levels. Therefore, we are uncertain, based on invertebrates, exactly how impaired the water quality may be due to pollution.

The Big Walnut Watershed has overall good to excellent habitat for aquatic life. The biggest concerns to habitat for aquatic life are lack of riparian vegetation and stream bank erosion. Nutrient enrichment also appears to be a problem in several locations based on the composition of species present. The complete Aquatic Macroinvertebrate Report can be referenced in Appendix F.

6.0 LAND USE

6.1 Land Use Composition by Subwatersheds

Land use in the Big Walnut Watershed is mostly rural or agricultural (Figure U1). Figures U2-U20 (Appendix A) show land use at a more usable scale for each priority 14-HUC subwatershed. The land use layer that was referenced was generated from the Central Indiana Water Resources Partnership (CIWRP) Pilot Studies by Indiana University-Purdue University Indianapolis Center for Earth and Environmental Science and Center for Urban Policy and the Environment (IUPUI-CEES and CUPE) (J. Wilson) 2003. The predominant land use is agriculture. Other major land use types within the watershed include forest and grasslands/suburban land. Residential/urban areas would compose a majority of the remaining land use. Table 17 defines acreage and percentages of each land use within the Big Walnut Watershed on an individual 14-HUC watershed level. For the most part, when looking at land use across the subwatersheds, percent of each subwatershed in a particular land use was considered more heavily than total acreage of a given land use. Since the water quality sampling strategy generally links water quality findings to a given subwatershed, it is more important to consider the land use characteristics of that subwatershed rather than total acreage when trying to understand the various land use influences.

6.1.1 Agricultural

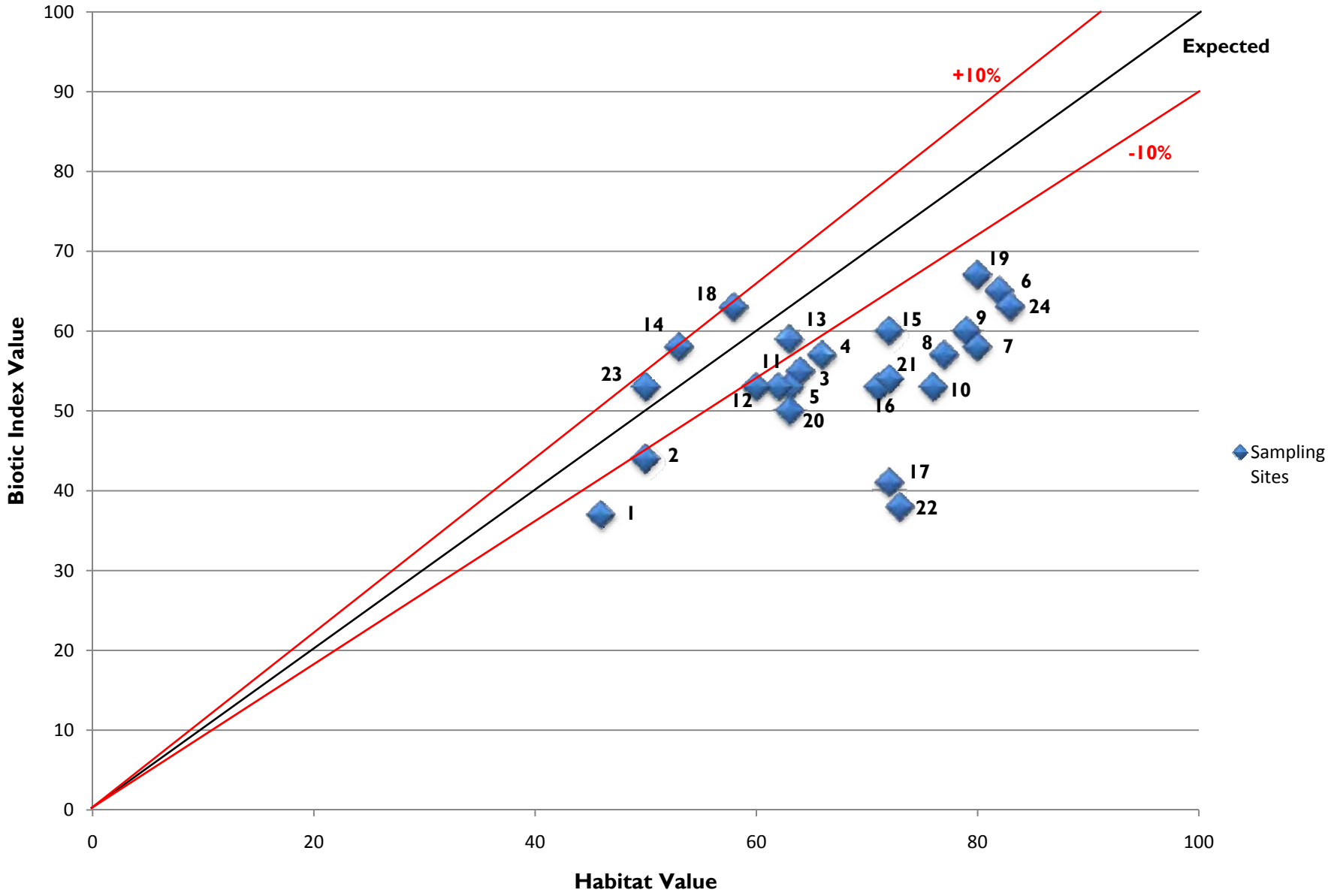
With agriculture dominating the majority of the land use, many of the subwatersheds have similar acreages/percentages of such land use. Subwatersheds with greater than 70% of their acreage in active agricultural production include Subwatersheds J, P, Q, R, X, Y, Z, BB, and CC. Several of these subwatersheds are clustered in certain areas of the larger watershed. These areas can be generally described as the headwaters areas of Big Walnut Creek in Boone and Hendricks Counties, as well as the headwaters area of Deer Creek in Hendricks and Putnam County.

6.1.2 Forested

In general, forested land use increases in the southern portion of the watershed. Subwatersheds with the greatest percentages of forested land use include Subwatersheds C, E, G, K, M, V, and W. Most notable are Subwatersheds E and G (the most southern end of the mainstem of Big Walnut Creek and K (the most southern end of Deer Creek where Deer Creek enters Big Walnut Creek). The forested land use in these areas is clearly associated with steeper terrain and topography in this portion of the watershed. The local terrain and soils do not lend themselves to agricultural land use.

