VFC Index - Watershed (Plan)

Program: Watershed

IDEM Document Type: Plan

Document Date: 9/29/2005

Security Group: Public

Project Name: Clifty Creek WMP

Plan Type: Watershed Management Plan

HUC Code: 05120206 Upper East Fork White

Sponsor: Bartholomew Co SWCD

Contract #: 3-749

County: Bartholomew

Cross Reference ID: 23062401

Comments: Decatur, Rush, Shelby

Additional WMP Information

Checklist: 2003 Checklist

Grant type: 319

Fiscal Year: 2003

IDEM Approval Date: 9/29/2005

EPA Approval Date:

Project Manager: Kathleen Hagan

Clifty Creek Watershed
Comprehensive Management Plan

August 19, 2008

Vision Statement:
Clifty Creek Watershed: Alive & Well, Because We Care!

Mission Statement:
The Mission of the Clifty Creek Watershed Project is to maintain and enhance the natural resources of the watershed by encouraging and building partnerships through a common sense approach to education, communication, and facilitation of local strategies and projects.

EXECUTIVE SUMMARY

Based on the information gathered, the Watershed Project Steering Committee has identified increased occurrence of urban/suburban runoff, E.coli, pesticide, nutrient, and sediment levels, as well as continued illegal dumping to be primary sources of water quality degradation in the Clifty Creek, threatening the health of the creek and its recreational value.

It is the belief of the Committee that these contaminants continue to influence tributaries and main stem portions of Clifty Creek due to 1.) Minimal public awareness regarding water quality issues and influences, including a general lack of communication between urban/suburban and rural communities, 2.) Nonpoint Source runoff from agricultural and urban/suburban related practices, including stream bank erosion, unrestricted livestock access, waste management, impervious surface runoff, nutrient/pest application (urban and agricultural), and household hazardous waste disposal, 3.) Concentrated sources of E.coli contamination, including failing or poorly maintained residential septic systems, manure runoff, and unrestricted livestock access to streams, 4.) The need for convenient recycling/waste disposal options throughout the region, 5.) Absence of a continuous wooded corridor along main stem segments and primary contributing tributaries.

In response to the identified problems, the Committee has outlined the following goals for water quality improvement:

<u>Runoff and Nonpoint Source Pollution due to a lack of public awareness.</u>

- Cultivate future citizen interest and leadership in conservation and natural resources by educating children at an early age and maintaining presence throughout their academic career. Project will reach at least 300 new students each year for the next two (2) years, offering 500 water quality specific education hours in the next three (3) years.

- Increase urban/suburban awareness about impacts of Nonpoint Source pollution on water quality, including participation in Watershed Project activities (or related water quality initiatives) by thirty (30) new households and three (3) new businesses each year for the first two (2) years.

- Increase local capacity for citizen involvement in water quality related issues, building contact list to over one hundred (100) individuals by 2007.

<u>Sedimentation and erosion due to exposed soil and degrading stream banks.</u>

- Increase implementation of conservation practices for the reduction of sedimentation and smothering due to overland soil runoff. For urban/suburban related practices, increase participation by 100% in the next three (3) years and 200% in the next five (5) years. For agricultural practices, increase annual participation figures by 10% for the next three (3) years [Phase I] and cumulatively to 50% within the next five (5) years [Phase II].

- Increase Best Management Practice (BMP) use in livestock operations by 20% in three (3) years, in order to reduce sedimentation and erosion from livestock without compromising the economic integrity of existing operations.

- Reduce peak runoff rates, subsequently reducing overland runoff and rates of stream bank erosion.

Biological and chemical contaminant infiltration in streams.

- Increase participation in conservation practices for the reduction of nutrient / pesticide / and salt infiltration to tributaries and main stem portions of the Clifty Creek. For urban/suburban related practices, increase participation by 100% in the next three (3) years and 200% in the next five (5) years. For agricultural practices, increase annual participation by 15% for the next three (3) years and 50% in the next five (5) years.

- Reduce seasonal E. coli spikes by 20% in targeted subwatersheds within the next three (3) years (percent reduction is determined from peak E.coli counts in Duck Creek and Middle Fork).

- Increase participation in household hazardous waste and recycling programs by 50% within the next five (5) years.

These goals provide direction for specific objectives and action items identified in this Plan for the improvement of water quality in the Clifty Creek Watershed. Implementation of the ideas outlined in this Plan have already begun, and the Committee will utilize funds from a 2-year Section 319 Clean Water grant to install conservation practices, support educational programming, and improve overall project quality.

If you have any questions regarding the content of this Plan or the implementation process, please contact:

Bartholomew County Soil & Water Conservation District
1040 Second Street, Columbus, Indiana 47201.
Phone: 812.378.1280 ext. 3
Fax: 812.378.1213

OR

Decatur County Soil & Water Conservation District
1333 N. Liberty Circle E., Greensburg, Indiana, 47240
Phone: 812.663.8685 ext. 3
Fax: 812.663.9261
www.decaturswcd.org

Table of Contents

EXECUTIVE SUMMARY 3
Table of Contents 5
Tables and Figures 6
1.0 Introduction 9
1.1 Brief History and Overview 9
1.2 Building Partnerships 10
2.0 Describing the Watershed 16
2.1 Topography 16
2.2 Hydrology 18
2.3 Physiography 22
2.4 Geology 24
2.5 Soils 26
2.6 Natural Features, Endangered Species, & Wetlands 29
3.0 Land Use 34
3.1 Natural History and Human Influence 34
3.2 Existing Landscape 35
3.3 Land Ownership 37
3.3.1 Anderson Falls 37
3.3.2 Clifty Park 38
3.3.3 Classified Forest 38
3.4 Point Source Discharge and, Regulated Permits 39
3.5 Legal Drains 39
4.0 Investigation of Water Quality Issues and Benchmarks 41
Section Overview: Watershed Assessment 41
4.1 Designated Use, Assessment, and Impairment 41
4.2 Land Inventory 42
4.2.1 Agricultural Practices 43
4.2.2 Agricultural Practices Livestock 45
4.2.3 Urban/Suburban/Impervious Surface and Population Density 46
4.3 Land Inventory: Visual Assessment and Spatial Research by Region 48
Headwaters (Map ID: 6) 48
Central Main stem Region (Map ID: 5) 50
Middle Fork (Map ID: 4) 52
Fall Fork Region (Map ID: 3) 54
Duck Creek Region (Map ID: 2) 56
Lower Main stem Region (Map ID: 1) 57
4.4 Existing Data and Current Water Quality Sampling 58
4.4.1 Chemical and Pathogen Data 59
4.4.2 Physical Data and Stream Habitat 62
4.4.3 Biological Communities 63
5.0 Problem Statements, Prioritization, and Goals Development 65
5.1 Local Concerns 65
5.2 Problem Statements 65
5.2.1 Lack of public knowledge correlated to water quality degradation 65

5.2.2 Increased sedimentation 67
5.2.3 Nonpoint Source Biological and Chemical Runoff 69
5.2.4 Project Management and Development 73
5.3 Setting Goals & Choosing Measures to Apply 75
6.0 Identifying Critical Areas 90
6.1 Nonpoint Source chemical runoff - Nutrients 90
6.2 Nonpoint Source Biological Pathogens: E.coli 91
6.3 Sediment 92
7.0 Implementing the Plan, Long-term Results, and Evaluation 94
8.0 References and Appendices 100
Steering Committee 104
Technical Advisory Team 104
Educator Brainstorming Session 104

Tables and Figures

Figure 1.1 Clifty Creek Watershed map in relation to East Fork White River 9
Figure 1.2-1 Clifty Creek Watershed Project Organizational Structure 11
Figure 1.2-2 Past Project Timeline 14
Figure 1.2-3 Present Project Timeline 15
Figure 2.1-1 Elevation of Clifty Creek Watershed 16
Figure 2.1-2 Slope within Clifty Creek 17
Figure 2.2-1a Subwatersheds within the Clifty Creek Watershed 18
Figure 2.2-1b Prior subwatersheds within the Clifty Creek Watershed 19
Figure 2.2-2 Major Contributing Tributaries and Intermittent Streams in the Clifty Creek Watershed 21
Figure 2.2-3 Average annual precipitation in and around the Clifty Creek Watershed. 22
Figure 2.3 Physiographic features in the Clifty Creek Watershed 23
Figure 2.4-1 Clifty Creek Watershed bedrock geology Surficial Geology 24
Figure 2.4-3 Clifty Creek Watershed surficial geology 26
Figure 2.5 Soil associations in the Clifty Creek Watershed 28
Figure 2.6 Wetlands in the Clifty Creek Watershed 30
Figure 3.2 Land use in Clifty Creek Watershed 35
Figure 3.3 Forested Corridors, Special Areas, and Classified Forests in Clifty Creek Watershed 37
Figure 3.3.1 Anderson Falls 38
Figure 4.1 Segments in the Clifty Creek Watershed listed on the 2004 303(d) List of Impaired Waterways 42
Figure 4.2.1 Crop transect data for counties in the Clifty Creek Watershed 44
Figure 4.2.2-2 Unrestricted livestock access 46
Figure 4.2.3 Population increase in Columbus and the Columbus commuting area 47
Figure 4.3 Six common drainage areas in Clifty Creek Watershed 48
Figure 4.3-1 Land use and Confined Feeding Operations in headwaters region 49
Figure 4.3-2 Central Mainstem Clifty Creek Watershed 50
Figure 4.3-3 Middle Fork Region 52

Figure 4.3-4 Fall Fork Region 54
Figure 4.3-5 Duck Creek Region 56
Figure 4.3-6 Lower Mainstem Region 57
Figure 4.4 Current and previous water quality sampling sites in the Clifty Creek Watershed.... 59
Figure 4.4.3 Biological sampling results for the Clifty Creek Watershed 63
Figure 5.2.2-1 CQHEI classifications by sampling site in the Clifty Creek Watershed 67
Figures 5.2.2-2 Exposed soil susceptible to runoff and exposed streambanks 68
Figure 5.2.3-1 Phosphorus levels in the Clifty Creek Watershed 69
Figure 5.2.3-2 Relationship of E.coli and temperature data from watershed sampling 71
Figure 5.2.3-3 Occurrence of E.coli in the Clifty Creek Watershed 72
Figure 6.1 Subwatersheds prioritized for Nonpoint source chemical runoff-nutrients 90
Figure 6.2 Subwatersheds prioritized for pathogens 91
Figure 6.3 Subwatersheds prioritized for increased sediment levels 92

Table 1.1 Watershed area relative to county boundaries 10
Table 1.2 Steering Committee Concerns and Prioritizations 11
Table 2.2a Subwatersheds draining within the Clifty Creek Watershed 20
Table 2.2b Previous subwatersheds draining within the Clifty Creek Watershed 20
Table 2.4 Clifty Creek Watershed surficial geology 25
Table 2.5 Soil associations in the Clifty Creek Watershed 27
Table 2.6-1 Native vegetation relative to soil types in the Clifty Creek Watershed 29
Table 2.6-2 State and Federally listed endangered species potentially found in the Clifty Creek Watershed 31
Table 3.2 General land use percentages for the Clifty Creek Watershed 36
Table 3.4 Confined Feeding Operation (CFO) permit status in the Clifty Creek Watershed..... 39
Table 4.2 Land use percentages for the Clifty Creek Watershed 43
Table 4.2.1-1 Crop yields per year by county 43
Table 4.2.1-2 2004 Crop transect data by county 44
Table 4.2.2 Correlating Figures Livestock numbers by county and trends over time 45
Table 4.3-1 Land use percentages for headwaters region 49
Table 4.3-2 Land use percentages for central mainstem region 51
Table 4.3-3 Land use percentages for Middle Fork Region 53
Table 4.3-4 Land use percentages for the Fall Fork Region 55
Table 4.3-5 Land use percentage in Duck Creek Region 57
Table 4.3-6 Land use percentage in Lower Mainstem Region 58
Table 4.4.1-1 Summary statistics for selected parameters, 1996-2001, BCSWCD/CCU 60
Table 4.4.1-2 Summary statistics for selected parameters, 1993-1995 USGS NAWQA, Clifty Creek, Hartsville 61
Table 4.4.1-3 Summary statistics for selected parameters, 1993-1995 USGS NAWQA, Clifty Creek , Hartsville 61
Table 4.4.1-4 Summary statistics for E.coli in Duck Creek and Middle Fork(colonies/100mL) 61
Table 4.4.2 CQHEI correlation to turbidity values in the Clifty Creek Watershed 63
Table 4.4.3 Predominant fish species/families documented during 1993-1995 NAWQA 63
Table 5.2.1 Watershed-wide survey results 66
Table 5.2.2 Priority ranking for potential sources of sediment delivery 69
Table 5.2.3-1 Priority ranking for potential sources of biological and chemical runoff 69

Table 5.2.3-2 E.coli counts in the Clifty Creek Watershed by sampling site 71
Table 5.2 Water quality problem statements, concerns, stressors, and potential sources 74
Table 7.1 Conservation Practices endorsed by the Technical Advisory Team and projected acreage to meet Committee goals 96
Table 7.2 Combined watershed BMP efficiencies from the BMP calculator 96
Table 7.3 Total load by land use (with BMP) 97
Table 7.4 Load Calculation Reductions for the Clifty Creek Watershed 97
Table 7.5 Load Reductions to date 98

1.0 Introduction

1.1 Brief History and Overview

The Clifty Creek Watershed encompasses approximately 205 square miles (132,000 acres) in the White River Basin as a tributary to the East Fork White River (Figure 1.1). The majority of this acreage occurs in Bartholomew and Decatur counties, with portions of the watershed area lying in Rush and Shelby counties (Table 1.1).

Figure 1.1 Clifty Creek Watershed map in relation to East Fork White River

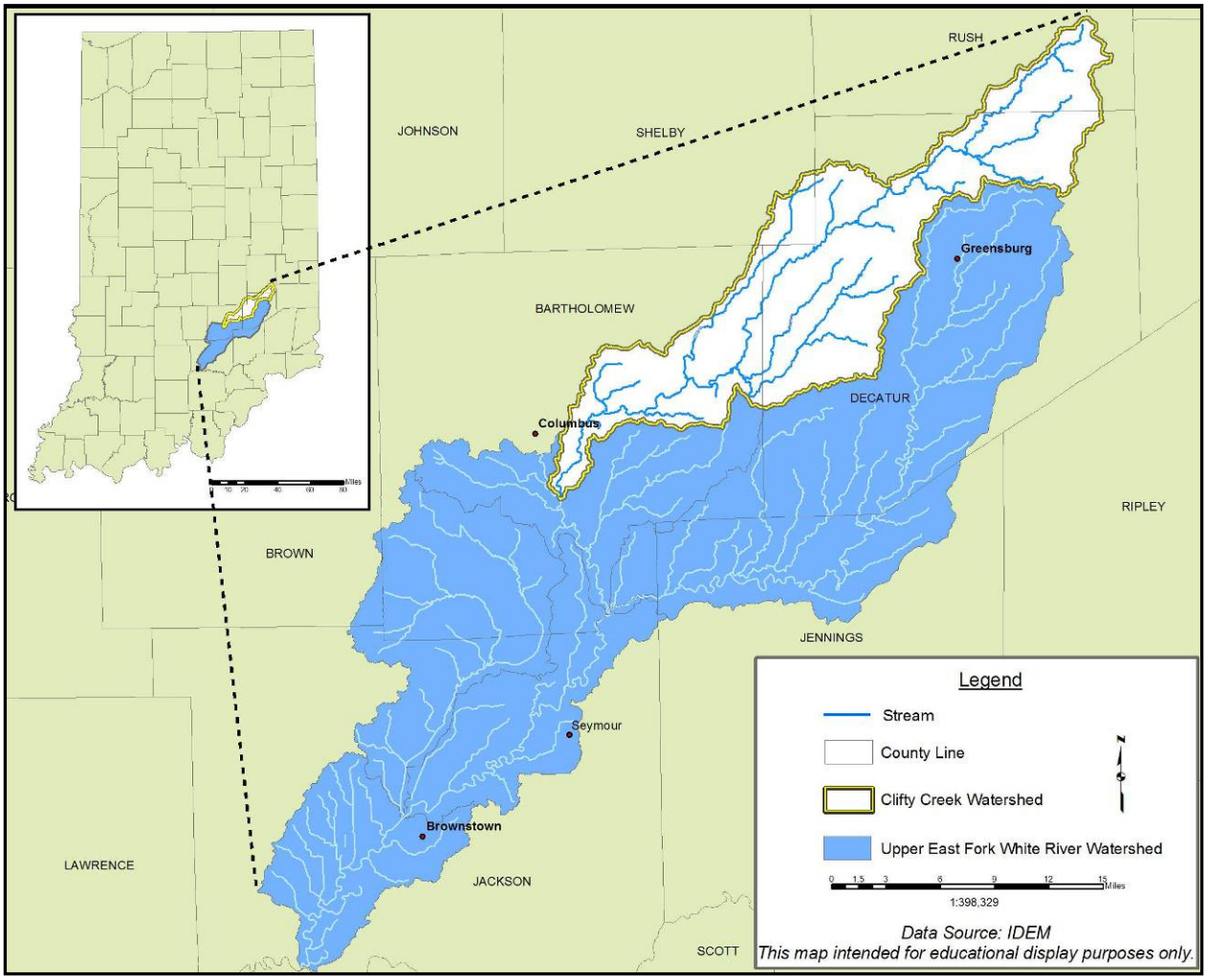


Table 1.1 Watershed area relative to county boundaries

County	Percentage of Watershed	Approximate Area in Watershed (Acres)	Percent of County
Rush	10%	12,800	5%
Shelby	4%	5000	2%
Decatur	57%	75,200	32%
Bartholomew	29%	40,000	15%

Predominantly agricultural (92 percent), land use for the Clifty Creek Watershed is characterized by corn and soy croplands with occasional grain, produce, greenhouse, and pastoral operations. Livestock operations vary throughout the watershed, ranging from small, concentrated hobby farms to large-scale feeding operations. Urban and residential areas are also present, but are commonly localized in town centers and farm homesteads, with occasional pockets of rural developments. These areas comprise less than two (2) percent of the total watershed area. However, as population and business in the region has increased, so too has the concentration of shopping facilities, new housing, and highway development along Clifty Creek. In addition to agricultural and urban areas, there are also several areas designated for recreational parks and nature preserves in the watershed area.

The presences of preserved natural areas, as well as the continuing implementation of conservation practices on agricultural lands are indicators of the overall interest residents and landowners in the area have towards the health of natural resources. Additionally, the region is characterized by initiatives that promote overall environmental health and awareness.

Continuing this tradition of initiative, the Bartholomew County Soil and Water Conservation District (BCSWCD) Supervisory Board recognized the need for enhanced water quality programming and education in the late 1990s. After monitoring water quality intermittently throughout the county for several years, the Board identified increased levels of sediment, bacteria, nitrates and pesticides in local creeks. Concurrently, the Indiana Department of Environmental Management (IDEM) designated segments of Clifty Creek as not meeting recreational standards due to high levels of E.coli.

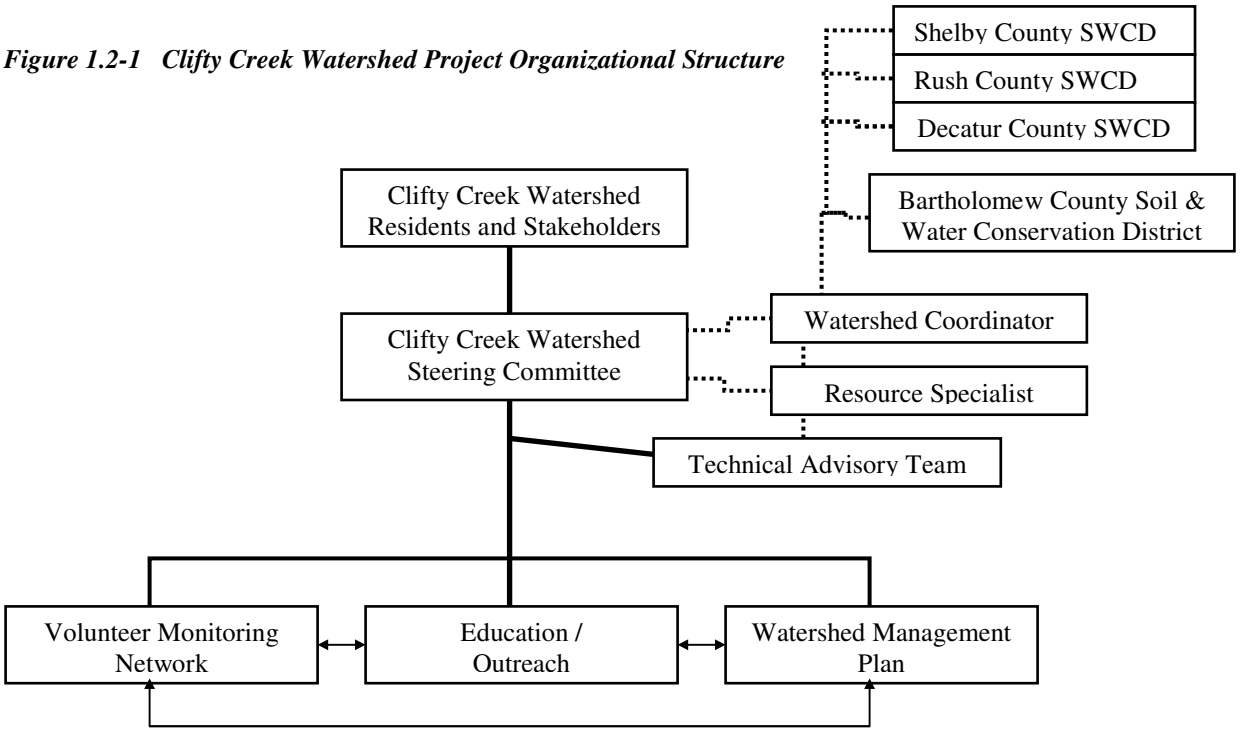
Based on this information, the Bartholomew County Board approached neighboring Decatur, Rush, and Shelby County Districts for support in application for IDEM Section 319 Nonpoint Source Program Funds. Funds were awarded by the State to the Bartholomew County SWCD in September 2003 in order to address Nonpoint Source Pollution in the Clifty Creek Watershed. To accomplish a project of this scope, it was determined that a thorough inter-county assessment and comprehensive management plan of the Clifty Creek Watershed would be required.

1.2 Building Partnerships

Having taken significant strides independently in order to best represent the needs and interests of the county (Appendix A), the Board and State agreed that project decisions and the direction of management planning should be made by a representative local steering committee unique to the watershed project (Appendix B). Additionally, the Board decided to hire a full-time position to coordinate the details of the project and facilitate its progress (Figure 1.2-1). The project was

introduced to residents of the watershed through an initial watershed survey (Appendix B), a series of meetings with local representatives, newspaper advertising, personal invitations, and a large-scale public kickoff meeting. The kickoff meeting hosted one hundred forty (140) individuals representing Bartholomew, Decatur, and Rush county residents. The purpose of the outreach campaign was to seek interest from residents and landowners to form the above-mentioned locally led steering committee.

Figure 1.2-1 Clifty Creek Watershed Project Organizational Structure



Response to the public meeting and newspaper articles was overwhelming, with approximately thirty (30) individuals in attendance at the first steering committee meeting. Initial concerns were identified, and discussion on a group vision occurred. As monthly meetings progressed, the unique identity and mission of the steering committee began to emerge, and meetings focused on the consolidation and prioritization of committee concerns and interests. (Table 1.2)

Table 1.2 Steering Committee Concerns and Prioritizations

Concern	Priority Points Given*	Priority Ranking
Lack of Education	43	1
Erosion (Sedimentation)	32	2
Contamination: Biological, Chemical (Runoff and Leaching)	21	3
Lack of Accurate, Scheduled, Consistent Monitoring/Data Acquisition	20	4
Lack of Complete Stakeholder Representation	1	5

*Committee members voted on their top three (3) priorities. Votes were weighted based on priority.

Through interviews as well as group discussion at committee meetings, members agreed unanimously that the largest threat to local water quality emanates from general public apathy regarding natural resources. Secondarily, committee members identified existing erosion and biological/chemical contamination to be primary factors currently degrading the quality of water in the Clifty Creek Watershed. Ongoing concerns included the quality of data collected when sampling water, and the continued fair representation of stakeholder interests in the Watershed Project.

In order to assure that the committee's primary goals for education were realistic, an educator review and brainstorming session was held with area educators to ensure that committee ideas were tailored to avoid duplication of existing programs, while providing traditional and non-traditional education resources to the watershed community and surrounding area. This session was hosted by an ongoing project partner, the Columbus Center for Teaching and Learning. Ideas presented in the session were co-created by content from the steering committee and in partnership with the kidscommons Children's Museum. Additionally, Indiana Project WET and Hoosier Riverwatch components were integrated into educational programming concepts and curriculum delivery. Partners contributing also included Southside, Rockcreek, and L.F. Smith Elementary Schools, Columbus East High School, Sand Creek Watershed Project, Friends of the Muscatatuck River Society, and Indiana University Purdue University Columbus.

As the committee pursued solutions to the identified problems, the details surrounding their secondary goals became quite technical. In order to properly address conservation needs within the watershed, the committee requested the formation of a technical advisory team comprised of conservation professionals, agricultural producers with specific practice experience, and local health specialists. The committee drew on partnerships with the Natural Resource Conservation Service (NRCS), Indiana Department of Natural Resources (IDNR), IDEM, Hope Hardwoods, the Bartholomew County Cattlemen's Association, Strand Associates, and the Bartholomew and Decatur County Health Departments. The technical advisory team was created to provide specific recommendations for the implementation of conservation practices that would address erosion and contamination.

Throughout the planning process, the committee worked to maintain contact with local officials, SWCD boards, and local media to ensure that opportunities for input and information outreach were not overlooked. Additionally, the committee created and currently supports a volunteer monitoring network in cooperation with Hoosier Riverwatch, Columbus City Utilities, and Strand Associates. The monitoring network was designed to collect data throughout the watershed in order to establish and document baseline conditions for Clifty Creek and its major tributaries.

Once key ideas, priorities, and regions were identified for improvement in the Management Plan, the committee initiated a public meeting. The purpose of the public meeting was threefold: 1.) to present committee work and key concepts of the plan, 2.) to garner public support for Project direction, and 3.) to receive public input on implementation strategies. In August, 2005 the committee hosted the meeting, which involved approximately seventy (70) individuals. The format of the meeting encouraged small group discussion and public involvement. Ideas from the meeting are incorporated throughout the Management Plan, predominantly in Section 5.0: Setting Goals & Choosing Measures to Apply.

The process of collaborative development and data gathering each contribute an important component of management planning. The Clifty Creek Watershed Management Plan is intended to be flexible and dynamic, meaning that it is destined for revision. As information is uncovered and interests continue to emerge, the Plan should adapt to reflect changes in knowledge, strategy, and community interest.

Figure 1.2-2 Past Project Timeline

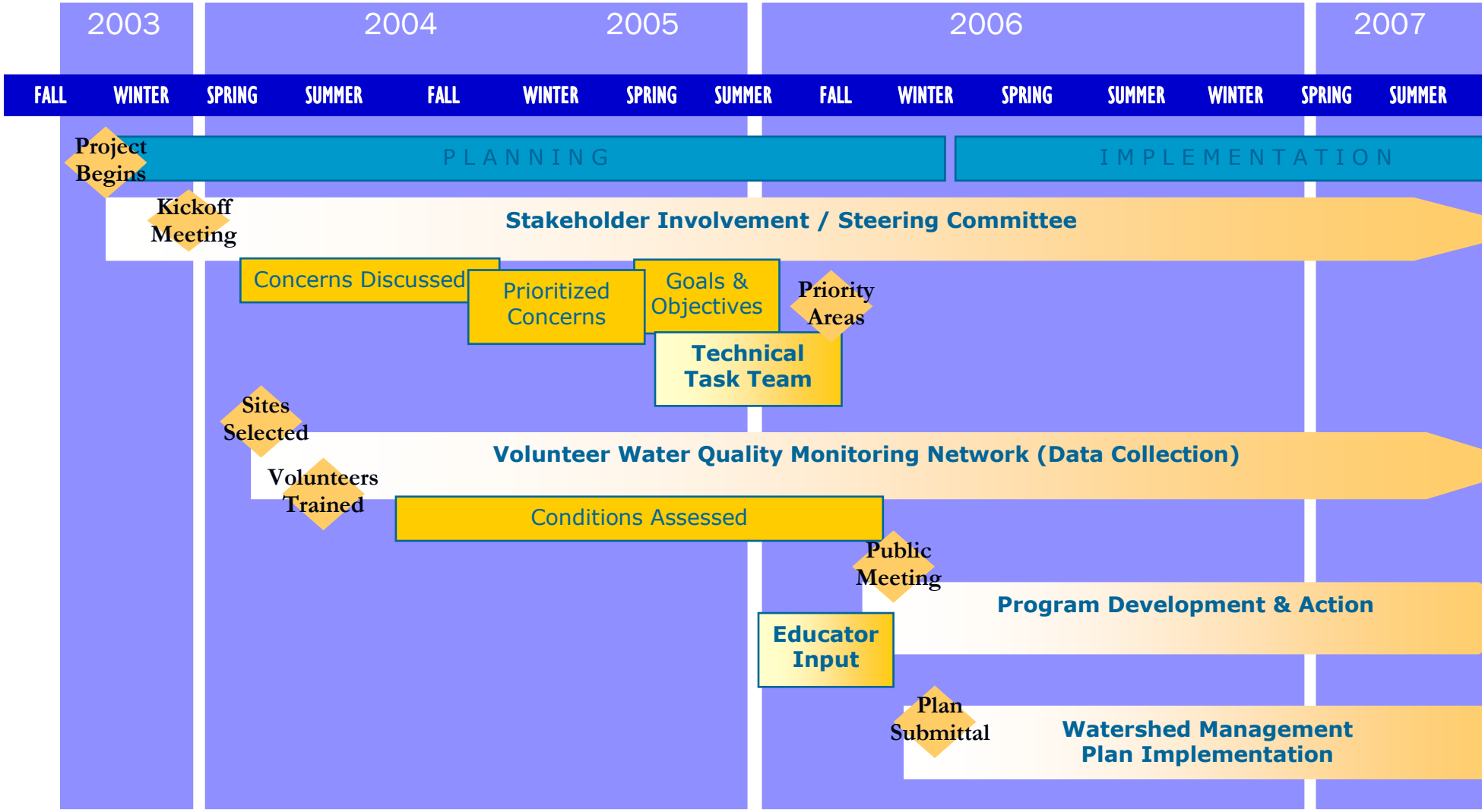
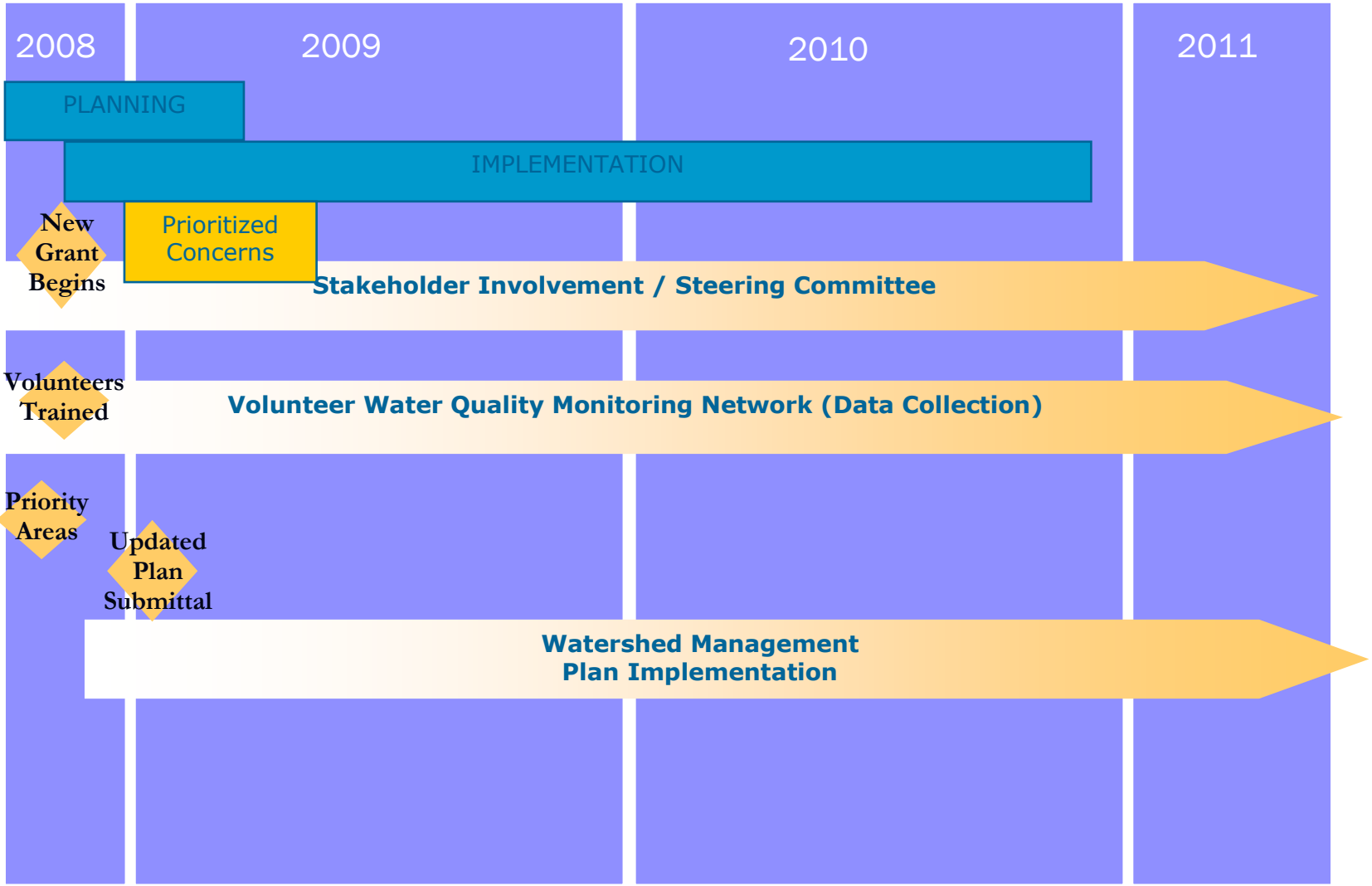


Figure 1.2-3 Present Project Timeline



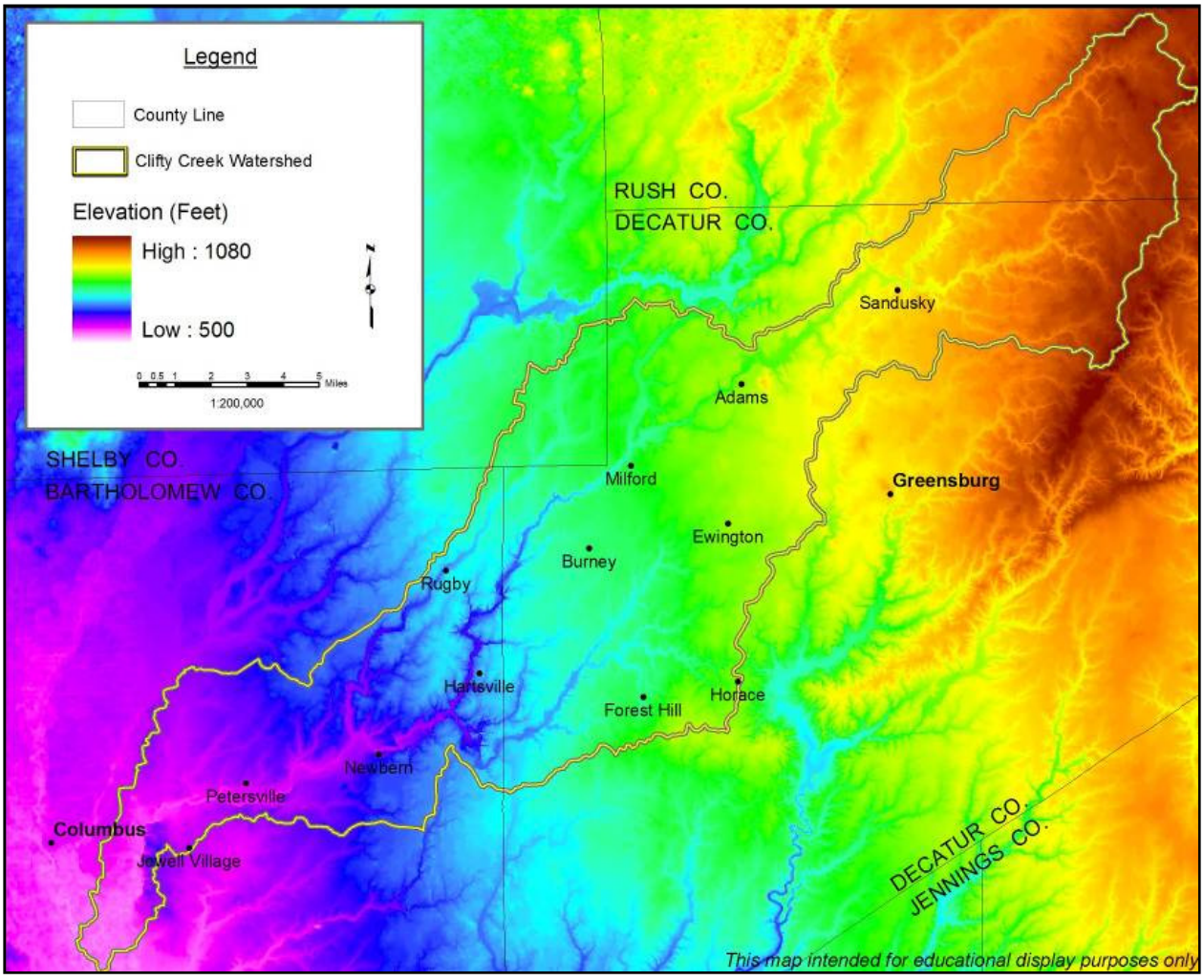
2.0 Describing the Watershed

This section describes physical information gathered through spatial data research in order to provide basic background information for the reader. Information includes descriptions of watershed topography, geology, soils, hydrology, wetlands, climate, and natural history.

