to BDC RM	23.77 -	SCR	
		20.2	PCR	
		18.41	SCR	
	Greenbrier Creek		PCR	
	Georges Run		SCR	
Antidegradation Category	Big Darby Creek - Outstanding State Water			Ecological

Causes of impairment	**Sources of impairment**	**Addressed in this TMDL?**
Low dissolved oxygen	Septic systems, package plants	√
Nutrients	Septic systems, rowcrop agriculture, suburban run-off, package plants	√
Siltation	Construction, hydromodification	√

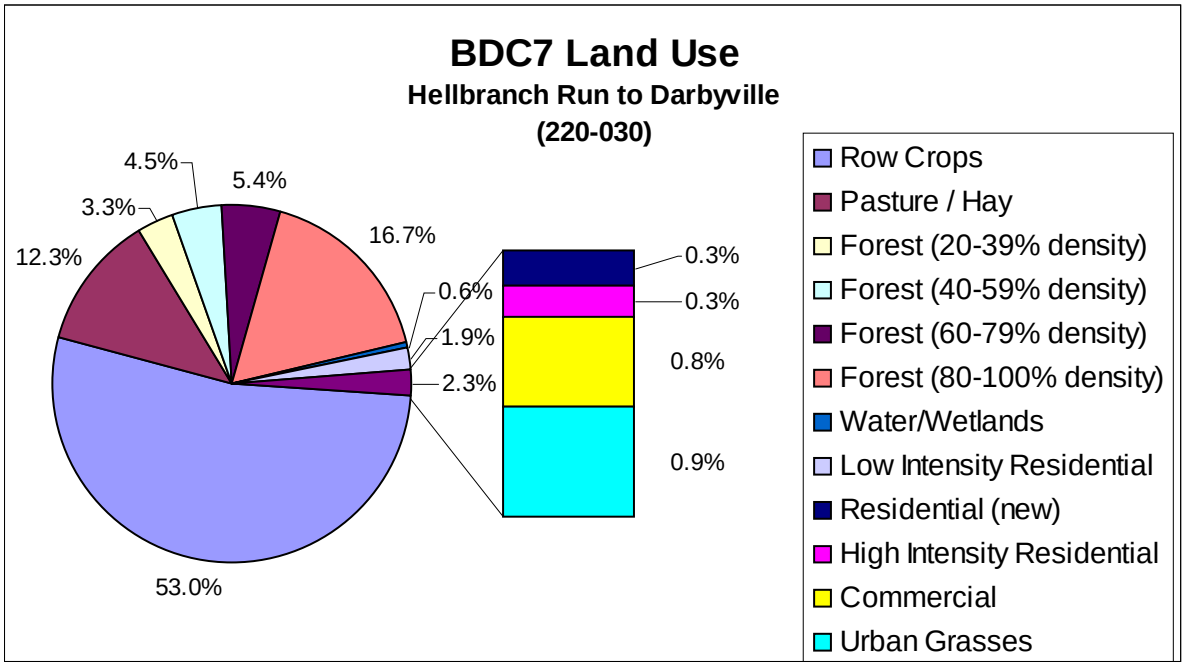

Figure 2.5.3.1. Land use in the middle lower Big Darby Creek minor sub-watershed.

Table 2.5.3 Habitat Assessment Results for middle lower Big Darby Creek (05060001-220-030)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-220-030						
Big Darby Creek (EWH)	26.1	None	94.5	None	None	Not impaired
	23.8	None	87.5	None	Substrate embeddedness	
	22.8	None	84.5	None	Substrate embeddedness	
	18.7	None	85	None	Substrate embeddedness	
	15.7	None	88.5	None	None	
	13.4	None	85.5	None	Substrate embeddedness	
Georges Run (WWH)	0.9	Substrate, riparian	61	None	Poor pool quality, no fast current, substrate embeddedness	Not Impaired
Greenbrier Creek (WWH)	2.7	Pool, riffle, gradient	57	None	Sand substrate, hardpan substrate origin, poor pool quality, no fast current, riffle embeddedness	Not Impaired
	1.3	None	74.5	None	Sand substrate, hardpan substrate origin, poor pool quality, no fast current	
Springwater Run (WWH)	0.8	Cover, channel, riparian, pool, riffle, gradient	48.5	Low sinuosity, no cover, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Impaired
UT to Big Darby Creek (RM 23.77) (WWH)	0.1	Cover, pool, riffle, gradient	61.5	Low sinuosity, max. pool depth < 40 cm	hardpan substrate origin, poor pool quality, riffle embeddedness	Impaired
UT to Big Darby Creek (RM 20.20) (WWH)	0.8	None	77.5	None	No fast current, substrate embeddedness	Not Impaired
UT to Big Darby Creek (RM 18.41) (WWH)	0.1	Substrate, cover, channel, pool, riffle, gradient	52.5	Low sinuosity, no cover, max. pool depth < 40 cm	Channelized-recovering, hardpan substrate origin, poor pool quality, no fast current, substrate embeddedness	Not Impaired