Figure 1a

Macroinvertebrate Data - OEPA



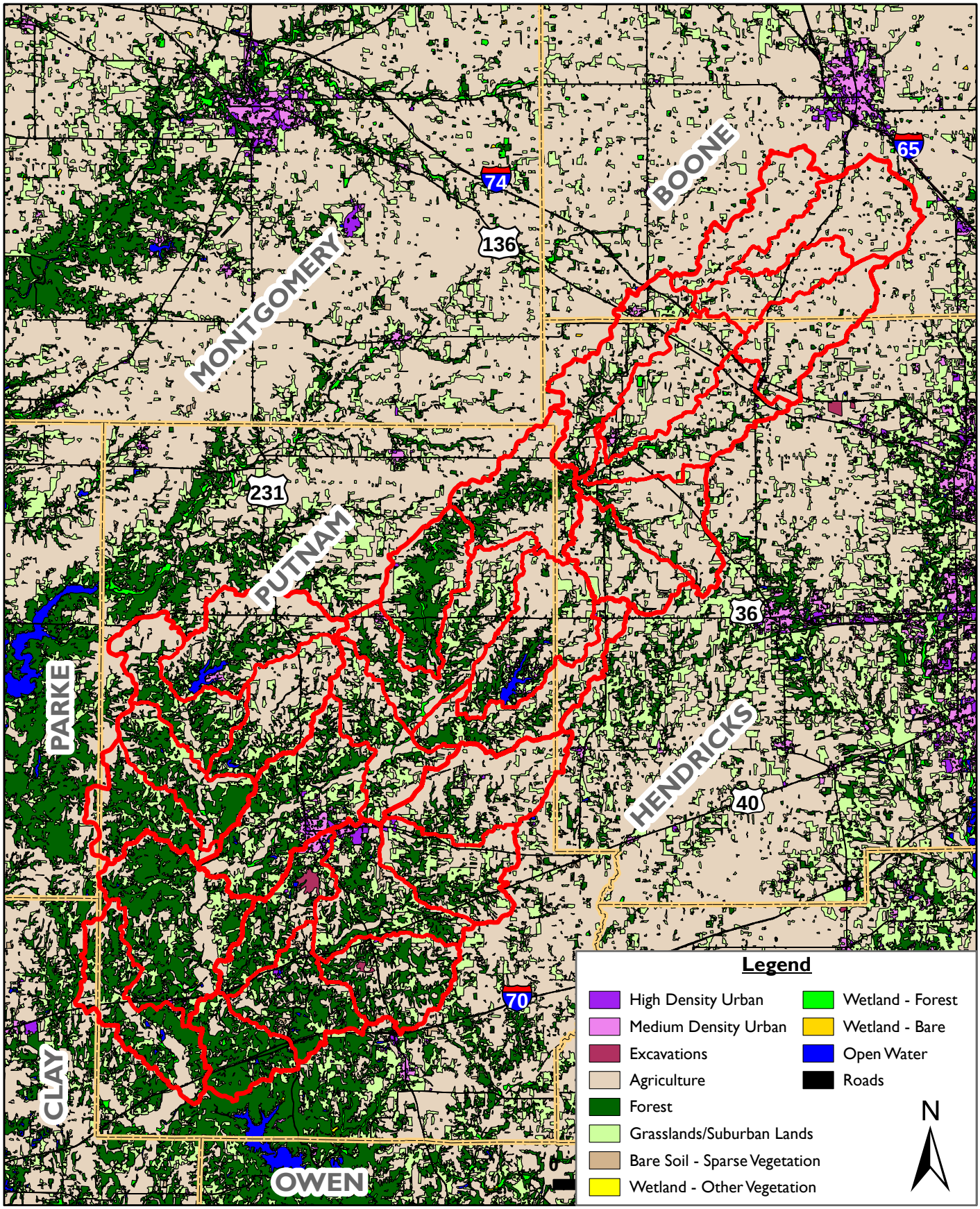


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Figure U1 - Land Use

Big Walnut Creek Watershed

Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

Table 17: Land Use

	Subwatersheds	Watershed Acreage	Acres of Agriculture	Percent Agriculture	Acres of Forest	Percent Forest	Acres of High Density Urban	Percent High Density Urban
A	Big Walnut Creek - Barnard	10027	6249.32	62.32%	2051.61	20.46%	0.00	0.00%
B	Big Walnut Creek - Dry Branch	8145	4360.21	53.53%	1389.16	17.06%	24.73	0.30%
C	Big Walnut Creek - Ernie Pyle Memorial Highway	8417	2714.11	32.25%	3476.97	41.31%	17.04	0.20%
D	Big Walnut Creek - Greencastle	14170	4020.17	28.37%	4336.05	30.60%	187.13	1.32%
E	Big Walnut Creek - Johnson Branch	9462	3125.95	33.04%	4184.78	44.23%	9.36	0.10%
F	Big Walnut Creek - Plum Creek/Bledsoe Branch	12122	6050.71	49.92%	2637.92	21.76%	21.48	0.18%
G	Big Walnut Creek - Snake Creek/Maiden Run	15537	4068.31	26.18%	7620.56	49.05%	8.70	0.06%
H	Clear Creek Headwaters (Putnam)	11125	6348.07	57.06%	1681.67	15.12%	13.08	0.12%
I	Clear Creek - Miller Creek	8778	5062.25	57.67%	1480.80	16.87%	17.49	0.20%
J	Deer Creek Headwaters (Putnam)	10573	7406.24	70.05%	1141.33	10.79%	18.91	0.18%
K	Deer Creek - Leatherwood Creek	5852	708.05	12.10%	3724.92	63.65%	0.00	0.00%
L	Deer Creek - Little Deer Creek	8798	4198.31	47.72%	1801.51	20.48%	80.45	0.91%
M	Deer Creek - Mosquito Creek	8094	2205.75	27.25%	3548.30	43.84%	61.52	0.76%
N	Deer Creek - Owl Branch	9727	2920.66	30.03%	3036.53	31.22%	279.68	2.88%
O	Deweese Creek	7006	1771.74	25.29%	2254.57	32.18%	72.81	1.04%
P	East Fork Big Walnut Creek - Lower	8909	6295.25	70.66%	723.43	8.12%	12.25	0.14%
Q	East Fork Big Walnut Creek - Ross Ditch	8975	7733.63	86.17%	201.17	2.24%	10.51	0.12%
R	Hunt Creek	6880	5103.54	74.18%	535.64	7.79%	0.00	0.00%
S	Jones Creek	8704	5106.92	58.67%	1291.30	14.84%	0.00	0.00%
T	Limestone Creek	8366	3247.13	38.81%	2929.24	35.01%	23.55	0.28%
U	Little Walnut Creek - Headwaters	7780	3436.25	44.17%	2233.96	28.71%	0.00	0.00%
V	Little Walnut Creek - Leatherman Creek	7303	2178.18	29.83%	3372.25	46.18%	0.00	0.00%
W	Little Walnut Creek - Long Branch	6991	2318.59	33.17%	3103.23	44.39%	0.00	0.00%
X	Main Edlin Ditch - Grassy Branch	5622	4906.08	87.27%	54.26	0.97%	3.81	0.07%
Y	Main Edlin Ditch - Smith Ditch	9377	8584.39	91.55%	110.45	1.18%	0.00	0.00%
Z	Middle Fork Big Walnut Creek	8681	6576.4	75.76%	216.71	2.50%	14.42	0.17%
AA	Owl Creek	10343	5590.94	54.06%	2089.77	20.20%	9.20	0.09%
BB	Ramp Run - East Fork Outlet	8219	6082.55	74.01%	559.66	6.81%	0.00	0.00%
CC	West Fork Big Walnut Creek Headwaters	7065	6459.83	91.43%	47.70	0.68%	0.00	0.00%
DD	West Fork Big Walnut Creek - Lower	10107	6756.92	66.85%	923.01	9.13%	5.59	0.06%
	Totals	271155	141586.45	52.22%	62758.46	23.14%	891.71	0.33%

Table 17: Land Use (cont)							
Subwatersheds		Acres of Medium Density Urban	Percent Medium Density Urban	Acres of Grasslands/ Suburban Lands	Percent Grasslands/S uburban Lands	Acres of Excavation	Percentage Excavation
A	Big Walnut Creek - Barnard	0.00	0.00%	1516.15	15.12%	0.00	0.00%
B	Big Walnut Creek - Dry Branch	1.67	0.02%	2256.26	27.70%	0.00	0.00%
C	Big Walnut Creek - Ernie Pyle Memorial Highway	22.41	0.27%	1904.68	22.63%	0.00	0.00%
D	Big Walnut Creek - Greencastle	634.93	4.48%	4695.70	33.14%	0.00	0.00%
E	Big Walnut Creek - Johnson Branch	13.38	0.14%	1884.95	19.92%	0.67	0.01%
F	Big Walnut Creek - Plum Creek/Bledsoe Branch	114.24	0.94%	3087.19	25.47%	0.00	0.00%
G	Big Walnut Creek - Snake Creek/Maiden Run	78.59	0.51%	3497.94	22.51%	0.00	0.00%
H	Clear Creek Headwaters (Putnam)	344.32	3.10%	2246.72	20.20%	0.00	0.00%
I	Clear Creek - Miller Creek	17.24	0.20%	2079.20	23.69%	2.97	0.03%
J	Deer Creek Headwaters (Putnam)	61.24	0.58%	1855.63	17.55%	0.00	0.00%
K	Deer Creek - Leatherwood Creek	5.93	0.10%	1235.78	21.12%	0.60	0.01%
L	Deer Creek - Little Deer Creek	9.46	0.11%	2556.40	29.06%	6.21	0.07%
M	Deer Creek - Mosquito Creek	40.90	0.51%	1911.60	23.62%	13.71	0.17%
N	Deer Creek - Owl Branch	172.85	1.78%	3025.46	31.10%	15.59	0.16%
O	Deweese Creek	378.35	5.40%	2064.77	29.47%	334.58	4.78%
P	East Fork Big Walnut Creek - Lower	25.44	0.29%	15.92	0.18%	28.78	0.32%
Q	East Fork Big Walnut Creek - Ross Ditch	32.69	0.36%	864.46	9.63%	2.10	0.02%
R	Hunt Creek	0.00	0.00%	1113.69	16.19%	0.00	0.00%
S	Jones Creek	2.29	0.03%	2099.53	24.12%	0.00	0.00%
T	Limestone Creek	1.99	0.02%	1950.26	23.31%	85.91	1.03%
U	Little Walnut Creek - Headwaters	0.00	0.00%	2026.72	26.05%	0.00	0.00%
V	Little Walnut Creek - Leatherman Creek	0.00	0.00%	1659.68	22.73%	0.00	0.00%
W	Little Walnut Creek - Long Branch	0.00	0.00%	1524.70	21.81%	0.00	0.00%
X	Main Edlin Ditch - Grassy Branch	0.00	0.00%	643.28	11.44%	0.00	0.00%
Y	Main Edlin Ditch - Smith Ditch	0.00	0.00%	597.07	6.37%	3.12	0.03%
Z	Middle Fork Big Walnut Creek	88.07	1.01%	1534.22	17.67%	22.56	0.26%
AA	Owl Creek	105.51	1.02%	2027.68	19.60%	4.46	0.04%
BB	Ramp Run - East Fork Outlet	0.00	0.00%	1533.32	18.66%	0.00	0.00%
CC	West Fork Big Walnut Creek Headwaters	0.00	0.00%	539.43	7.64%	0.00	0.00%
DD	West Fork Big Walnut Creek - Lower	121.58	1.20%	1997.19	19.76%	11.77	0.12%
	Totals	2273.08	0.84%	55945.58	20.63%	533.03	0.20%

6.1.3 Residential/Urban

The watershed area in general does not contain much impervious area. Areas with extensive impervious land cover have been shown to undergo degradation in water quality and the ability to support biotic stream life. For the purposes of considering water quality impacts associated with impervious area, percent land use in high-density residential and medium-density residential categories were used as surrogate indicators of areas with higher impervious surface. It is important to note that comparisons of acreages in each land use category is a relative comparison among other subwatersheds in the Big Walnut project area, not that acreages or percentages that are labeled or discussed as 'large' or 'high' are actually notably so when compared across the state or to other communities.

Subwatersheds with relatively larger percentages of high-density residential land use include Subwatershed D, L, and N. All three of these areas are influenced by the City of Greencastle. Subwatersheds with high percentages of medium-density residential land use include some of those mentioned above associated with Greencastle (Subwatersheds D and N), as well as Subwatersheds H, O, Z, and AA. These subwatersheds are influenced by Heritage Lake, suburban growth southwest of Greencastle, north Salem in Hendricks County, and the Van Bibber mobile home community around Van Bibber/Glenn Flint Lake.

6.2 Riparian Habitat, Floodplains, and Wetland Soils

Watershed scientists have known for decades the critical role floodplains and wetlands play in overall water quality protection and quantity control. Floodplains, National Wetland Inventory (NWI) wetlands, and hydric soils, are shown in Figures F1-F21 (Appendix A) and summarized in Tables 1 and 2 (pgs 10 &13).

All of the subwatersheds have some acreage of wetlands, however, Subwatersheds H, AA, D, and G, all have greater than 25 acres of mixed wetland types within their boundaries. If the percentage of wetland acres is looked at none of the subwatersheds wetland acre percentage is greater than 0.40% of the total land acreage. Subwatershed C has the greatest acreage of forested wetland. Subwatershed C is part of the area along the Big Walnut Creek Corridor with much of the land protected in nature preserves and other forms of land conservation.

Several of the subwatersheds have high percentages of floodplain relative to their total acreage. Subwatersheds E, G, T, and X are some examples of subwatersheds like this. Subwatersheds with the most acres of floodplain include D, E, G, and H all with greater than 3000 acres of floodplain.

The subwatersheds in part or all of Boone County, Subwatersheds Q, X, Y, Z, CC, and DD, all have the greatest acreage and percentage of hydric soils. This is because the NRCS is currently reclassifying soils throughout the State of Indiana and Boone County was one of the first counties to be done. Most of the Subwatersheds in Putnam County will not have much hydric soil because of the topography of the county.

6.3 Agricultural Practices

Transect data collected by the Putnam County SWCD and NRCS was analyzed for the Putnam County portion of the Big Walnut Watershed. Information collected for transect data includes

information such as present crop, previous crop, tillage practice, and several other items relating to soil.

The data analyzed shows 261 points within the watershed. Of the 261 points within the watershed, seven still show conventional tillage practices. No till practices show up as 180 of the points. The remaining points collected are either practices of mulch tillage, reduced tillage, or unknown/not applicable. Figure V shows the path of transect data collected for Putnam County.

Further conversation with the SWCD and NRCS personnel stated that most of the conventional tillage in Putnam County occurs in the northern part of the County, outside of the watershed. Subwatershed N, as well as the northern and western portions of Subwatersheds A and C are also areas where conventional tillage is still practiced, but these areas are not areas where transect data is collected.

In addition to transect data for Putnam County, data was received for Boone and Hendricks Counties as well. Boone County shows 67 points within the Big Walnut Creek Watershed. Of the 67 points, 16 points are no till practices. Conservation practices are represented as 28 of the points. The remaining 23 points are either practices of mulch tillage, reduced tillage, or unknown/not applicable. Hendricks County sampled 261 points within the Big Walnut Creek Watershed. Unfortunately, tillage information was not collected for the sample points.

6.4 Septic Areas & Sewer Utilities

Septic discharge is a concern of the county health departments of the Big Walnut Creek Watershed. This is because the majority of the homes in the watershed are in rural areas where sewer utilities are not available. The county health departments are working to help educate septic owners and installers on the proper do's and don'ts of septic systems.

The county health departments were contacted to find out if they were aware of septic system problems within the watershed. The Putnam County Health Department, who is currently working on a mapping septic system data into a GIS layer, noted several areas of concern. They have problems on a regular basis throughout the watershed. Areas with recent problems which have been repaired, or are in the process of being repaired include Ivanwald, Roachdale, Heritage Lake, and Morton. Their biggest problem areas are the Applewood Subdivision and the Van Bibber area.

The Boone County Health Department stated that the area of the county located in the Big Walnut Creek Watershed is a low diversity area and not much is known about septic concerns for that area.