2.1 Topography

The Lenape named Clifty Creek "essenhi-ahanhokqui", meaning "descending from high rocks", which does well to describe the overall topographic character of Clifty Creek.

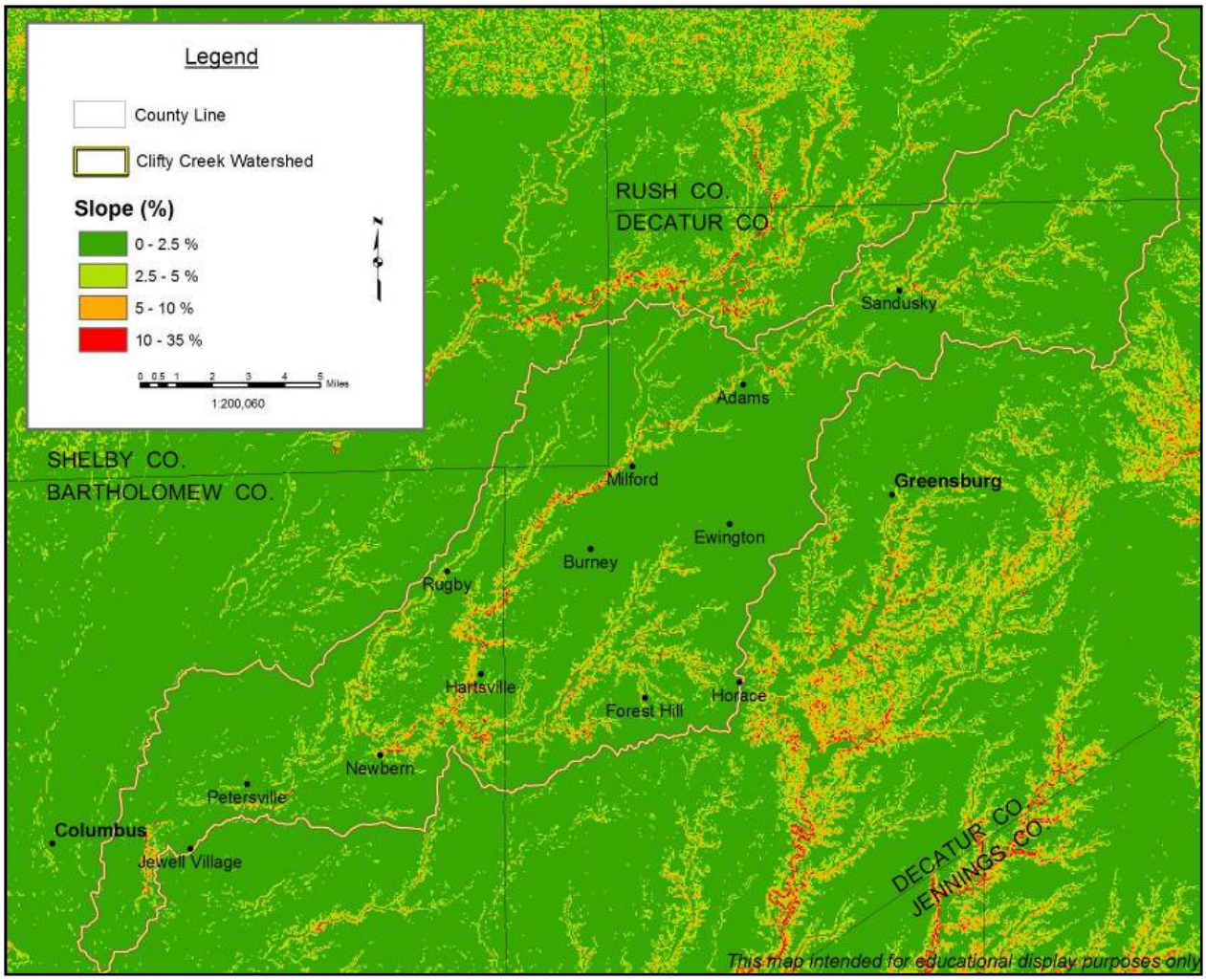
Figure 2.1-1 Elevation of Clifty Creek Watershed



From the headwaters of Clifty Creek in Rush County to its confluence with the East Fork of the White River, elevation drops over 500 feet in less than forty (40) miles (Figure 2.1-1).

Additionally, areas along the main stem are characterized by sporadic slopes and cliffs (Figure 2.1-2). The highest point in the watershed rests along the northeastern divide, separating the Clifty Creek Watershed from the Sand Creek Watershed at 1080 feet. The lowest point in the watershed is 500 feet, located along the southwestern edge of the watershed boundary, just above Clifty Creek's confluence with the East Fork White River (Figure 2.1-1).

Figure 2.1-2 Slope within Clifty Creek Watershed



2.2 Hydrology

Defined as the total area of land draining to a particular waterbody, watersheds are delineated utilizing topography, which indicates areas of elevation and natural divides. Drainage areas typically coincide with stream size. Just as smaller streams combine to form larger streams, smaller watersheds converge within larger watersheds. For this reason, watersheds are identified by scale and are coded as such. Larger watersheds are identified by shorter, more general codes, and smaller watersheds are identified by longer codes, designed to be more specific. These designations are referred to as Hydrologic Unit Codes (HUCS).

The Clifty Creek Watershed is identified by a ten (10) digit HUC (0512020601), and is further subdivided into seven (7) subwatersheds (Figure 2.2-1a), which are identified by twelve (12) – digit HUCs (Table 2.2a). In the past Clifty Creek Watershed was identified by an eleven (11) digit HUC (05120206010), and was further subdivided into sixteen (16) subwatersheds (Figure 2.2-1b), which were identified by fourteen (14) digit HUCs (Table 2.2b).

Figure 2.2-1a Subwatersheds within the Clifty Creek Watershed

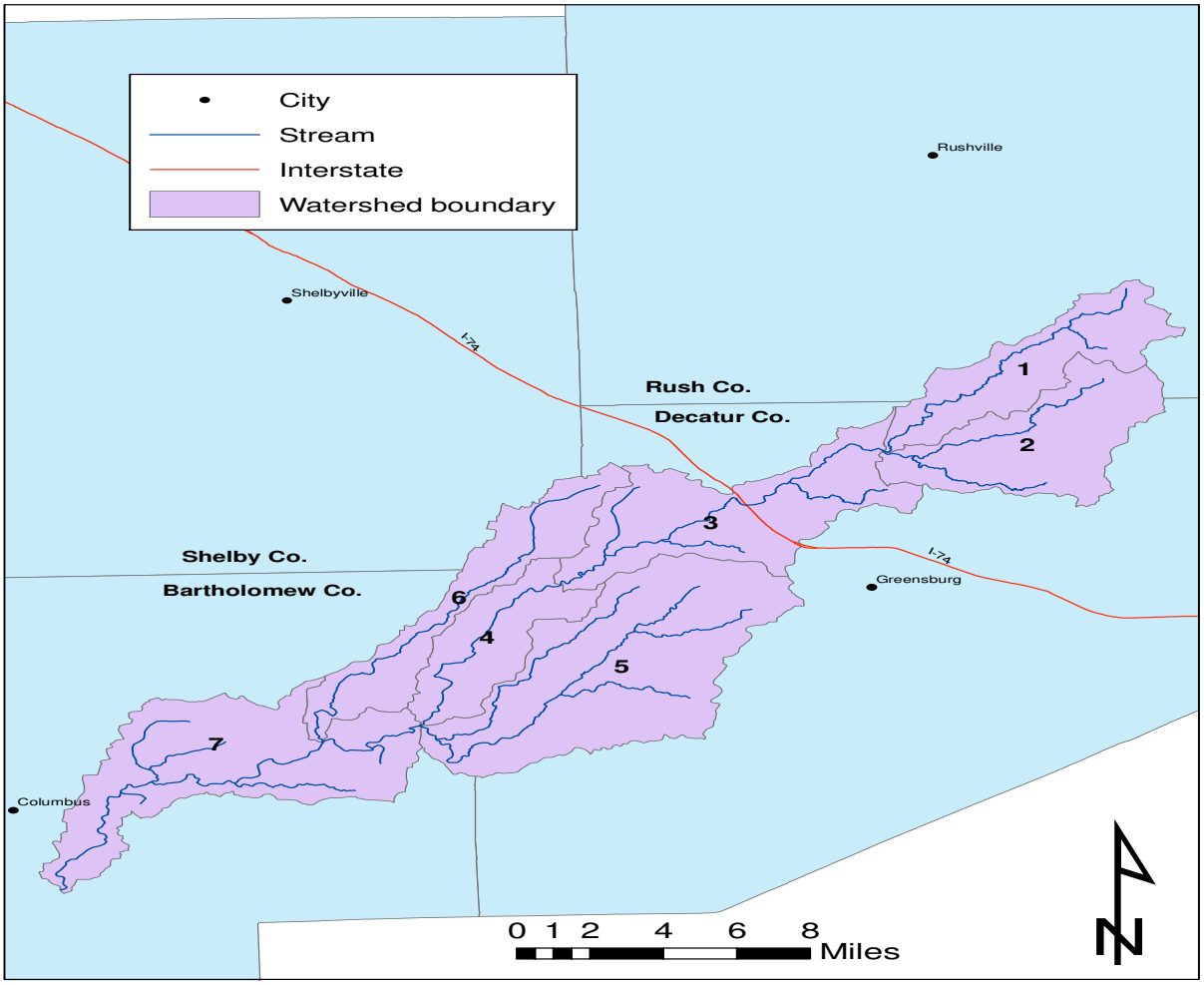


Table 2.2a Subwatersheds draining within the Clifty Creek Watershed

MAP ID	Subwatershed Name	Miles2	Acres	12-digit HUC
7	Otter Creek Clifty Creek	39.94	25,575	051202060107
6	Duck Creek	21.23	13,595	051202060106
5	Fall Fork	50.54	32,362	051202060105
4	Town of Hartsville Clifty Creek	16.19	10,365	051202060104
3	Pond Branch Clifty Creek	31.37	20,085	051202060103
2	Middle Branch Clifty Creek	25.52	16,340	051202060102
1	North Branch Clifty Creek	20.8	13,318	051202060101

Subwatersheds in the Clifty Creek Watershed specify a mainstream segment or major contributing tributary to the Clifty Creek. Identified in the table above, major tributaries to Clifty Creek include: Otter Creek, Duck Creek, Fall Fork, Pond Branch, Middle Branch, and North Branch.

Figure 2.2-1b Prior subwatersheds within the Clifty Creek Watershed

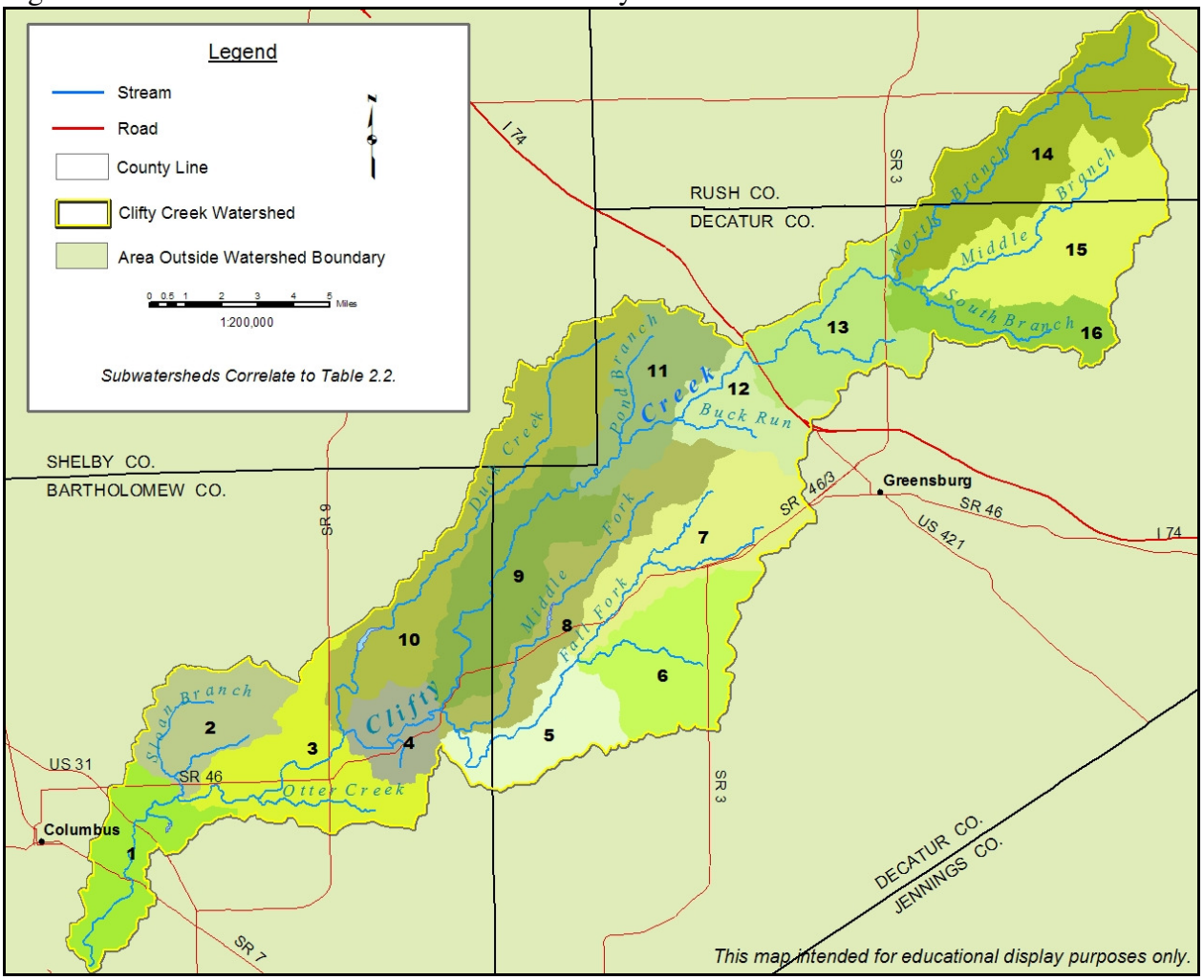
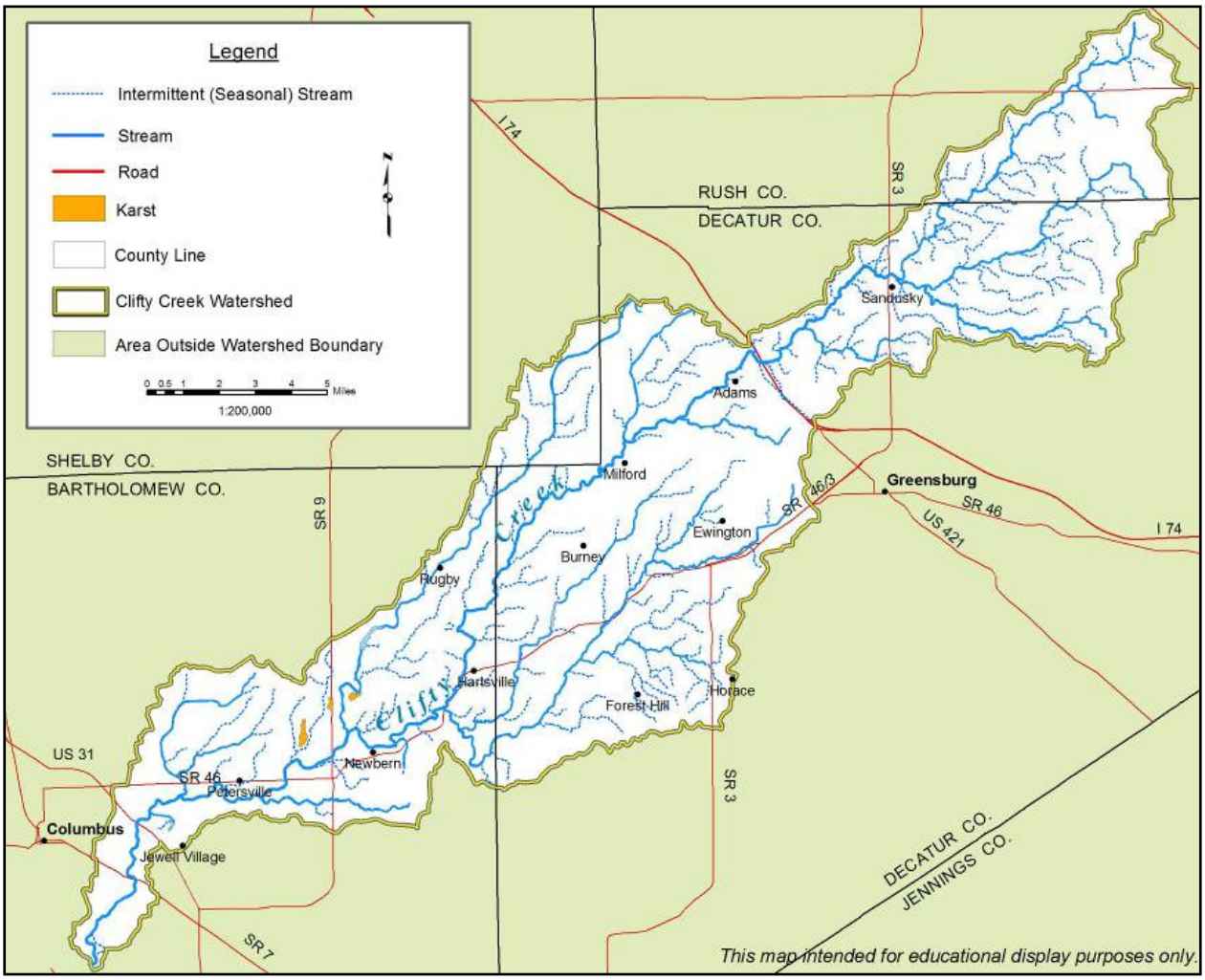


Table 2.2b Previous subwatersheds draining within the Clifty Creek Watershed

MAP ID	Subwatershed Name	Miles2	Acres	12-digit HUC
16	South Branch Clifty Creek	8	5,000	05120206010020
15	Middle Branch Clifty Creek	18	11,000	05120206010010
14	North Branch Clifty Creek	21	13,000	05120206010030
13	Clifty Creek-Sandusky to US421	13	8,000	05120206010040
12	Buck Run	7	5,000	05120206010050
11	Pond Branch	11	7,000	05120206010060
10	Duck Creek	21	14,000	05120206010130
9	Clifty Creek-Hartsville	16	10,000	05120206010070
8	Middle Fork	13	8,000	05120206010110
7	Fall Fork – Headwaters	15	10,000	05120206010080
6	East Tributary Fall Fork	13	9,000	05120206010090
5	Fall Fork Anderson Falls	9	6,000	05120206010100
4	Clifty Creek- Newbern	6	4,000	05120206010120
3	Otter Creek	14	9,000	05120206010140
2	Sloan Branch	10	6,000	05120206010150
1	Clifty Creek- Columbus	10	6,000	05120206010160

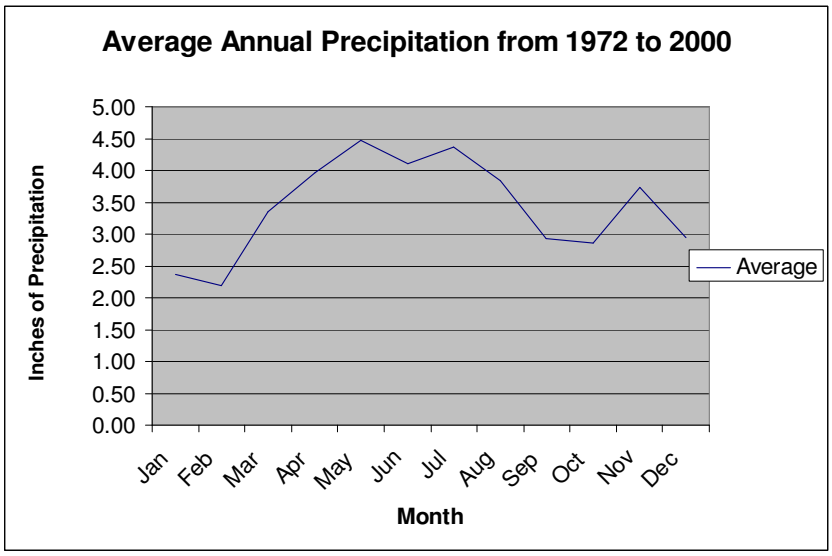
Including these major tributaries, the watershed contains over 140 stream miles, accounting for less than one percent (1%) of watershed area. Although percentage changes minimally when considering intermittent streams, seasonal flows add an additional 1160 miles of waterways to the watershed (Figure 2.2-2).

Figure 2.2-2 Major Contributing Tributaries and Intermittent Streams in the Clifty Creek Watershed



Although there is relatively little karst in the Clifty Creek Watershed (Figure 2.2-2), the carbonate-rock aquifers are shallow, and surface / groundwater transfer is regularly observed during large storm events. Annual precipitation trends are represented in Figure 2.2-3.

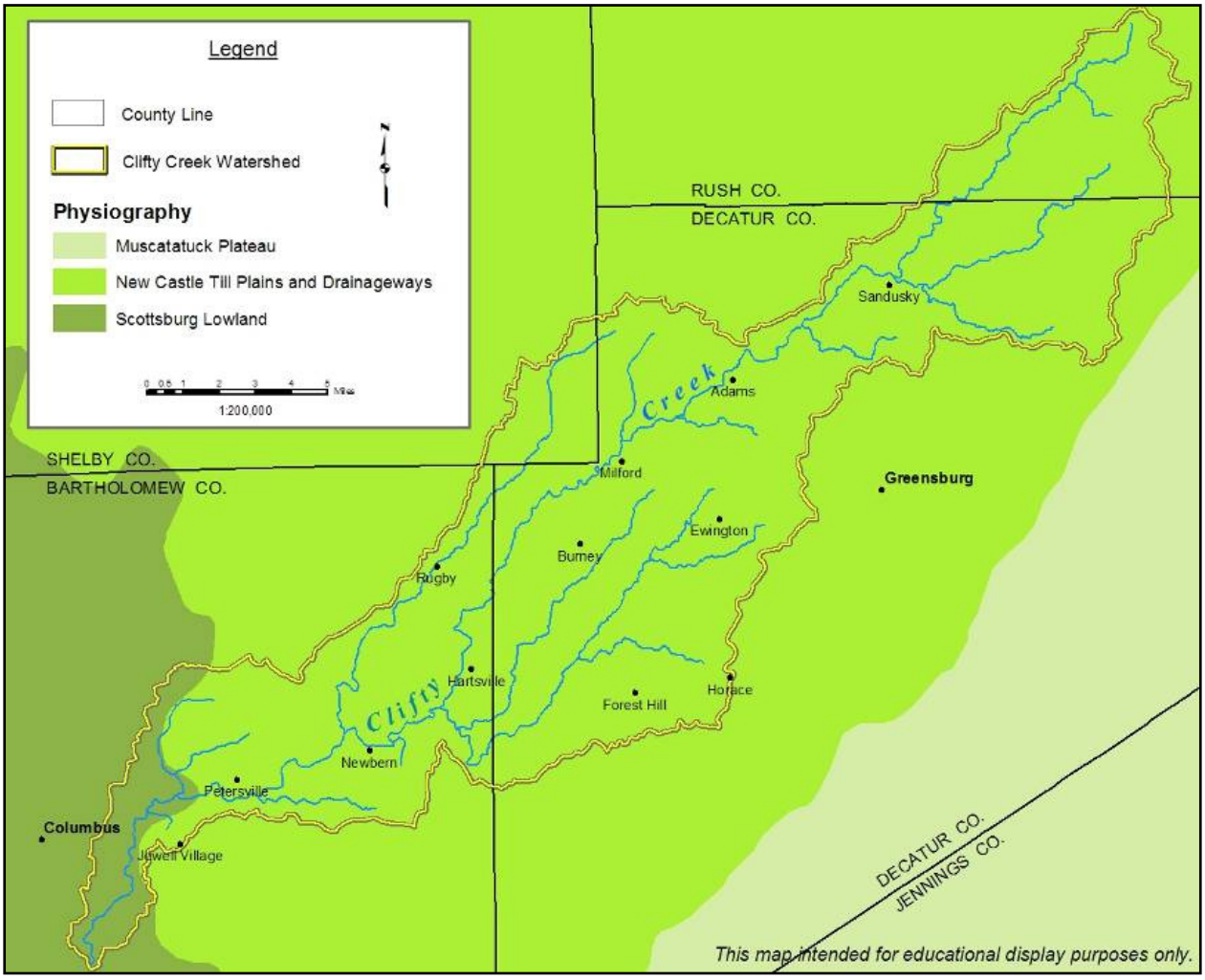
Figure 2.2-3 Average annual precipitation in and around the Clifty Creek Watershed.



2.3 Physiography

The Clifty Creek Watershed spans two distinct physiographic regions: the New Castle Till Plains and Drainage ways and the Scottsburg Lowland (Figure 2.3) (Gray, 2000). Most of the Clifty Creek Watershed is classified as New Castle Till Plains and Drainage ways, part of the larger Central Till Plain. The till plains were formed from glacial deposits. They are characterized by fairly low relief with occasional terminal moraines and knolls that rise above the level ground.

Figure 2.3 Physiographic features in the Clifty Creek Watershed



The southwestern portion of the watershed surrounding the Columbus area is classified as Scottsburg Lowland. This region includes broad outwash plains and terraces in addition to wide bottomlands (Young's Creek, 10).

2.4 Geology

Within the watershed, remnants of periods long before settlement exist in the bedrock along which Clifty Creek travels. On a geologic timescale, bedrock was established as continents formed and moved (Figure 2.4-1). Millions of years later, much of the area within the watershed was defined by glacial movement from the Huron-Erie Lobe, a massive movement of ice miles thick that traveled from the Great Lakes System down across the state of Indiana.

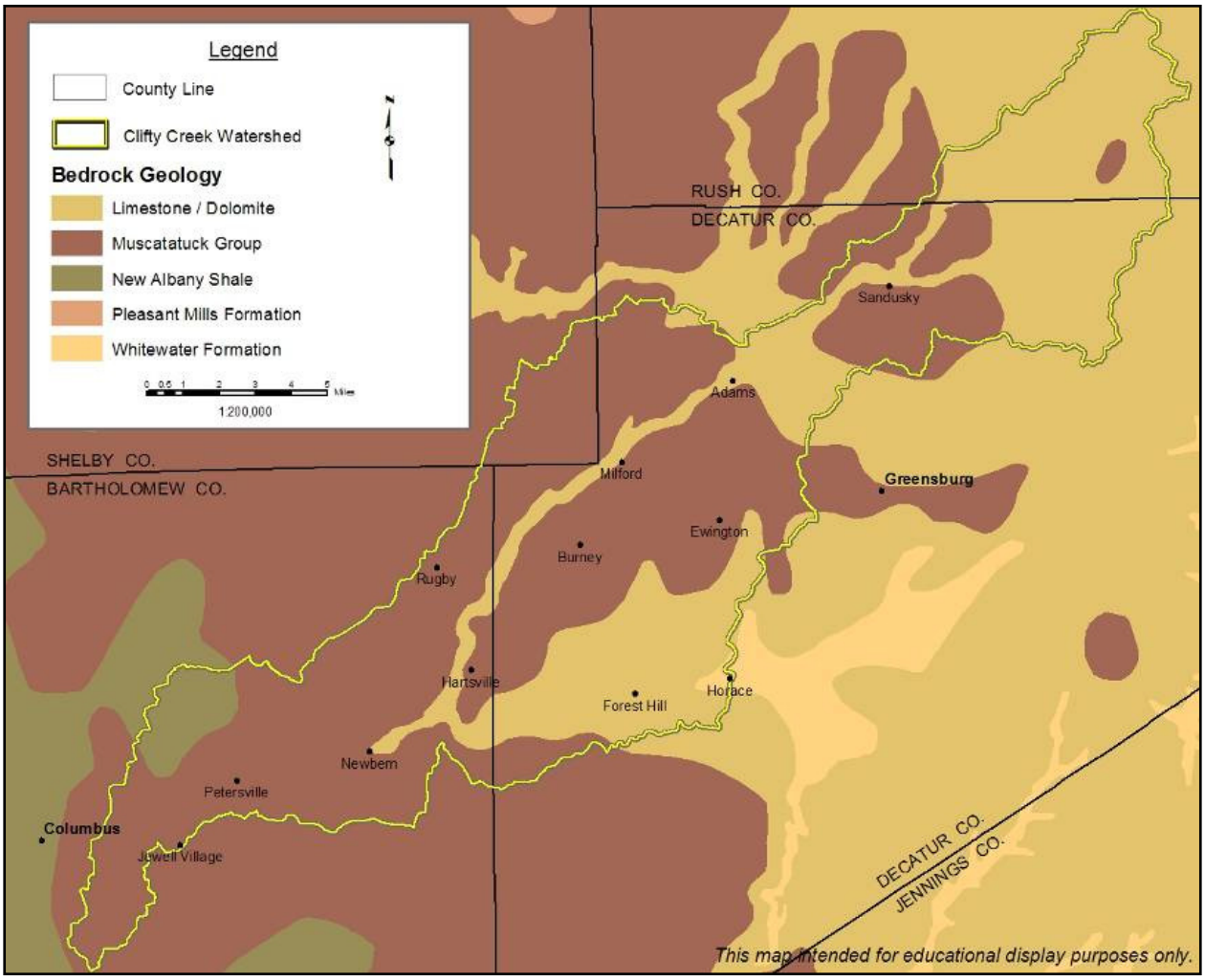


Figure 2.4-1 Clifty Creek Watershed bedrock geology Surficial Geology

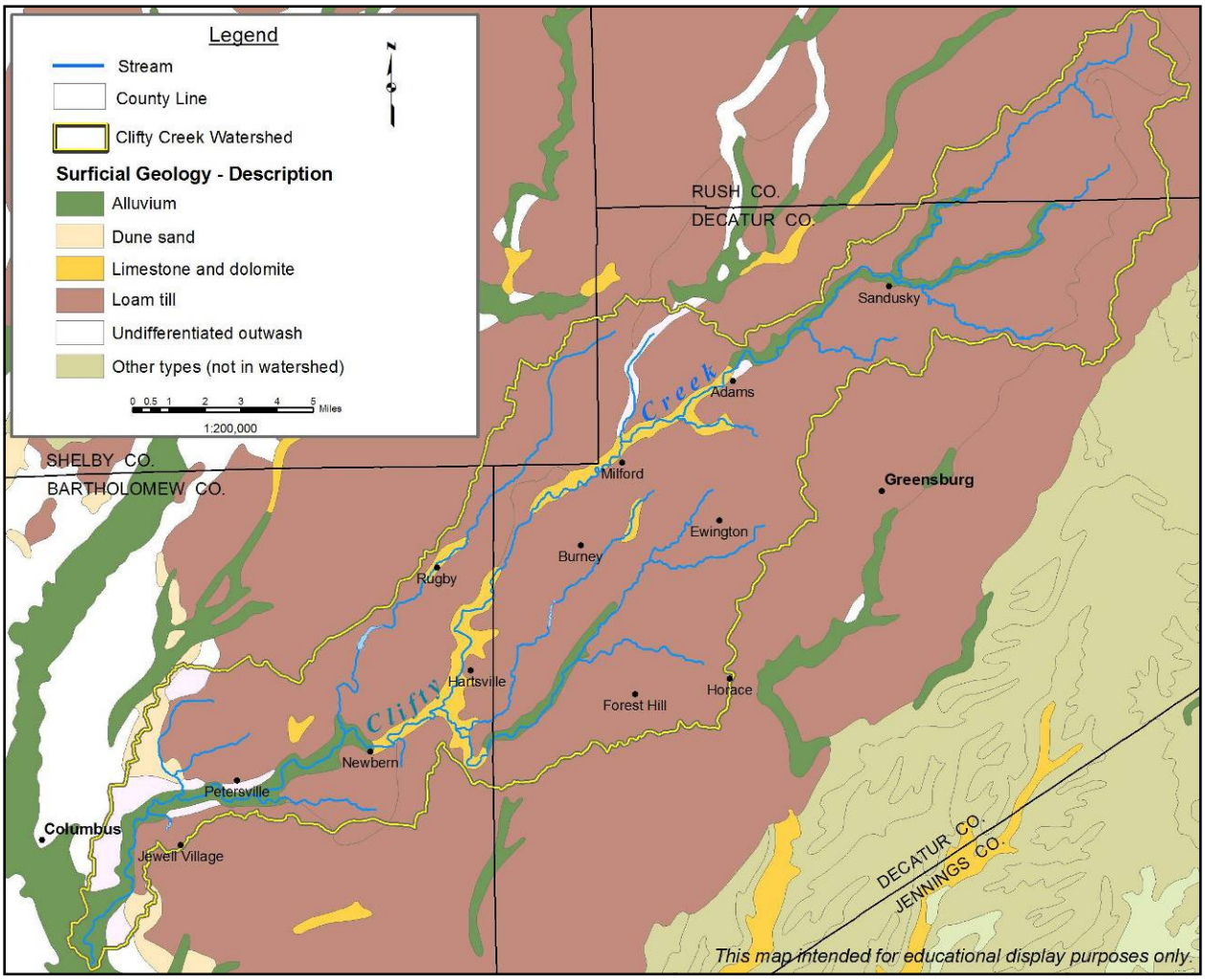
Significant limestone and dolomite seams frame the central main stem segments of Clifty Creek and date to the continent forming Silurian and Devonian periods (Figure 2.4-3). These bedrock portions are narrow and occupy just four percent (4%) of the watershed's surface (Table 2.4). Surrounding this bedrock are deposits from glacial movement, including loam till, scattered sand, gravel, and alluvial materials that now dominate the surficial geology of the watershed.