The extremely high quality habitat downstream from the confluence with Hellbranch Run appeared to have ameliorated most of the impacts that would be expected downstream from this tributary. There was a slight decline in the ICI and, while the IBI recorded was 54, there was a noteworthy decline in the number of sucker species and overall numerical abundance. Elimination of the Timberlake WWTP, which is currently the main source of impairment in lower Hellbranch Run, should improve this situation.

Conditions appear to have improved downstream from the PCI WWTP in recent years. However, when last sampled in 1997 fish communities posted significant declines downstream from the PCI WWTP. The WWTP was routinely operating above design flow between 1988 and 1998, which had led to increased pollutant loadings to this segment of Big Darby Creek and the subsequent biological impairment. Recent upgrades and process improvements at the PCI WWTP have led to much improved treatment, lowered loadings and much improved biological performance. With the planned expansion of this facility and the elimination of several package plants and diversion of their sewage to PCI, the loadings from this plant are expected to increase, while the overall loadings to the stream will decrease. Ensuring optimum performance of the PCI WWTP as the expected changes occur will be important to the very high quality of the receiving stream and protection of sensitive and endangered organisms downstream.

Springwater Run is the small tributary draining Harrisburg. Downstream from town, channelization and nutrient enrichment have led to low dissolved oxygen levels and algal productivity which is impacting the benthic macroinvertebrates. Harrisburg is currently investigating options for dealing with domestic sewage and should eliminate most of the nutrient inputs to Springwater Run

The unnamed tributary to Big Darby Creek at RM 23.77 is believed to be a naturally intermittent stream that dries out after freshets as a result of the underlying alluvial geologic deposits which have resulted in it being a losing stream.

The unnamed tributary to Big Darby Creek RM 20.2 is fully meeting its recommended use, however, the elimination of effluent from the Clark's Lake Subdivision, Dot Mar MHP WWTP, and Foxlair Farms WWTP should improve water quality to the point that biological communities would meet the criteria for EWH based on the instream habitat potential.

The unnamed tributary to Big Darby Creek at RM 18.41 has habitat that was judged suitable for supporting WWH communities even though it is in a state of partial recovery from past channelization and wood removal. Sedimentation and some nutrient enrichment are still affecting macroinvertebrate communities. Habitat improvement will help support improved biological quality.. Nonpoint source run-off (agriculture, pasture, a golf course) was the source of excess sediment and nutrients.

Natural stream dessication in Greenbrier Creek associated with the underlying alluvial deposits yielded poor macroinvertebrate results in 2001 at RM 1.1. However, both sites upstream in 2001 and 2002 met biocriteria.

Recreational uses are being attained in this minor sub-watershed.

2.5.4 Lower Lower Big Darby Creek (220-040)

The lower lower Big Darby Creek minor sub-watershed extends from Darbyville down to the confluence of the Scioto River and Big Darby Creek. A description of lower lower Big Darby Creek is given in Box 2.5.4.

<table>
<tr><th colspan="6">Box 2.5.4 Overview of lower lower Big Darby Creek (BDC8, 220-040).</th></tr>
<tr><td>Area (acres)</td><td colspan="5">14,038</td></tr>
<tr><td>Streams</td><td colspan="5">Big Darby Creek, from Darbyville to the Scioto River (RM 13.0 to mouth, RM 0.0), including Lizard Run.</td></tr>
<tr><td>Point Source Dischargers</td><td colspan="5">none</td></tr>
<tr><td>Land Use</td><td colspan="5">see Figure 2.5.4</td></tr>
<tr><td rowspan="4">Aquatic Life Use</td><td>Name</td><td colspan="2">Designated use</td><td colspan="2">Impairment</td></tr>
<tr><td>Big Darby Creek</td><td colspan="2">EWH</td><td colspan="2">No</td></tr>
<tr><td rowspan="2">Lizard Run</td><td colspan="2" rowspan="2">LRW</td><td colspan="2">Yes - 100% of sites impaired</td></tr>
<tr><td>Deviation</td><td>ICI VP ➜G</td></tr>
<tr><td rowspan="2">Recreational Use</td><td>Big Darby Creek</td><td colspan="2">PCR</td><td colspan="2" rowspan="2">No</td></tr>
<tr><td>Lizard Run</td><td colspan="2">SCR</td></tr>
<tr><td>Antidegradation Category</td><td colspan="5">Big Darby Creek - Outstanding State Water</td></tr>
<tr><td colspan="2">Causes of impairment</td><td colspan="2">Sources of impairment</td><td>Addressed in this TMDL?</td></tr>
<tr><td colspan="2">Low dissolved oxygen</td><td colspan="2">Ground water</td><td>no</td></tr>
</table>