The Boone County Health Department (BCHD) did provide information on a junkyard that was noted while driving the watersheds during windshield surveys. The junkyard is a well documented problem of Boone County. The junkyard has been the complaint of neighbors for many years. There have been several illegal open burning incidents, along with numerous permit and compliance violations. Violations are primarily focused on oil and tire storage and

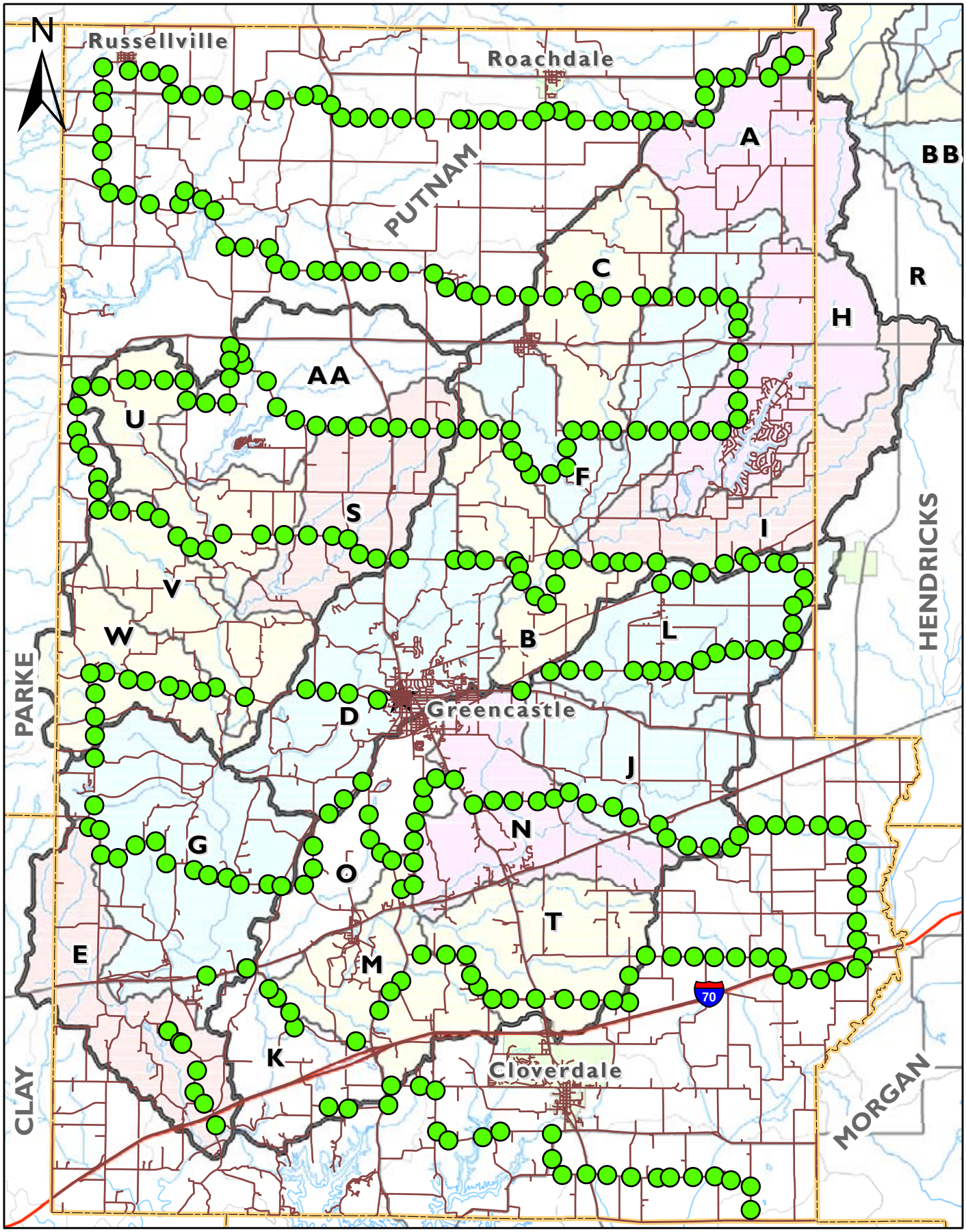

Figure V - Tillage Transect Data

Big Walnut Creek Watershed

Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

disposal. Numerous inspections to the site by IDEM and the BCHD have revealed pipes discharging to the adjacent ditch. Surface runoff and leaching are also believed to be problems. Petroleum waste is believed to be the biggest concern of contamination. The BCHD is continuously working with the owner to improve the conditions of the site.

The Hendricks County Health Department provided information stating that over 1000 of the septic systems within the Big Walnut Creek Watershed do not have documented records. Many of these systems are concentrated around the towns of North Salem, Lizton, and Jamestown. Septic systems with documentation are typically 20 years old or less. Several complaints have been received by the health department in scattered locations throughout the Hendricks County portion of the watershed.

6.5 Future Land Use

Putnam County is currently working on a new comprehensive plan for the county as the current plan is out of date. The majority of the land in Putnam County under the current plan remains unchanged. Proposed areas of development include residential, nature preserve, and commercial.

Zoning in Boone County within the area of the Big Walnut Watershed is predominantly general agriculture. Some county zoning is in place around the smaller towns such as Jamestown and New Brunswick. Zoning categories in these areas include low-density single-family residential, low-density single and two family residential, high-density multifamily residential, local business, general business, and light industry. Boone County is also currently updating their county comprehensive plan.

Hendricks County released their most current comprehensive plan in early 2007. Future land use for the area in which the Big Walnut Watershed is proposed as agricultural with some commercial development. Several small towns with mixed uses are located in these areas. Figures W1-W19 (Appendix A) illustrate land use via 2005 aerial photography within each priority 14-HUC watershed of the Big Walnut.

7.0 FIELD EVALUATIONS

7.1 Indiana Smallmouth Conservation Float Survey

On May 26th, 2007 a group of volunteers from the Indiana Smallmouth Conservation (ISC) surveyed a 15 mile portion of Big Walnut Creek by canoeing and kayaking the creek. The trip was from US 36 east of Bainbridge south to county road 100S southwest of Greencastle. The group documented their trip by taking GPS points and photographs of areas of concern. Streambank erosion and lack of buffer on agricultural fields was the biggest issue found by the group. The group also noted areas of farm field erosion and field tile drains.

The ISC also surveyed a southern stretch of Big Walnut Creek over several weekends in October 2008. This section was from Greencastle to the southern portion of the watershed. The main purpose of this trip was to pinpoint logjams, severe agricultural erosion areas, and other areas where the heavy June rains caused major flooding damage to the landscape.

Appendix G shows several maps of the areas that the ISC group surveyed. It also includes a photo journal of some of the poor land use practices and deteriorated areas.

7.2 Windshield Survey

Windshield surveys were conducted in all 30 14-digit HUC subwatersheds of the Big Walnut Watershed in early 2008. The surveys were conducted by driving all accessible roads in the watershed. The drives were performed with help from staff of the Boone, Hendricks, and Putnam County SWCDs. Large 24 inch by 36 inch maps of each individual 14-digit HUC watershed showing aerial photography, NWI features, and environmental issues were used as guides for the surveys.

The windshield surveys were carried out in order to gain a greater understanding of happenings within the Big Walnut Watershed. In addition, they were used to confirm items that GIS map layers illustrated and note items that were not visible using GIS. Items that were looked at during the surveys included, but were not limited to the following items:

- ✓ Confirmation of aerial land use categorization
- ✓ Field erosion/gullies
- ✓ Denuded pasture areas
- ✓ Livestock in or with access to streams
- ✓ Notable wet spots (wetland restoration sites and/or flooding concerns)
- ✓ Lack of buffers – farmed/mown to edge of streams
- ✓ No-till versus conventional tillage
- ✓ Bank erosion at stream crossings
- ✓ Culvert constriction at road crossings
- ✓ Buffer width
- ✓ Environmental site confirmation (open dumps, NPDES pips, CAFOs, etc.)
- ✓ Additional CFOs
- ✓ NWI confirmation

Handwritten notes and GPS points were recorded on the large field maps in locations where areas of concern were identified. These locations and findings were then incorporated into the project GIS. Photographs of streams and other locations were also taken to document some of the findings. Figure X shows all of the points where one or more of the above listed items were documented.

Concerns within the subwatersheds resulting from the windshield surveys were narrowed to the most common observations, namely livestock access to streams and lack of stream/ditch buffers. The other items on the list which were looked at had very few to no occurrences. The minimal number of occurrences of these issues also does not represent a significant water quality impacts on the Big Walnut Creek Watershed.

7.2.1 Buffers

Buffers are important to waterways as they work to filter nutrients and reduce sediment from entering the waterways. Buffers are effective at reducing pollutant loads if they are at least 25 feet from the top of bank; although, 70 feet is preferred/ideal, with a maximum typically of 100 feet. These widths are recommended by the NRCS, but vary by site. A simple rating system of 'very poorly buffered' and 'moderate to poorly buffered' was developed to gauge the relative condition or presence of buffers observed during the windshield survey. The 'moderate to poorly buffered' subwatersheds were defined as such when the number of observations of buffers less than 20 feet ranged from four to seven in a given subwatershed. 'Very poorly buffered' subwatersheds are those where the number of observations of buffers less than 20 feet was eight or more instances in the same subwatershed. 'Very poorly' or 'moderately to poorly' buffered subwatersheds were noted in 7 of the 30 subwatersheds (Figure Y).

Very Poorly Buffered Subwatersheds – "Orange"

Two of the subwatersheds, Main Edlin Ditch and Big Walnut Creek – Plum Creek, have high numbers of observations of little to no buffers.

- Main Edlin Ditch – Smith Ditch – Subwatershed Y
  This subwatershed is dominated by agricultural production. The majority of the fields are in conservation tillage; however, fields are worked and planted as close as possible to the edge of waterways.

- Big Walnut Creek – Plum Creek/Bledsoe Branch – Subwatershed F
  This subwatershed is primarily agricultural, but also has a high percentage of grassland/suburban land and forest. Most of the buffer problems in this subwatershed are associated with small tributaries that do not show up as blue lines on the maps.

Moderately to Poorly Buffered Subwatersheds – "Blue"

Five subwatersheds were observed to have a moderate number of instances of little to no buffer. Not surprisingly, some of the subwatersheds with moderate to poor buffers cluster together in the larger watershed. The moderate to poorly buffered subwatersheds all cluster around or near the very poorly buffered subwatersheds. All of the below watersheds have land uses that are primarily agriculture based. The buffer problems are a result of farming practices that come up to the edge of waterways.