Table 2.4 Clifty Creek Watershed surficial geology

Description	Geologic Period	Deposition	% of Watershed
Loam till	Wisconsinian (Pleistocene)	Till (Huron-Erie Lobe)	86
Dune sand	Wisconsinian to Holocene	Aeolian	1
Undifferentiated outwash	Wisconsinian	Outwash	3
Alluvium	Holocene	n.a.	6
Limestone and dolomite	Silurian and Devonian	n.a.	4

The above description characterizes the central and northeastern portions of the watershed. Further south, surrounding the confluence of the Clifty Creek and the East Fork White River, surficial geology transitions from Loam Till into Undifferentiated Outwash and Dune Sand. It should also be noted, that throughout these regions, erratic rock formations have been documented and often attributed with a local name.

Figure 2.4-3 Clifty Creek Watershed surficial geology



2.5 Soils

Information on soils in the state of Indiana was compiled digitally in 2002 by the NRCS through the National Cooperative Soil Survey. Digital information is based on data provided from extensive county surveys which were most recently updated in 2004.

Due to the large number of individual soil types within the Clifty Creek Watershed, this report discusses soil associations. A soil association is a landscape that is comprised of a distinctive pattern of individual soils in defined proportions. The soil association is named for the most prevalent soil types within the association (Young's Creek, 11).

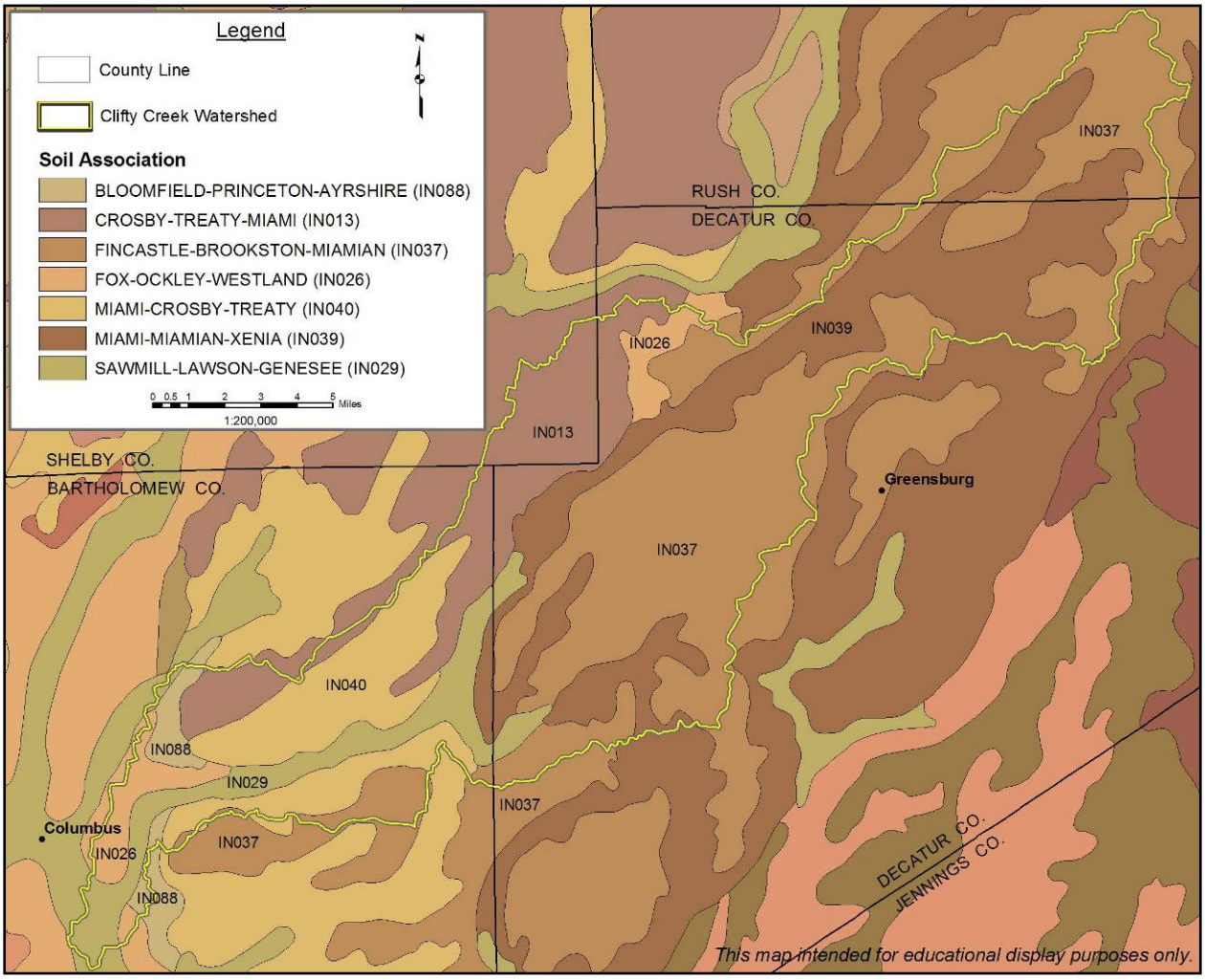
There are seven (7) major soil associations in the Clifty Creek Watershed (Figure 2.5): (1) Fincastle-Brookston-Miamian, (2) Miami-Miamian-Xenia, (3) Crosby-Treaty-Miami, (4) Miami-Crosby-Treaty, (5) Sawmill-Lawson-Genesee, (6) Fox-Ockley-Westland, and (7) Bloomfield-Princeton-Ayrshire. Table 2.5 lists the soil associations, the percentage of area in the watershed each association occupies, and a brief description of basic soil characteristics for the dominant soil type found in each association.

Table 2.5 Soil associations in the Clifty Creek Watershed

Soil Association	% of Watershed	Characteristics
Fincastle-Brookston-Miamian	41	Deep, Somewhat poorly drained to very poorly drained, found on level and gently sloping soils on uplands.
Miami-Miamian-Xenia	23	Deep, well drained to somewhat poorly drained, found on nearly level to strongly sloping soils on uplands.
Crosby-Treaty-Miami	12	Deep, somewhat poorly drained, nearly level soils on uplands.
Miami-Crosby-Treaty	11	Deep, well drained to somewhat poorly drained, found on nearly level to strongly sloping soils on uplands.
Sawmill-Lawson-Genesee	7	Deep, well drained and somewhat poorly drained, nearly level soils on bottomlands.
Fox-Ockley-Westland	4	Moderately deep, well drained, nearly level to moderately sloping soils on terraces.
Bloomfield-Princeton-Ayrshire	2	Deep, well drained, moderately sloping soils on uplands.

Data Source: Indiana State Soil Geographic Database (STATSGO), Natural Resource Conservation Service

Figure 2.5 Soil associations in the Clifty Creek Watershed



2.6 Natural Features, Endangered Species, & Wetlands

Both the *History of Bartholomew County, Indiana - 1888* and the *History of Decatur County, Indiana, Its People, Industries, and Institutions* describe pre-settlement conditions in detail for the region, emphasizing native wildlife and natural features, including expansive woody wetlands.

> "Half the country seemed to be under water, hence settlers mostly selected lands near water courses … In passing from Flatrock to Clifty, in the spring of the year, and sometimes a good part of the year, water from one to three feet deep would have to be waded for near half the distance, the scene being enlivened by the croaking of innumerable frogs, and occasionally by a deer which went bounding through, or over the thickets of spice and other underbrush." (Decatur County, 99)

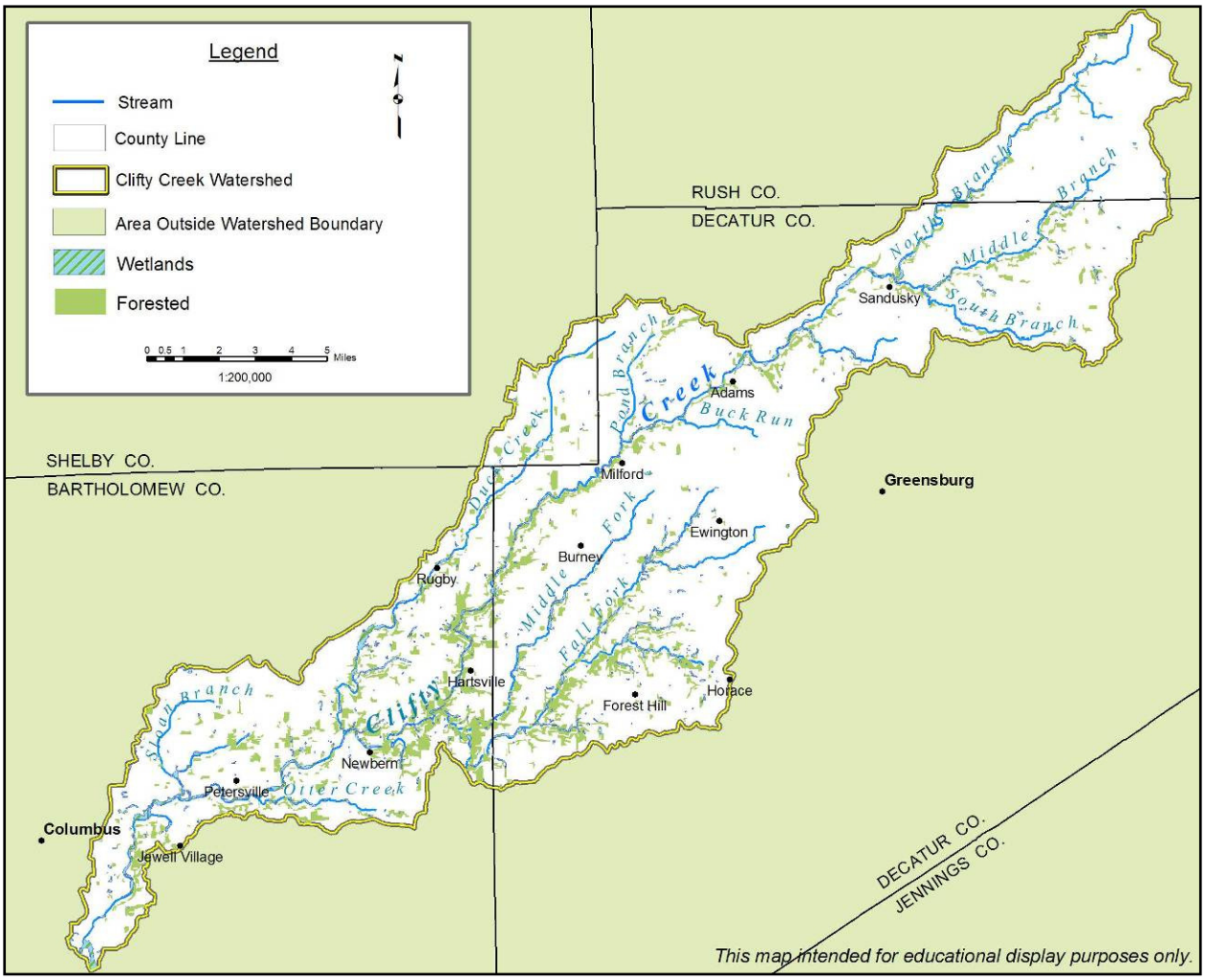
These conditions were typical of the larger region and supported a diverse mixture of hardwoods. Water tolerant species were found in valleys along stream banks with sedges and grasses or in areas known for the dense, wet soil types, whereas stands along ridges or areas with sandier soils included more drought-tolerant species (Table 2.6-1).

Table 2.6-1 Native vegetation relative to soil types in the Clifty Creek Watershed

Soil Association	% of Watershed	Native Vegetation
Fincastle-Brookston-Miamian	41	Mixed hardwoods; Water-tolerant hardwood trees and shrubs along with some sedges and grasses.
Miami-Miamian-Xenia	23	Mixed hardwoods
Crosby-Treaty-Miami	12	Mixed, water-tolerant hardwoods
Miami-Crosby-Treaty	11	Mixed hardwoods; Mixed, water-tolerant hardwoods
Sawmill-Lawson-Genesee	7	Mixed hardwoods
Fox-Ockley-Westland	4	Mixed hardwoods; Mixed water-tolerant hardwood trees, grasses, and sedges.
Bloomfield-Princeton-Ayrshire	2	Drought-tolerant, mixed hardwoods; Mixed hardwoods

Since that time, wetlands and native vegetation continue to exist in the Clifty Creek Watershed. However, increased drainage and expanding human activity throughout the years have restricted forested areas and wetlands primarily to stream bank corridors (Figure 2.6). This includes Anderson Falls State Nature Preserve (Section 3.3.1); known for abundant plant life and biodiversity of plants native to Southern Indiana.

Figure 2.6 Wetlands in the Clifty Creek Watershed



Although natural areas exist in the watershed and some are protected by private or public means, the ongoing fragmentation of native habitat impacts plant and wildlife communities significantly. Table 2.6-2 identifies all state and federally listed endangered species that could be found in the Clifty Creek Watershed. In some cases, species listed have not been seen in years.
For more information on common and endangered species identified in the geographic region, please refer to the Indiana Department of Natural Resources website: www.in.gov/dnr/.

Table 2.6-2 State and Federally Listed Endangered Species Potentially Found in the Clifty Creek Watershed

Common Name	State Rank	Federal Rank	Habitat	County
Vascular Plants				
Spreading Rockcress	SE	**	Limestone creek banks	Bartholomew
Straw Sedge	ST	**	Open woods by ponds	Bartholomew
Thinleaf Sedge	SE	**	Dry woods	Rush
Hemlock Parsley	SE	**	Springy areas in sandy soil	Decatur
Illinois Hawthorn	SE	**	Well drained woods, fields and brushland	Bartholomew
Scarlet Hawthorn	ST	**	Wooded banks of streams	Decatur
Butternut	WL	**	Terraces and banks of streams	Bartholomew/Decatur
Cattail Gay-Feather	ST	**	Prairies	Bartholomew
Small Sundrops	SR	**	Hard, white clay soil	Bartholomew
A Panic-grass	SE	**	Dry wooded slopes	Bartholomew
Gray beardtongue	SE	**	White oak slopes	Bartholomew
Smith's Bulrush	SE	**	Wet, sandy borders of lakes	Bartholomew
Branching Bur-Reed	ST	**	Wet areas (not well known)	Bartholomew
Yellow Nodding Ladies'-Tresses	ST	**	Dry rocky roadcuts and old fields	Bartholomew
American Ginseng	WL	**	Well drained woods	Bartholomew
Yellow Sedge	ST	**	Wet prairies and fens	Decatur
Ridged Yellow Flax	WL	**	Moist woods, sandy soils	Decatur
Dwarf Ginseng	WL	**	Moist open or wooded areas	Decatur
Mussels				
Eastern Fanshell Pearlymussel	SE	LE	Medium to large rivers in gravel riffles	Bartholomew
Slippershell Mussel	*	**	Creeks and the headwaters of large rivers in sand, mud, or fine gravel	Rush/Shelby
Northern Riffleshell	SE	LE	Medium to large rivers in gravel riffles	Shelby
Snuffbox	SE	**	Medium to large rivers in clear, gravel riffles	Bartholomew/Shelby
Wavy-rayed Lampmussel	SSC	**	Medium-sized streams in gravel riffles	All
Kidneyshell	SSC	**	Medium to large rivers in gravel	All
Yellow Sandshell	*	**	Medium to large rivers in sand or fine gravel	Bartholomew
Rabbitsfoot	SE	**	Medium to large rivers in mixed sand and gravel	Bartholomew/Shelby

Round Hickorynut	SSC	**	Medium-sized streams in sand and gravel in areas with moderate flow	Bartholomew
Clubshell	SE	LE	Medium to large rivers in gravel or mixed gravel and sand	All
Pyramid Pigtoe	SE	**	Medium to large rivers in sand or gravel in areas with a good current	Bartholomew
Salamander Mussel	SSC	**	Medium to large rivers on mud or gravel bars	Shelby
Purple Lilliput	SSC	**	Lakes and small to medium streams in gravel	All
Lilliput	*	**	Creeks to large rivers in mud, sand, or fine gravel	Rush
Little Spectaclecase	SSC	**	Small to medium streams in sand or gravel	All
Fish				
Eastern Sand Darter	*	**	Creeks with moderate current over sand	Bartholomew/Shelby
Northern Studfish	*	**	Clear streams over moderate gradient	Bartholomew/Shelby
Popeye Shiner	SX	**	Warm, shallow and medium rivers	Rush
Harlequin Darter	*	**	Multiple, migratory	Bartholomew
River Redhorse	*	**	Creeks with moderate to swift water over clean gravel and rubble	Bartholomew
Arthropods				
Northeastern Cave Isopod	SE	**	wet caves	Decatur
Reptiles				
Kirtland's Snake	SE	**	Wet, grassy areas along waterways (adaptable in urban settings)	Bartholomew
Amphibians				
Northern Leopard frog	SSC	**	shallow ponds and wet meadows	Rush
Birds				
Bachman's Sparrow	SX	**	Dry, open woodlands	Bartholomew/Decatur
Henslow's Sparrow	SE	**	Wet, shrubby fields and grasslands	Bartholomew
Great Blue Heron	*	**	Edge of water bodies	Bartholomew/Decatur/Rush
Red-shouldered Hawk	SSC	**	Moist, mixed woodlands	Bartholomew
Loggerhead Shrike	SE	**	Forest edges	Rush

Sedge Wren	SE	**	Wet meadows and sedge marshes	Bartholomew
Peregrine Falcon	SE	E (S/A)	Open wetlands near cliffs	Bartholomew
Worm-Eating Warbler	SSC	**	Dense undergrowth on wooded slopes	Bartholomew
Black and White Warbler	SSC	**	Mixed woodlands	Bartholomew
Hooded Warbler	SSC	**	Swamps and moist woodlands	Bartholomew
Black-Crowned Night-Heron	SE	**	Edge of water bodies	Bartholomew
Barn Owl	SE	**	Open woodlands	Bartholomew
Bald Eagle	SE	LT, PDL	Large woods near water bodies	Bartholomew
Hooded Warbler	SSC	**	Small clearings with thick underbrush	Bartholomew
Mammals				
Bobcat	*	**	Remote hilly forests	Bartholomew/Decatur
Indiana Bat	SE	LE	Streams with deciduous forests	Bartholomew/Rush
Evening Bat	SE	**	Variety of habitats	Bartholomew/Rush
Northern River Otter	*	**	Medium to large streams and rivers	Shelby
American Badger	*	**	Dry fields and pasture	All

State: SX=extirpated, SE=endangered, ST=threatened, SR=rare, SSC= special concern, WL=watch list, SG=significant, * not status but rarity warrants concern
Federal: LE=endangered, LT=threatened, LELT=different listings for specific ranges of species, PE=proposed endangered, PT=proposed threatened, E/SA= appearance similar to LE species, PDL= Proposed for delisting, **=not listed
Indiana DNR, 2005

3.0 Land Use

3.1 Natural History and Human Influence

The Clifty Creek Watershed is characterized by its rural landscape and small town feel, where agricultural practices and small communities have existed for generations. Covered bridges are used to describe stream crossings by those that remember them, and county road names are seldom found on a map. Valued for recreational use, it is common in Clifty Creek to see anglers fishing for smallmouth bass, and to hear children laughing with their parents underneath the falls in Anderson Falls State Nature Preserve.

In earliest periods of recorded history, the Clifty Creek Watershed was a transient area with no documentation of native settlement. There is record of an archaic indigenous site in the northwest corner of the watershed where Bartholomew, Decatur, and Shelby Counties meet (Hearne Brothers). However, prevailing sources indicate that the region was typically traversed for trading purposes or as extended hunting grounds.

During this early period of native history, well drained, fertile areas in the watershed were dominated by beech and maple trees, which characterized principal habitat: deciduous, old growth forest (Atlas 14-15). Early white settlers documented evidence of this "ancient forest" in fertile areas of eastern townships in Bartholomew County, recording "Where this black soil is penetrated, quite frequently pieces of wood, roots, masses of decayed leaves and thick muck are found." (Bartholomew Co. 1888, 5-6)

It was not until the mid-eighteenth century that the region became populated by eastern tribes pushed westward from Ohio and Pennsylvania due to white expansion. The Lenape (Delaware) occupied settlements outside of the watershed, but were considered to control the territory that includes the Clifty Creek Watershed. During this time, native agricultural practices infiltrated areas that were well drained (Atlas, 15). Traffic from trade increased in the region, and the state's earliest recorded squatters claimed land along Clifty Creek. According to Decatur County History, the Lenape and squatters coexisted in a "mutual friendship" which occupied the region for a period.

Later displacement of the Lenape was inevitable due to the "New Purchase" accorded by the 1818 Treaty of St. Mary's, in which tribal leaders ceded their territory within Indiana to the United States. White settlement and legislation flooded the state, organizing the region into Delaware County. This historic territory would be further subdivided into existing county boundaries, including Bartholomew (1821), Decatur (1822), Rush (1822), and Shelby (1822).

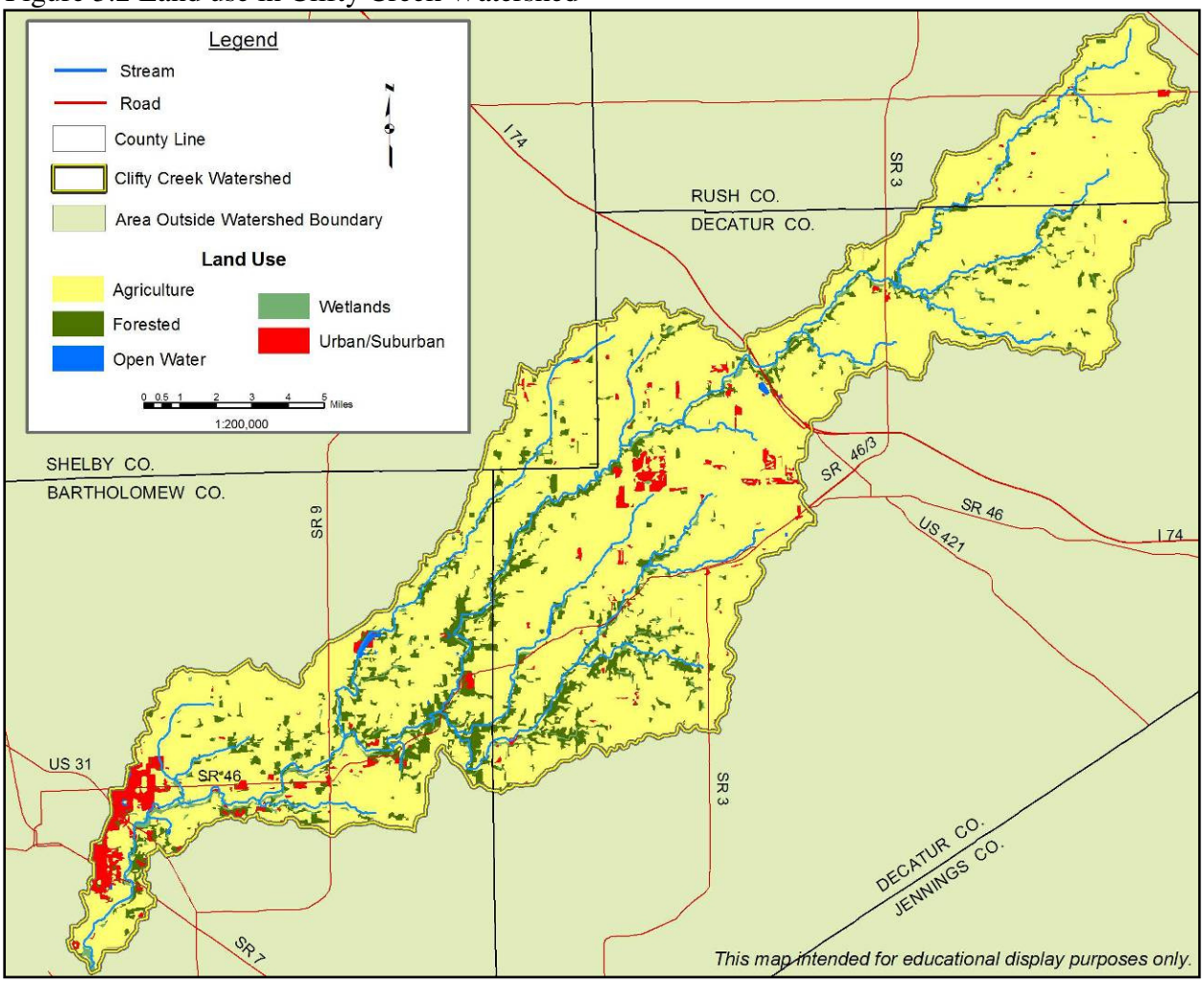
As settlement progressed, forest areas were cleared for timber and the fertile soil beneath them. Mills were constructed, eventually utilizing the flow of Clifty Creek to increase productivity. In areas where land was poorly drained, tile systems were eventually installed to further cultivate land for agricultural production. This transition is well documented, and its culmination exists in the dominance of agricultural production in current land use percentages (Section 3.2: Existing Landscape). Additionally, many of the settlements developed into existing towns and cities such as Columbus, Hartsville, Newbern, Burney, Milford, Adams, and Sandusky.

In addition to the visible changes in natural landscape, human development has also influenced transition from historic natural communities into the existing natural community. County histories documented the existence of wolves, bears, and rattlesnakes throughout areas of the watershed, overly abundant squirrels, and the now extinct passenger pigeon, all directly or indirectly dependent on the historic concentration of beech trees in the region.

3.2 Existing Landscape

For a detailed map of land use in the Clifty Creek Watershed, please refer to Figure 3.2.

Figure 3.2 Land use in Clifty Creek Watershed



Although population throughout the watershed continues to grow, there are no major areas of rapid development or uncontrolled sprawl (Section 4.2: Land Inventory). In general, development occurs within established towns (Columbus, Hartsville, Newbern, Burney, Milford, Adams, and Sandusky) and existing rural subdivisions, which combined comprise less than two (2) percent of the total watershed area (Table 3.2). Bartholomew and Decatur County both

support commissions designed to encourage planned growth. Please refer to existing County Comprehensive Plans for more information.

Table 3.2 General land use percentages for the Clifty Creek Watershed

Land Use	% of Watershed
Water	Less than 1 %
Urban/Suburban	2 %
Natural Vegetation	6 %
Agriculture	92 %
Parks	Less than 1 %
Wetlands	1 %

Percentages derived from 1992 USGS land cover datasets.

The majority of land in the watershed is rural. Agriculture is mixed and includes substantial, conventional corn and soybean row cropping, large confined livestock feeding operations, hay and pasture lands, as well as an assortment of hobby farms and homesteads. Notable transitions in agriculture over the past forty (40) years involve significant operation expansion. Historically, crop fields were limited to fifty (50) acres or less, and were bordered by fencerows. Livestock operations were also limited in size. As technology advances, agricultural operations continue to increase in size, removing fencerows and head per acre restrictions. Large livestock operations are regulated by IDEM. There are no size requirements or restrictions on cultivation.

It should be noted that areas categorized by agricultural use may include substantial conservation practices through federally supported programs. These practices may include filter strips, riparian buffers, grass waterways, wildlife habitat, and/or wetlands. Bartholomew and Decatur Counties currently generate the highest workload in the region for conservation practices through federal programs, as well as substantial independent conservation efforts by residents.

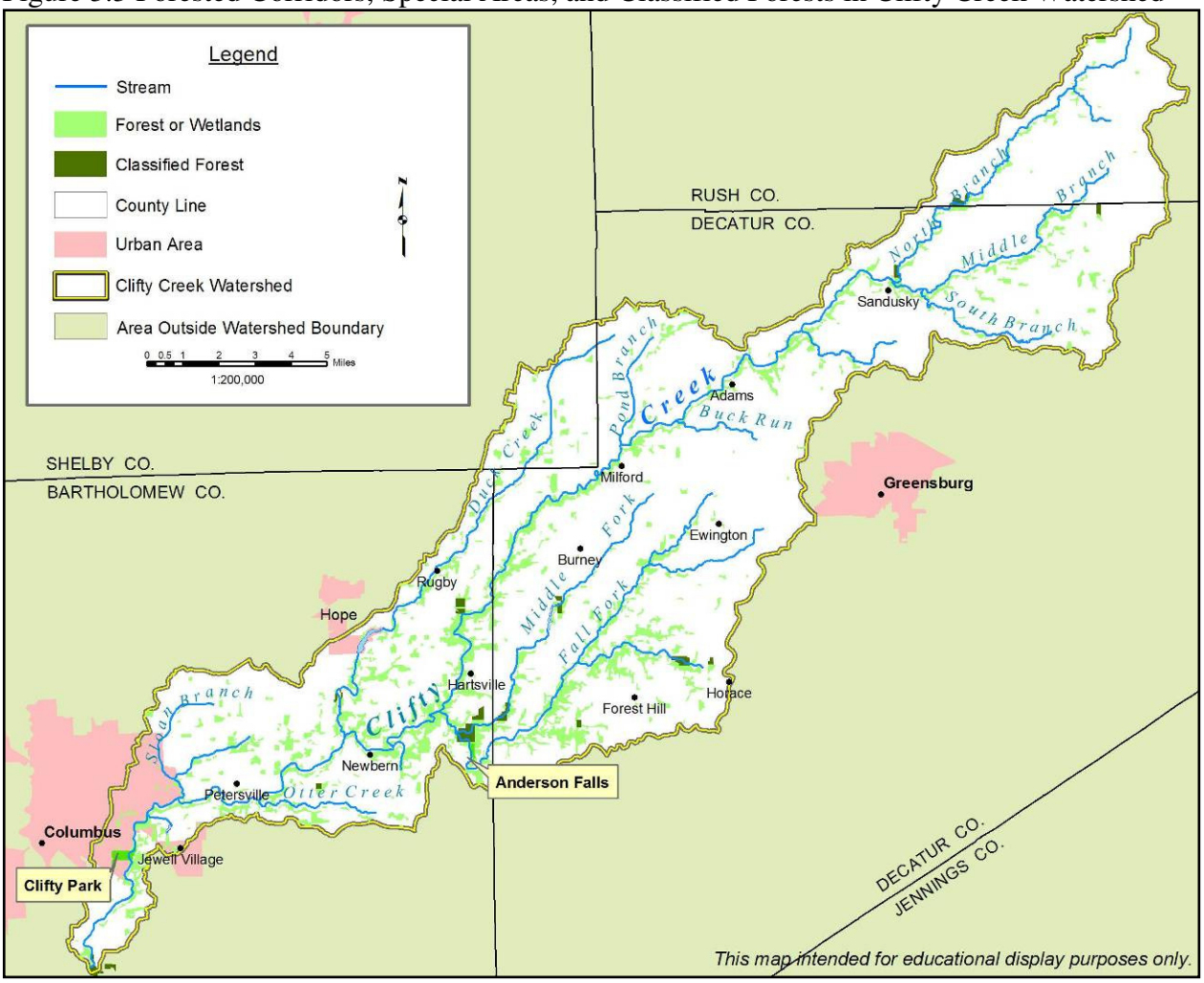
Remaining areas in the watershed include rough ground, ravines, and waterways, which are typically forested and can be wet seasonally.

3.3 Land Ownership

Figure 3.3 identifies forested areas within the watershed in addition to areas designated specifically for environmental or recreational benefits.

Two areas in the watershed are designated Special Areas by the Upper East Fork White River Watershed Restoration Action Strategy (WRAS). Clifty Creek Park is located on the main stem Clifty Creek in Columbus, and Anderson Falls State Nature Preserve is located on the Fall Fork of Clifty Creek (Section 3.3.1). Areas of Classified Forest are distributed across the watershed.

Figure 3.3 Forested Corridors, Special Areas, and Classified Forests in Clifty Creek Watershed



3.3.1 Anderson Falls

Anderson Falls is a clear testament to the importance of civic action and the intrinsic value of natural space. Slated in the early seventies to be dammed by the Army Corps of Engineers, Anderson Falls was a rallying point for the Clifty Creek Concerned Citizens who worked to successfully halt the reservoir project, which was eventually deregistered by the Corps.

The falls and surrounding property were acquired by The Nature Conservancy in 1977, which later transferred ownership to the Bartholomew County Park Board. Dedicated as a State Nature Preserve in spring 2004, the Indiana Department of Natural Resources recognized Anderson Falls as an area rich in native plant diversity and aesthetic beauty.

Native wildflowers are abundant in early spring months, a rare assembly of over 200 different types of wild plants on display for the eager botanist. The majority of these flowers are to the east of the falls. Many visitors are unaware that the preserve is much larger than the viewing area and roadside trails. In fact, the preserve extends across just over 40 acres incorporating a small trail network.

Figure 3.3.1 Anderson Falls

From a geological perspective, Anderson Falls is unique to the region. The area contains steep-walled valleys and a waterfall. At the falls, spanning close to 100 feet, water cascades 13 feet from the limestone bed to a pool below. Beneath the limestone lies outcroppings of Waldron shale that is easily eroded which is how the falls were formed and what is still causing them to slowly progress upstream.

3.3.2 Clifty Park

The City of Columbus has an expansive park system for a city of its size. Clifty Park is located along the main stem, providing riparian areas to stabilize extreme cliffs and shade sandy beds. A portion of the city's greenway, the People Trail, traverses the park. Natural foot paths are woven through the wooded corridor, and the park helps to balance green space with downstream areas of development.

3.3.3 Classified Forest

Indiana Department of Natural Resources (IDNR) sponsors a program to encourage landowners to keep private forests intact. According to the IDNR website:

> "[Classified Forests] are areas of 10 acres or more, supporting a growth of native or planted trees, which have been set aside for the production of timber and wildlife, the protection of watersheds, or the control of soil erosion. Lands designated as such by the state forester are eligible for assessment at $1.00 per acre and taxes are paid on that assessment…. The owner of classified forest land does not relinquish ownership or control of his property and Division of Forestry does not become connected in any way with the ownership of the land. The Division of Forestry is interested in seeing that the land is protected from fire, grazing and destructive harvest practices and in assisting the woodland owner in obtaining the multiple benefits of a healthy forest."

There are several areas within the watershed that are registered in the Classified Forest program, accounting for approximately 795 acres (Figure 3.3). Areas in Classified Forest exist throughout the watershed, and there are significant stands surrounding the Anderson Falls State Nature

Preserve, as well as the mouth of Clifty Creek as it empties into the Upper East Fork of the White River.

3.4 Point Source Discharge and, Regulated Permits

The Clifty Creek Watershed Management Plan focuses primarily on nonpoint source pollution, which encompasses diffuse, unregulated contaminants and respective sources. The approach to management planning is non-regulatory, and is designed to improve water quality through traditional Best Management Practices (BMPs), innovative solutions, and community collaboration.

Point source pollution is the opposite of nonpoint source pollution. Point source pollution comes from a distinct, regulated outfall. These sources are permitted through a regulatory process titled the National Pollution Discharge Elimination System (NPDES). Contaminants discharged from these sources are monitored daily. Results of monitoring are reported to IDEM on a monthly basis. In the Clifty Creek Watershed, there are twelve (12) entities that hold NPDES permits (Appendix E). However, there are only two (2) active outfalls located in the watershed, both permits are wastewater related.

In addition to NPDES outfalls, the state regulates and monitors confined feeding operations (CFOs). Livestock operations designated as CFOs meet specific state criteria regarding size and practice. According to 2007 data from IDEM, there are fifty (52) CFOs in the Clifty Creek Watershed. Thirty-three (33) of these permits were active in 2007 (Table 3.4).

Table 3.4 Confined Feeding Operation (CFO) permit status in the Clifty Creek Watershed

Permit Status	Bartholomew County	Decatur County	Rush County	Shelby County
Active	1	26	5	1
Inactive	0	1	0	0
Pending	0	0	0	0
Voided	1	13	3	1

3.5 Legal Drains

Legal drains are regulated waterways engineered to move water from drained land as quickly as possible. The presence of legal drains is common to the Midwest, due to the combination of abundant fresh water, agricultural growth, and poorly drained soils (Section 3.1: Natural History and Human Influence). Bartholomew, Rush, and Shelby Counties all have regulated legal drain systems. Decatur County does not have a regulated legal drain system. It should be noted that most acres in the watershed are influenced by some sort of human-influenced drainage such as tile lines. In many instances, regulated drains serve as a means to direct tile drainage as well as surface drainage away from fields and residences. Typically, legal drains are channelized intermittent streams or roadside ditches.