Conspicuous algal mats observed in recent years at locations where the stream canopy has permitted sunlight to reach the water's surface suggest that lower Big Darby Creek is being subjected to increasing nutrient loads. Additionally, changes in hydrology have resulted in destabilization of the streambed making it hostile to bivalve molluscs, as documented in 2001/2002. See the macroinvertebrate and fish discussions in Sections B.7 and B.8 of the TSD (Ohio EPA, 2004), respectively, for specific details.

Lizard Run is a small stream that was found to be dry even after a recent rain and must flow only during significant precipitation events. The underlying alluvial deposits make it a losing stream.

Recreational uses are being attained in this minor sub-watershed.

Table 2.5.4 Habitat Assessment Results for lower lower Big Darby Creek (05060001-220-040)

Stream/River	River Mile	Assessment Results				Use Attainment Status
		Habitat metrics that are not meeting target values at the site	QHEI	Undesirable habitat attributes present at the site		
				High Influence	Moderate Influence	
05060001-220-040						
Big Darby Creek (EWH)	10.4	None	85	None	No fast current, substrate embeddedness	Not Impaired
	8.4	Channel	69.5	None	Channelized-recovering, no fast current, substrate embeddedness	
	3.1	None	82	None	No fast current, substrate embeddedness	
	0.3	Substrate, riparian	71.5	None	No fast current, substrate embeddedness	

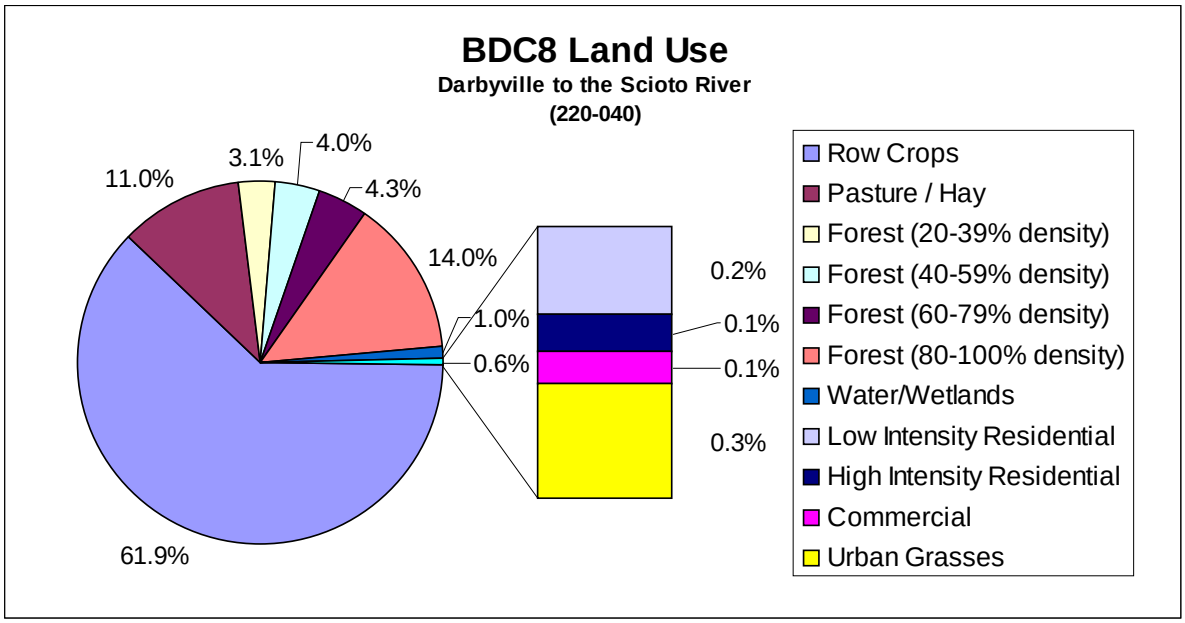

Figure 2.5.4.1. Land use in the lower lower Big Darby Creek minor sub-watershed.