- Clear Creek – Headwaters (Putnam) – Subwatershed H
- Clear Creek – Miller Creek – Subwatershed I
- East Fork Big Walnut Creek – Ross Ditch – Subwatershed Q
- Main Edlin Ditch – Grassy Branch – Subwatershed X
- West Fork Big Walnut Creek – Headwaters – Subwatershed CC

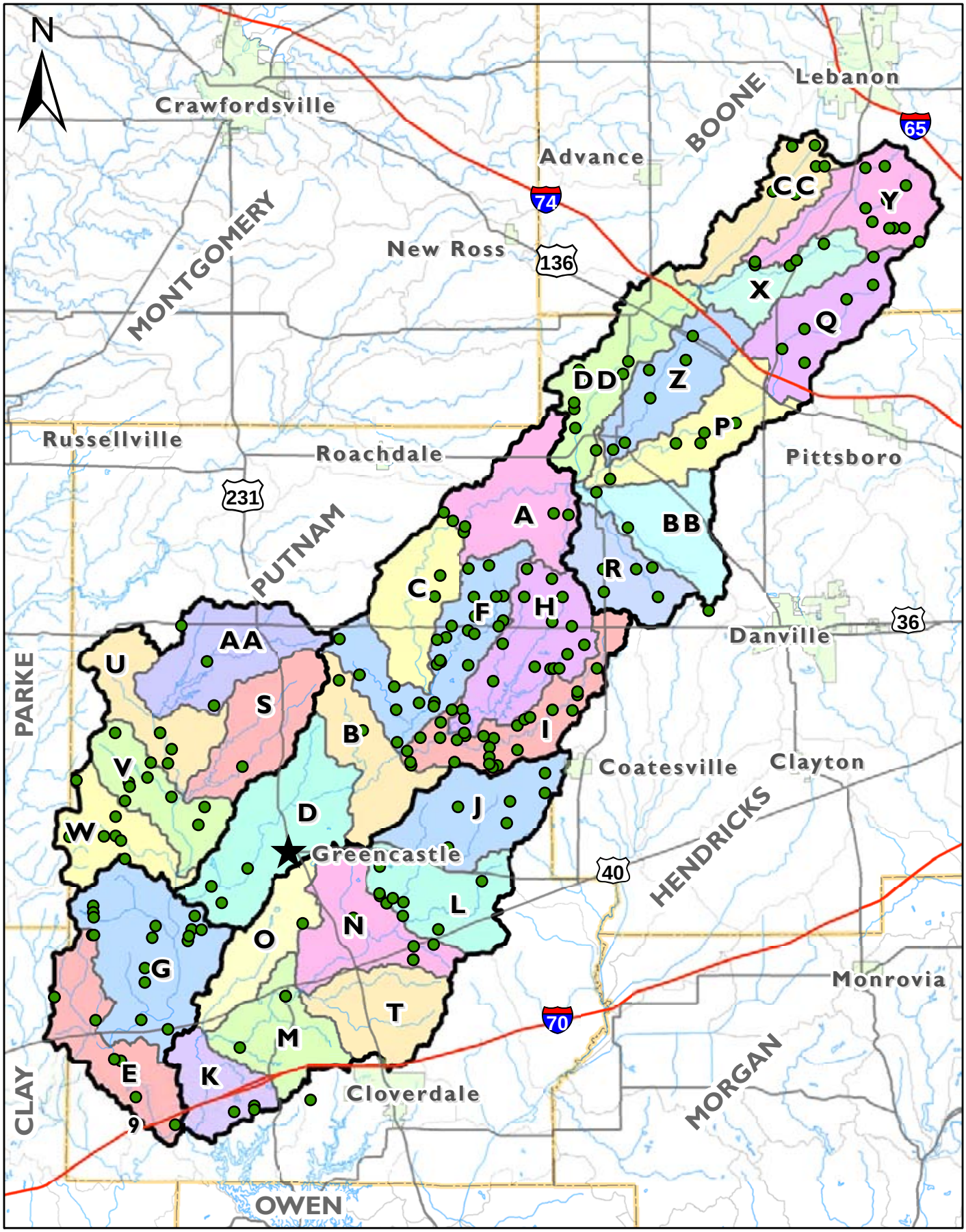

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Figure X - Windshield Survey Waypoints

Big Walnut Creek Watershed

Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

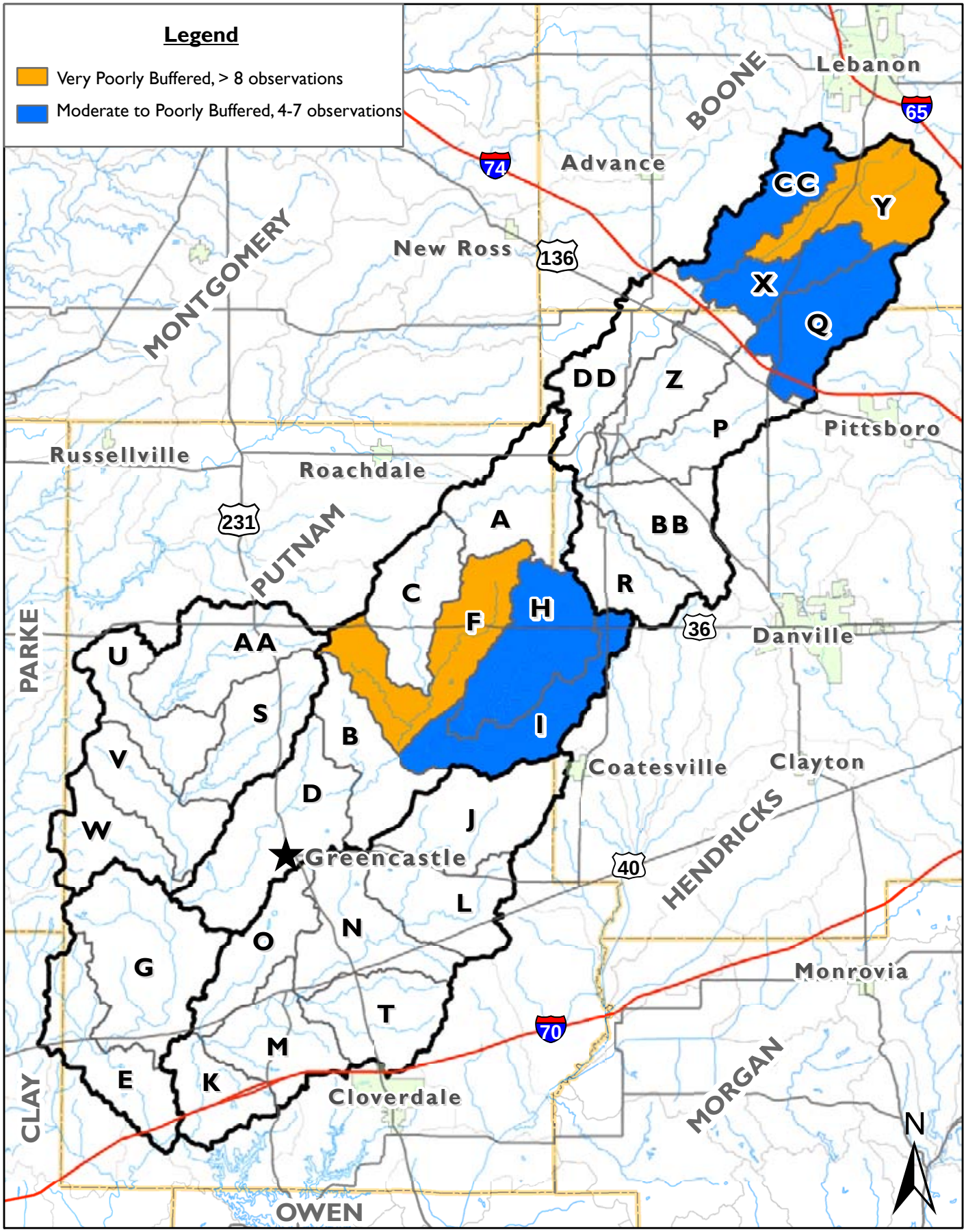


Figure Y - Poorly Buffered Areas
Dec 2007- March 2008
Big Walnut Creek Watershed
Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

7.2.2 Livestock Access to Streams

Livestock with access to streams have been documented as a concern because they deposit fecal material in or near streams making them potential source of *E. coli*. The livestock also walk over stream banks causing stream bank erosion and deposition of sediment into streams or increases in total suspended solids (TSS). Livestock in or with access to streams was noted in 27 of the 30 subwatersheds. A simple rating system of 'frequent' and 'moderate' was developed to gauge the relative frequency of livestock with access to streams. Six of the subwatersheds have 'frequent' numbers of observations (greater than eight) of livestock with access to streams. Eight of the subwatersheds have 'moderate' numbers of observations (greater than five but less than eight) (Figure Z). Figure Z also depicts the location of Confined Feeding Operations (CFOs) in each subwatershed. This environmental feature was included to assist in better understanding of livestock concentrations in the watershed relative to the locations where livestock were observed in the stream.

Frequent Livestock in the Stream Subwatersheds – "Purple"

- Big Walnut Creek – Plum Creek/Bledsoe Branch – Subwatershed F
- Big Walnut Creek – Snake Creek/Maiden Run – Subwatershed G
- Clear Creek – Miller Creek – Subwatershed I
- Deer Creek – Little Deer Creek – Subwatershed L
- Deer Creek – Owl Branch – Subwatershed N
- West Fork Big Walnut Creek – Lower – Subwatershed DD

These watersheds have a combined total of nine CFOs

Moderate to Frequent Livestock in the Stream Subwatersheds – "Tan"

- Big Walnut Creek – Greencastle – Subwatershed D
- Clear Creek – Headwaters (Putnam) – Subwatershed H
- Deer Creek – Headwaters – Subwatershed J
- Hunt Creek – Subwatershed R
- Jones Creek – Subwatershed S
- Limestone Creek – Subwatershed T
- Little Walnut Creek – Long Branch – Subwatershed W
- Ramp Run – East Fork Outlet – Subwatershed BB

These watersheds have a combined total of thirteen CFOs

8.0 SELECTION OF CRITICAL AREAS (PRIORITY SUBWATERSHEDS)

A variety of criteria were used to develop Critical Areas (i.e. Priority Subwatersheds) in the larger watershed. Nutrient and sediment loads were calculated using concentration and flow data from each site for each of the sample sites on each sample date and then compared against values recognized by water quality professionals to be indicative of healthy conditions. In addition to relative load information, the subwatersheds were scored against information collected during windshield surveys such as lack of buffered streams present and cattle with access to the streams, as well as the presence of NPDES dischargers, significant water users,