According to the Purdue University College of Engineering:

> "Channelization may take on many forms. It may entail removing bends from a meandering river to make it more navigable. On a smaller scale it may entail "ditching" or straightening of a stream in order to divert water away from agricultural fields… Regardless of the intent, the overall impact of channelization … is likely to be negative. Channelization of streams and rivers typically results in increased downstream sedimentation and increasingly severe downstream flooding." (http://agen521.www.ecn.purdue.edu/)

Sloan Branch is the only maintained, legal drain in the Clifty Creek Watershed. This tributary is one component of a larger system of regulated drains in Bartholomew County. However, there are many unregulated drains throughout the watershed. Rush County has an extensive system of legal drains, which may divert water from land outside of the watershed boundary into the Clifty Creek Watershed.

4.0 Investigation of Water Quality Issues and Benchmarks

Section Overview: Watershed Assessment

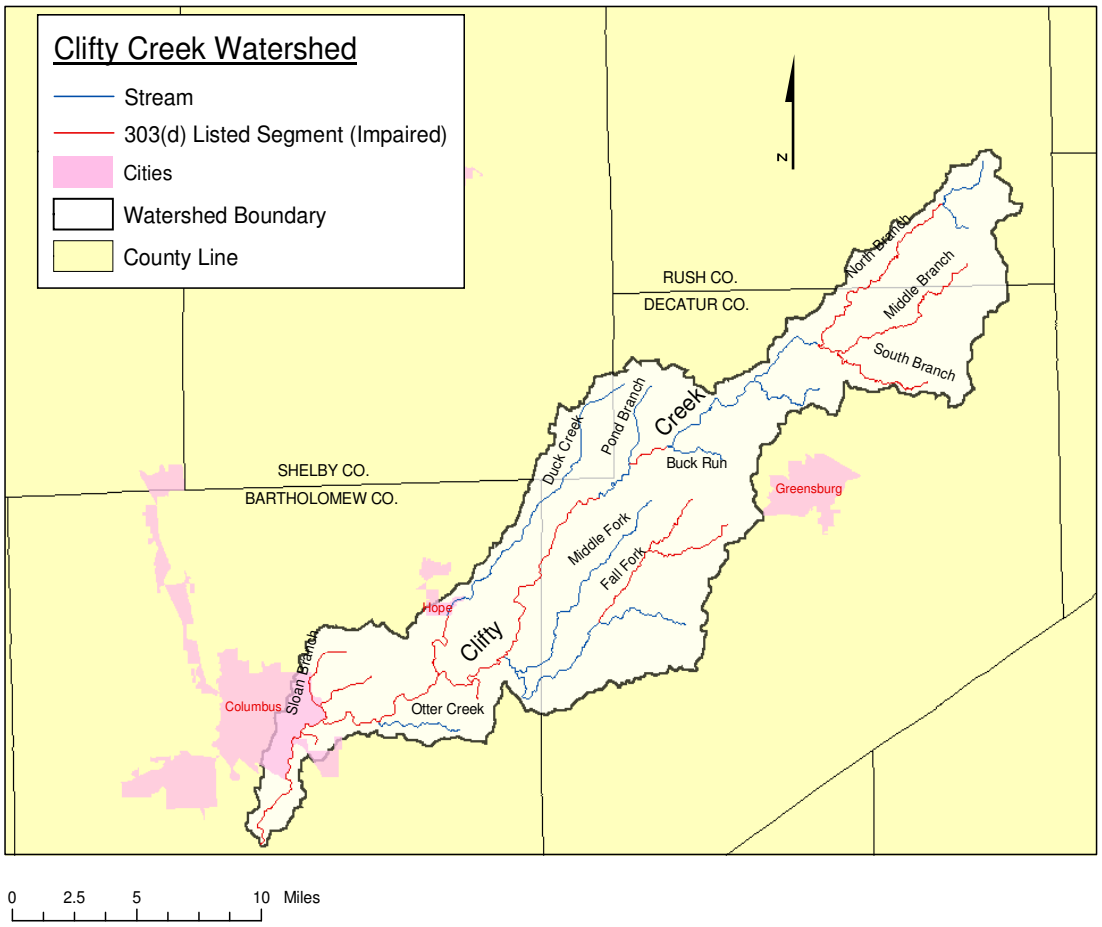
Throughout the planning process, data gathering, visual assessments, and spatial data research have been conducted for the purpose of compiling a watershed inventory. This inventory is designed to address watershed concerns comprehensively. As land use changes and practices evolve, it will be necessary to modify this section to reflect new information.

4.1 Designated Use, Assessment, and Impairment

Streams throughout the United States are classified on a state-by-state basis according to provisions established in the amended Federal Clean Water Act (1977). Classification is based on specific use designations such as the support of aquatic life, human health, and recreation. Indiana waters are designated by the Indiana Water Pollution Control Board (IAC, Title 327), which requires that water bodies outside of the Great Lakes System support full body contact recreation from April to October, a well-balanced, warm water aquatic community, and where temperatures permit, put-and-take out trout fishing (IAC 327 2-1-3(a)).

In addition to the classification of water bodies, Section 303 of the Clean Water Act also requires that states assess and prioritize the condition of waters every two (2) years. Assessment relies on state minimum water quality standards (IAC 327 2-1-6). Those water bodies not meeting state standards for designated use are considered impaired.

Figure 4.1 Segments in the Clifty Creek Watershed listed on the 2008 303(d) List of Impaired Waterways



Water bodies in the Clifty Creek Watershed are all designated to support full body contact recreation and a well-balanced, warm water aquatic community. In 2008, eighteen segments of the Clifty Creek were listed on the 303(d) list of Impaired Waterways (ID: 376) for E.coli. These segments include water bodies on the Clifty Creek Middle Branch, Clifty Creek South Branch, Clifty Creek North Fork, Clifty Creek (upstream of Pond Branch), Clifty Creek-Hartsville, Clifty Creek-Newbern, Sloan Branch Clifty Creek, Duck Creek (downstream of Shaefer Lake), Clifty Creek-Columbus and a portion of main stem Clifty Creek. These segments are included in year 2008 annual 305(b) report, indicating that Clifty Creek does not meet state designated recreational standards for full body contact. Stressors for pathogens are considered by the report to be slight. In 2008, three segments were listed on the 303(d) list of Impaired Waterways (ID: 376) for Impaired biotic communities (IBC) (Figure 4.1). The three segments listed for IBC were on the Fall Fork Clifty Creek headwaters section. Segments listed are scheduled for Total Maximum Daily Load (TMDL) development within the next five years.

4.2 Land Inventory

Total drainage of the watershed area accounts for approximately 132,000 acres, encompassing agricultural, rural residential, urban/suburban, and commercial land uses through four counties (Table 4.2). For more information, please see Section 2: Describing the Watershed. Land use

practices significantly influence the quality of water, which depends largely on the types of practices employed. For many operations, there are Best Management Practices, or methods incorporated for the purpose of preventing and/or reducing environmental degradation.

Table 4.2 Land use percentages for the Clifty Creek Watershed

Land Use	Area (Acres)	% of Watershed	Categories
Water	290	Less than 1 %	Water
Low intensity residential	1,470	1 %	Urban/Suburban
High intensity residential	100	Less than 1 %	
Commercial	550	Less than 1 %	
Deciduous forest	7,400	6 %	Natural Vegetation
Evergreen forest	140	Less than 1 %	
Mixed forest	Marginal	Marginal	
Pasture/hay	30,280	23 %	Agriculture
Row crops	90,330	69 %	
Urban recreational grasses	390	Less than 1 %	Parks
Woody wetlands	750	Less than 1 %	Wetlands
Emergent herbaceous wetlands	Marginal	Marginal	

Percentages derived from 1992 USGS land cover datasets.

4.2.1 Agricultural Practices

Typically, agricultural use is based on topography and soil type. Flatter, well drained areas are dominated by corn and soy production (Table 4.2.1-1). Areas in the watershed towards the stream corridor vary substantially in terms of topography and drainage, and are often left to natural vegetation or used as marginal pastureland.

Table 4.2.1-1 Crop yields per year by county

County	Corn		Wheat	
	Acres	Yield (bushels)	Acres	Yield (bushels)
Bartholomew	55,476	5,872,668	3,946	204,344
Decatur	83,777	10,437,791	9,023	497,771
Rush	95,585	12,282,075	7,884	486,735
Shelby	92,051	11,069,155	6,710	371,207
	Soy beans		**Hay***	
	Acres	Yield (bushels)	Acres	Yield (tons)
Bartholomew	70,383	2,747,217	3,720	9,752
Decatur	62,057	3,006,111	5,393	14,717
Rush	88,600	4,229,922	6,007	17,923
Shelby	78,870	3,533,601	3,784	9,582

*2006 Data, all other data is from 2007

Similarly, conservation practices are employed in areas where soil type, topography, and drainage are conducive to such practices: i.e. conservation tillage is typically incorporated in well-drained, rolling areas with highly erodible lands (HEL) as opposed to flat tracts with heavy, wet soils. Utilizing Indiana crop transect data, conservation tillage practices for counties in the watershed are represented below (Table 4.2.1-2).

Table 4.2.1-2 2004 Crop transect data by county

	Corn			Soybeans		
County	No Till	Mulch Till	Conventional Till	No Till	Mulch Till	Conventional Till
Bartholomew	41%	20%	39%	63%	27%	10%
Decatur	10%	31%	59%	66%	30%	4%
Rush	27%	36%	37%	65%	20%	15%
Shelby	26%	22%	52%	81%	12%	7%

"Conventional-till or intensive-till - Full width tillage which disturbs all of the soil surface and is performed prior to and/or during planting. There is less than 15 percent residue cover after planting. Generally involves plowing or intensive (numerous) tillage trips. Weed control is accomplished with crop protection products and/or row cultivation

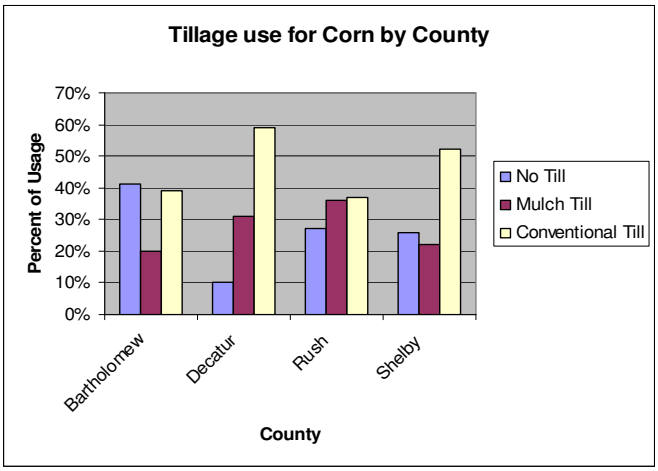
Conservation Tillage - Any tillage and planting system that covers 30 percent or more of the soil surface with crop residue, after planting, to reduce soil erosion by water.

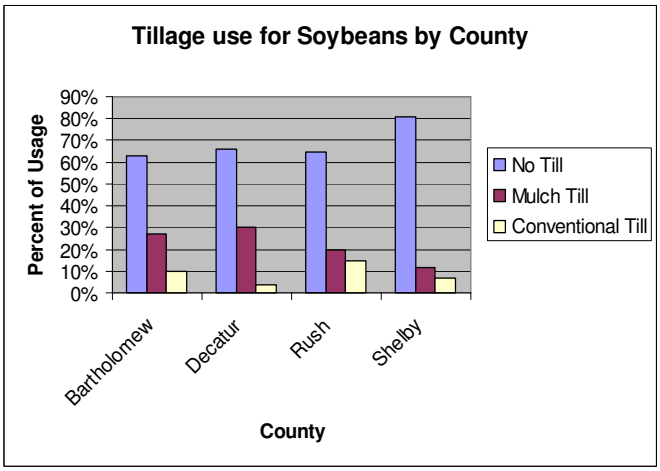
No-till/strip-till - The soil is left undisturbed from harvest to planting except for strips up to 1/3 of the row width (strips may involve only residue disturbance or may include soil disturbance). Planting or drilling is accomplished using disc openers, coulter(s), row cleaners, in-row chisels or roto-tillers. Weed control is accomplished primarily with crop protection products. Cultivation may be used for emergency weed control. Other common terms used to describe No-till include direct seeding, slot planting, zero-till, row-till, and slot-till.

Mulch-till – Full-width tillage involving one or more tillage trips which disturbs all of the soil surface and is done prior to and/or during planting. Tillage tools such as chisels, field cultivators, disks, sweeps or blades are used. Weed control is accomplished with crop protection products and/or cultivation."

- Definitions from the Conservation Technology Information Center (CTIC)

Figure 4.2.1 Crop transect data for counties in the Clifty Creek Watershed



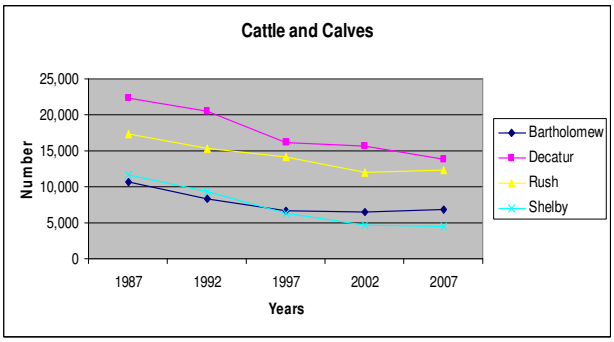


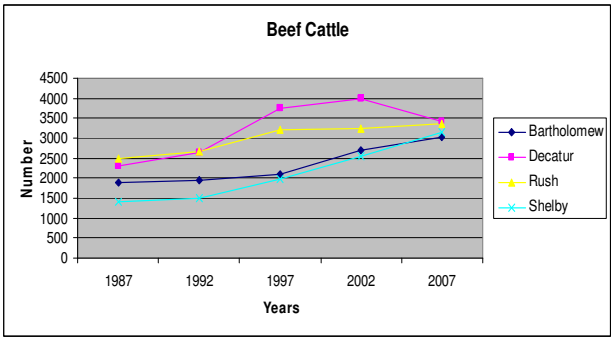
4.2.2 Agricultural Practices: Livestock

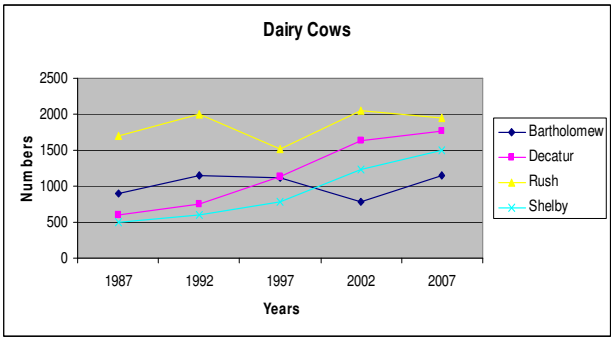
In addition to the cultivation practices in the watershed, agriculture includes substantial livestock production. Livestock operations are diverse, categorized by the number of animals and the amount of space utilized in production. Confined operations are permitted and regulated by the state (See Section 3.4: Point Source Discharge and Regulated Permits). Livestock concentrations by county are represented in Table 4.2.2 and Figure 4.2.2-1 below:

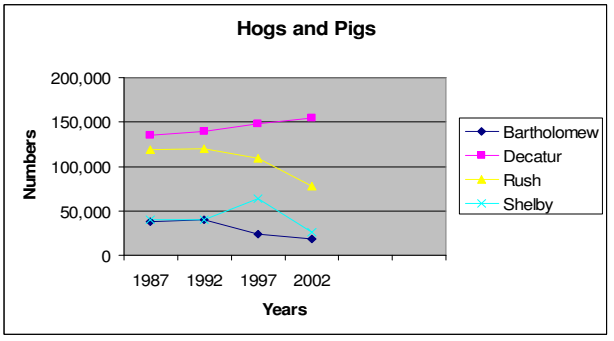
Table 4.2.2 and Correlating Figures Livestock numbers by county and trends over time

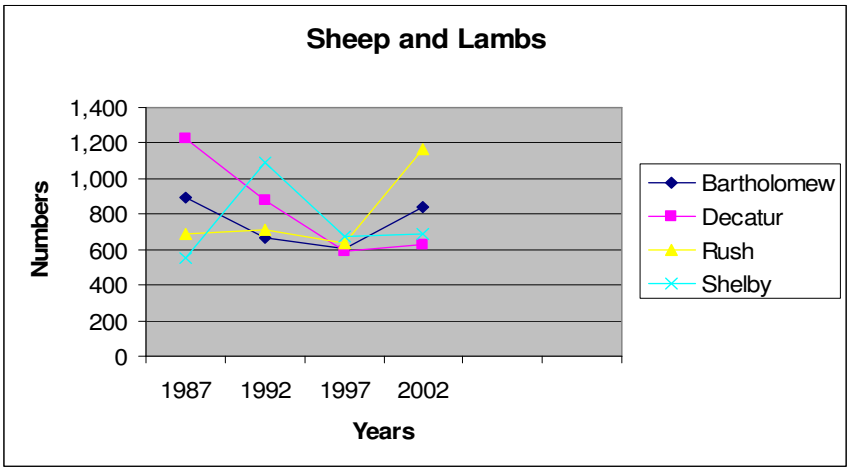
County	Livestock Type	Number
Bartholomew	Cattle and Calves*	6,900
	Beef Cows*	1,900
	Milk Cows*	900
	Hogs and Pigs	18,755
	Sheep and Lambs	837
Decatur	Cattle and Calves*	13800
	Beef Cows*	2,300
	Milk Cows*	600
	Hogs and Pigs	154,586
	Sheep and Lambs	629
Rush	Cattle and Calves*	12,400
	Beef Cows*	2,500
	Milk Cows*	1,700
	Hogs and Pigs	77,549
	Sheep and Lambs	1,165
Shelby	Cattle and Calves*	4,500
	Beef Cows*	1,400
	Milk Cows*	500
	Hogs and Pigs	25,471
	Sheep and Lambs	685











** 2007 Data, all other data is from 2002*
Data Source: USDA Agricultural Marketing Service
Figure 4.2.2 -1 Livestock numbers by county and trends over time

Livestock are present throughout the Clifty Creek Watershed, and in many places, livestock access to streams is unrestricted (Figure 4.2.2-2). Additionally, waste storage and manure management are pressing issues for producers. Best Management Practices for livestock operations include the development and use of Nutrient Management Plans and/or Prescribed Grazing Plans. Prescribed Grazing Plans often incorporate stream bank fencing and improved watering systems to reduce livestock use and access to streams (Figure 4.2-2).

Figure 4.2.2-2 Unrestricted livestock access

4.2.3 Urban/Suburban/Impervious Surface and Population Density

Although the Clifty Creek Watershed is predominantly agricultural, urban, suburban, and rural residential influences exist. Additionally, urban/suburban areas within the watershed cater to heavy commuter traffic, which augments the influence these areas have on water quality. Residential, commercial, and impervious surface occupy just over two percent (2%) of the total watershed area, just over 2,100 acres, largely concentrated in the Columbus area. Cities, towns, and major subdivisions in the watershed include: Adams, Burney, Columbus, Ewington, Forest Hill, Hartsville, Horace Jewell Village, Milford, Newbern, Petersville, Rugby, and Sandusky.

Growth in population throughout the watershed is consistent. However, with respect to the wider commuting area, population has steadily increased, and a dramatic surge in growth has occurred in the past twenty (20) years (Figure 4.2.3).

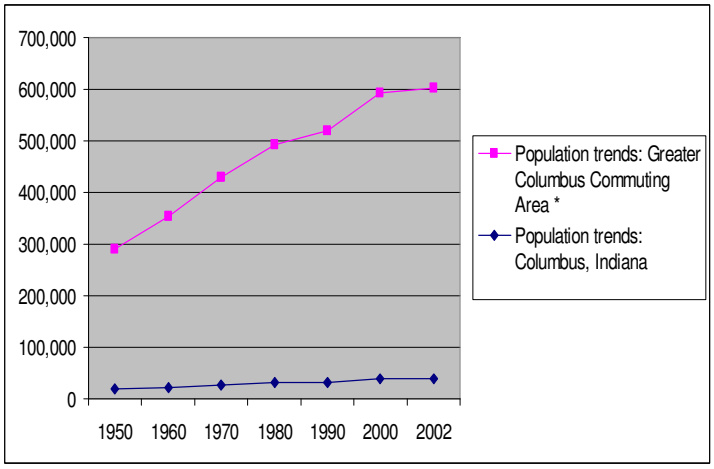
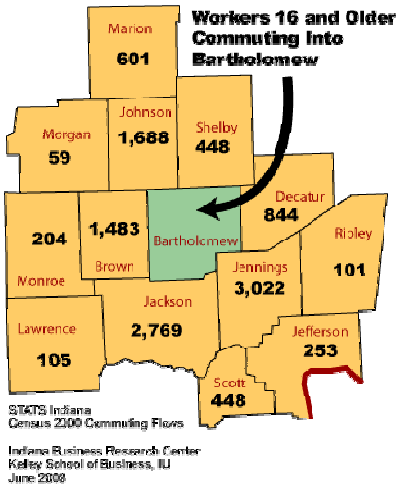


Figure 4.2.3 Population increase in Columbus and the Columbus commuting area

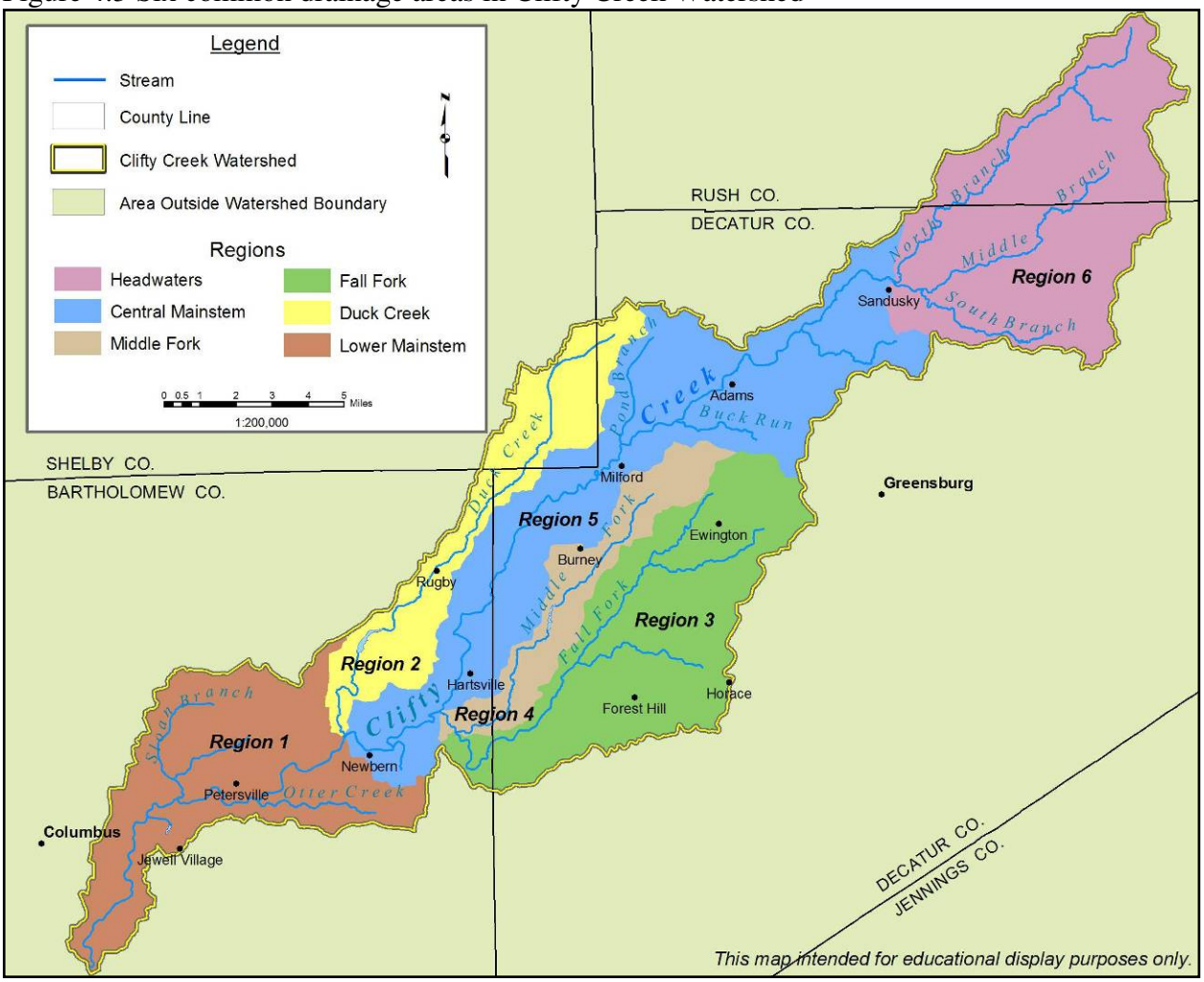
The Columbus commuting area includes Bartholomew, Brown, Decatur, Jackson, Jennings, Johnson, Lawrence, Monroe, Ripley, Shelby and Scott Counties (Graphic below)



4.3 Land Inventory: Visual Assessment and Spatial Research by Region

Due to the scale of the watershed area, the watershed has been divided into six (6) common drainage areas, which reflect similar land use practices, hydrology, and datasets (Figure 4.3).

Figure 4.3 Six common drainage areas in Clifty Creek Watershed



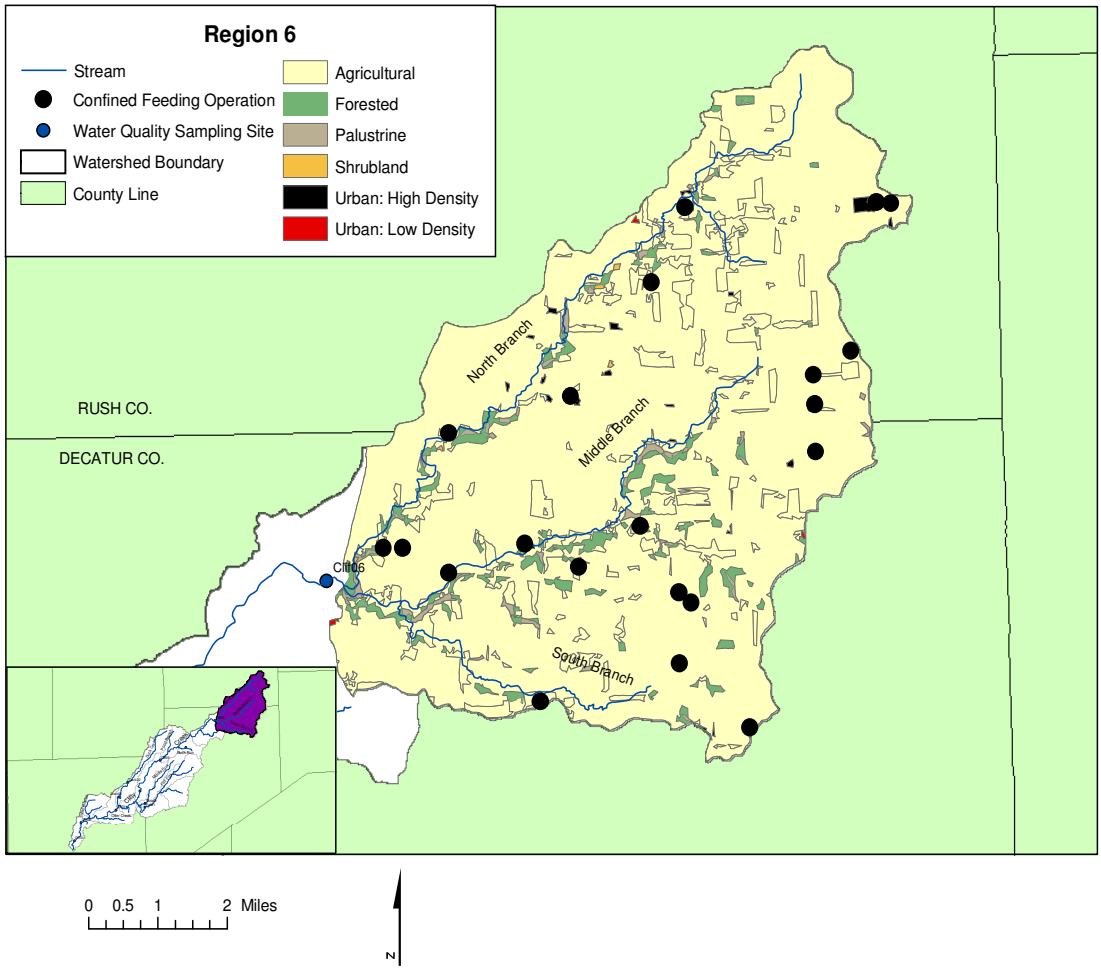
Headwaters (Map ID: 6)

The headwater region includes the North, Middle, and South Branches of Clifty Creek. Occupying portions of southeastern Rush County and northeastern Decatur County, the headwaters drain lands used predominantly for row crops, with occasional rural homes and farm homesteads (Table 4.3-1). Row crops typically incorporate full till practices, and land beyond the stream corridor is flat, though elevated. There are twenty one (21) regulated confined feeding operations in this region (Figure 4.3-1). Flow varies seasonally. In early spring, flows can be difficult to stand in. However, flow is reduced significantly in late summer months such that stream beds form slow to stagnant ponds in low areas. It is not uncommon for the creek to freeze during winter months.

Table 4.3-1 Land use percentages for headwaters region

Land Use	% of Watershed
Water	Less than 1 %
Urban/Suburban/Commercial	Less than 1 %
Natural Vegetation	3 %
Hay/Pastureland	18 %
Row Crops	78 %
Parks	0
Wetlands	Less than 1 %

Figure 4.3-1 Land use and Confined Feeding Operations in headwaters region



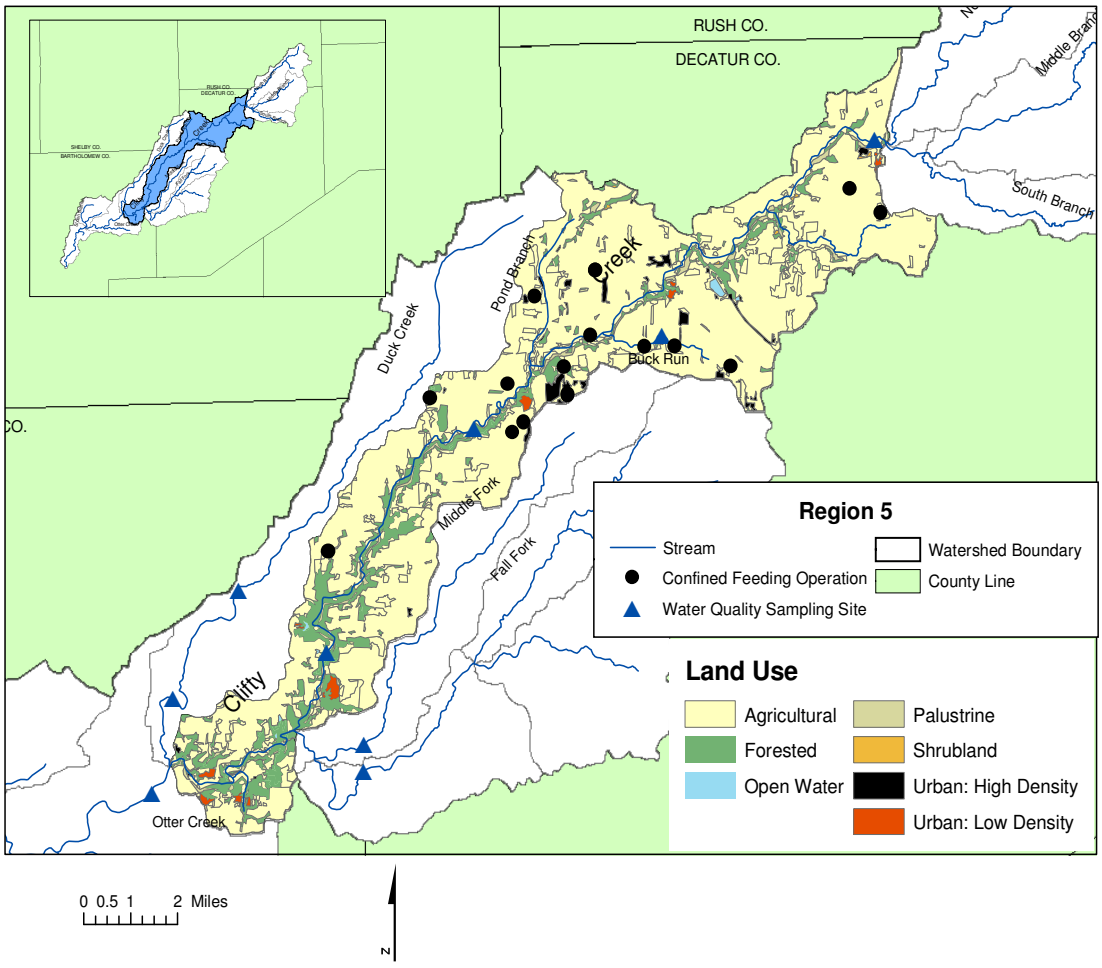
Current data collection for this region is represented by CLIF06, sampled north of Sandusky upstream of the State Highway 3 Bridge (Figure 4.3-1). Access to the site is granted by Knecht Builders. Additionally, IDEM sampled three (3) sites during the 2002 TMDL assessment. Water quality samples indicate seasonal elevations of nitrates, chloride, and sediment. IDEM TMDL data collection in this region documented extreme values in August 2002. Turbidity measured 119.5 NTU, dissolved oxygen was 2.13 mg/L, and pH was 6.9 (water temperature was 23.75 degrees Celsius).

Central Main stem Region (Map ID: 5)

Main stem segments of Clifty Creek (Figure 4.3-2) are characterized by wide riparian corridors, broad, cobbled stream beds, and small towns. Traveling downstream from Sandusky, Clifty Creek passes Milford, Adams, and Hartsville towards Petersville and Columbus. Sandusky, Milford, and Adams all incorporate septic systems for wastewater treatment. The Decatur County Health Department has documentation of septic system failure in each town.

Land beyond the stream corridor is typically agricultural (91%), with mixed use ranging from row cropping to hay/pasturelands (Table 4.3-2). Seventeen (17) regulated feeding operations exist in this region, predominantly in Decatur County. Additionally, both regulated National Pollutant Discharge Elimination System (NPDES) outlets discharge to the Clifty Creek in this region.

Figure 4.3-2 Central Main stem Clifty Creek Watershed



Current data collection for this region is represented by sites CLIF04 (USGS gage station), CLIF05, and CLIF07. USGS, BCSWCD, and IDEM have sampled multiple sites in this region, and for this region existing data is abundant. Several main stem segments in this region represent exceptional conditions in Clifty Creek.