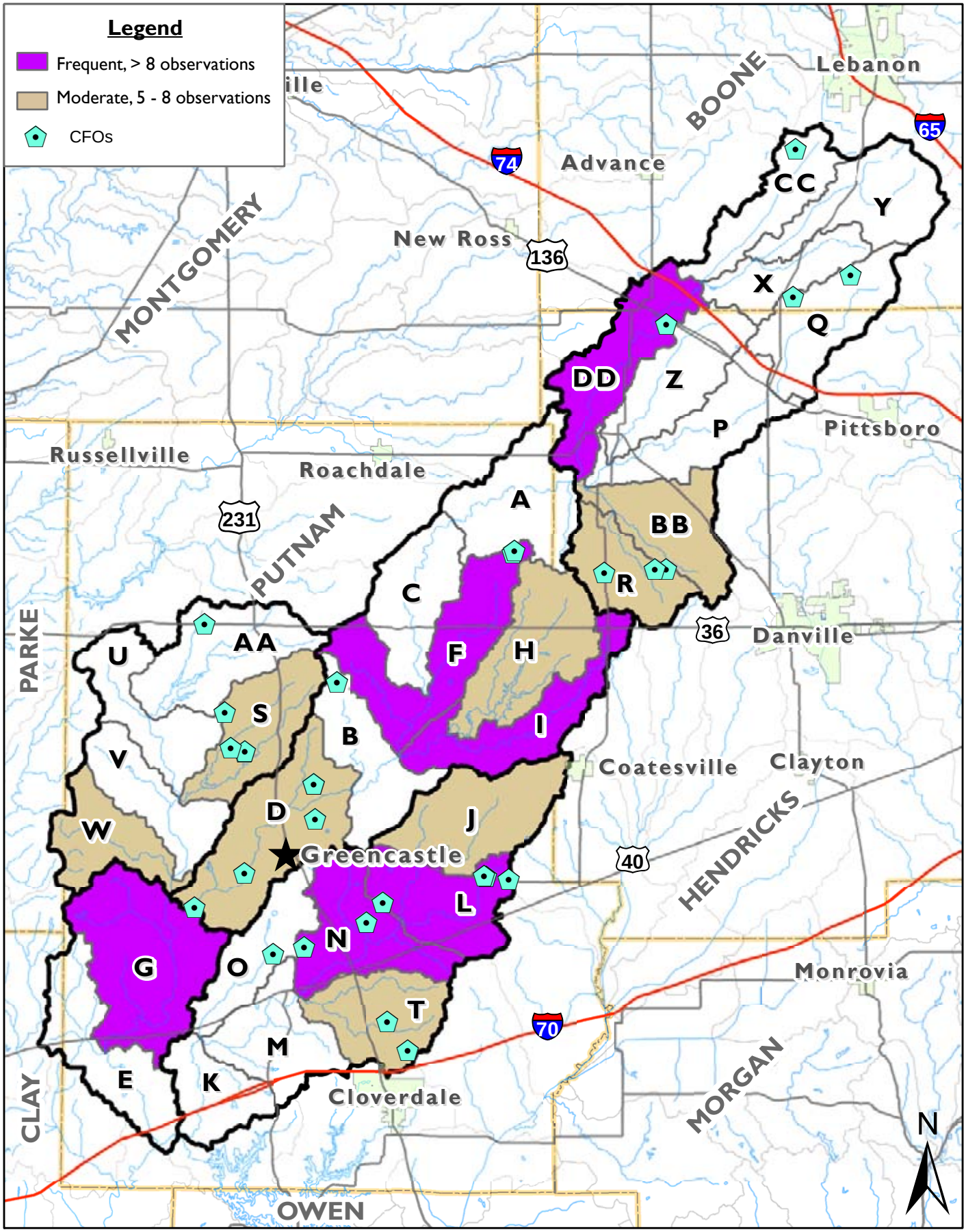


Figure Z - Livestock Access to Streams
Dec 2007- March 2008
Big Walnut Creek Watershed
Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

and historic knowledge of Steering Committee members. Each subwatershed was listed in a spreadsheet and scored against twelve criteria based upon the aforementioned data (Table 18).

The original "1" and "2" scores (red and yellow coding) came from the relative impact that each subwatershed displayed for each parameter over the six sampling events (Shown as highlighted values in Tables 8-16). The Steering Committee then applied some discretion when reviewing the weighted scores by adjusting the importance of some parameters relative to others (e.g. double weighting the macroinvertebrate score since they are a more reliable long-term indicator than the individual chemical parameters). The scores for each subwatershed were totaled across the parameters to arrive at a total relative score. Subwatersheds associated with sample sites that showed elevated concentrations for multiple parameters, especially parameters that grossly exceeded state standards, targets, or were representative of multiple ecological concerns received a high score in the ranking table, those with a moderate concern, a low score, and those of little to no concerns were not given scores (Table 18). Since higher scored were assigned to higher concerns, those subwatershed with the highest total score (greater than nine) were identified as priority subwatershed for restoration and/or BMP implementation. In addition to the subwatersheds scoring nine or higher, some subwatersheds were also selected as priority watersheds based on concerns and knowledge of the Steering Committee. For example, Subwatershed O was selected as a 'moderate' (yellow) priority watershed because it was surrounded by four 'high' (red colored) priority Subwatersheds D, G, M, and N and implementing conservation practices with landowners in that area will likely require work in Subwatershed O. For the purposes of visual depiction and communication, the subwatersheds with highest concern (weighted score) were assigned a red status/color, while those with 'moderate' concern were assigned a "yellow" status/color. All remaining subwatersheds with lesser or limited concerns are white. A final status/color distinction was made regarding subwatersheds of exceptional quality and/or ecological function. These subwatersheds were colored green and will be further discussed in Section 8.2. A summary map showing the priority subwatersheds is represented in Figure AA.

The highest priority subwatersheds (shown in red on Figure AA) and their individual parameters of concern include:

<u>Big Walnut Creek – Greencastle (Subwatershed D)</u>

Total Suspended Solids, *E. coli*, Total Phosphorus, Nitrate, Biochemical Oxygen Demand, Macroinvertebrates, Livestock in Streams, Confined Feeding Operations, NPDES Noncompliance, and Significant Water Users

<u>Big Walnut Creek – Snake Creek/Maiden Run (Subwatershed G)</u>

Total Suspended Solids, *E. coli*, Total Phosphorus, Nitrate, Biochemical Oxygen Demand, Livestock in Streams, and NPDES Noncompliance

<u>Clear Creek - Headwaters (Subwatershed H)</u>

Total Suspended Solids, *E. coli*, Dissolved Oxygen, Macroinvertebrates, Livestock in Streams, and NPDES Noncompliance

Clear Creek – Miller Creek (Subwatershed I)

Total Suspended Solids, *E. coli*, Total Phosphorus, Dissolved Oxygen, Biochemical Oxygen Demand, Livestock in Streams, and Buffers

Deer Creek – Mosquito Creek (Subwatershed M)

Total Suspended Solids, Total Phosphorus, Nitrate, Biochemical Oxygen Demand, Macroinvertebrates, and NPDES Noncompliance

Deer Creek – Owl Branch (Subwatershed N)

Total Suspended Solids, *E. coli*, Total Phosphorus, Nitrate, Biochemical Oxygen Demand, Macroinvertebrates, Livestock in Streams, and Confined Feeding Operations

West Fork Big Walnut Creek – Lower (Subwatershed DD)

Total Suspended Solids, Total Phosphorus, Nitrate, Biochemical Oxygen Demand, Livestock in Streams, Confined Feeding Operations, and NPDES Noncompliance

Subwatersheds ranked as 'moderate' priorities (shown in yellow on Figure AA) and their individual parameters of concern include:

Big Walnut Creek – Dry Branch (Subwatershed B)

Total Suspended Solids, Total Phosphorus, Nitrate, Biochemical Oxygen Demand, and Confined Feeding Operations

Deer Creek – Leatherwood Creek (Subwatershed K)

Total Suspended Solids, Total Phosphorus, Nitrate, Biochemical Oxygen Demand, and Macroinvertebrates

Deweese Creek (Subwatershed O)

E. coli, Confined Feeding Operations, NPDES Noncompliance, and Significant Water Users

Jones Creek (Subwatershed S)

Dissolved Oxygen, Macroinvertebrates, Livestock in Streams, and Confined Feeding Operations

Limestone Creek (Subwatershed T)

Total Suspended Solids, Dissolved Oxygen, Macroinvertebrates, Livestock in Streams, Confined Feeding Operations, NPDES Noncompliance, and Significant Water Users

Main Edlin Ditch – Grassy Branch (Subwatershed X)

Total Suspended Solids, *E. coli*, Nitrate, Macroinvertebrates, and Buffers

Main Edlin Ditch – Smith Ditch (Subwatershed Y)

Total Suspended Solids, *E. coli*, Nitrate, Macroinvertebrates, and Buffers

Owl Creek (Subwatershed AA)

Confined Feeding Operations, NPDES Noncompliance, and Significant Water Users

West Fork Big Walnut Creek – Headwaters (Subwatershed CC)

Dissolved Oxygen, Macroinvertebrates, Buffers, and Confined Feeding Operations

Finally, the remaining subwatersheds (shown in white on Figure AA) are considered, at this point, to be lower priorities from a water quality perspective. However, it is important to note that some areas shown in white have limited sample sites and therefore limited water quality data with which to draw conclusions. Even though these are lower priority subwatersheds areas it does not mean that protection of high quality land and other best management practices are not important in these areas.

8.1 Comparison with Dr. Gammon's Data

As part of the background investigation into historical Big Walnut Creek Watershed data, Dr. Gammon's macroinvertebrate and fish work was used to develop historical priority subwatersheds. These priority subwatersheds were assigned similar relative rankings and assigned the same red and yellow status/color system (i.e. 'red' representing those subwatersheds that are most impaired or degraded and therefore, high priorities). This historic summary of Dr. Gammon's work is based primarily on fish IBI while our priority subwatersheds are based on a combination of biological and chemical factors, as well as field observation. Figure BB shows these watershed priorities side-by-side with current subwatershed priorities.

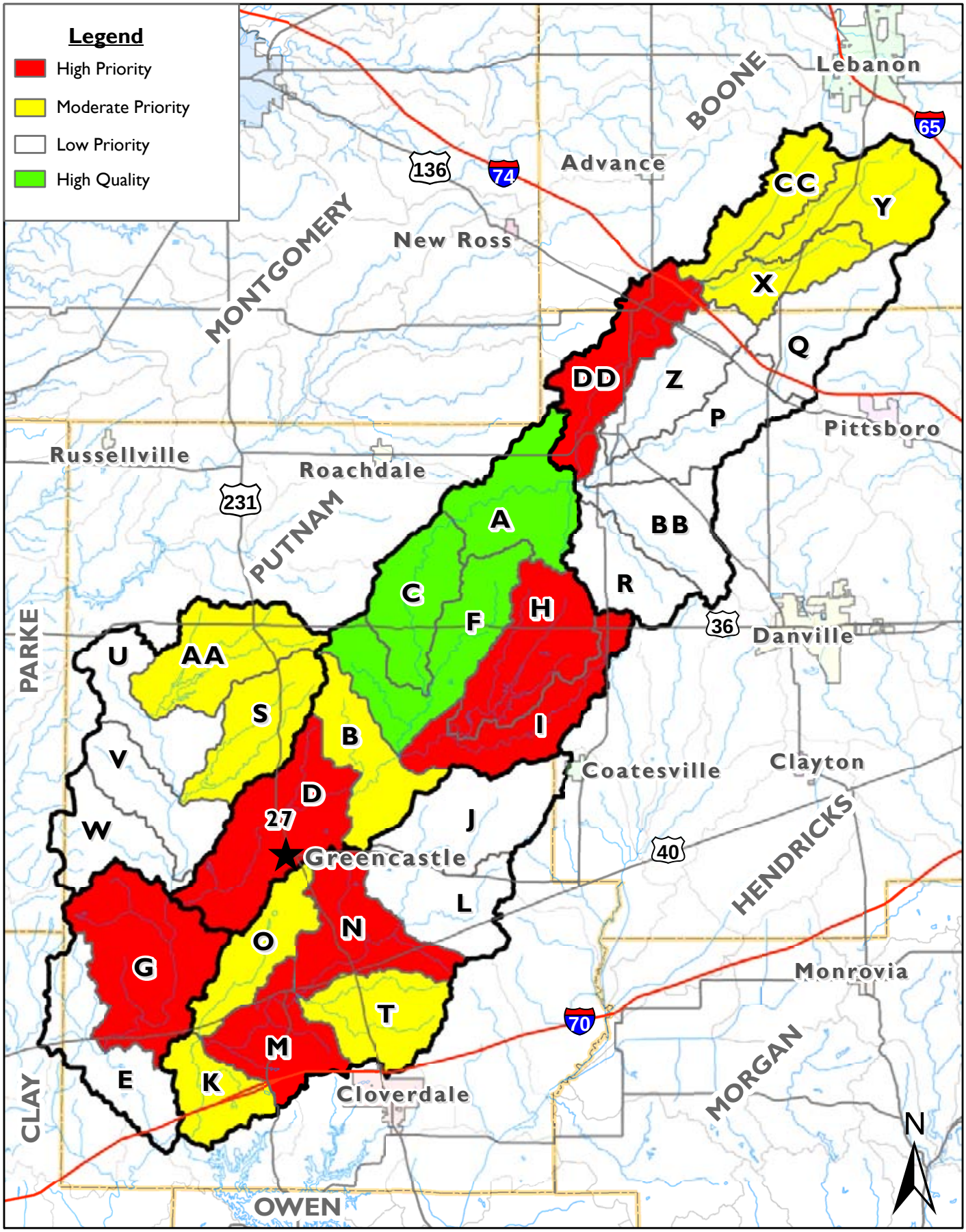
From Figure BB, one can see that many of the critical subwatersheds that Dr. Gammon noted are the same ones that remain areas of concern today based on current and varied data. The current priority subwatersheds map includes more subwatersheds than Dr. Gammon's primarily because more factors were considered in the evaluation. Dr. Gammon's priority subwatersheds are all subwatersheds that current data reflects as having low QHEI scores. This comparison makes logical sense, as the criteria that make up the QHEI evaluation are parameters that denote favorable for fish habitat.

8.2 Additional Priority Subwatersheds

Analysis of the water quality monitoring data collected revealed an interesting, reoccurring circumstance along one particular segment of Big Walnut Creek. Between sample points 6 and 7, both along mainstem Big Walnut, there was a reduction in nutrient and sediment loads. Typically a nutrient and sediment load increase is expected as a stream flows downstream and picks up more drainage area and the influence of numerous tributaries. It is interesting to note that because of the work of IDNR-DNP, CILTI, and TNC, much of the land adjacent to Big Walnut between points 6 and 7 is in nature preserves or conservation easements. This area has notable, wide forested buffers, intact floodplains and some contiguous wetland. The important functional nature of this area for both water quality and habitat makes it a critical area to continue protecting and restoring. For this reason, Subwatersheds A, C, and F are also listed as priority subwatersheds (Figure AA). Figure CC shows priority Subwatersheds A, C, and F along with the nature preserves and conservation areas along the Big Walnut Creek Corridor that are currently being protected in addition to those lands that are priorities to be protected.

Table 18: Watershed Priority Ranking

Sub	TSS	E.coli	TP	Nitrate	DO	BOD	Macro-invertebrates	Livestock in Streams	Buffers	CFOs	NPDES Non-Compliance	Significant Water Users	Score	Subwatershed priority
A	1												1	A
B	2		2	2		2				1			9	B
C	1										2		3	C
D	2	1	2	2		2	2	2		2	2	1	18	D
E	2		2	1		2						1	8	E
F	1	2					2	4	2	1			12	F
G	2	2	2	1		2		4			2		15	G
H	1	6			2		2	2	1		1		15	H
I	2	1	2		2	1		4	1				13	I
J			1					2					3	J
K	2		2	2		2	2						10	K
L			1					4		2			7	L
M	2		2	2		2	2				1		11	M
N	2	2	2	2		2	2	4		1			17	N
O		1								1	2	1	5	O
P	1		2	1		1					2		7	P
Q	1		2	1		1			1	1			7	Q
R				1	1			2					4	R
S					2		4	2		2			10	S
T	1				1		4	2		1	2	1	12	T
U	2	1	2	2		1							8	U
V	2		2	2		1							7	V
W					1			2					3	W
X	1	1		1			2		1				6	X
Y	1	1		1			2		2				7	Y
Z											1	0.5	1.5	Z
AA										1	1	0.5	2.5	AA
BB				1	1			2		1			5	BB
CC					2		2		1	1			6	CC
DD	2		2	2		2		4		1	1		14	DD



0 2 4 8 12 Miles

Figure AA - Priority Subwatersheds
Big Walnut Creek Watershed
Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

8.3 New HUC Boundaries for Priority Subwatersheds

In 2008 new watershed boundaries were released and implemented as standard nomenclature for State and Federal projects in Indiana. These new watershed definitions are on a 10-digit and 12-digit scale. The new boundaries are intended to replace the currently used 11-digit and 14-digit scale watersheds. With the release of these new boundaries, the priority subwatersheds for this project will slightly change. Instead of 16 of the 30 14-digit subwatershed being defined as priority subwatersheds, 9 of the new 15 12-digit scale subwatersheds will be considered priority subwatersheds for this project. This change is being shown in this plan only for the purpose of future grant funding. Subwatershed analysis will not be reevaluated for this plan on the 10 and 12-digit scale. The new subwatersheds are shown on Figures DD1-DD6 and are listed below.

- Town of Barnard – Big Walnut Creek (Subwatershed A1)
- Clear Creek (Subwatershed B1)
- Deweese Branch – Deer Creek (Subwatershed C1)
- Dry Branch – Big Walnut Creek (Subwatershed D1)
- Edlin Ditch (Subwatershed E1)
- Owl Creek (Subwatershed G1)
- Owl Branch (Subwatershed I1)
- Headwaters Little Walnut Creek (Subwatershed J1)
- Snake Creek – Big Walnut Creek (Subwatershed M1)
- Bledsoe Branch – Big Walnut Creek (Subwatershed N1)
- West Fork Big Walnut Creek (Subwatershed O1)

9.0 PUBLIC INPUT AND LOCAL CONCERNS

9.1 Stakeholders

An introductory public meeting was held on April 19th, 2007 at the Commissioner's Court in Greencastle, Indiana at 7 pm. Initial public concerns identified at this meeting included:

- Saving Soil
- Land use and practices in headwaters (Boone and Hendricks Counties)
- Economic Development (tax base for Bainbridge, Cloverdale, Greencastle)
- Flood Prevention – role of bridges, control structures, etc. Cost/benefit of structures
- Sedimentation (brown water)
- Growth rate and sewers – need for commercial growth
- Trail Connections (along streams, public access)
- Patterns of Flooding (road impairments, small storms lend big effect)
- Mining Activities (quarries)
- Historic Bridges
- Isolated approach to solving local problems (Conservancy District Boundaries)

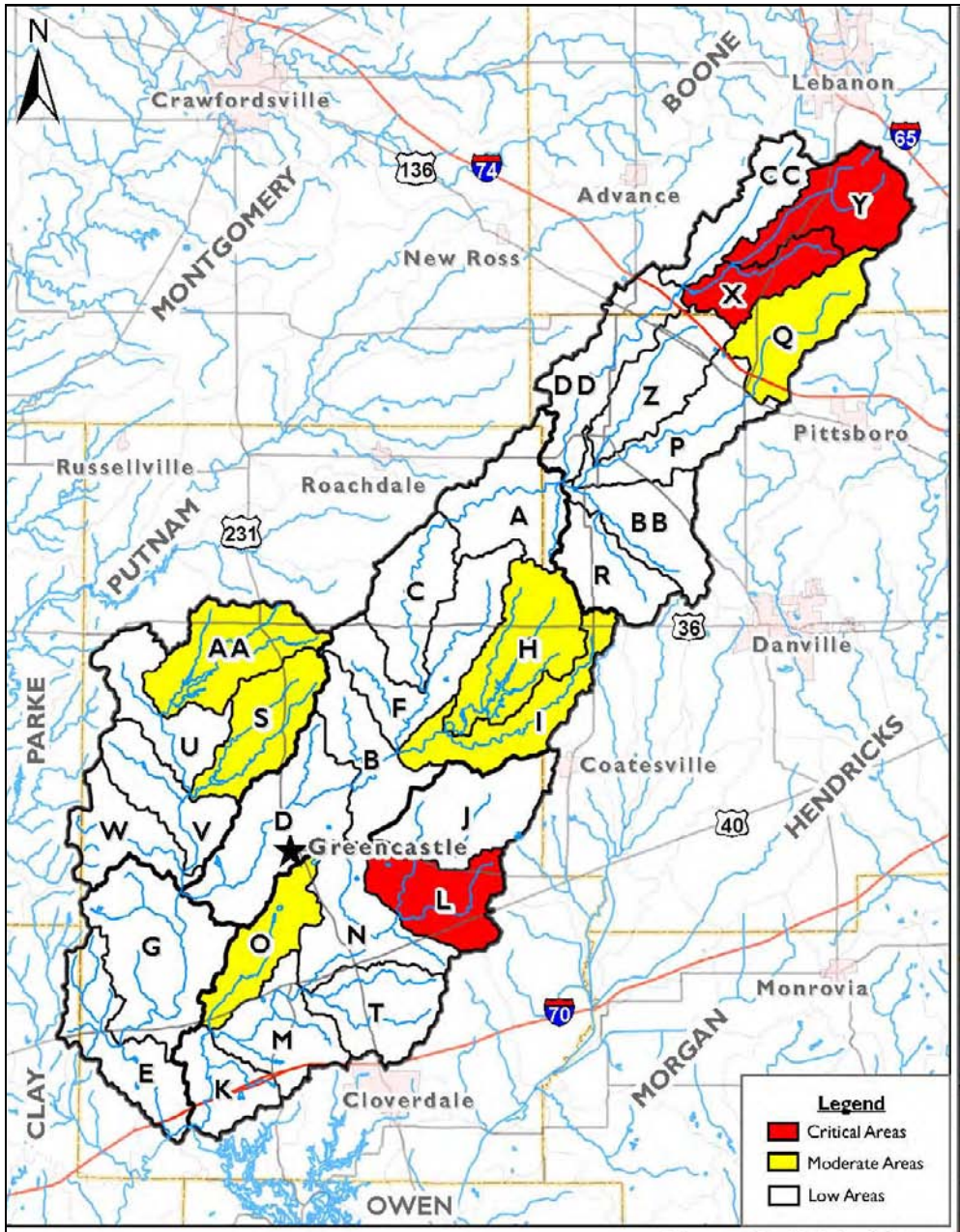


Figure O - Critical Areas Determined by Dr. Gammon
Big Walnut Creek Watershed
Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