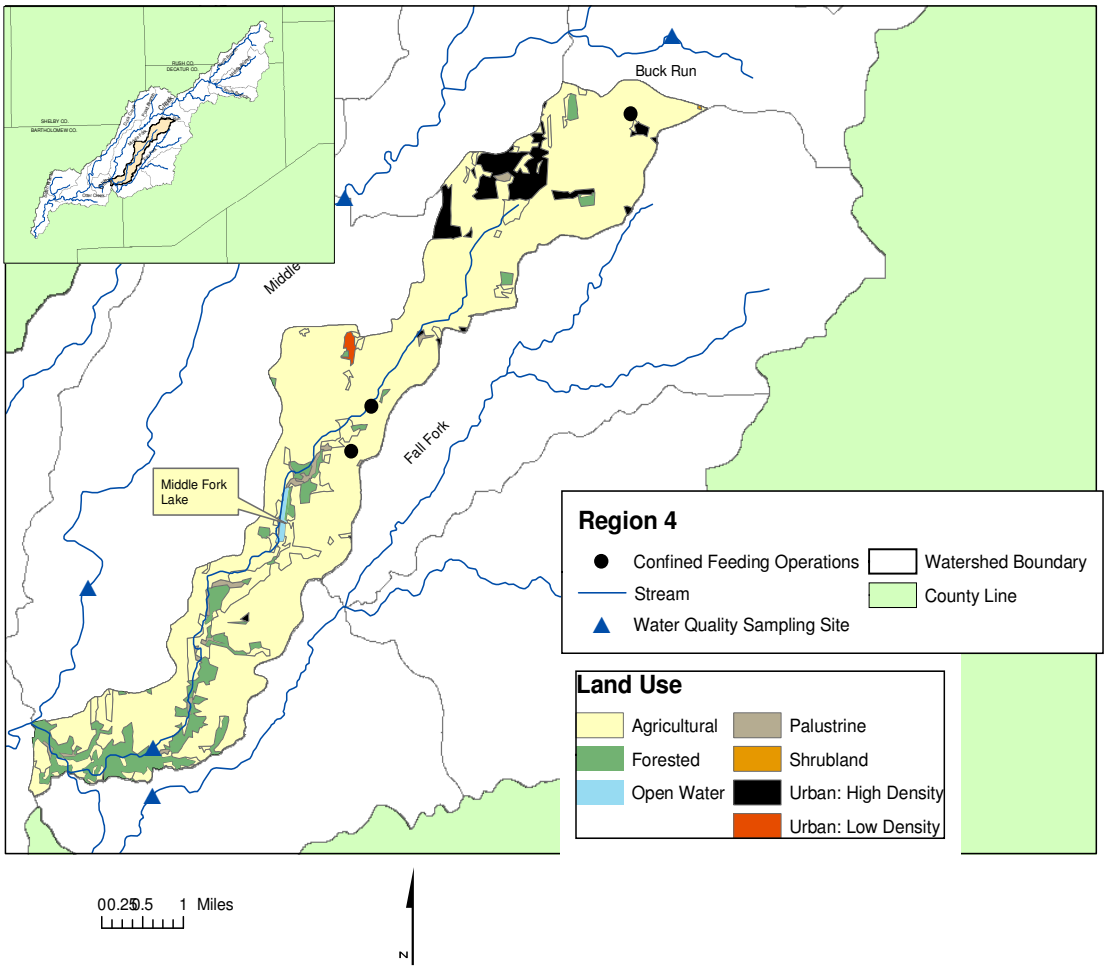
Table 4.3-2 Land use percentages for central main stem region

Land Use	% of Watershed
Water	Less than 1 %
Urban/Suburban/Commercial	1 %
Natural Vegetation	8 %
Hay/Pastureland	22 %
Row Crops	69 %
Parks	1
Wetlands	Less than 1 %

Middle Fork (Map ID: 4)

Middle Fork is geologically different from main stem Clifty Creek and neighboring Fall Fork, with loam till deposits dominating streambeds, as opposed to solid bedrock. Flow varies seasonally, conditions are conducive to whitewater paddling in spring and early-summer, but are reduced significantly in late-summer. A principal tributary to Clifty Creek, Middle Fork is bisected by Middle Fork Lake, which is an enhanced agricultural pond (Figure 4.3-3). Canada Geese have been observed on Middle Fork Lake, which is surrounded by a farm homestead.

Figure 4.3-3 Middle Fork Region



The town of Burney is also located in this region. Homes in the town rely on septic systems. According to the Decatur County Health Department, there is a well-documented history of septic system failure due to the age of systems, design, and placement.

Please see Table 4.3-3 for complete land use calculations for the Middle Fork subwatershed.

Land use upstream of Middle Fork Lake is dominated by agriculture (93%), with few areas of natural vegetation (6%). This results in narrow riparian corridors, increased livestock access, and eroding stream banks. Several areas are devoid of stream buffers. There are three (3)

confined feeding operations in this region. Below the lake, riparian corridors exist, but are often narrow and unconnected. However, just above the confluence of Middle Fork with Fall Fork, deciduous forest cover is reestablished, and is relatively contiguous.

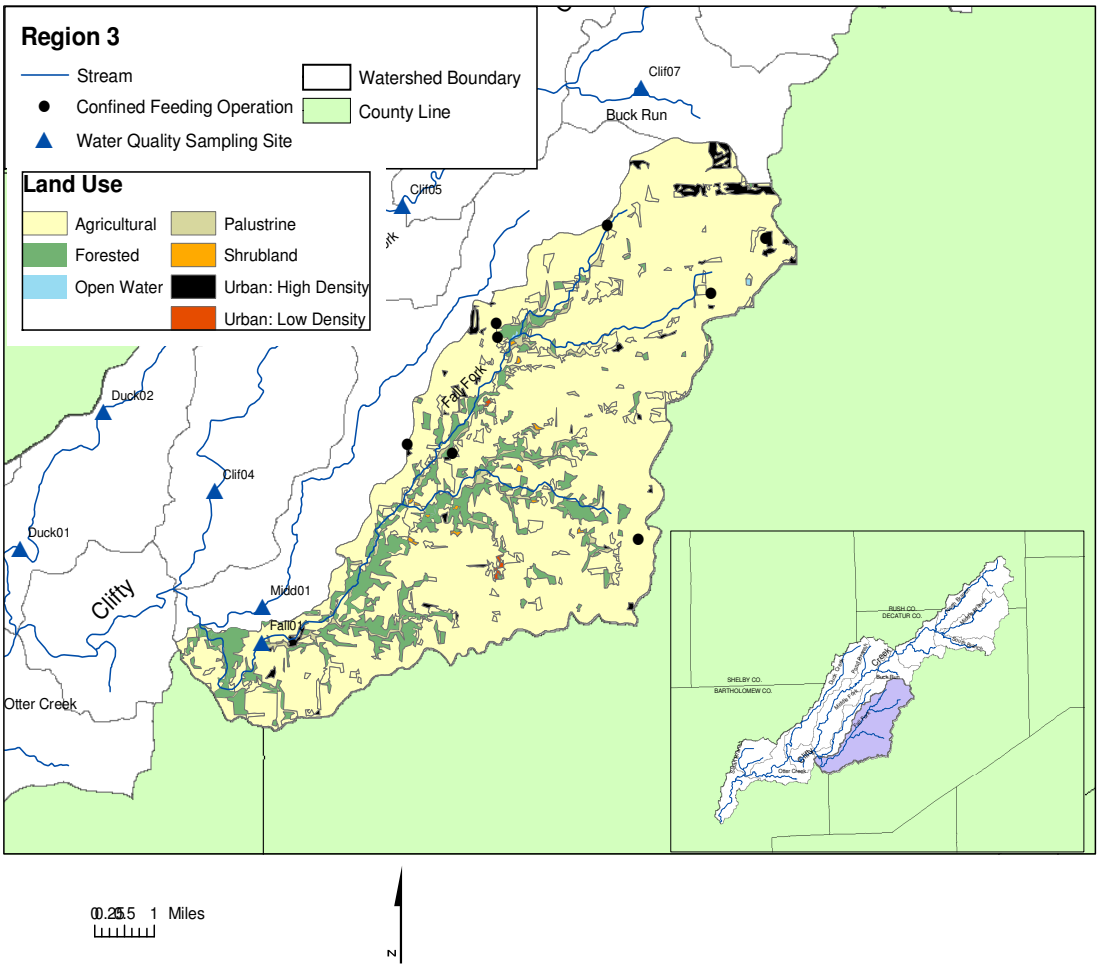
Table 4.3-3 Land use percentages for Middle Fork Region

Land Use	% of Watershed
Water	Less than 1 %
Urban/Suburban/Commercial	Less than 1 %
Natural Vegetation	6 %
Hay/Pastureland	21 %
Row Crops	72 %
Parks	0
Wetlands	Less than 1 %

Current data collection for Middle Fork is represented by site MIDD01. Historic data collection has typically occurred downstream from the confluence of Middle Fork and Fall Fork. This information can be utilized for calculating contaminant loading. However, data ranges do not accurately represent conditions solely in Middle Fork.

Fall Fork Region (Map ID: 3)

Figure 4.3-4 Fall Fork Region



Fall Fork is the largest contributing tributary to Clifty Creek when considering the total area of land drained (37.5 miles^2). However, flow varies seasonally, and is substantially reduced in late summer months, similar to the described flow in the headwaters region. In mid- to late-summer months, several tributaries as well as upstream portions of Fall Fork demonstrate increased algal growth. Sediment has also been observed to accumulate along bedrock portions.

Although land use percentages are similar to those in Middle Fork (Table 4.3-4), the Fall Fork maintains a relatively contiguous riparian corridor throughout the region. Anderson Falls State Nature Preserve is located in this region, which is valued for high biodiversity and rare wildflowers.

Agriculture accounts for over ninety percent (90%) of the region, and conventional tillage is prevalent. Livestock have access to the creek throughout the region, and a large portion of pastureland is adjacent to stream corridor. There are eight (8) confined feeding operations in this region.

Table 4.3-4 Land use percentages for the Fall Fork Region

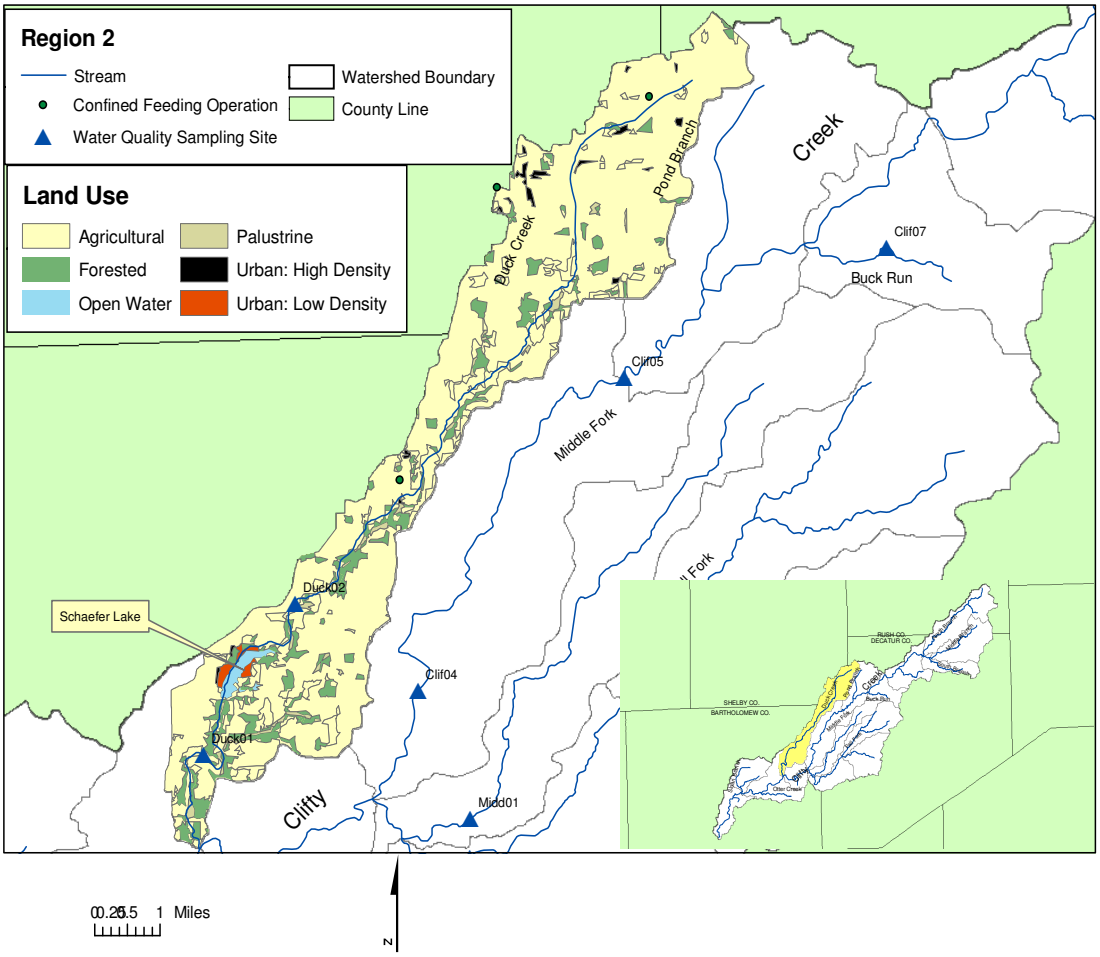
Land Use	% of Watershed
Water	Less than 1 %
Urban/Suburban/Commercial	Less than 1 %
Natural Vegetation	8 %
Hay/Pastureland	21 %
Row Crops	70 %
Parks	0
Wetlands	Less than 1 %

Current data collection for this region is represented by site FALL01. Existing data for this region includes 2002 TMDL assessment as well as intermittent pesticide sampling initiated by the Bartholomew County SWCD in cooperation with Columbus City Utilities.

Duck Creek Region (Map ID: 2)

Duck Creek originates in southeastern Shelby County, draining across pastureland and intermittent wooded areas (Figure 4.3-5). Duck Creek forms Schaefer Lake, which is densely surrounded by residential lots. From Schaefer Lake, the percentage of wooded buffer increases while the corridor oscillates between channelized runs and large, natural bends. Flow is typically slow and deep in runs, and riffles exist year-round.

Figure 4.3-5 Duck Creek Region



Although row crops comprise the highest percentage of land use in Duck Creek (Table 4.3-5), pastureland dominates the visual landscape, and Schaefer Lake is a fundamental component of the region. Livestock access the creek at various points throughout the region, and stream banks in these areas are eroding at varying rates. Several major projects to restrict livestock access have been initiated along Duck Creek through federal Natural Resource Conservation Service (NRCS) programs. There are three (3) confined feeding operations in this region.

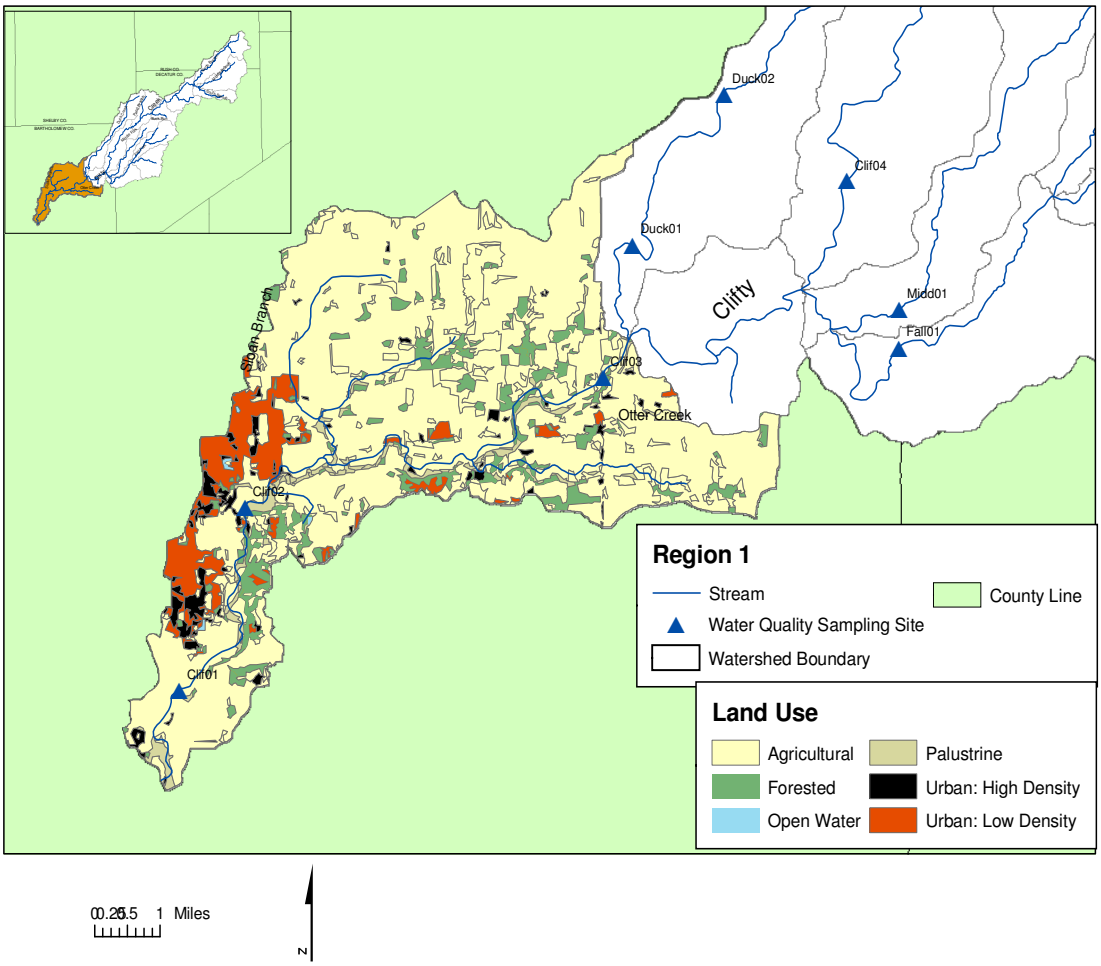
Table 4.3-5 Land use percentage in Duck Creek Region

Land Use	% of Watershed
Water	Less than 1 %
Urban/Suburban/Commercial	Less than 1 %
Natural Vegetation	5 %
Hay/Pastureland	26 %
Row Crops	68 %
Parks	0
Wetlands	Less than 1 %

Duck Creek has been extensively sampled and is currently represented by sites above (DUCK01) and below (DUCK02) Schaefer Lake. Both IDEM and the BCSWCD sampled this creek during their assessments.

Lower Main stem Region (Map ID: 1)

Figure 4.3-6 Lower Main stem Region



As the main stem portion of Clifty Creek flows towards its confluence with the East Fork of the White River (Figure 4.3-6), the landscape transitions from agricultural production into the urban/suburban neighborhoods of Columbus (Table 4.3-6). The transition is gradual. Sloan Branch is heavily cropped, and is the only regulated drain in the watershed. However, alongside the farm boundaries emerge golf courses and rural residences. Commercial properties begin past Petersville, and by the time Clifty Creek flows beneath State Highway 31, the landscape is entirely urban.
The Lower Main stem region has been extensively sampled and is currently represented by sites CLIF01 (USGS gage site), CLIF02, and CLIF03.

Table 4.3-6 Land use percentage in Lower Main stem Region

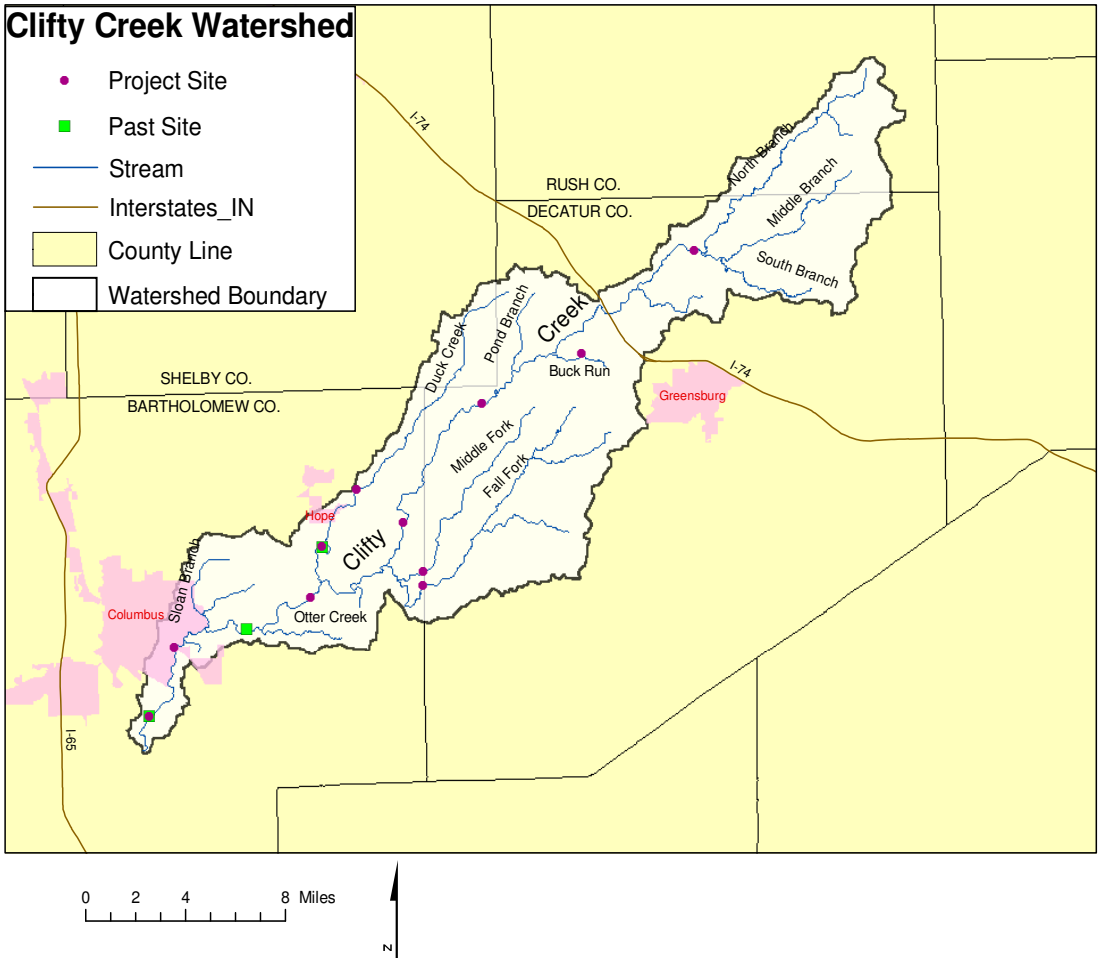
Land Use	% of Watershed
Water	Less than 1 %
Urban/Suburban/Commercial	8 %
Natural Vegetation	4 %
Hay/Pastureland	32 %
Row Crops	53 %
Parks	2 %
Wetlands	1 %

4.4 Existing Data and Current Water Quality Sampling

In addition to state level assessments, various studies were conducted in the Clifty Creek Watershed by the United States Geological Survey (USGS) as well as the Bartholomew County Soil & Water Conservation District (BCSWCD) in cooperation with Columbus City Utilities. This information was used to assess conditions during the planning process. Sites previously sampled were also taken into consideration as the Watershed Project established a volunteer water quality monitoring network in June 2004.

Currently, volunteer data collection occurs at ten sites throughout the watershed from Columbus to Sandusky, for the purpose of monitoring flow, chemistry, biology, and habitat. (Data can be found in Appendix D.) Flow, chemistry, and habitat data collection occur monthly in accordance with submitted Clifty Creek Watershed Quality Assurance Program Plan (QAPP), approved by IDEM in 2005. Biological sampling occurs twice yearly in late spring and early fall. Data collection incorporates in-field sampling methods as well as laboratory analysis utilizing and EPA approved methods. Total phosphorus is analyzed by the Columbus City Utilities laboratory. Sampling sites are identified in Figure 4.4.

Figure 4.4 Current and previous water quality sampling sites in the Clifty Creek Watershed



4.4.1 Chemical and Pathogen Data

Existing chemical data, most notably over the past ten years supports public concern for the Clifty Creek Watershed. In 1996, the BCSWCD initiated county-wide water quality sampling with Columbus City Utilities (CCU), selecting three (3) sites in the Clifty Creek Watershed. Results indicated E. coli levels well above state designated recreational standards (235 colonies/100 mL) in Clifty Creek, spiking at 1733 colonies/100mL, and remaining consistently between 240 and 660 colonies/100mL throughout the year.

The results of this study prompted a continuation of water quality sampling, widening study parameters to include pesticide assays in April 1999. Pesticide data revealed seasonal spikes of atrazine in the Clifty Creek, where levels reached 7 parts per billion (ppb) (Table 4.4.1-1). These values concur with 2002 Total Maximum Daily Load (TMDL) data collected by the IDEM Assessment Branch in the Clifty Creek Watershed, which identified similar values and peaks for E.coli and atrazine.

Table 4.4.1-1 Summary statistics for selected parameters, 1996-2001, BCSWCD/CCU

Location	Parameter	Median	Minimum	Maximum
Clifty Creek, Gladstone (corresponds to CLIF01)	Atrazine (ppb)	2.39	BDL	7.00
	Alachlor (ppb)	BDL	BDL	0.34
	Simazine (ppb)	0.10	BDL	1.2
	E. coli (cfu/100mL)	240	0	1533
	Suspended Sediment	14	4	70
	Total Phosphorus (mg/L)	0.16	0.03	0.54
Clifty Creek, 500E (downstream Otter Creek)	E. coli (cfu/100mL)	234.5	0	1733
	Suspended Sediment	11	2	58
	Total Phosphorus (mg/L))	0.165	0.05	0.66
Duck Creek, 620N (corresponds to DUCK02)	Atrazine (ppb)	0.16	BDL	1.2
	Alachlor (ppb)	BDL	BDL	BDL
	Simazine (ppb)	0.08	BDL	0.24
	E. coli (cfu/100mL)	182	18	500
	Suspended Sediment	15	6	40
	Total Phosphorus (mg/L)	0.18	0.12	0.74
Duck Creek, 1200E (county line)	Atrazine (ppb)	0.66	BDL	2.4
	Alachlor (ppb)	BDL	BDL	BDL
	Simazine (ppb)	BDL	BDL	0.25
Clifty Creek, 700N (county line)	Atrazine (ppb)	.52	BDL	3.4
	Alachlor (ppb)	BDL	BDL	0.29
	Simazine (ppb)	BDL	BDL	BDL
Fall Fork (county line)	Atrazine (ppb)	1.4	BDL	3.4
	Alachlor (ppb)	BDL	BDL	BDL
	Simazine (ppb)	BDL	BDL	0.47

BDL=Below Detection Limits

Further emphasis of existing water quality problems can be found in corresponding chemical data from basin-wide studies supporting prioritization of Clifty Creek for restoration under the Unified Watershed Assessment of Indiana and the USGS National Water Quality Assessment (NAWQA). Samples collected for NAWQA were gathered at the current gage station on Clifty Creek near Hartsville. Information evidenced atrazine levels as high as 16 ppb (Table 4.4.1-2), as well as extreme ranges for seasonal nutrient concentrations (Table 4.4.1-3).

Table 4.4.1-2 Summary statistics for selected parameters, 1993-1995 USGS NAWQA, Clifty Creek, Hartsville

Detections	Common Name	Trade Name	Class	Minimum	Maximum
19/19	Simazine	Princep	Herbicide	0.006	0.670
19/19	Metolachlor	Dual	Herbicide	0.011	2.800
19/19	Atrazine	Several	Herbicide	4.576	16.00
17/19	Alachlor	Lasso	Herbicide	<0.002	4.100
16/19	Cyanazine	Bladex, Conquest, Cycle, Extrazine	Herbicide	0.008	4.100
13/19	Dieldrin	Several	Insecticide	<0.001	0.064
8/19	Fonofos	Dyfonate	Insecticide	<0.003	0.051
8/19	Metribuzin	Axiom, Lexone, Sencor	Herbicide	<0.004	0.190
7/19	Butylate	Genate, Sutan	Herbicide	<0.002	0.094
5/19	Fluometuron	Cotoran, Meturon	Herbicide	<0.04	<0.04

All values in parts per billion (ug/L). 15 other pesticides were detected at a frequency of 3/19 or less, respectively. The 19 samples represent each month (12), in addition to samples for April, May, June, and July.

Table 4.4.1-3 Summary statistics for selected parameters, 1993-1995 USGS NAWQA, Clifty Creek, Hartsville

Parameter	Median	Minimum	Maximum
Nitrate (mg/L)*	5.8	<0.05	15
Total Nitrogen (mg/L)*	6.9	0.225	16.8
Orthophosphate (mg/L)*	0.06	<0.01	0.61
Total Phosphorus (mg/L)*	0.07	<0.01	1.4
Suspended Sediment (mg/L)	37	3	886
Discharge (cfs)*	46	0.11	2200

*Seasonal information available through Indiana USGS

Current data collection supports prior information regarding consistently elevated levels of E.coli throughout the watershed. Volunteer monitoring has also detected several concentrated occurrences, specifically in Duck Creek and Middle Fork, where levels have repeatedly exceeded 2000 colonies/100mL in 2006 and 2007. (Table 4.4.1-4).

Table 4.4.1-4 Summary statistics for E.coli in Duck Creek and Middle Fork (colonies/100mL)

Location	Median	Minimum	Maximum
DUCK01 (Volunteer Data) (2004-present)	500	0	3050
DUCK02 (Volunteer Data) (2004-present)	613.5	0	9150
MID01 (Volunteer Data) (2004-present)	200	0	40000

Although Duck Creek has evidenced the greatest median pathogen concentrations, volunteer monitoring has recorded elevated bacterial levels in Middle Fork, Fall Fork, and main stem segments downstream of Fall Fork. The maximum value at DUCK01 has increased since 2005, and the median has remained the same. The previous data at that site showed a median of 500 colonies/100 mL and a maximum of 2500 colonies/100 mL. The median has increased since 2005, and maximum concentrations at Duck02 have stayed below the maximum seen in 2005. In the past the median was 600 colonies/100 mL and the maximum was 9150 colonies/100 mL. Mid01 wasn't listed in the previous plan but has shown some extreme spikes, as can be seen from the maximum value in the above table, although the overall average is below both Duck Creek sampling sites.

Though there is little information on groundwater, 2004 bacteriological data from an informal, private well-testing study in Bartholomew and Decatur counties indicated coliform presence in over forty percent (40%) of wells tested.

In addition to pesticide and bacteria data, volunteer monitors have documented substantial sedimentation, algal growth, and color change in downstream portions of Duck Creek, Middle Fork, Fall Fork, and Clifty Creek. Visual assessments and photographic documentation note the volume of sediment delivered to streams after rain events and the presence of dense algae in mid- to late-summer months.

4.4.2 Physical Data and Stream Habitat

The USGS maintains a real-time gage station on Clifty Creek near Hartsville. For over 30 years, stream flow and stage information have been collected, which documents the extreme variation in flow annually throughout the Clifty Creek Watershed. Specifically, data collected during a 1993-1995 assessment of the White River Basin indicated that variation in flow was most dramatic in Clifty Creek when compared to other sites.

The effects of such extreme variations of flow in Clifty Creek are observed by volunteers during habitat evaluation. Habitat assessments utilize a Citizens Qualitative Habitat Evaluation Index (CQHEI), which scores sites based on the presence or absence of specific natural characteristics. Overall, sites sampled score well due to the abundance of preserved natural features along stream corridors in the watershed. However, there are several sites where the velocity of water during storm events has stripped stream banks of vegetation. This is often observed with excessive sedimentation and subsequent smothering. Lack of vegetation, increased sediment, and smothering all reduce scores. For this reason, volunteer water quality data documents a mild correlation between CQHEI scores and transparency values, which represent sediment levels (Table 4.4.2).

Looking at the past data the average CQHEI and turbidity didn't show the pattern you would expect. Typically, if turbidity would increase you would expect to see a decrease in habitat quality and vice-versa. This is only the case with two sites (CLIF02 and CLIF06). At CLIF02 the average turbidity increased from 15.25 NTU to 22.59 NTU and the average habitat score decreased from 84.8 to 73.25. At CLIF06 the turbidity decreased from 25.4 NTU to 17.81 NTU and the habitat increased from 79.6 to 80.58. The other sites went against the expected trend. This could be due to the average values and the length of time that the data has been collected, as there is usually some natural variation over time based on year to year climate changes.

Table 4.4.2 CQHEI (2005-2008) correlation to turbidity values in the Clifty Creek Watershed

Site	Average CQHEI Score	Average Turbidity (NTU)
CLIF01	65.85	23.75
DUCK02	55.92	22.00
MIDD01	59.02	24.00
DUCK01	46.43	25.22
FALL01	72.12	20.23
CLIF06	80.58	17.81
CLIF03	81.25	26.25
CLIF02	73.25	22.59
CLIF05	89.15	20.89
CLIF04	88.7	21.71
CLIF07	80.53	20.54

Although there are unstable stream banks in the watershed, there are also outstanding examples of stream habitat in the Clifty Creek Watershed. Specifically, the area around Hartsville was documented by 1993 and 1995 USGS NAWQA as able to support exceptional biological communities. The sampling site was rated highest among those sampled in the White River Basin.

In addition to naturally occurring habitat, there are several downstream main stem segments of Clifty Creek that are rip-rapped with large concrete slabs. As well, several sites monitored are currently inundated with large trash (appliances, tires, etc.). Throughout the period of assessment, several sites were cleaned by local residents only to have materials reintroduced due to illegal dumping.

4.4.3 Biological Communities

NAWQA biological community studies rank the fish community at the Clifty Creek Site as good, which is defined by USGS as "species richness somewhat below expectation, especially because of loss of the most intolerant forms". In 1993 and 1995, studies documented forty-six (46) and forty-eight (48) species of fish respectively (Table 4.4.3-1). It should be noted that the percentage of intolerant fish species increased from 1993 to 1995. However, hydrologist Wes Stone with the USGS points out that the qualitative score attributed to habitat indicates that Clifty Creek should be able to support an excellent biotic community.

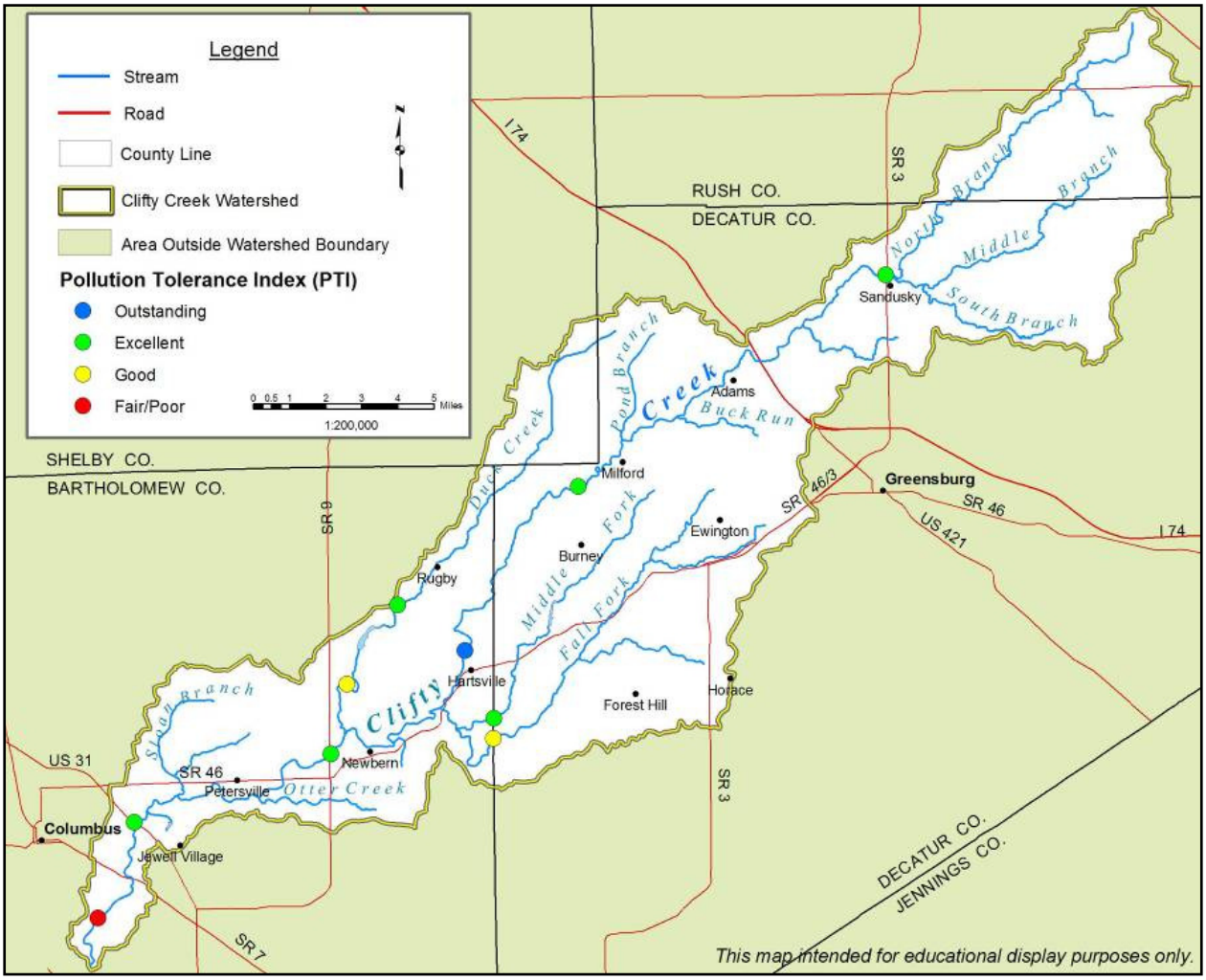
Table 4.4.3 Predominant fish species/families documented during 1993-1995 NAWQA

Year	Predominant fish species / families
1993	Minnow, longear sunfish, hogsucker, redhorse, bass, darter
1995	Minnow, river chub, hogsucker, redhorse, bass, rock bass, darter

Volunteer water quality monitoring ranks the macroinvertebrate community in Clifty Creek as good (Figure 4.4.3). Several sites demonstrate excellent community diversity, abundance and size. However, there are several sites in the watershed where macroinvertebrate communities

reflect the sentiment expressed in the USGS fish study: “below expectation, especially because of loss of the most intolerant forms.”