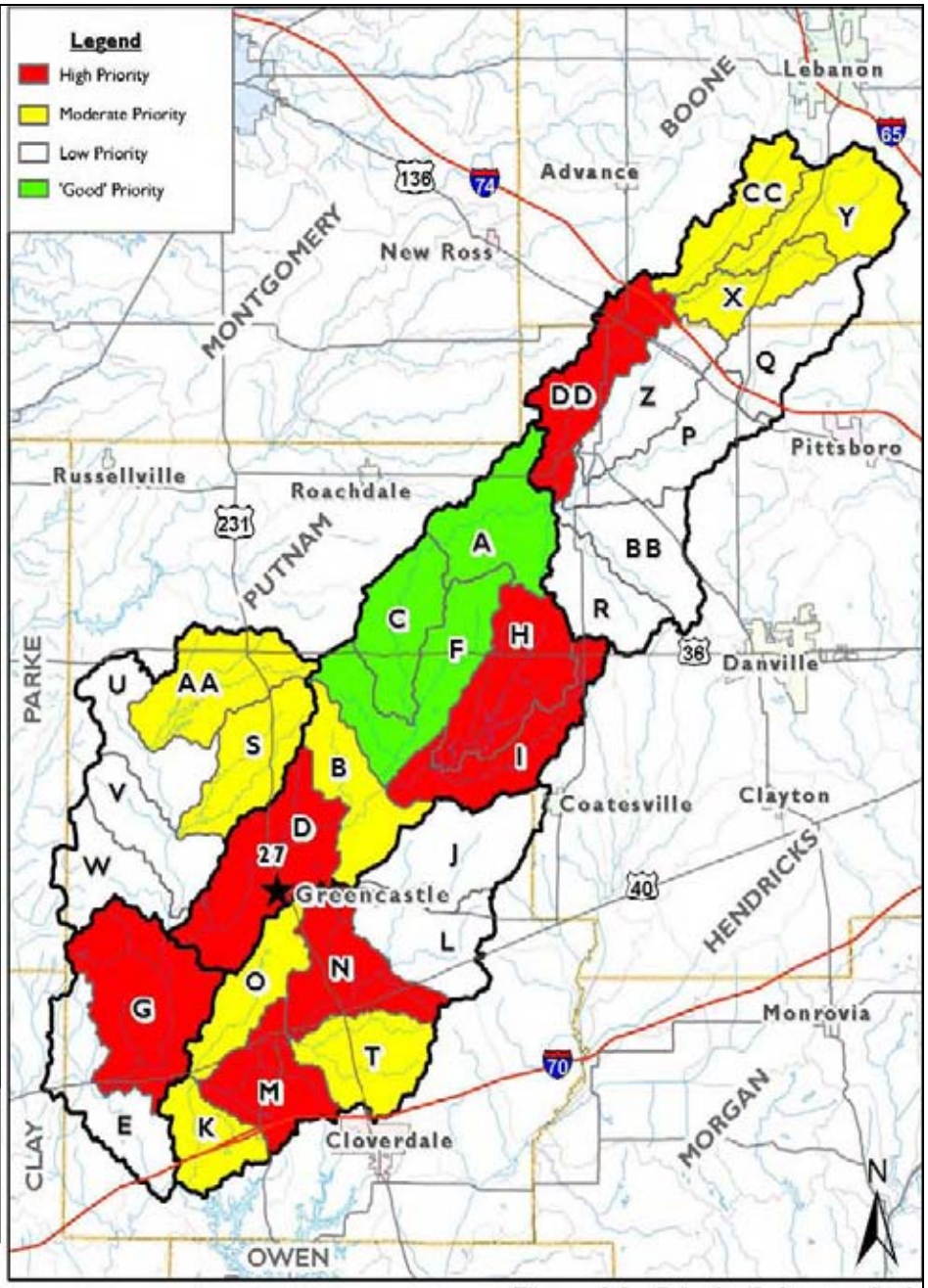
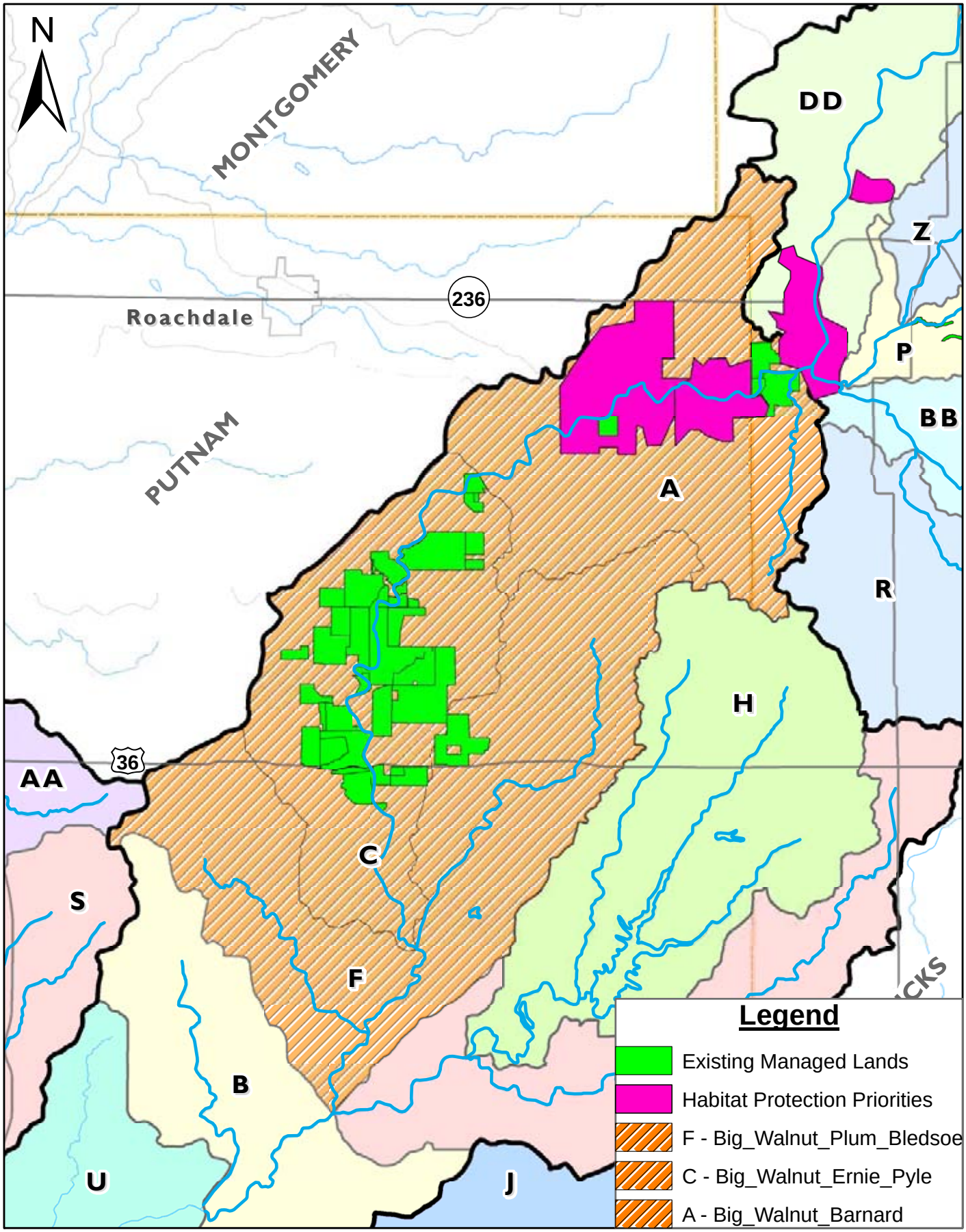


Figure AA - Priority Subwatersheds
Big Walnut Creek Watershed
Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

Figure BB — Priority Subwatershed Comparison

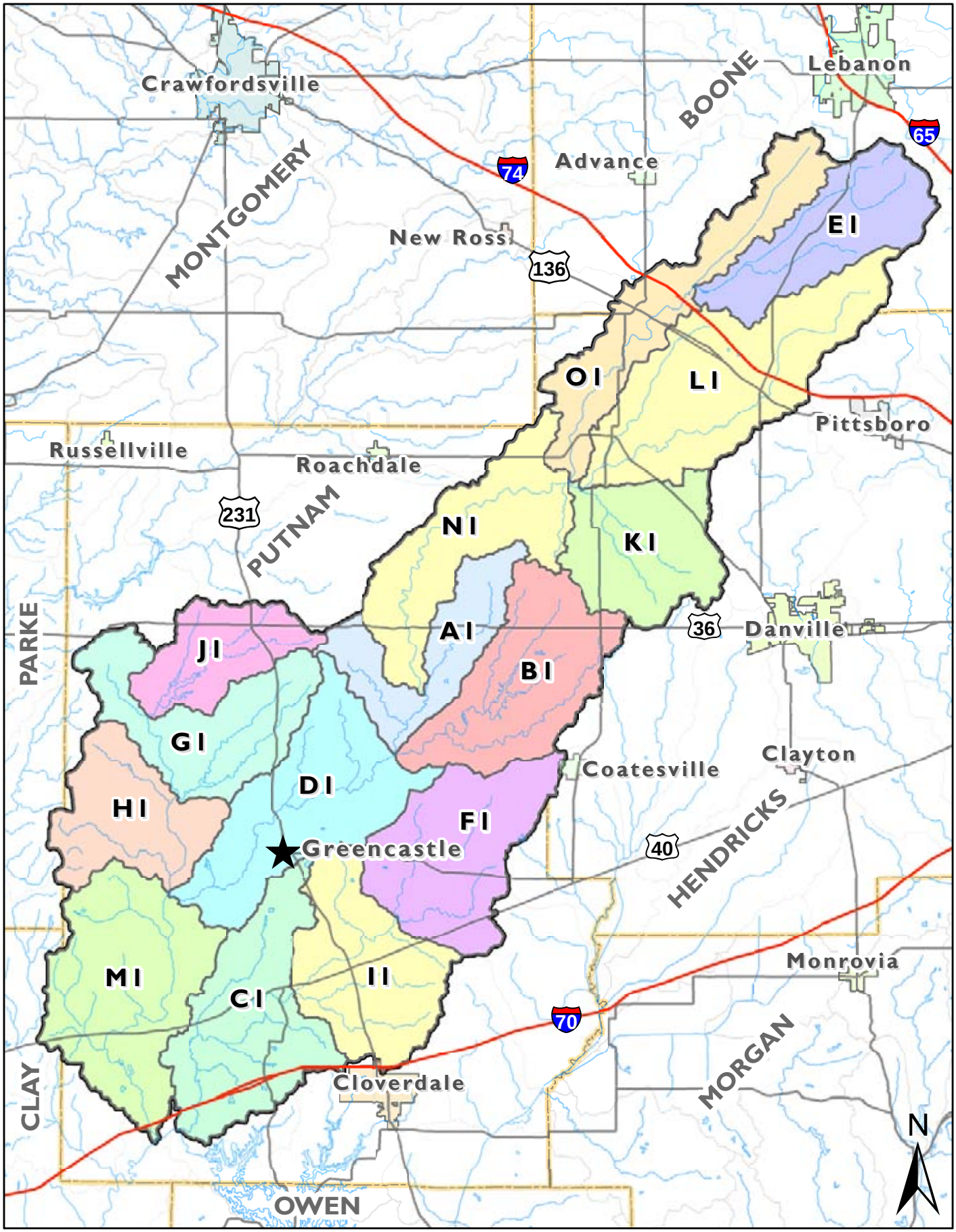


0 0.5 1 2 3 Miles

Figure CC - High Quality Subwatersheds and Protection Areas

Big Walnut Creek Watershed

Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana



0 1.5 3 6 9 Miles

Figure DD1 - Big Walnut HUC 12 Watersheds

Big Walnut Creek Watershed

Boone, Clay, Hendricks, Parke, & Putnam Counties, Indiana

Upon reviewing the above list and water quality data collected as part of this project, the Steering Committee identified the following additional or related concerns:

- E. coli bacteria levels higher than the State standards in many locations
- Elevated nutrient levels especially in the headwaters and around Greencastle
- High loads of organic matter (elevated BOD at some locations)
- Habitat is degraded in certain areas/habitat improvement may improve water quality
- Ground water withdrawal and recharge
- Lack of public education on environmental topics (timing of impacts, who is affected and how, drinkability and recreation potential or limitations)
- Land use practices (impacts on velocity of water and erosion)
- Erosion from in-stream meandering, bridge building, and location of erodible soils
- Increased run-off from urban areas
- Location, connection, and protection of conservation areas/natural areas
- Failing septic systems (homeowner regulatory fears, cost or repairs, no cost share programs, education on maintenance practices)
- Corridor and floodplain protection
- Strategic placement/planning for development (i.e. "controlled sprawl")
- Low flow water quality (stagnant water, algae blooms)

Following a review of the issues and focus of the original grant request for this project, the following issues/concerns identified by the public were determined to be outside of this project's approach and therefore will not be addressed in this Watershed Management Plan.