Figure 4.4.3 Biological sampling results for the Clifty Creek Watershed



Additionally, biological sampling between CLIF02 and CLIF01 documents a reduction in volunteer Pollution Tolerance Index (PTI) Scores from 34 (excellent) to 17 (fair). This drop is due to a complete transition in community dynamics: species extremely intolerant of pollution such as (stoneflies, mayflies) were out-competed by species extremely tolerant of pollution (blood midges, rat-tailed maggots).

5.0 Problem Statements, Prioritization, and Goals Development

Based on the information gathered, the Watershed Project Steering Committee has identified elevated levels of E.coli, nutrient, and sediment, as well as continued illegal dumping to be primary stressors to water quality in the Clifty Creek, threatening the health of the creek and its recreational value. Existing data and watershed inventory results also indicate potentially elevated levels of pesticides. The Committee recognizes numerous potential sources for these stressors. In order to effectively address the problems associated with water quality degradation, the Committee has prioritized the problems, stressors, and potential sources and detailed supporting information in this section regarding the process used (Table 5.2, page 53).

5.1 Local Concerns

Early in the planning process, local residents were asked to contribute their concerns for water quality in the Clifty Creek Watershed. Overall, emphasis was placed on preservation of the existing exceptional quality of the Clifty Creek Watershed for future generations, which led to adoption of the vision statement: Alive & Well, Because We Care.

Recognizing the watershed's value, concerns over sources of degradation and recreation were discussed, specifically relating to the following: recorded levels of bacteria well above the state designated standard, the impacts of agricultural practices, residual effects from historic landfills, increasing urban/suburban developments, storm water influence, extreme variance and increase in rate of flow, the prevalence of neurological disease in the region, as well as increasing changes in the color and visual quality of the water.

Many of these concerns are corroborated by data collection and geographic information detailed further in this section. Some of the concerns listed are beyond the scope of the existing Management Plan.

Additionally, it should be noted, that several of the concerns identified related to the development of the Management Plan itself, specifically regarding fair representation, grassroots involvement, education, and accurate water quality data collection.

5.2 Problem Statements

In order to effectively address local concerns, the Steering Committee consolidated similar ideas and categorized concerns in order of priority (Table 1.2). As consensus was reached, the top three (3) priorities were discussed in-depth at Steering Committee meetings for the purpose of identifying the root of local concerns. Once identified, the Committee phrased the prioritized concerns into problem statements, which are discussed (in order of priority) below:

5.2.1 Lack of public knowledge correlated to water quality degradation

<u>Problem</u>: The quality of the watershed continues to degrade due to a lack of knowledge in the classroom, home, and business about how each component affects or complements the others. Public education across the spectrum is the most beneficial method for reducing the patterns of low public awareness, public apathy, and lack of education.

Information regarding residential knowledge on Nonpoint Source (NPS) pollution was assessed by a survey conducted throughout the Clifty Creek Watershed in November 2003 on general watershed knowledge (Appendix C). The survey indicates that although sixty-one percent (61%) of responses accurately defined a watershed, the majority (83%) were unable to correctly identify sources of nonpoint pollution (Table 5.2.1).

Additionally, the survey included questions designed to poll local opinion on the importance of water quality as a factor in decision-making. Question results indicated that water quality concerns significantly influence personal decisions, and that it should be a factor in community decision-making. The combination of results on knowledge and opinion questions suggests that increased awareness of Nonpoint Sources would be employed by local residents for the purpose of improving water quality. For this reason, the Steering Committee prioritized a lack of public education as the largest short- and long-term threat to water quality in the Clifty Creek Watershed.

Table 5.2.1 Watershed-wide survey results

Knowledge questions	Number Correct [Percentage]	Incorrect [Percentage]	
Defining a watershed	46 [61%]	29 [39%]	
Identifying Nonpoint Source (NPS) pollution	14 [17%]	62 [83%]	
Opinion questions	**High**	**Medium**	**Low**
Influence of water quality on personal decisions	51	20	4
Influence of water quality on community decisions	62	12	1

Values based on 75 surveys received

Coinciding with survey results, Steering Committee discussions and in-field observations described a growing number of illegal dump sites in the watershed. The Committee identified the occurrence of improper waste disposal as a noticeable symptom of cumulative human influences in Clifty Creek. This combination of ideas led to increased concern regarding the cumulative impacts of urban/suburban Nonpoint Source pollution.

Monthly water quality sampling results lend support to Committee concern. Volunteers reported distinct visual changes in water quality in urban/suburban sites, specifically in main stem segments between CLIF02 and CLIF01 (Figure 5.2.2-1). This transition is evidenced by lower CQHEI scores (habitat), lower PTI scores (biology), and increased turbidity. Additionally, datasets coincide with a large increase in urban/suburban concentration.

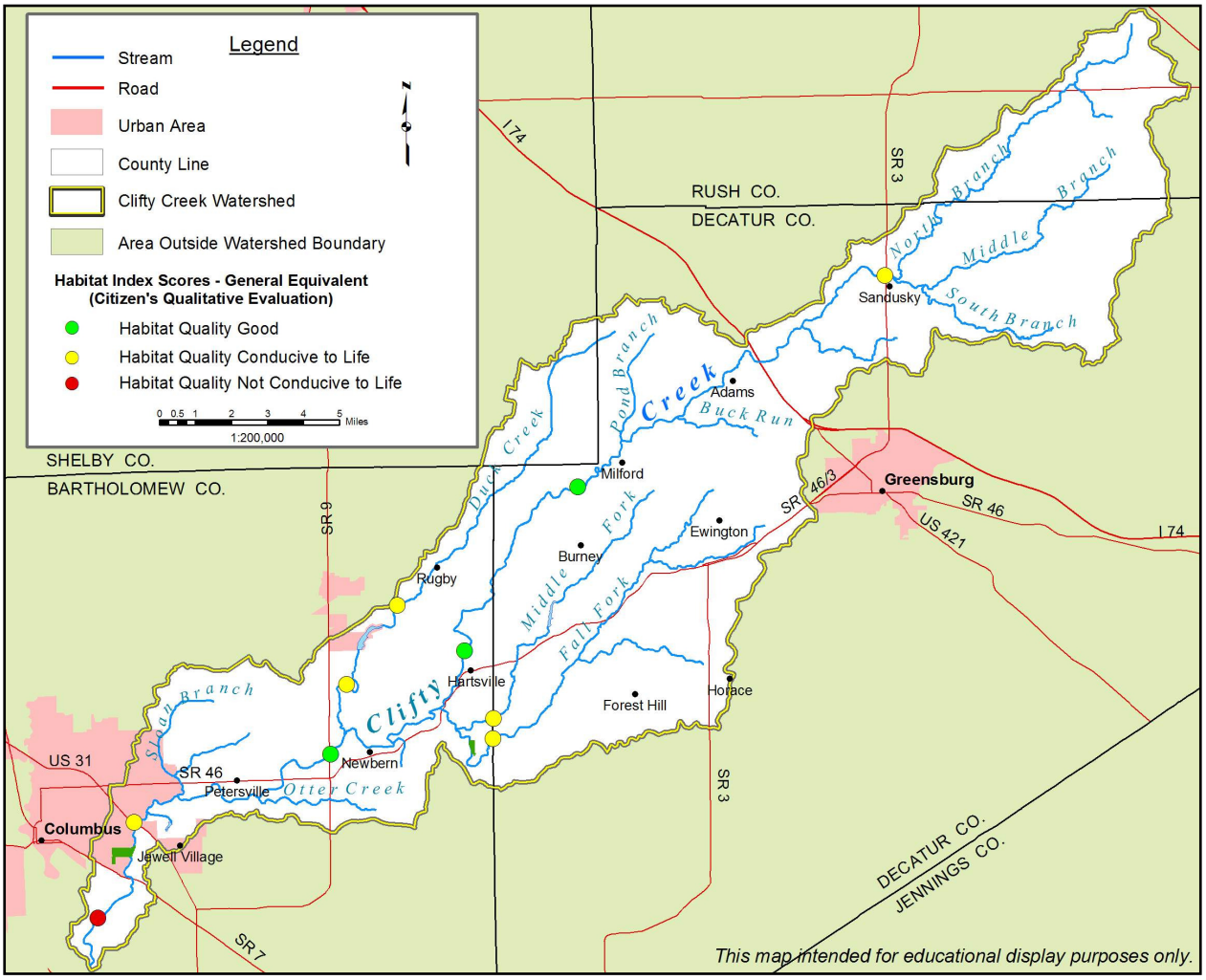


Figure 5.2.2-1 CQHEI classifications by sampling site in the Clifty Creek Watershed

Based on this information, the Steering Committee correlated increased population with an increased occurrence of Nonpoint Source (NPS) Pollution. Specifically, the Committee identified the following potential sources of NPS pollution: lawns, impervious surfaces (roads, parking lots, and rooftops), on-lot septic systems, and illicit dumping.

5.2.2 Increased sedimentation

<u>Problem</u>: Sedimentation is a major contributing factor to water quality degradation in the Clifty Creek. Land development, delayed implementation of erosion control mechanisms, full tillage agricultural systems, high impact recreational use, and unprotected stream banks appear to be the largest contributors of sediment due to high rates of erosion.

Sediment delivery substantially influences physical stream characteristics and chemistry. Fine particles in sediment threaten habitat and aquatic organisms by filling crevices and smothering streambeds. Excessive smothering suffocates newly hatched larvae, destroys eggs, disrupts gill function, and can decrease organisms' resistance to certain diseases. Those particles that do not settle along streambeds are typically suspended, causing brown or cloudy appearance in creeks. This suspension modifies the amount of sunlight reaching stream bottoms, which can influence rates of photosynthesis and subsequent oxygen production.
Additionally, particles mentioned above are charged molecules, ready to bind with other charged molecules. For this reason, sediment is considered a carrier for nutrients and chemicals into

creeks. Therefore, increased sedimentation can indicate increased chemical contamination, which is discussed further in the following problem statement.
Methods for observing sediment include visual assessment, monthly turbidity measurements, and total suspended solids (TSS) data from existing studies. It should be noted that algal growth influences these results on a seasonal basis. Volunteer data also documents presence of sedimentation and smothering through the Citizen's Qualitative Habitat Index (CQHEI). The presence of sediment and smothering in streams will lower the overall score.

The two primary contributing stressors increasing sediment delivery in the Clifty Creek Watershed include overland runoff of exposed soil and stream bank erosion. Sources of exposed soil susceptible to runoff include human development and construction, fields cultivated with conventional tillage, areas devoid of vegetation, as well as non-regulated feedlots where livestock are concentrated.

Figures 5.2.2-2 Exposed soil susceptible to runoff and exposed stream banks

Sources of stream bank erosion in the watershed include unrestricted livestock access to streams, increased flow seasonally and during storm events (flashing), a lack of vegetative cover along stream banks, and occurrences of high-impact recreation along stream banks, such as all-terrain vehicles (ATVs) and dirt bikes. For each source of potential runoff and stream bank erosion, there are practices designed to reduce runoff through erosion control, filtration, and buffers.

Due to the fact that sedimentation is widespread, incorporating both human influenced as well as natural sources, the Steering Committee enlisted the experience of the Technical Task Team to recommend priority sources of sediment in the watershed (Table 5.2.2). Prioritization of potential sources allows for planning to focus on greatest potential sediment load reduction at the outset of implementation.

Table 5.2.2 Priority ranking for potential sources of sediment delivery

Ranking	Priority Concerns: Potential Sources
1	Conventional Tillage
2	Stream bank Erosion Influenced by Livestock Access
3	Construction and Development
4	Gully Erosion
5	Lack of Buffers

Priority ranking as recommended by Technical Team

5.2.3 Nonpoint Source Biological and Chemical Runoff

Problem: ***Biological and chemical contaminants pose a threat to the Clifty Creek to an undefined extent. This is due primarily to increased overland runoff of nutrients, chemicals, and pathogens as well as leaching from failed waste removal systems. Livestock, wildlife, urban/suburban/recreational nutrient/chemical applications, agriculture, and highways all contribute contaminants in overland runoff. Leaching concerns revolve around pathogens and nutrients from failed and/or failing septic systems as well as metals and chemical infiltration into Clifty Creek due to leaching from old landfills.***

Due to the broad and diffuse sources of biological and chemical runoff, the Steering Committee identifies many potential sources in the problem statement above. In order to most effectively address the problem, the Committee prioritized the greatest potential sources of biological and chemical runoff in the watershed (Table 5.2.3-1). Prioritization of potential sources allows for planning to focus on greatest potential contaminant load reduction at the outset of implementation.

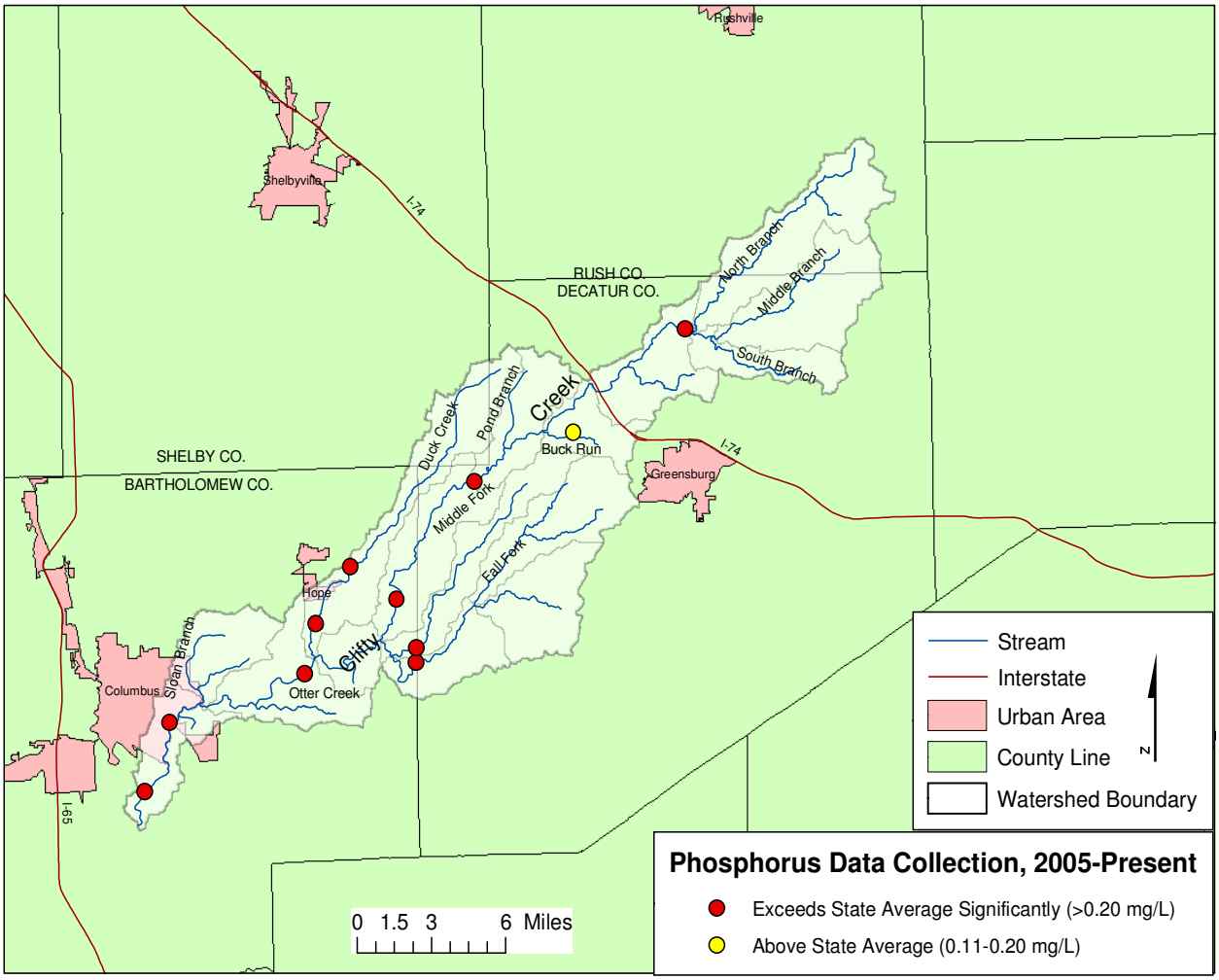
Table 5.2.3-1 Priority ranking for potential sources of biological and chemical runoff

Priority Concerns: Potential Sources	Potential Contaminants
Crop Related Agriculture	Fertilizer & pesticides carried by sediment runoff, pathogens (if manure application)
Unrestricted Runoff	Sediment and subsequent nutrient/chemicals, pathogens, salts
Trash	Hazardous material, chemicals, oil & grease, aesthetic
Septic Tanks	Septage, coliform bacteria, viruses, nitrates, heavy metals, synthetic detergents, cooking and motor oil, bleach, pesticides, paints, paint thinner, photographic chemicals, septic tank cleaner chemicals, chlorides, sulfate, calcium, magnesium, potassium, phosphate.

Potential Contaminants Identified by EPA

Volunteer water quality data includes sampling for phosphorus, which serve as an indicator for chemical and waste runoff (Figure 5.2.3-1). Phosphorus is a limiting nutrient in stream ecology and exists naturally. Human influences such as commercial fertilizers and impervious surface runoff can increase the level of phosphorus in streams. Increased levels of phosphorus can significantly alter stream ecology, which is one reason why Indiana was one of the first states to ban the use of phosphate additives in laundry detergent. Dishwashing detergents still contain phosphate additives, but the law in place requires these to have no phosphate additives by 2010.

Figure 5.2.3-1 Phosphorus levels in the Clifty Creek Watershed



Biological runoff contributes pathogens to the Clifty Creek Watershed that may compromise the recreational value of the watershed. Pathogens are monitored through coliform and specific E.coli sampling. Coliforms are a general type of bacteria, and can emanate from vegetative or fecal sources. Their presence indicates biological influences in water.

E.coli is a specific type of bacteria found in the gut of warm blooded animals (humans, livestock, and wildlife). Due to its origin, E.coli counts serve as an indicator of fecal contamination. Counts are represented as colony forming units per 100 milliliters of water (cfu/100mL). Sources of E. coli watershed-wide include failing septic systems, overland runoff of manure from agricultural fields, direct pipe discharges, unrestricted livestock access to streams, and wildlife.

Currently, volunteer monitors sample for E. coli and coliforms monthly. Existing data includes E. coli sampling by IDEM, which resulted in the 2002 designated impairment and subsequent 303(d) listing of two (2) main stem segments (Figure 5.2.3-4). Current and existing datasets demonstrate elevated levels of E. coli in the watershed, consistently exceeding the state designated standard: 235 cfu/100mL (Table 5.2.3-2). E. coli responds to temperature and is

therefore seasonally influenced (Figure 5.2.3-3). During cold months, E. coli levels are greatly reduced due a rapid die-off related to temperature. In warmer summer months and early fall, levels are at their highest. Some sites consistently exceeded state standards. In these cases the sites had spikes of high E. coli levels as well as an average E. coli count above state standard levels. The sites that occasionally exceeded state standards had some times when counts were above the state standard but the overall average was below the state standard levels. Sites within the state standard showed below state standard levels at every collection, and also had an overall average below state standard levels (Figure 5.2.3-3).

Table 5.2.3-2 E.coli counts in the Clifty Creek Watershed by sampling site (2005-2008)

Site	Median (cfu/100mL)	Minimum(cfu/100mL)	Maximum(cfu/100mL)
CLIF01	150	0	900
CLIF01M	100	0	6000
CLIF02	150	0	10000
CLIF03	25	0	50
CLIF04	100	0	8000
CLIF05	200	0	9000
CLIF06	200	0	1500
CLIF07	50	0	1900
DUCK01	750	0	3050
DUCK02	500	100	1500
FALL01	200	0	3800
MIDD01	400	0	40000

Figure 5.2.3-2 Relationship of E.coli and temperature data from watershed sampling.

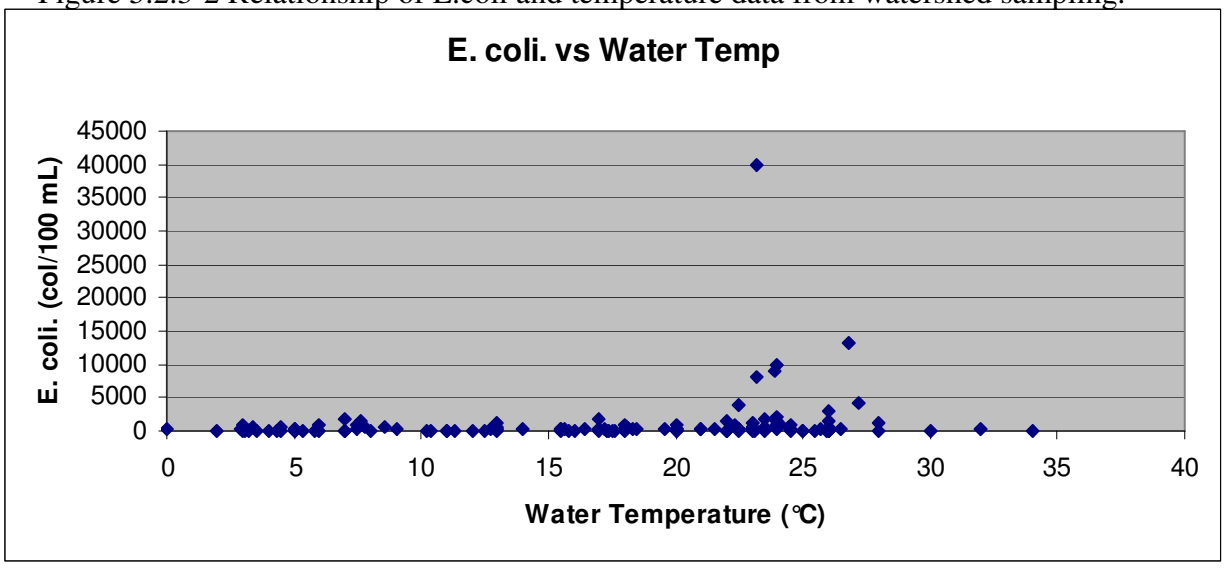
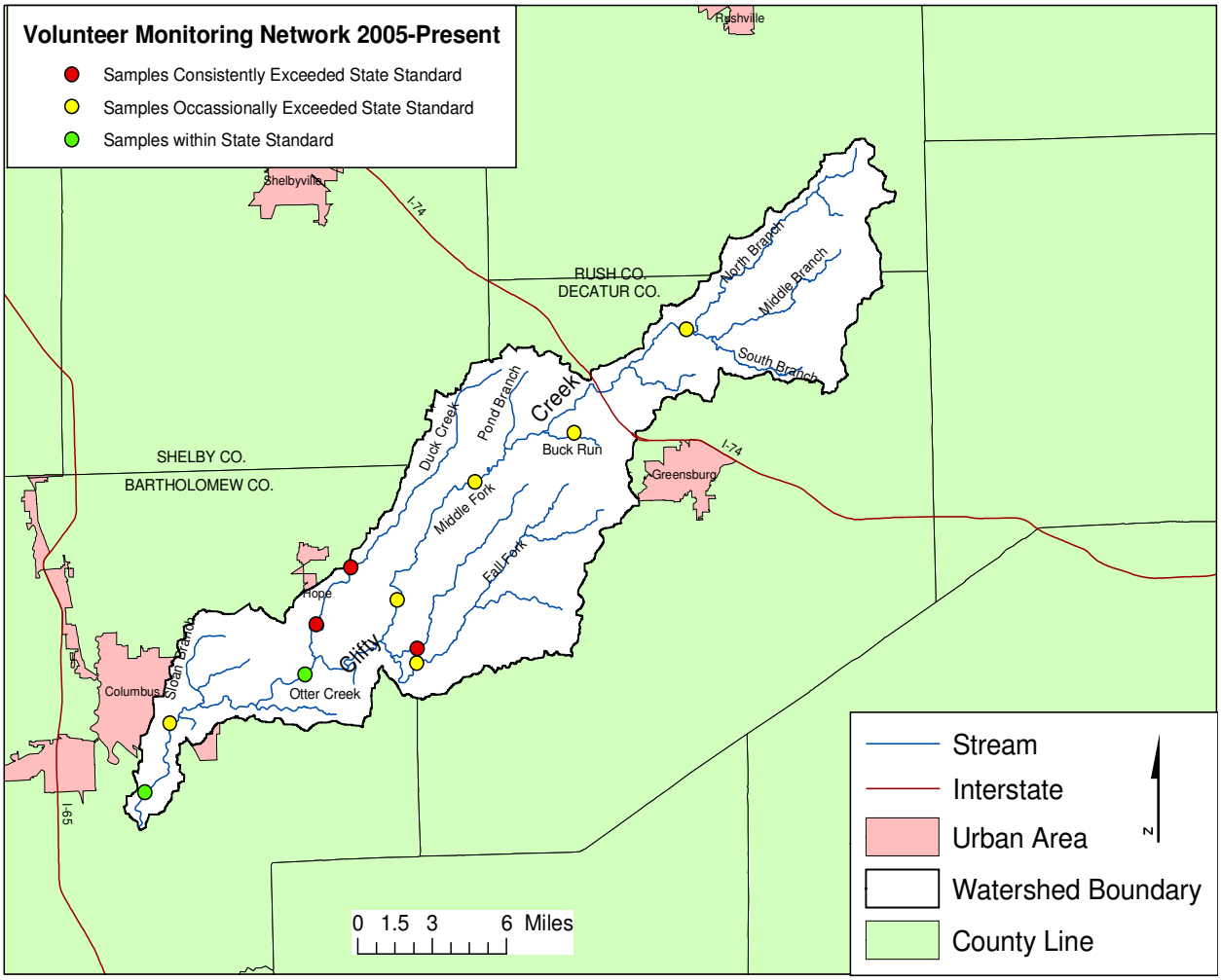


Figure 5.2.3-3 Occurrence of E.coli in the Clifty Creek Watershed



5.2.4 Project Management and Development

The Steering Committee also identified components of the Watershed Project that need improvement relating to volunteer water quality monitoring and diversity within the Steering Committee.

Water quality monitoring

Problem: ***The Watershed Project needs a consistent base of trained volunteers. We need to streamline collection procedures and continue to improve analysis.***

Although the existing volunteer data collection network functions to provide monthly data at all ten (10) sites throughout the watershed, there are often times that one to several sites will go unsampled due to volunteer schedules or unpredicted events. In order to establish a reliable baseline, it is extremely valuable to have data collected regularly at all sites on the same day. Regularly, this occurs, but there are months when the current number of volunteers makes this difficult to achieve.

Stakeholder representation

Problem: ***All interests in the watershed are not adequately represented on the Steering Committee.***

From its creation, the Steering Committee has been composed of individuals from diverse professional backgrounds, geographic locations, and walks of life. Recognizing that the interests within any given watershed can be as numerous as the number of residents living within, it is difficult to ensure that all needs are represented equally. In the past the steering committee was well represented by multiple groups. There were Soil & Water Conservation District board members and employees, general landowners, community members, educators, and people who work for the City of Columbus. Unfortunately the number of current members has dwindled. There are still two city employees, an educator, and some landowners on the committee but many of the community members have dropped off as active members. Although overall the representation is there, only a few members from each group are present. Only a few are speaking for many now, which can potentially be a problem as more people can help provide input and ideas.

Table 5.2. Water quality problem statements, concerns, stressors, and potential sources

Water Quality Concern	Stressor	Potential Source	Problem Statement
Increased urban / suburban / rural residential Nonpoint Source pollution (Lack of education)	Increased turbidity	Storm water runoff: nutrients, pesticides, household detergents, and automotive fluids.	The quality of the watershed continues to degrade due to a lack of knowledge in the classroom, home, and business about how each component affects or complements the others. Public education across the spectrum is the most beneficial method for reducing the patterns of low public awareness, public apathy, and lack of education!
	Negative biological impact		
	Evidence of trash and illicit dumping	Improper waste disposal	
	Bacteria / Pathogens	Poorly maintained/failing septic systems	
Sedimentation	Eroding stream banks are contributing sediment to streams	Lack of vegetation	Sedimentation is a major contributing factor to water quality degradation in the Clifty Creek. Land development, delayed implementation of erosion control mechanisms, full tillage agricultural systems, high impact recreational use, and unprotected stream banks appear to be the largest contributors of sediment due to high rates of erosion.
		Unrestricted livestock access to creeks	
		Increased rate of flow	
		High impact recreation: ATVs along stream banks	
	Sediment is running off land into streams	Lack of erosion control practices during highway development, and subsequent lack of enforcement	
		Conventional tillage practices, lack of ground cover	
		Inadequate riparian corridor, buffers, filters	
		Concentrated livestock feedlots (non-regulated)	
Biological / Chemical Contamination	Elevated bacteria levels, unsafe for recreation	Failing septic systems and/or direct pipes	Biological and chemical contaminants pose a threat to the Clifty Creek to an undefined extent. This is due primarily to increased overland runoff of nutrients, chemicals, and pathogens as well as leaching from failed waste removal systems. Livestock, wildlife, urban/suburban/recreational nutrient/chemical applications,
		Wildlife	
		Livestock access to creeks	
	Overabundance of algae	Lack of vegetative cover for shade and filtration of runoff	
	Excessive nutrients, pathogens and	Overland runoff	

	pesticides		agriculture, and highways all contribute contaminants in overland runoff. Leaching concerns revolve around pathogens and nutrients from failed and/or failing septic systems as well as metals and chemical infiltration into Clifty Creek due to leaching from old landfills.
	Impaired biotic community	Increased area of impervious surface and urban runoff	
	Increased chloride loads	Road maintenance, seasonal use of salt	
		Runoff from feeding operations	
	Illicit Dumping	Litter/dumping from people in the region	
	Leaching heavy metals and organic chemicals	Unlined landfills	

5.3 Setting Goals & Choosing Measures to Apply

Steering Committee discussions indicate that project approach must integrate components designed to achieve short and long-term goals. Education and public outreach are at the forefront of each program element, and throughout the process of water quality restoration and protection, public involvement is critical. Additionally, it is necessary that the short-term benefits of tangible, on-the-ground restoration balance the slower process of educating the general public. Implementation of Best Management Practices (BMPs) throughout the watershed will be vital for the purposes of short-term load reduction, public interest, and project sustainability.

The following tables restate the identified, overarching problem and introduce the goals, objectives, and action items developed to address the problem. These tables are designed to be a guide for the actions of the Steering Committee and the Watershed Project. The nature of adaptive management is to modify procedure as experience is gained. For this reason these tables represent the initial framework for action. As action items are pursued new information and strategies will become available from which fresh ideas to solve larger problems can be identified.

It is the intention of the Steering Committee to revisit this information regularly to ensure that major goals and objectives are at the forefront of project efforts.

<u>Problem:</u> The quality of the watershed continues to degrade due to a lack of knowledge in the classroom, home, and business about how each component affects or complements the others. Public education across the spectrum is the most beneficial method for reducing the patterns of low public awareness, public apathy, and lack of education!

Goal 1: Cultivate future citizen interest and leadership in conservation and natural resources by educating children at an early age and maintaining presence throughout their academic career. Project will reach at least 300 new students each year for the next two (2) years, offering 500 water quality specific education hours in the next three (3) years.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicator(s)
Promote use of water quality materials in the classroom.	Train teachers in Project WET and Project WEBFOOT Curriculum.	Elementary and Middle School Teachers	Watershed Project and SWCDs. (Partners: Project WET, Ducks Unlimited, kidscommons, and Bartholomew Co. Solid Waste District.)	Initiated in 2005, to be completed by 2011.	Number of teachers trained; evaluation results.
	Create and compile subject boxes specific to water quality issues.				
	Promote resources for classroom use.	Elementary, Middle, and High School Teachers			
Provide an in-field experience for students to access local creeks.	Cultivate teacher relationships to encourage participation.	Middle/Jr. High School Teachers and Administrators	Watershed Project. (Partners: kidscommons, Hoosier Riverwatch, and SWCDs.)	Initiated in 2005, Program to be delivered through 2011.	Number of in-field hours offered; student evaluations.
	Develop programming that meets time requirements and state standards.	Elementary, Middle, and High School Teachers and Administrators			
	Engage students directly	Students 4th - 8th grade			
	Incorporate hands-on activities				
	Allow for discovery, exploration, and excitement.				
	Follow-up field experience with a session involving analysis.				
Develop sustainable youth programming in the watershed.	Work in partnership with kidscommons Children's Museum and Mike Strohm to create a water quality exhibit.	Elementary and Middle School Students	Watershed Project and kidscommons. (Partners: SWCDs)	Initiated in 2005, Programs delivered through 2011.	Number of students involved; teacher hours.
	Encourage and assist schools to initiate Water Festivals				
	Create an outreach package to be delivered				

<u>Problem:</u> The quality of the watershed continues to degrade due to a lack of knowledge in the classroom, home, and business about how each component affects or complements the others. Public education across the spectrum is the most beneficial method for reducing the patterns of low public awareness, public apathy, and lack of education!

	to diverse groups.				
Offer professional development opportunities in conservation and natural resource fields	Mentor Yearly Senior Projects	High School	Watershed Project and SWCDs. (Partners: Volunteer Action Center, HIP, and Sierra Club)	Initiated in 2005, Programs delivered through 2011.	Participant evaluations; number of projects.
	Become involved in High School Interdisciplinary Program (HIP)				
	Involve students in water quality monitoring network				
	Support student led clubs and civic group efforts.				
	Offer summer internship through project	College/University			

Goal 2: Increase urban/suburban awareness about impacts of Nonpoint Source pollution on water quality, including participation in Watershed Project activities (or related water quality initiatives) by thirty (30) new households and three (3) new businesses each year for the first two (2) years.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicator(s)
Promote urban/suburban best management practices (BMPs)	Offer cost-share for soil testing before nutrient application	Homeowners and Commercial/Recreational Businesses	Watershed Project and SWCDs.	Initiated in 2005, planning completed by Spring 2008, implementation through 2011	Number of soil tests; reduction in downstream chloride/orthophosphate loading.
	Host urban/suburban BMP workshops.				
	Develop and cost-share an urban/suburban demonstration project, highlighting innovative practice.				
Provide accurate, up-to-date information on local water quality to local residents.	Submit regular press releases	Urban/Suburban Residents, Businesses, and Public Officials	Watershed Project.	Initiated in 2005, sustained for life of the project. Website to be updated in 6 months.	Number of media contacts; hits recorded on website.
	Host radio spot, titled: "Your Watershed Moment"				
	Develop and post a project website				
Increase name	~~Maintain a booth at the Bartholomew &~~	Urban/Suburban	Watershed	Initiated in	Household

<u>Problem:</u> The quality of the watershed continues to degrade due to a lack of knowledge in the classroom, home, and business about how each component affects or complements the others. Public education across the spectrum is the most beneficial method for reducing the patterns of low public awareness, public apathy, and lack of education!

recognition in urban/suburban areas and connect with general public.	Decatur County 4H Fairs Sponsor floats in the Hope Heritage and Columbus Christmas Parades Create an emotional message that is posted widely.	Residents, Businesses, and Public Officials	Project.	2005, continue through 2011 and evaluate.	survey.

Goal 3: Increase local capacity for citizen involvement in water quality related issues, building contact list to over one hundred (100) individuals by 2007.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicator(s)
Clarify differences between regulated and non-regulated contaminant sources.	Research state/federal policy. Post information and links on website. Distribute state/federally produced information on regulatory policy.	Local Residents and Local Political Officials.	Watershed Project and SWCDs.	Initiated in 2006, develop and finalize by 2010.	Web page hits.
Update watershed group regularly on issues involving water quality.	Develop a distribution list. Create and distribute an e-newsletter.	Watershed Project Participants and Supporters.	Watershed Project.	Initiated in 2005, to publish no fewer than 4/year.	Distribution list size and number of newsletters produced.

Problem: *Sedimentation is a major contributing factor to water quality degradation in the Clifty Creek. Land development, delayed implementation of erosion control mechanisms, full tillage agricultural systems, high impact recreational use, and unprotected stream banks appear to be the largest contributors of sediment due to high rates of erosion.*

Goal 1: Increase implementation of conservation practices for the reduction of sedimentation and smothering due to overland soil runoff. For urban/suburban related practices, increase participation by 100% in the next three (3) years and 200% in the next five (5) years. For agricultural practices, increase annual participation figures by 10% for the next three (3) years [Phase I] and cumulatively to 50% within the next five (5) years [Phase II].

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Full Tillage Agriculture					
Encourage implementation of conservation tillage practices	Offer modifications to conventional equipment so that it can be used for conservation tillage.	Conventional farmers in the watershed.	Watershed Project, NRCS, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Sediment load reduction, Acres in conservation tillage. BMP Surveys completed.
	Research manure application options for conservation tillage.	Farmers incorporating manure application in crop practices.			
	Research and/or create economic comparison (short and long term) projections relating to conservation tillage and soil types.	Conventional farmers in the Clifty Creek Watershed.			
Increase use of cover crops in conventional systems.	Research cover crop options for conditions in the watershed.	Conventional farmers and first-time conservation farmers.	Watershed Project, NRCS, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Sediment and Phosphorus load reduction, Acres of cover crops installed. BMP Surveys completed.
	Create a cost-share program designed to offset initial costs of cover crop implementation.				
	Provide technical resources and/or contacts to producers for cover crop installation.				
	Coordinate outreach and advertising for use of cover crops and respective benefits.	Farmers in the watershed.			
Initiate and support a cooperative mentoring network of conservation	Develop a list of existing conservation farmers.	Conservation farmers throughout the region (East Fork White River Watershed).	Watershed Project, NRCS, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II	Number of farmers involved. Interviews and farmer feedback.
	Request participation in network, providing incentives for mentor farmers.				
	Create a list of new farmers and/or those interested in developing a mentor relationship.	Conventional farmers and first-time			

<u>Problem:</u> Sedimentation is a major contributing factor to water quality degradation in the Clifty Creek. Land development, delayed implementation of erosion control mechanisms, full tillage agricultural systems, high impact recreational use, and unprotected stream banks appear to be the largest contributors of sediment due to high rates of erosion.

farmers.		conservation farmers in watershed.		completion: 2008-2011	
	Provide opportunities for farmers to network (see following objective).	Farmers throughout the region (East Fork White River Watershed).			
	Grant an annual water quality award for outstanding conservation farmers.	Conservation farmers in the watershed.			
Offer professional development opportunities such as field-days and hands-on workshops on specific topics generated by producer interest.	Plan dates during off-season.	Primary Audience: Farmers throughout the watershed Secondary Audience: Farmers in the region (East Fork White River Watershed).	Watershed Project, NRCS, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Number of field-days provided. Participation / attendance at events. Surveys / Feedback. New interest generated.
	Research farmer preferred publications and advertise in advance.				
	Request input from producers regarding specific topics and areas of conservation interest.				
	Develop subject-specific agendas that avoid duplication or repetition of existing efforts.				
	Recruit top-professionals in subject fields to lead workshops.	Agriculture, conservation, natural resource, and research professionals developing new work in the field.			
Urban/Suburban/Highway Construction and Development					
Increase implementation of existing erosion control practice requirements.	Research Rule 5 regulations and implementation requirements.	Steering Committee and Interested Residents	Watershed Project, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II	Sediment load reduction. Percent increase in practices implemented.
	Participate in plan review process where applicable and stay informed on current political transitions.	Local Officials, Municipal Authorities			

<u>Problem:</u> Sedimentation is a major contributing factor to water quality degradation in the Clifty Creek. Land development, delayed implementation of erosion control mechanisms, full tillage agricultural systems, high impact recreational use, and unprotected stream banks appear to be the largest contributors of sediment due to high rates of erosion.

	Contribute to local planning committees (i.e. ordinance review, highway development, etc.)	Planning Commissions, Local Officials		completion: 2008-2011	
	Initiate dialogue with INDOT regarding state highway projects through watershed.	INDOT			
Encourage progressive use of urban/suburban Best Management Practices.	Compile a list of contractors, developers, builders, homeowner's associations, and highway officials that the service or reside in the watershed area.	Local contractors, developers, builders, homeowners associations, and highway officials in the watershed.	Watershed Project, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Sediment and Chloride load reductions. Number of practices installed. Homeowner feedback.
	Develop relationships with highway, residential, commercial contractors.				
	Offer specific professional workshops tailored to technical implementation needs for Best Management Practices.				
	Initiate participation in the Watershed Project from homeowner's associations.				
	Develop and install a demonstration urban/suburban conservation project.				
Gully Erosion					
Reduce Gully Erosion	Market existing conservation programs addressing gully erosion.	Landowners and farmers in the watershed.	Watershed Project, NRCS, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Sediment load reduction.
	Assist site-specific pond development.				

(If not defined, watershed refers to the Clifty Creek Watershed)

Problem: *Sedimentation is a major contributing factor to water quality degradation in the Clifty Creek. Land development, delayed implementation of erosion control mechanisms, full tillage agricultural systems, high impact recreational use, and unprotected stream banks appear to be the largest contributors of sediment due to high rates of erosion.*

Goal 2: Increase BMP use in livestock operations by 20% in three (3) years, in order to reduce sedimentation and erosion from livestock without compromising the economic integrity of existing operations.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Reduce intensive overgrazing and year round feeding on small lots	Assist livestock owners with the development of prescribed grazing plans.	Traditional and recreational livestock owners.	Watershed Project, NRCS, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion 2008-2011	Sediment load reduction. Number of practices developed
	Develop outreach materials for diverse livestock interests.				
	Provide livestock owners with access to technical resources.				
	Offset technical assistance and nutrient management planning costs.				
Reduce livestock access to seasonal streams and tributaries.	When appropriate, incorporate stream bank fencing.	Traditional and recreational livestock owners.	Watershed Project, NRCS, SWCDs.	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion 2008-2011	Miles of fence installed, number of systems installed.
	Promote and install offsite water systems				
	Develop cost-share opportunities for watering systems and stream bank fencing.				
	Restore stream banks with natural vegetation.				
	Compile cost/benefit analysis of grazing marginal pastureland along stream banks.				
Encourage supplemental seeding and pasture/hayland planting.	Research and promote implementation of native vegetation where applicable.	Traditional and recreational livestock owners.	Watershed Project, NRCS, SWCDs	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion 2008-2011	Number of acres involved.
	Provide technical assistance and cost-share opportunities.				
Maintain and enhance stream buffers and riparian corridors	Inventory existing corridors and Best Management Practices.	Landowners with property adjacent to stream banks.	Watershed Project, NRCS,	Initiated in 2005 Phase I completion:	Miles of stream restored.
	Market existing conservation programs to				

<u>Problem:</u> Sedimentation is a major contributing factor to water quality degradation in the Clifty Creek. Land development, delayed implementation of erosion control mechanisms, full tillage agricultural systems, high impact recreational use, and unprotected stream banks appear to be the largest contributors of sediment due to high rates of erosion.

	sensitive areas.		SWCDs	2005-2007 Phase II completion 2008-2011	

Goal 3: Reduce peak runoff rates, subsequently reducing overland runoff and rates of stream bank erosion.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Foster discussion on existing drainage methods and possible alternatives.	Incorporate drainage concepts into educational seminars and workshops.	Area producers, residents, and public officials.	Watershed Project, NRCS, SWCDs	Initiated in 2005, planning completed by Spring 2009, implementation through 2011	Partnerships created. Participation at seminars.
	Create outreach materials on drainage concepts and alternatives to traditional methods.				
	Participate when possible with local drainage boards and planning meetings.	County drainage boards and planning commissions.			
Restore moist-soil environments.	Compile current and historic maps of moist-soil environments and hydric soils.	Rural residents, landowners, farmers, developers, and planners.	Watershed Project	Initiated in 2005, planning completed by Fall 2008, implementation through 2011.	Number of practices installed. Documented increase in participation of existing programs.
	Investigate relevant partnerships and facilitate collaboration for future project development.				
	Encourage maintenance and enhancement of existing natural wetlands.				
	Provide existing materials to interested landowners.				
	Research and market existing wetlands / habitat conservation programs.				
Investigate Drainage Management	Research existing practices, relevant soil types, and slope.	Steering Committee and resource professionals.	Watershed Project	Initiated in 2005, schedule to be determined based on research results.	Report created.
	Determine practicality of application in watershed and potential for cost-share.				

<u>Problem:</u> Biological and chemical contaminants pose a threat to the Clifty Creek to an undefined extent. This is due primarily to increased overland runoff of nutrients, chemicals, and pathogens as well as leaching from failed waste removal systems. Livestock, wildlife, urban/suburban/recreational nutrient/chemical applications, agriculture, and highways all contribute contaminants in overland runoff. Leaching concerns revolve around pathogens and nutrients from failed and/or failing septic systems as well as metals and chemical infiltration into Clifty Creek due to leaching from old landfills.

Goal 1: Increase participation in conservation practices for the reduction of nutrient, pesticide, and salt infiltration to tributaries and main stem portions of the Clifty Creek. For urban/suburban related practices, increase participation by 100% in the next three (3) years and 200% in the next five (5) years. For agricultural practices, increase annual participation by 15% for the next three (3) years and 50% in the next five (5) years.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Develop and implement nutrient/pesticide management plans.	Research recent technology offerings to reduce application rates and offer alternatives to nutrient/pesticide application.	Farmers involved in row crop production.	Watershed Project, NRCS, SWCDs.	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Number of plans developed. Phosphorus and Nitrogen load reductions.
	Investigate cost-share opportunities for management plan development and conservation practices.				
	Market existing conservation planning resources and programs.	Commercial applicators: farmers, landscape professionals, and park managers.			
	Develop outreach methods specific to non-agricultural, commercial applicators.				
Increase percentage of stream corridor buffered by filter strips and riparian corridors.	Market existing conservation planning resources and programs.	Landowners along Clifty Creek and its tributaries.	Watershed Project, NRCS, SWCDs.	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Miles of stream corridor restored.
	Target outreach to areas that currently lack vegetative buffers.				
	Incorporate urban/suburban/rural residential segments into outreach.				
Increase homeowner awareness of lawn/soil requirements for nutrients/pesticides.	Provide educational workshops for Backyard Conservation and Soil Testing.	Homeowners and residents in the watershed.	Watershed Project and SWCDs. (Partners:	Initiated in 2005 Phase I completion: 2005-2007	Number of soil tests distributed. Professional
	Provide soil test kits to homeowners/residents.				

<u>Problem:</u> Biological and chemical contaminants pose a threat to the Clifty Creek to an undefined extent. This is due primarily to increased overland runoff of nutrients, chemicals, and pathogens as well as leaching from failed waste removal systems. Livestock, wildlife, urban/suburban/recreational nutrient/chemical applications, agriculture, and highways all contribute contaminants in overland runoff. Leaching concerns revolve around pathogens and nutrients from failed and/or failing septic systems as well as metals and chemical infiltration into Clifty Creek due to leaching from old landfills.

	Support existing educational efforts by Cooperative Extension.	Homeowners, residents, master gardeners, and landscape professionals.	NRCS, Cooperative Extension, Sierra Club.)	Phase II completion: 2008-2011	participation. Phosphorus and nitrogen load reduction.
	Initiate dialogue with commercial lawn care companies, local landscape architects, and residential contractors.	Landscape professionals, contractors, and lawn chemical companies.			
Minimize impervious surface runoff.	Compile a list of commercial businesses and management contacts in the watershed.	Commercial Business Managers for facilities in the watershed.	Watershed Project and SWCDs.	Initiated in 2005 Phase I completion: 2005-2007 Phase II completion: 2008-2011	Chloride load reduction. Reduced rate of runoff. Number of practices and stormdrain markers installed.
	Develop outreach and training materials regarding commercial facility maintenance.				
	Continue educational and stormdrain marking programs.	Watershed residents.			
	Support municipal storm water program and ordinance development.	Local Officials			
	Research storm water Best Management Practices.	County Highway, City Garage, and Homeowners / Residents.			
	Facilitate discussion and implementation of urban/suburban Best Management Practices.				
	Promote installation of rain gardens.				

<u>Problem:</u> Biological and chemical contaminants pose a threat to the Clifty Creek to an undefined extent. This is due primarily to increased overland runoff of nutrients, chemicals, and pathogens as well as leaching from failed waste removal systems. Livestock, wildlife, urban/suburban/recreational nutrient/chemical applications, agriculture, and highways all contribute contaminants in overland runoff. Leaching concerns revolve around pathogens and nutrients from failed and/or failing septic systems as well as metals and chemical infiltration into Clifty Creek due to leaching from old landfills.

Goal 2: Reduce seasonal E. coli spikes by 20% in targeted subwatersheds within the next three (3) years (percent reduction is determined from peak E.coli counts in Duck Creek and Middle Fork).

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Promote septic system maintenance.	Increase distribution of existing educational materials.	Residents in the watershed.	Watershed Project.	Initiated in 2005, Phase I delivered through 2011.	Number of septic systems influenced. Count reduction in targeted subwatersheds.
	Foster cooperative partnerships with County Health Departments.	Bartholomew, Decatur, Rush, and Shelby County Health Departments			
	Develop cost-share program to encourage maintenance.	First-time homeowners, rural/small town homeowners, and residents in the watershed with septic systems.			
Facilitate area discussion on wastewater treatment options.	Build relationships with local communities currently served by septic systems or package treatment plants.	Homeowner's Associations, Town Boards, and rural residential homeowners.	Watershed Project.	Initiated in 2006 immediately, sponsor seminars annually through 2009.	Participation in technical seminars.
	Provide professional/technical seminars focused on new construction, septic system design, and installation.	Contractors, developers, and new home builders.			
Reduce livestock access	Develop cost-share opportunities for stream bank fencing	Traditional and recreational livestock owners	Watershed project, NRCS, SWCD	Initiated in 2005, continued through 2011	Miles of fence installed
Promote alternatives to traditional wastewater	Research alternative practices in wastewater treatment.	Contractors, developers, new	Watershed Project,	Initiated in 2005, demonstration	Completion of demonstration

<u>Problem:</u> Biological and chemical contaminants pose a threat to the Clifty Creek to an undefined extent. This is due primarily to increased overland runoff of nutrients, chemicals, and pathogens as well as leaching from failed waste removal systems. Livestock, wildlife, urban/suburban/recreational nutrient/chemical applications, agriculture, and highways all contribute contaminants in overland runoff. Leaching concerns revolve around pathogens and nutrients from failed and/or failing septic systems as well as metals and chemical infiltration into Clifty Creek due to leaching from old landfills.

treatment.	Develop a demonstration project to showcase a practical alternative treatment system for local conditions.	home builders, homeowner's associations, real estate professionals, and homeowners.	SWCDs.	project installed by summer 2008.	, participation at showcase event.

Goal 3: Increase participation in household hazardous waste and recycling programs by 50% within the next five (5) years.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Reduce occurrence of illicit dumping.	Utilize educational opportunities to promote proper waste disposal, specifically the Adopt-A-River program.	Residents in the watershed.	Watershed Project.	Initiated in 2005, deliver programs through 2011	Participation in Creek Cleanups, increased volume and household statistics at Recycling Center.
	Support existing efforts by County Solid Waste Management Districts, Recycling Centers, and civic groups.				
	Increase distribution and marketing of educational materials concerning amnesty days, recycling options, and proper disposal methods.				
Increase waste disposal options for rural residents.	Facilitate cooperative partnerships with County Solid Waste Management Districts and private waste removal businesses.	County Solid Waste Management Districts and privately-owned solid waste management operations.	Watershed Project.	Immediate, research to be completed by late-2006, programs initiated in 2007 and offered through 2011	Programs created, frequency of Amnesty Days, statistics.
	Research sustainable systems of waste removal in rural areas.				
	Increase the number of Amnesty Days.				

Problem: *The Watershed Project needs a consistent base of trained volunteers. We need to streamline collection procedures and continue to improve analysis.*

Goal 1: Maintain and improve the Project Water Quality Monitoring Network, ensuring that all ten (10) sites are monitored monthly through 2007.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Increase number of trained volunteer monitors.	Constantly recruit new volunteers and advertise upcoming workshops.	Potential Volunteers inclined to spend time outdoors.	Watershed Project.	Will continue regularly through 2011.	Number of volunteers. Hours of training provided.
	Host Hoosier Riverwatch Training Workshops.	Interested Volunteers.			
	Train at least one volunteer to be a Hoosier Riverwatch Instructor.	Experienced Volunteer Monitor			
	Publicize sampling results.	Watershed Residents.			
Sample all sites on a monthly basis.	Continue to streamline sampling procedures.	Volunteer Monitors & Watershed Coordinator.	Watershed Project.	Began in 2005, Will continue monthly through 2011.	Data collected.
	Coordinate schedules.				

Goal 2: Utilize Monitoring Network to track Project progress, incorporating new technology and methods to provide enhanced monthly data.

Objective	Action Item	Target Audience	Responsible Party	Schedule	Indicators
Develop future sites to monitor cost-share project improvements.	Digitally map all implementation sites.	Watershed Project Steering Committee & Volunteer Monitors.	Watershed Project, NRCS, SWCDs.	Began in 2006, ongoing through implementation.	Sites recorded and data collected. L-THIA information generated.
	Plan pre- and post-construction studies.				
	Project load reductions and compare results.				
Incorporate specific indicator sampling into	Research Total Suspended Solids for volunteer data collection.	Watershed Project Steering Committee &	Watershed Project	Ongoing, probe installed in June	Data collected.

Problem: *The Watershed Project needs a consistent base of trained volunteers. We need to streamline collection procedures and continue to improve analysis.*

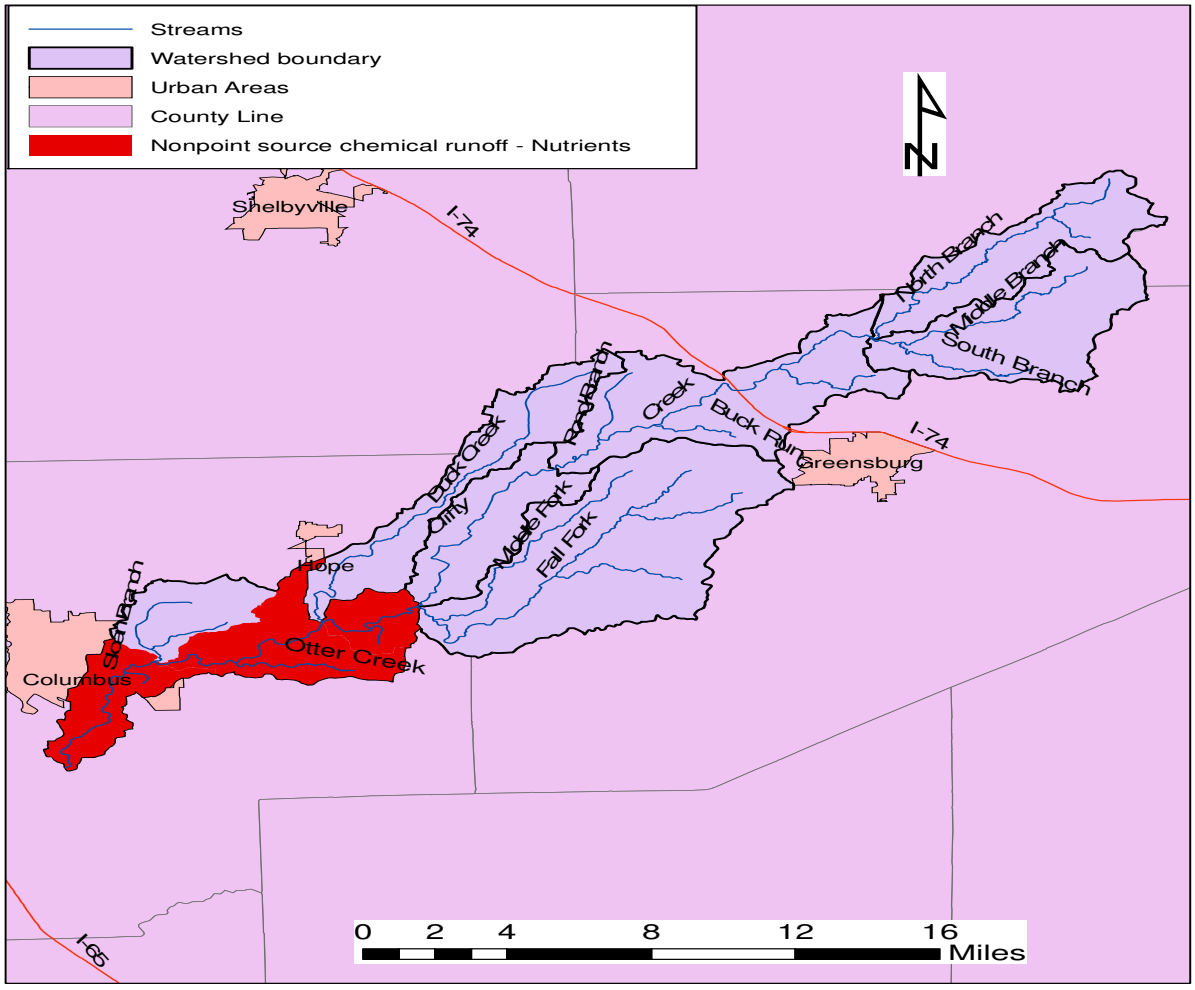
Monitoring Network.	Improve flow measurements.	Volunteer Monitors.	Steering Committee & the USGS.	2007.	
	Investigate methods for use with Project Spectrophotometer.				
	Install a long-term, multiparameter probe in the existing USGS gage station in Hartsville.				

6.0 Identifying Critical Areas

Steering Committee discussions clearly articulate that prioritized concerns exist watershed-wide. However, the scale of the Clifty Creek Watershed (132,000 acres) is broad. Consequently, the Steering Committee utilized data collection, visual assessments, and local knowledge to identify areas of the watershed where concentrated efforts would most substantially improve water quality. Utilizing subwatershed boundaries, the Committee prioritized areas for Nonpoint Source chemical runoff - Nutrients, elevated pathogen levels (E.coli), and increased sediment loading.

6.1 Nonpoint Source chemical runoff - Nutrients

Figure 6.1 Subwatersheds prioritized for Nonpoint source chemical runoff- nutrients

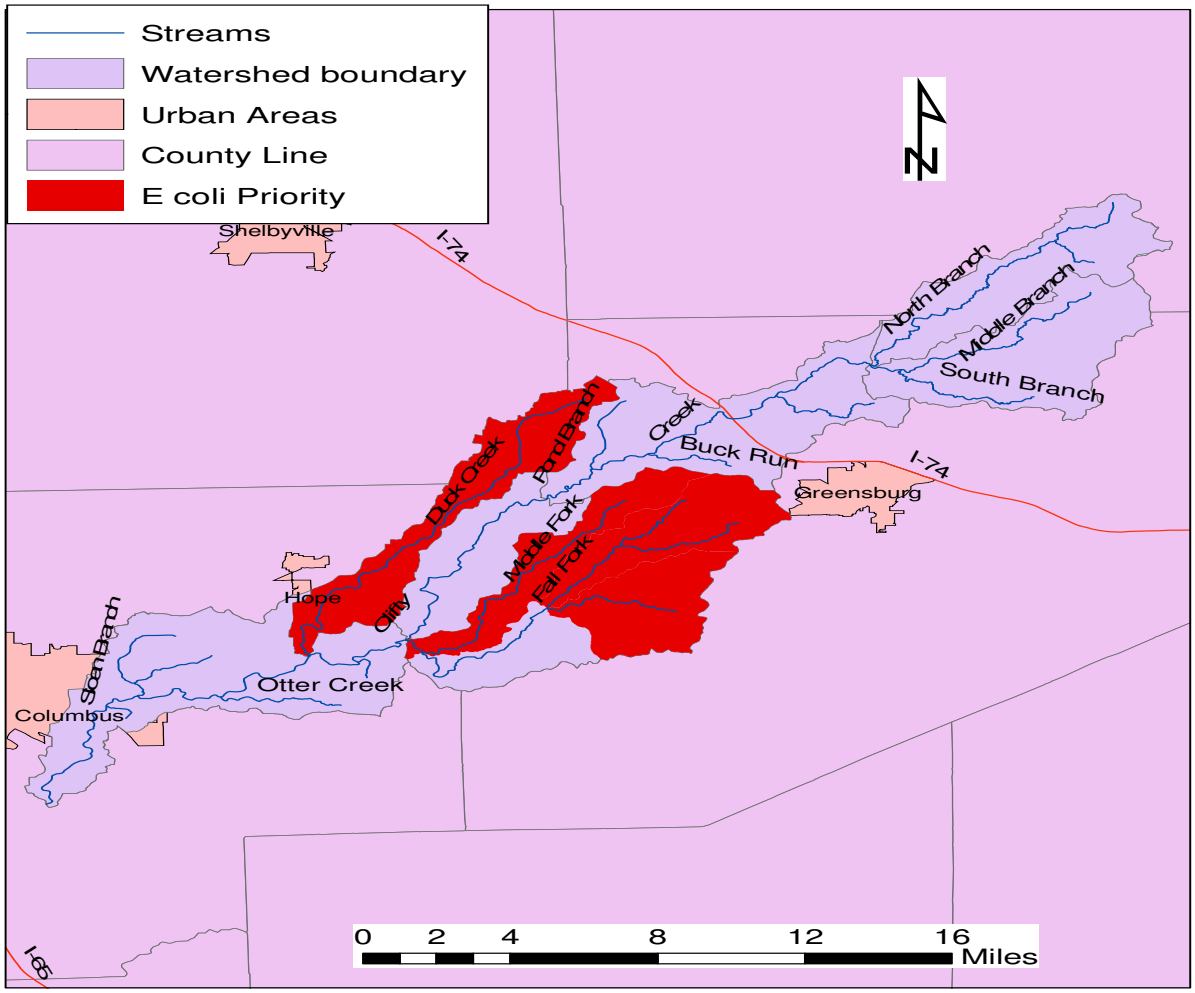


Subwatersheds prioritized for Nonpoint Source chemical runoff include the southern and eastern portion of Otter Creek-Clifty Creek (HUC 12: 051202060107) (Figure 6.1). Collectively, prioritized subwatersheds drain approximately 19,000 acres of the watershed (14%). Area encompasses segments of Clifty Creek where data collection documents rapid degradation of biotic communities, as well as a visible increase in algal growth and subsequent turbidity values. The PTI was the worst at the lower end of this area (Figure 4.4.3) as was the CQHEI (Figure

5.2.2-1). Overall this area has the two highest mean NO_3 value recorded for any of the monitoring sites (13.75 and 9.03 mg/L). One area that was removed from the critical areas is section of the watershed that includes Sloan Branch tributary. Just downstream of this area the average NO_3 is 6.22 mg/L, approximately half of the Indiana state average. This area, while important, is not deemed as critical as the other areas in this region.

6.2 Nonpoint Source Biological Pathogens: E.coli

Figure 6.2 Subwatersheds prioritized for pathogens

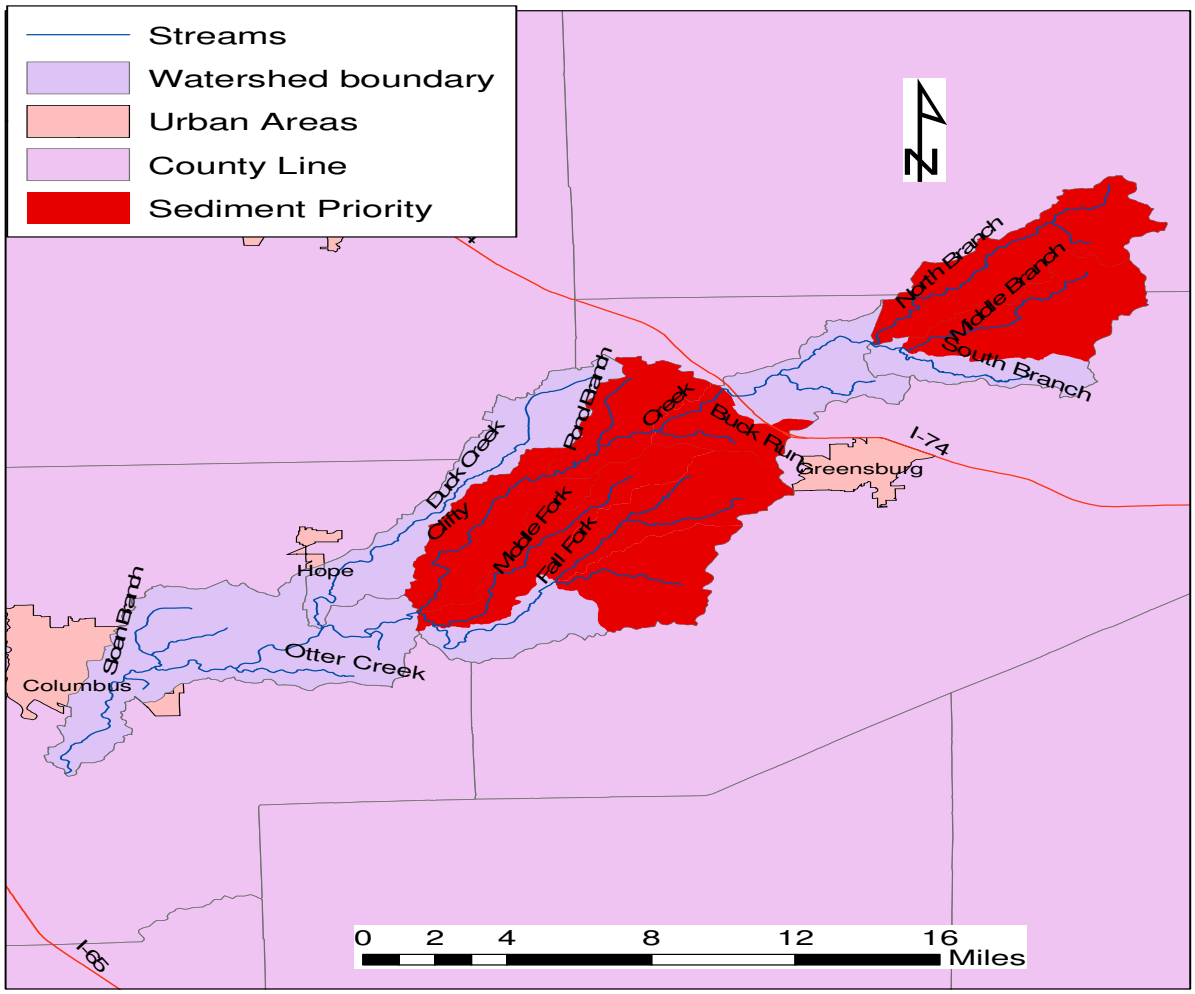


Subwatersheds prioritized for pathogens are Duck Creek (HUC 12: 051202060106) and the northeastern portion of Fall Fork (HUC 12:051202060105) (Figure 6.2). Combined, these subwatersheds drain approximately 41,000 acres in the watershed (31%). Current and existing bacteria data collection indicates that coliform forming units in these subwatersheds consistently exceed the state standard (235cfu/100mL) (Table 4.4.1-4). E. coli emanates from warm blooded animals (humans, livestock, and wildlife). Sources of E. coli watershed-wide include failing septic systems, direct pipe discharges, unrestricted livestock access to streams, and wildlife. These subwatersheds have certain common characteristics, which influence E. coli levels. All of the subwatersheds have documented occurrences of unrestricted livestock access, wildlife, and septic system failure. Although there are 18 segments in Clifty Creek Watershed that are on the

303d list for E. coli the areas that are identified as critical are the sections that showed the worst overall in water quality monitoring. Just as with nutrients, even though there are many areas that are a concern the areas identified above are the ones determined to be the most critical.

6.3 Sediment

Figure 6.3 Subwatersheds prioritized for increased sediment levels



Subwatersheds prioritized for increased sediment levels are parts of Fall Fork (HUC 12: 051202060105), Town of Hartsville-Clifty Creek (HUC 12: 051202060104), Pond Branch (HUC 12: 051202060103), North Branch (HUC 12: 051202060101), and Middle Branch-Clifty Creek (HUC 12: 051202060102) (Figure 6.3).

The northeastern portion of Fall Fork is upstream of Anderson Falls State Nature Preserve, making sediment in this area a priority concern. This area was designated a special area by the Upper East Fork White River Watershed Restoration Action Strategy (WRAS). Town of Hartsville-Clifty Creek is a concern since the highest turbidity values were found at the sampling site that is approximately 10 miles downstream from this subwatershed. The site where the highest turbidity measurements have been isn't included in the critical area found, but by

prioritizing areas that are directly upstream of this site (Town of Hartsville –Clifty Creek) there will hopefully be a reduction in sediment loading. Pond Branch is prioritized for sediment due to the large number of livestock that have unrestricted access to the stream. Finally, all of North Branch and the northern portion of Middle Branch Clifty Creek are prioritized due to the commonality of full tillage agricultural practices utilized in these two subwatersheds. Combined, these subwatersheds drain approximately 73,000 acres in the watershed (55%).

The corridor along 46 that was previously prioritized was removed from the critical area. In the past plan it was listed as critical due to visual assessments. Throughout the corridor along 46 there were large areas of exposed soils and a minimum amount of erosion control practices installed. The area is now better vegetated and has a low amount of exposed soil. Since this construction is finished the committee felt that the area didn't hold as high of a concern as it had in the past.

7.0 Implementing the Plan, Long-term Results, and Evaluation

During the process of management planning, the Steering Committee recognized the financial requirements for implementation. For this reason, the Committee applied for a third Section 319 Nonpoint Source grant from the Indiana Department of Environmental Management. The grant request was awarded for $506,350.00, which will be used for implementation of the ideas expressed and outlined in this Plan. The newest grant extends from April 25, 2008 until April 24, 2011.

Included in the grant for implementation are dollars for installation of agricultural and urban/suburban Best Management Practices (BMPs), public outreach, educational programming, conservation partnerships, and professional development. This includes funds required for personnel and administrative costs.

In order to deliver BMPs throughout the watershed, the Committee will finalize a cost-share program, designed to assist producers, homeowners, and residents with the costs of implementation. Projects will be ranked according to objective criteria, designed to maximize dollars spent for improvement of water quality in the Clifty Creek Watershed.

Applications for involvement in the cost-share program for agricultural practices and urban/suburban projects will be available through the Bartholomew, Decatur, Rush, and Shelby County SWCDs.

The Steering Committee will continue to meet on a regular basis for the purpose of directing implementation efforts, while ensuring that project efforts reflect the ideas expressed in the planning process. To accomplish this, the Committee will review staff reports quarterly on project progress. On an annual basis, the Committee will review project efforts according to this Plan's goals, objectives, and action items.