- Patterns of Flooding (road impairments, small storms lend big effect)
- Flood Prevention – role of bridges, control structures, etc. cost/benefit of structures
- Historic Bridges
- Mining Regulation
- Economic Development (tax base for Bainbridge, Cloverdale, Greencastle)

9.2 Problems and Causes

After an evaluation of all the above information, watershed problems can be summarized with the following problem statements:

1. Nutrient loads, associated BOD loads and subsequent oxygen sags threaten the health of Big Walnut Creek and its tributaries.
2. E. coli loads create unsafe recreational conditions in certain locations of Big Walnut Creek and its tributaries.
3. Too many livestock have access to watershed streams leading to nutrient, erosion, and E. coli problems.
4. Many septic systems are located in poorly drained soils and are poorly maintained contributing to *E. coli* concerns.
5. Several segments of stream, particularly the headwaters, are poorly buffered leading to poor in-stream habitat and non-point source pollution impacts.
6. Poor buffers and lack of floodplain protection and corridor planning are leaving important natural areas vulnerable.
7. Several segments of stream shows signs on in-stream/bank erosion and Total Suspended Solids (TSS) measurements confirm sediment impacts in some locations.

8. Low flow conditions lead to poor water quality and general concern about water quality and use in the watershed.
9. Increasing urban runoff is carrying more pollutants into Big Walnut Creek; yet, there are limited educational materials and cost share programs for average citizens and urban stakeholders.

9.3 Sources of Pollution

Nonpoint pollution sources are varied, yet common throughout almost any watershed. Several earlier sections of this document including the above Section 9.2 and Subsections of Section 5.3 denote possible sources of the pollutants of concern in the Big Walnut Watershed. However as a matter of summary, source of various pollutants are included below:

Nutrients –

- Conventional cropping practices
- Waste water treatment discharges
- Industrial discharges
- Landfill leachate
- Agricultural fertilizer
- Residential fertilizer
- Construction site runoff
- Animal/human waste (including septic systems)

BOD –

- Conventional cropping practices
- Waste water treatment discharges
- Industrial discharges
- Landfill leachate
- Algae (induced by fertilizers)
- Animal/human waste (including septic systems)
- Grass/lawn clipping or natural plant matter

E. coli –

- Human waste (including septic systems)
- Animal waste (including livestock in stream and poor manure management)
- Urban runoff (pet waste)
- Wildlife

Sediment –

- Conventional cropping practices
- Industrial discharges
- Mining operations
- In-stream erosion
- High velocities or increased urban run-off
- Construction activities

- Cattle trampling banks

As noted in Section 4.4, the Big Walnut Creek watershed has several NPDES point source dischargers, many of which are regularly out of compliance. These industrial or municipal dischargers should also be approached as part of the overall watershed planning and implementation process. With these point sources regularly present in some of the priority subwatersheds it becomes harder to narrow down suspected nonpoint sources of pollutants.

10.0 GOALS

10.1 Broad Project Goals Based on Public Concern

The Steering Committee reviewed the concerns raised by the public, as well as early-stage water quality findings to arrive at broad concerns and project goals. Specific concerns outlined in Section 9.1 were lumped together and can be found listed under the broad goals outlined below.

Sediment Concern = Erosion Goal

- Land use and practices in headwaters (Boone and Hendricks Counties)
- Land use practices (impacts on velocity of water and erosion)
- Sedimentation (brown water)
- Saving Soil
- Erosion from in-stream meandering, bridge building, and location of erodible soils
- Mining Activities (quarries)

Pollutants = Water Quality Goal(s)

- E. coli bacteria levels higher than the State standards in many locations
- Elevated nutrient levels especially in the headwaters and around Greencastle
- High loads of organic matter (elevated BOD at some locations)
- Low flow water quality (stagnant water, algae blooms)

Resource Protection and Loss = Habitat and Recreation Goal

- Location, connection, and protection of conservation areas/natural areas
- Habitat is degraded in certain areas/habitat improvement may improve water quality
- Corridor and floodplain protection
- Trail Connections (along streams, public access)

Growth Impacts = Land Use / Future Development Goal

- Strategic placement/planning for development (i.e. “controlled sprawl”)
- Increased run-off from urban areas
- Ground water withdrawal and recharge
- Growth rate and sewers – need for commercial growth
- Failing septic systems (homeowner regulatory fears, cost or repairs, no cost share programs, education on maintenance practices

Lack of Knowledge = Education/Outreach Goal

- Lack of public education on environmental topics (timing of impacts, who is affected and how, drinkability and recreation potential or limitations)
- Isolated approach to solving local problems (Conservancy District Boundaries)

10.2 Specific Goals and Water Quality Targets

After review of the above-mentioned broad goals, the Steering Committee worked to refine the project goals and develop pollution reduction targets. The following five major goals address all of the issues raised and articulated in the Problem Statements in Section 9.2. Water quality data collected as part of this project was used to determine target load reductions.

Goal reductions are to be met in terms of loads. The concentration values mentioned in the below goals were used as references in order to calculate the load reduction necessary to achieve the goal.

Goal 1: **Reduce soil erosion and sediment inputs into streams that result in a 1% TSS reduction in 5 years.**

This goal and water quality target was determined by a brief literature review and conversations with a local expert (Mr. Greg Bright). Bright actually suggested a higher concentration value of 50 mg/l; however, the current water quality data for most sample sites already displayed concentrations lower than this value. Literature (Holbeck-Pelham and Rasmussen, 1997) helped identified a more applicable target concentration (25mg/l) that would be indicative of healthy to above average aquatic life in similar Mid-western streams. Upon comparison of this concentration to current data concentrations, the above load reduction target was established by substituting 25 mg/l TSS in for all sites that exceeded this value, then recalculating loads. The difference in the newly calculated load was then subtracted from the true/original load. The difference between loads was compared to arrive at an appropriate reduction target.

Goal 2: **Reduce Total Phosphorus and Nitrate inputs by 20% in 5 years and Nitrate inputs by 40% in 10 yrs.**

This goal was determined by a brief literature review and conversations with a local water quality expert (Mr. Greg Bright) that helped identified target concentrations (0.2 mg/l Total Phosphorus, 2.0 mg/l Nitrate) that would be indicative of healthy to above average aquatic life in similar Mid-western streams. Upon comparison of this concentration to current data concentrations, the above load reduction target was established as described above for TSS. It should be noted that the Steering Committee intentionally did not link the water quality target directly to future concentration values due to concerns about low flow impacts creating conditions that make achieving the goal a moving target that can be seasonally affected.

A 20% reduction in Total Phosphorus represents what would be needed to have all sample sites display target concentration. The Steering Committee felt this reduction would be possible in 5 years of BMP implementation. Nitrate reduction is the biggest challenge among the various parameters. If all sites displayed target

concentrations, a 40% load reduction would result. The Steering Committee thought this percent reduction would require a longer time frame and a variety of BMP and compliance solutions; thus, a stepped approach was outlined over a ten year period.

Goals 3: **Reduce *E. coli* inputs such that all sample sites meet the State water quality standard of 235 cfu/100ml during base flow conditions and no more than 15% of the sites exceed the standard during storm flow conditions in 5 years. The long-term goal (10 years) is for all storm flow events to meet State water quality standards.**

Since so few of the sites exceed State standards in base flow conditions, the Steering Committee felt a reduction of E. coli inputs resulting in all sites meeting State standards during base flow was achievable in five years. However, since the inputs are much larger during storm events, a stepped approach was outlined over a ten year period for storm event samples/conditions. Currently, about 30% of all sites exceed State standards in storm flow conditions. A 50% reduction is targeted in the first five years of BMP implementation, with the remaining 50% being achieved in ten years.

Goal 4: **Protect and enhance important and unique natural aspects of Big Walnut Creek and its watershed (endangered and high quality species/natural areas).**

This goal was developed in response to public concerns about protection of existing conservation areas/natural areas, habitat degradation, corridor and floodplain protection and trail connections (along streams, public access sites). Several land holding stakeholders (IDNR, CILTI, TNC) participate on the Steering Committee and are interested in protecting and restoring several areas in the watershed. Water quality monitoring data also helped identify the functional role of some of the unique aspects of Big Walnut natural areas in Subwatersheds A, C, and F.

Goal 5: **Develop public awareness on how individual activities and actions will/do impact the watershed.**

This goal was developed in response to public concerns about the lack of public education on environmental topics. Several of the problems and sources of pollution are a direct result of limited public awareness regarding the negative impacts individuals and the collective behavior of a community can have on water quality. Awareness and education is needed regarding septic systems, water use, fertilizers, and managing animal waste. Concerns related to pollutant loads and stormwater runoff could be address using education as the primary BMP.

11.0 STRATEGIES

The Steering Committee then developed strategies to help address the project goals. The strategies are designed to help mold public outreach throughout the project and develop a work plan for various stakeholders, particularly the local Soil and Water Conservation Districts to begin targeted BMP implementation into the future. Action items associated with each

strategy were identified by the Steering Committee and a rough schedule was assigned. The schedule was defined by three timeframes: 2009-2010 (immediate), 2010-2012 (near future/next grant cycle), 2012-2019 (later, planning or earlier steps required). Table 19 reflects these strategies and action items. The following section, Section 12.0, works to identify more specifically where the strategies related to Best Management Practices (BMPs) could or should be targeted based on the characteristics and water quality concerns of each priority subwatershed.

12.0 BEST MANAGEMENT PRACTICE SELECTION BY SUBWATERSHED

Best Management Practices (BMPs) were selected by for each priority subwatershed using several criteria. Table 20 summarizes some of the criteria used for making decisions on BMP selections in each subwatershed. Topics listed in the table are related to current land use and existing load conditions. The table includes such information as predominate land use, NPDES dischargers, and prevalence of hydric soils and floodplain. Topics such as buffer restoration potential, wetland restoration potential, and floodplain restoration potential indicate that there are many areas where this could occur. In addition to this table, BMPs were also selected based on Steering Committee input and water quality issues within the subwatersheds that caused them to be selected as priority subwatershed.

Once the makeup of the watershed was understood, several BMP selections were made for each subwatershed. At this time BMPs are not being targeted to specific areas within critical subwatersheds due to the number and total acreage of the subwatersheds. The Steering Committee will continue to work with the local SWCDs and NRCS to identify landowners willing to participate in the implementation of BMPs. These selections are listed in Table 21.

12.1 Load Reduction Targets – BMP Options

Table 22 lists BMP installation recommendation options for load reductions in the priority subwatersheds. BMP load reductions were calculated using several different formulas based on the type of BMP and nutrient/sediment removal efficiencies for each type of BMP. Once general reductions for each BMP were calculated, the options were formulated based on load reduction quantity and time goals set in Section 10.2. Each option combination shown below reduces load parameters of nitrate, total phosphorus, total suspended solids, and *E. coli* below the targeted pollutant goal amount in the timeframe desired.