Integrated into the review process will be input from the project sponsor and supporting Soil & Water Conservation Districts. Based on the nature of adaptive management, as the Watershed Project progresses, prioritizations, goals, and, objectives will need to be reassessed and revised. This will occur on no less than a biannual basis.

Overall, project progress will be tracked by measurable items such as attendance at events and acres of conservation implemented (7.1). Ultimately, long-term goals for the project involve contaminant load reduction for the improvement of water quality. Utilizing data from the watershed inventory in conjunction with the USEPA STEPL model, estimated load reductions for nitrogen, phosphorus, biochemical oxygen demand, and sediment have been calculated (Table 7.4). These numbers are based on estimated annual implementation of targeted Best Management Practices (BMPs) utilizing the model's BMP Calculator. However, BMP efficiencies do not include reduction from any urban BMPs.

In order to monitor the effective load reduction of conservation practices throughout the watershed, the existing volunteer water quality monitoring network will continue to collect water quality data with several modifications. Existing site locations will remain the same, and data collection procedures will be maintained in order to document any reductions to contaminant loading previously identified by baseline data collection. In addition to gathering flow, habitat,

and chemical data on a monthly basis, the network will incorporate a long-term, multi-parameter water quality probe. This probe will be installed to accompany the existing USGS gage station at Columbus for the purpose of collecting continuous water quality data in conjunction with real-time flow data. In addition to standard parameters (temperature, dissolved oxygen, pH, and turbidity), the probe will also measure sediment levels. Through continuous monitoring of water quality at the Columbus station, major seasonal shifts and contaminant spikes can be more thoroughly documented, while also measuring any improvements established by implementation of on-the-ground practices.

Other monitoring network enhancements include site specific studies to be planned and coordinated with any major cost-share projects. Studies will include upstream and downstream locations, utilizing existing sites where possible. Ideally, these studies will provide a very basic "before and after" glimpse at positive improvements made through implementation of Best Management Practices.

Table 7.1 Conservation Practices endorsed by the Technical Advisory Team and projected acreage to meet Committee goals

Practice/Goal	Estimated Annual Application in Watershed (NRCS)	Projected Additional Acreage from Project Efforts	
		Phase I (3 years)	Phase II (5 years)
Conservation Crop Rotation & Cover Crops	4000	1200	2400
Conservation Tillage	5200	1500	2600
Filter Strips/Grassed Waterways	60	30	45
Moist Soil Environments/Emergent Habitat	2	15	25
Nutrient/Pest Management	4900	2100	2400
Pasture/Hay Planting	65	20	35
Prescribed Grazing/Use Exclusion	115	70	--
Riparian Corridors	40	25	35

Data for annual NRCS application was generated from Bartholomew & Decatur County PRS information for 2004 & 2005. Estimate for watershed derived from percentage of each county in the watershed.

Table 7.2 Combined watershed BMP efficiencies from the BMP calculator

Watershed	Watershed Combined BMP Efficiencies				
	N	P	BOD	Sediment	BMPs
Crop	0.929	0.936	0	0.933	Combined BMPs
Pasture	0.75	0.75	0	0.75	Combined BMPs
Forest	0	0	0	0.71	Combined BMPs
Palustrine	0.2	0.44	0.63	0.775	Combined BMPs

Table 7.3 Total load by land use (with BMP)

Sources	N Load (lb/yr)	P Load (lb/yr)	BOD Load (lb/yr)	Sediment Load (t/yr)
Urban	12710.8	1956.4	48999.6	291.7
Cropland	89299.3	20661.8	1808257.5	2425.9
Pastureland	14125.1	1206.5	178406.2	148.3
Forest	1967.7	979.1	4898.7	12.8
Feedlots	1121396.3	34393.3	1723196.4	0.0
User Defined	593.1	228.3	1186.2	185.3
Septic	2487.1	974.1	10155.5	0.0
Total	1242579.3	60399.7	3775100.1	3064.0

Table 7.4 Load Calculation Reductions for the Clifty Creek Watershed

Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
Clifty Creek	2462062.0	527071.9	3998434.4	37960.0	1219482.7	466672.3	223334.3	34896.0

N Load (with BMP)	P Load (with BMP)	BOD (with BMP)	Sediment Load (with BMP)	%N Reduction	%P Reduction	%BOD Reduction	%Sediment Reduction
lb/year	lb/year	lb/year	t/year	%	%	%	%
1242579.3	60399.7	3775100.1	3064.0	49.5	88.5	5.6	91.9

Table 7.5 Load Reductions to date.

Date Completed	BMP	Sediment Reduction	Phosphorus Reduction	Nitrogen Reduction
26-Oct-06	Extended Detention Wet Basins (NO.)	0	0	0
03-Oct-06	Prescribed Grazing (AC) (528A)	0	1	1
30-Oct-07	Heavy Use Area Protection (AC) (561)	5.6	4.9	9.8
08-Nov-07	Heavy Use Area Protection (AC) (561)	2.8	2.4	4.8
15-Jan-08	Fence (FT) (382)	20.4	21.2	42.4
23-Jul-07	Residue Mgt, No-Till Strip Till (AC) (329A)	307	354	708
30-Jan-07	Nutrient Management (AC) (590)	0	15313	0
09-Oct-07	Prescribed Grazing (AC) (528A)	57	69	139
07-Sep-07	Fence (FT) (382)	169	173.2	346.4
06-Aug-07	Prescribed Grazing (AC) (528A)	97	131	259
30-Jan-07	Nutrient Management (AC) (590)	0	31089	0
06-Aug-07	Residue Mgt, No-Till Strip Till (AC) (329A)	276	320	640
30-Nov-07	Pasture and Hay Planting (AC) (512)	36	46	92
28-Nov-07	Pasture and Hay Planting (AC) (512)	7.6	10.1	20.1
07-Aug-07	Residue Management, Mulch Till (AC) (329B)	464	492	985
18-Jun-07	Residue Management, Mulch Till (AC) (329B)	4703	4278	8559
29-Oct-07	Cover and Green Manure Crop (AC) (340)	7	8	16
23-Feb-07	Nutrient Management (AC) (590)	0	1584	0
05-Nov-07	Cover and Green Manure Crop (AC) (340)	27	36	72
24-May-07	Fence (FT) (382)	186.6	186.6	383.4
09-Jul-06	Stream Crossing (NO.) (578)	0.6	0.6	1.2
08-Dec-06	Heavy Use Area Protection (AC) (561)	1	2	4
24-Jan-08	Pasture and Hay Planting (AC) (512)	1.9	2.6	5.2
12-Oct-07	Heavy Use Area Protection (AC) (561)	0.6	0.8	1.7
07-Dec-07	Nutrient Management (AC) (590)	0	15539	0
29-Jan-07	Nutrient Management (AC) (590)	0	17439	0
14-Dec-07	Fence (FT) (382)	17.3	22	43.9
17-Nov-06	Nutrient Management (AC) (590)	0	1944	0
06-Aug-07	Heavy Use Area Protection (AC) (561)	0.8	0.9	1.8
21-Feb-07	Use Exclusion (AC) (472)	34	34	68
20-Nov-07	Pipeline (FT) (516)	67	83	165
24-Apr-07	Pasture and Hay Planting (AC) (512)	209	218	437
	TOTALS	**6698.2**	**89405.3**	**13005.7**
		tons/yr	pounds/yr	pounds/yr

Based on current load reductions that we have calculated to date, we have had a 19% reduction of both phosphorus and sediment by implementing the above listed BMPs. We have also had a 1.1% reduction of nitrogen by implementing the above listed BMPs. We have not calculated BOD load reductions at this point. This is something that will be looked at more in the future. Although we have not reached our goals set up in the original watershed management plan we are on our way to reducing loads from non point sources.

8.0 References and Appendices

References

Assessment of Water Quality at Selected Sites in the White River Basin, Indiana, 1993 and 1995 Using Biological Indices. Indianapolis: US Geological Survey, 1996.

Atlas of Great Lakes Indian History. Civilization of the American Indian Series Vol. 174, University of Oklahoma Press, 1987.

Conservation Technology Information Center (CTIC). http://www.ctic.purdue.edu

Environmental Setting and Natural Factors and Human Influences Affecting Water Quality in the White River Basin, Indiana. Indianapolis: US Geological Survey, 1999.

Fishes of the White River Basin, Indiana. Indianapolis: US Geological Survey, 1996.

Getting in Step: Engaging and Involving Stakeholders in Your Watershed. USEPA Publication 68-C-99-249. Tetra Tech, Inc.

Healthy Communities Initiative 2004 Report to the Community. Columbus: Healthy Communities Initiative, 2004.

History of Bartholomew County, Indiana – 1888. Indianapolis: Brant & Fuller, 1888.

History of Decatur County, Indiana, Its People, Industries and Institutions. Indianapolis: B.F. Bowen Company, Inc., 1915.

Indians of the State of Indiana (Map). Michigan: Hearne Brothers, US Patent No. 305, 744.

Indiana to 1816, The Colonial Period. History of Indiana Vol. 1. Indianapolis: Indiana Historical Society, 1994.

Occurrence of Pesticides in the White River, Indiana, 1991-95. Indianapolis: US Geological Survey, 1996.

Rule 410 IAC 6-8.1. Indianapolis: Indiana State Department of Health, 1990.

The Care and Feeding of a Section 319 Grant Project. Indianapolis: Indiana Department of Environmental Management, 2001.

Trends in Acetochlor Concentrations in Surface Waters of the White River Basin, Indiana, 1994-96. Indianapolis: US Geological Survey, 1997.

Watershed Action Guide for Indiana. Indianapolis: Indiana Department of Environmental Management, 1999.

Watershed Restoration Action Strategy for the Upper East Fork White Watershed. Bloomington: Wittman Hydro Planning Associates, Inc.,

Appendix A: Municipalities and Organizations involved with Project Development

Bartholomew County Soil & Water Conservation District
1040 2nd Street, Columbus, IN 47201
(812) 378-1280 ext. 3

Decatur County Soil & Water Conservation District
1333 N. Liberty Circle E.,
Greensburg, IN 47240
(812) 663-8685 ext. 3
www.decaturswcd.org

Rush County Soil & Water
Conservation District
146 East U.S. 52, Rushville, IN 46173
(765) 932-2813 ext. 3

Shelby County Soil & Water Conservation District
1110 Amos Road, Shelbyville, IN 46176
(317) 392-4149 ext. 3

Natural Resource Conservation Service
6013 Lakeside Boulevard
Indianapolis, IN 46278
(317) 290-3200
www.in.nrcs.usda.gov

Indiana Department of Environmental Management
Indiana Government Center North
100 N. Senate Avenue
Indianapolis, IN 46204
(317) 232-8603
www.in.gov/idem/

United States Geologic Survey
5957 Lakeside Boulevard
Indianapolis, IN 46278
(317)290-3333
http://in.water.usgs.gov/

Bartholomew County Conservation Council & Ducks Unlimited
c/o Max Jacobus
8880 W 930 S, Columbus, IN 47201

kidscommons Children's Museum of Columbus
309 Washington St., Columbus, IN 47201
(812) 378-3046
www.kidscommons.org

Hoosier Riverwatch
Fort Harrison State Park - NREC
5785 Glenn Road Indianapolis, IN 46216
(317) 541-0617
www.hoosierriverwatch.com

Indiana Project WET
Fort Harrison State Park - NREC
5785 Glenn Road Indianapolis, IN 46216
(317) 562-0788
www.in.gov/dnr/nrec/

Bartholomew County Solid Waste Management District
720 S. Mapleton St., Columbus, IN 47201
(812) 376-2614
www.bcswmd.com

Bartholomew County Health Department
440 Third Street, Suite 303
Columbus IN 47201
(812) 379-1550
www.bartholomewco.com/health/

Decatur County Health Department
801 N Lincoln St, Greensburg, IN 47240
(812) 663-8301
www.decaturcounty.in.gov/health/health.htm

Bartholomew County Commissioners
440 Third Street, Columbus, IN 47201
(812) 379-1515
www.bartholomewco.com/commissioner/

Decatur County Commissioners
150 Courthouse Square
Greensburg, IN 47240
(812) 663-2546
www.decaturcounty.in.gov

City of Columbus
123 Washington St., Columbus, IN 47201
(812) 376-2570
www.columbus.in.gov

Town of Hartsville
P.O. Box 812, Hartsville, IN 47244

Columbus Volunteer Action Center
1531 13th Street, Suite 1100
Columbus, IN 47201
(812) 375-2210
www.volunteerbartholomew.org

Columbus Center for Teaching and Learning
4555 Central Ave., Columbus, IN 47203
(812) 314-8709
www.columbusctl.com

Purdue University -Department of Forestry and Natural Resources
715 West State Street
West Lafayette IN 47907-2061
(765) 494-3531
www.fnr.purdue.edu/

Indiana University Purdue University Columbus (IUPUC)
4601 Central Avenue Columbus, IN 47203
(812) 348-7311
http://www.iupuc.edu

Appendix B: Project Committee Members and Advisors

Steering Committee

Officers (2003-March 2006)	
Steve	Rucker, Project Chair
Harold	Wilson, Project Vice-Chair
John	Rondot, Project Secretary
Officers (April 2006)	
Alan	VanNahmen, Project Chair
Steve	Rucker, Project Vice-Chair
Jane	Birdsong, Project Secretary
Officers (April 2008-present)	
Steve	Rucker, Project Chair
Robert	Finkel, Project Vice-Chair
Jack	Countryman, Project Secretary

Past & Present Members	
Lynn	Artis, Landowner
Jane	Birdsong, kidscommons
Jack	Countryman,Landowner/Educator
Greg	Daily, Landowner
Bob	Dawson, Associate Decatur Co. board member
Janice	Kroger, former FSA employee
Joy	Krutek, community member
Jeff	Linke, landowner
Chuck	Luurtsema, Landowner
Jon	Martin, Previous SWCD employee
Shane	Meier, Landowner
Mike	Meyer, Columbus City Utilities
David	Payne, landowner
Ron	Robbins, community member
John	Rondot, Previous Bartholomew Co. board member
Steve	Rucker, Assistant City Engineer
Charles	Shields, Landowner
Bridget	Steele, kidscommons educator
Michele	Sweet, community member
Alan	VanNahmen, community member
Harold	Wilson, Landowner
Jerry	Wiseman, Previous Decatur Co. board member, landowner
Robert	Finkel, Landowner
Randy	Aspenson, Code enforcement
Mike	Yeley, Previous Bartholomew Co. board member, landowner

Technical Advisory Team

Participants	
Jennifer	Boyle, IDEM
Bob	Dawson, Past Committee Member
Wayne	Downey, Non-Regulated Livestock
Bill	Gelfius, Crop Related Agriculture
Susannah	Hole, NRCS, Grazing Specialist
Adam	Heichelbech, NRCS,Bartholomew County
Jon	Martin, Past Committee Member
Dan	McGuckin, IDNR, Wildlife Biology
Lowell	Miller, Hope Hardwoods
Darrell	Nicholson, NRCS, Decatur County
Robert	Pumphrey, Regulated Livestock
Kristen	Whittington, Precision Partners
Harold	Wilson, Committee Member

Educator Brainstorming Session

Participants	
Janet	Baldwin, Rockcreek Elementary
Jane	Birdsong, Columbus kidscommons
Cynthia	Farnsley, BC SWCD
Debbie	Gaff, Central Middle School
Annette	Geis, Sand Creek Watershed
Cheryl	Hodapp, Southside Elementary
Bob	Kasting, Columbus East High School
Deb	McClellan, Northside Elementary
Larry	McClellan, Central Middle School
Janice	Montgomery, Center for Teaching & Learning
Leanne	Whitesell, Friends of the Muscatatuck River Society

Appendix C: Survey

Bartholomew and Decatur County Soil & Water Conservation Districts
Please take a few minutes to complete this short survey, and return it in the provided envelo_
All returned surveys will be entered into a drawing for Red Lobster Gift Certificates, graciously donated by the Columbus Red Lobster, located on 25th Street.

In general, do you think water quality in your area is improving, or do you think water quality is getting worse?
Improving
Getting worse.

Do you know what a watershed is?

a. Absolutely, no doubt in my mind.
b. I have a general idea.
c. I have heard of a watershed, but couldn't tell you what it is.
d. I have no idea

Please briefly (in 1-3 sentences) describe your definition of a watershed.

Please list any local rivers and/or streams you are familiar with.

Please circle any and all items listed below that are potential sources of nonpoint pollution in rivers/streams:

a. Residential lawn
b. Agricultural field
c. Industrial discharge
d. Sewage treatment plant
e. Roads/driveway/parking lot
f. Golf course

Are you familiar with Clifty Creek?

a. Yes
b. No

What do you think of the water quality in Clifty Creek?

a. The creek is clean.
b. The creek could be better, but overall is clean.
c. The creek is not clean, but is not terrible.
d. The creek is not clean.
e. I have no opinion on the subject.

How important do you think overall water quality is for you and/or your family?

a. Very important
b. Somewhat important
c. Not very important
d. Not at all important

On a scale of 1 to 10, with 1 being your lowest priority and 10 being your highest priority, where do you place water quality when making personal decisions?

1 2 3 4 5 6 7 8 9 10
lowest highest

On a scale of 1 to 10, with 1 being your lowest priority and 10 being your highest priority, where do you think water quality should be placed when making community decisions?

1 2 3 4 5 6 7 8 9 10
lowest highest

Please include any additional comments regarding the subject of water quality in your county here:

Appendix D:Project Water Quality Data (2004-2008)

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
3/20/2005	CLIF01			93.29	10	87			7.2	10.05	0.21		3.1	0.017	0	0.04	
4/18/2005	CLIF01	67.5		173.76	9	100	0	4600	7.8	17.1	1.23		4			0.11	
6/29/2005	CLIF01	51.5		61.78	7	84	650	12100	8.1	1.6	0.39	0.24	6.1		17	0	
7/17/2005	CLIF01	62		68.85	9	118	200	20400	8	0.6	0.1		1		16	1.21	
8/22/2004	CLIF01	45		19.16	6	78	0		8.25		0.18		2.2		15		
5/22/2005	CLIF01	71.5	17	70	7	90	350		7.6	1.2	1.58		4.6	0.01	16	0.26	
2/19/2005	CLIF01	41.5		303.19	7.5	57	150	6200	7.5	11.5	0.71		1.4		17		
10/16/2005	CLIF01									26.5	0.30		1.00			0.00	
2/5/2006	CLIF01				11.50	85	400		7.80	7.1	0.71		6.30		30	0.17	
3/5/2006	CLIF01	48.5			9.00	72			7.38				30.00	0.5	15		
4/2/2006	CLIF01																
5/7/2006	CLIF01	55.5			9.00	85	200	4700	7.50	1.8	0.32		33.00	0		0.14	
6/4/2006	CLIF01																
7/2/2006	CLIF01																
8/6/2006	CLIF01																
9/10/2006	CLIF01																
10/1/2006	CLIF01																
11/5/2006	CLIF01																
12/3/2006	CLIF01																
1/7/2007	CLIF01																
3/4/2007	CLIF01																
4/1/2007	CLIF01																
5/6/2007	CLIF01	78	48	99.03	7.9	83.0	100	0									
6/3/2007	CLIF01																
7/1/2007	CLIF01	85		135.46	10	110.0	350		7.80		0.24	0.23	9.66		20	0.14	
8/5/2007	CLIF01	76.5		43.47	5.25	60	400		7.56		0.09	0.15	0.90		17.5	0.08	
9/9/2007	CLIF01	81.5		22.47	10	112			7.6		0.02	0.04	1.21		15	0.05	
10/7/2007	CLIF01	58		25.54	5	58			8		0.02	0.02	0.69		16	<.3	
11/4/2007	CLIF01	53		5.29	9	82	0	300	8.63		< 0.01	0.02	0.82		15	0.04	
12/2/2007	CLIF01	64		14.02	5	36	0	1000	8.37		0.07	0.04	1.13		37	0.02	
1/6/2008	CLIF01	67		174.6	11	82	900	2000	8.5		0.07	0.06	11.40		15	0.05	
2/3/2008	CLIF01	75			9	64			8.13		0.1	0.1	10.1		17	0.05	
3/2/2008	CLIF01	62			11	87	0	1000	8.29		0.39	0.29	11.9		47.5	0.06	
4/6/2008	CLIF01	52			9	90	0	0	8.14		0.5	0.4	8.37		40	0.09	
5/4/2008	CLIF01	56		110.6081	5.5	50	0	0	8.09		0.04	0.06	4.76		15	0.05	

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
4/19/2005	CLIF02	79.5		148	9	102	0	2800	7.8	15.5	1.54		5.3		15	0.02	
6/29/2005	CLIF02	86		117.24	8	95	450	8950	8.3	0.9	0.36	0.21	5.6		15	0.13	
7/17/2005	CLIF02	72		81.68	8.3	115	200	22150	8.2	1.5	0.14		0.8		15	0.14	
5/22/2005	CLIF02		34		8	90	300			0.7	1.21		4.4	0.015	17	0.16	
2/19/2005	CLIF02	89		279.87	7.5	56	50	5050	7.5	10.3	1.1		0.4		16		
10/16/2005	CLIF02	64		20.33					7.50	57	0.43		0.40		5	0.07	
2/5/2006	CLIF02						200		6.20	16.4	0.77		10.00		35	0.06	
3/5/2006	CLIF02	70.5		139.32	9.00	70			6.50				5.00	0	15		
4/2/2006	CLIF02				9.00	81			7.00				7.50	0	50		
5/7/2006	CLIF02				7.00	70	300	6000	8.00				10.00	0	16		
6/4/2006	CLIF02				7.00	76	800		7.50	0.9	0.34		5.40	0	44	0.52	
7/2/2006	CLIF02	89	21		10.00	135	150	4500	8.8		0.1		5	0	15		
8/6/2006	CLIF02	92			9.00	108	0	6500	9	3.7	0.42		2.8	0	15	0.16	
9/10/2006	CLIF02	82	32		7.00	75			7.8								
10/1/2006	CLIF02																
11/5/2006	CLIF02	88			7.00	57			7						<15		
12/3/2006	CLIF02	42			6.00	47			6.5						50		
1/7/2007	CLIF02																
3/4/2007	CLIF02																
4/1/2007	CLIF02	60			5.5	56.0	1700		7.75						40		
5/6/2007	CLIF02	78			7	70.0	0	0	8.00						<15		0
6/3/2007	CLIF02	71			6	75.0	400		8.30			0.10	3.05		<15	0.10	0
7/1/2007	CLIF02	79			6	70.0	300		7.75		0.22	0.22	9.59		17	0.09	< 5
8/5/2007	CLIF02	72			5.5	65.0	10000	10000	7.50		0.23	0.12	1.21		15	0.10	1.15
9/9/2007	CLIF02	84.5			4.5	53	150	5000	7.5						<15		
10/7/2007	CLIF02	51			6	67	100	1100	8.5						<15		
11/4/2007	CLIF02	69			6	50	100	4000	7.5		0.04	0.02	1.57		<15	0.06	1.3
12/2/2007	CLIF02	71			6.8	52	0	2050	6.5		0.03	0.05	1.17		<15	0.03	1.15
1/6/2008	CLIF02	84			10	74	100	4000	7.65		0.06	0.07	11.80		<15	0.02	1.57
2/3/2008	CLIF02	67			7	51			6.75		0.1	0.1	10.3		15	0.04	2.26
3/2/2008	CLIF02	78			7	77	0	1100	8.09		0.36	0.28	12.4		22.5	0.05	1.43
4/6/2008	CLIF02	73			6	55	200	2000	8.21		0.49	0.4	8.47		45	0.08	1.95
5/4/2008	CLIF02	109			9	96	100	4500	8.35		0.04	0.06	5.1		<15	0.04	0.95
3/20/2005	CLIF03	83		97.61	11.3	88	0	600	8.2	7.1	0.14		5	0.022		0.09	
5/25/2005	CLIF03		25		8	88	0		8.4	1.7	1.14		5.3	0.087	15	0.13	

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
7/17/2005	CLIF03	83		41.75	8.5	115	400	21300	8.2	1.1	0.54		1.2		16	0.11	
6/13/2004	CLIF03	82	35		6.5	83	0		8.5		0.25		33				
8/23/2004	CLIF03	67		11.05	8	103	0		8		0.2		1.1		10		
2/19/2005	CLIF03			315.63	11	76	50	6100	7.3	9.4	0.99		1.4		16		
4/17/2005	CLIF03	83		43.9	8	90	0	1400	8.43	18	1.76		4.3		15	0	
10/16/2005	CLIF03	76		10.2	5.50	53				26.2	0.24		0.6		<15	0	
2/5/2006	CLIF03				11.00	70			7.5	0.9	0.6		8.8		40	0	
3/5/2006	CLIF03																
4/2/2006	CLIF03																
5/7/2006	CLIF03	86.5			9.20	95	0	0	6.7		0.55		44		35		
6/4/2006	CLIF03																
7/2/2006	CLIF03																
8/6/2006	CLIF03				7.70	89	50	4000	6	2.1	0.42		1.6		<15	0	
9/10/2006	CLIF03																
10/1/2006	CLIF03																
11/5/2006	CLIF03																
12/3/2006	CLIF03																
1/7/2007	CLIF03																
3/4/2007	CLIF03																
4/1/2007	CLIF03																
5/6/2007	CLIF03																
6/3/2007	CLIF03																
7/1/2007	CLIF03																
8/5/2007	CLIF03																
9/9/2007	CLIF03																
10/7/2007	CLIF03																
11/4/2007	CLIF03																
12/2/2007	CLIF03																
1/6/2008	CLIF03																
2/3/2008	CLIF03																
3/2/2008	CLIF03																
4/6/2008	CLIF03																
3/20/2005	CLIF04	88		23	10	82	0	700	8.1	5.6	0.18		5.1	0.023		0.02	
5/25/2005	CLIF04		38		9.5	104	0		8.5	1.3	1.45		6.9	0.007	15	0.11	
6/29/2005	CLIF04	83			7	84	0	0	8.4	0.3	0.26	0.09	7.6		15	0	

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
4/17/2005	CLIF04	94		50	7.3	81		700	8.5	16.1	1.12		5.4		19	-0.01	
10/16/2005	CLIF04				8.00	77			8.20	24.3	0.14		0.3		17	0	
2/5/2006	CLIF04																
3/5/2006	CLIF04																
4/2/2006	CLIF04	91			10.30	78			8.10						30		
5/7/2006	CLIF04	82.5			10.00	100	0	0	8.60	1.4	0.45		8.40		15	0.15	
6/4/2006	CLIF04		33		7.30	77	300		8.40	15.5	0.37		3.50		36	0.34	
7/2/2006	CLIF04	98.5			6.50	82	100	700	8.4						15		
8/6/2006	CLIF04			27.87	7.00	85	100	5200	8.4	16.8	0.49		0.4		15	0.14	
9/10/2006	CLIF04	96	30		5.50	60			8.2						17		
10/1/2006	CLIF04	87.5			7.00	70			8.1						15		
11/5/2006	CLIF04	94			9.00	76			8.6						<15		
12/3/2006	CLIF04	97			7.00	56			7.9						43		
1/7/2007	CLIF04	105			8.00	66	200		8.6						48		
3/4/2007	CLIF04	99			10.00	74.3	100		6.5						19		
4/1/2007	CLIF04	105			8	83.0	600		7.50						20		1
5/6/2007	CLIF04	94.5			8	82.2	0	200	8.50						<15		2
6/3/2007	CLIF04	93			8.5	99.6	1000		8.40			0.14	4.10		<15	0.08	1.5
7/1/2007	CLIF04	91			9	103.0	600	3000	8.40		0.27	0.24	12.10		25	0.05	< 5
8/5/2007	CLIF04	86			6.5	82.1	4200	10000	8.00		0.18	0.21	0.98		17	0.07	1.25
9/9/2007	CLIF04	81.5			2.5	29	8000		7.4		0.22	0.24	2.29		<15	0.38	
10/7/2007	CLIF04	61.5			4.5	52	0	2000	7.2		0.16	0.17	0.45		<15	<.3	2.20
11/4/2007	CLIF04	60			9	80.4	0	2000	8.06		0.1	0.12	1.05		<15	0.05	1.99
12/2/2007	CLIF04	61			10	78	0	2100	7.6		0.11	0.13	0.44		<15	0.02	1.17
1/6/2008	CLIF04																
2/3/2008	CLIF04																
3/2/2008	CLIF04	93			11.33	90	0	1500	8.37		0.22	0.19	14.3		19	0.03	1.36
4/6/2008	CLIF04	97			10.5	95.11	0	0	8.2		0.2	0.19	10.7		50	0.03	1.12
5/4/2008	CLIF04	90			11	120	1100	100	8.5		0.03	0.05	6.69		<15	0.04	1.2
3/20/2005	CLIF05	87		67.7	10.6	83	0	300	8.1	7.5	0.15		6.5	0.02	15	0.06	
6/29/2005	CLIF05	88		54.4	7.8	91	0	2000	8.4	0.3	0.15	0.11	8.7		15	0.18	
7/17/2005	CLIF05	90		44.8	6.6	90	100	0	8	1.4	0.24		1.7		16	0.15	
6/12/2004	CLIF05	102		58.98	7.67	97	0		9		0.13		22		15		
8/22/2004	CLIF05	82.5		10.87	7	88	0		9		0.22		4.4		15		
9/24/2004	CLIF05	75.5	30		8	97	250		9		0.2		0		15		

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
10/30/2004	CLIF05	80.5		9.83	8	90	0		9		0.18		4.4		15		
11/20/2004	CLIF05	95		137.86	9	82	150		8.5		0.07		22		15		
7/18/2004	CLIF05		37	8.55	7.33	93	0		9		0		4.4		15		
5/25/2005	CLIF05		30		8.3	90	0		8.5	1.8	0.63		4.9	0.016	15	0.13	
2/20/2005	CLIF05	91			9.7	70	0	7100	7.3	11.1	0.46		3.8		15		
4/17/2005	CLIF05	91		34.6	10	99	0	1300	7	13	2.61		7.3		15	0.05	
10/16/2005	CLIF05				7.00	70			8.20	25.7	0.34		0.8		<15	0	
2/5/2006	CLIF05																
3/5/2006	CLIF05																
4/2/2006	CLIF05	89		135.50	11.00	99			8.30						20		
5/7/2006	CLIF05	98		12.65	10.00	100	400		8.60	1.2	0.37		10.30		15	0.11	
6/4/2006	CLIF05	94	29	144.25	8.00	84	200	5600	8.3	13.7	0.44		3.70		48	0.29	
7/2/2006	CLIF05	81	27	50.76	8.50	100	0		8.4						15		
8/6/2006	CLIF05	90			6.00	72	0	7400	8.5	13.3	0.42		2		15	0.09	
9/10/2006	CLIF05	86	23	16.75	5.50	63			8.4						15		
10/1/2006	CLIF05	87		48.03	8.00	80			8.2						<15		
11/5/2006	CLIF05	95		160.80	9.50	82			8.2						15		
12/3/2006	CLIF05	98			9.00	72			8						28		
1/7/2007	CLIF05	100			10.00	82	800		8.5						68		
3/4/2007	CLIF05	91			10.00	75.2	100		6.33						17		
4/1/2007	CLIF05	98			10	105.0	200		7.25						17		1
5/6/2007	CLIF05	98			9.5	97.0	0	0	8.50						<15		2.5
6/3/2007	CLIF05	90			7.25	86.3	200		8.30			0.11	3.92		<15	0.07	0.25
7/1/2007	CLIF05				8	88.0	200	3000	8.50		0.24	0.23	12.70		19	0.26	< 5
8/5/2007	CLIF05																
9/9/2007	CLIF05	60			5	58	9000	10000	7.6		0.15	0.15	2.21		<15	0.1	0.09
10/7/2007	CLIF05																
11/4/2007	CLIF05	70			8.67	75.4	0	2000	8.23		0.04	0.04	0.34		<15	0.04	1.03
12/2/2007	CLIF05																
1/6/2008	CLIF05																
2/3/2008	CLIF05																
3/2/2008	CLIF05																
4/6/2008	CLIF05																
3/20/2005	CLIF06	76		21.25	8	64	0	1567	8.3	9.4	0.16		5.4	0.034	15	0	
6/29/2005	CLIF06	83		43.46	8.5	92	0	2700	8.4	12.6	0.29	0.07	7.4		15	0	

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
7/17/2005	CLIF06	80		7.3	6	77	250	13950	7.76	1.8	0.46		2.1		17	0.23	
6/14/2004	CLIF06	81	35	29.99	7	89	0		9		0.27		28.6		37		
7/21/2004	CLIF06	71		4.67	8	93	0		8.67		1		13.2		41		
8/22/2004	CLIF06	82		8.24	8.67	102	0		8.67		0.08		11		39		
9/25/2004	CLIF06	85	30	1.71	8.33	98	133		8.25		0		22		15		
10/30/2004	CLIF06	80		10.32	10	106	0		8		0.1		8.8		16		
5/22/2005	CLIF06	79	30	36.55	10	100	0		8.5	1.8	0.63		4.9	0.016	15	0.13	
4/17/2005	CLIF06	79		23.61	8.6	84	0	2500	8	12.9	1.2		8.5		15	0.08	
10/16/2005	CLIF06	70			9.00	82			7.30	26.2	0.90		1.10		15	0.00	
2/5/2006	CLIF06	81			8.00	59	200		7.60	4.1	0.87		11.00		50	0.00	
3/5/2006	CLIF06	83		31.27	9.50	68			7.00		0.00		5.00	0.15	15		
4/2/2006	CLIF06	83		46.75	10.00	86			8.30		0.00		2.00	0.15	17		
5/7/2006	CLIF06	73		43.44	9.00	85	300	4400	8.10	2	0.31		22.00	0.5	15	0.22	
6/4/2006	CLIF06	86		88.23	9.00	93	200	7900	8.1		0.46		4.40		17	0.35	
7/2/2006	CLIF06	76	27		8.00	95	250	3900	7.6		0.1		10	0	16		
8/6/2006	CLIF06	76			9.50	107	100	3000	8	14	0.43		1.8	0.15	15	0.18	
9/10/2006	CLIF06	77		4.49	8.00	83			8.2						<15		
10/1/2006	CLIF06	74	24		8.00	75			8.3						15		
11/5/2006	CLIF06	85			8.00				8.2						<15		
12/3/2006	CLIF06				8.00	61			8						19		
1/7/2007	CLIF06	88			7.00	54	450		7.5						20		
3/4/2007	CLIF06	85			9.50	65	200		6.6						18		
4/1/2007	CLIF06	75		42.4	9	85.0	1100		8.00						15		5
5/6/2007	CLIF06	85		37.78	9	83.0	100	0	8.00						15		1
6/3/2007	CLIF06	81		13.09	7	80.0	250		8.20			0.09	6.99		15	0.06	3
7/1/2007	CLIF06	87			9	97.0	400		8.30		0.10	0.10	12.60		20	0.04	< 5
8/5/2007	CLIF06	81		1.51	6	67	1500	3000	7.80		0.09	0.17	4.76		15	0.03	1.56
9/9/2007	CLIF06	76		11.59							0.75	0.8	7.78			0.09	0.98
10/7/2007	CLIF06	77		1.93	4	44	100	1000	7.6		0.04	0.04	5.1		15	<.3	0.21
11/4/2007	CLIF06	72			9	73	0	1000	8		0.06	0.06	4.9		<15	0.04	1.53
12/2/2007	CLIF06	81		4.65	8	72	100	2000	8		0.05	0.09	3.98		<15	0.02	1.87
1/6/2008	CLIF06	86		28.51	10	74	700	4000	8.2		0.04	0.05	14.00		15	0.02	1.21
2/3/2008	CLIF06	89			10	78			8.2						<15		
3/2/2008	CLIF06	82			8	66	0	1000	8.11		0.29	0.22	16		26	0.03	1.23
4/6/2008	CLIF06	86			8	87	100	1000	7.75		0.14	0.17	13.4		20	0.02	1.95

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
5/4/2008	CLIF06	81		11.56	9	83	200	0	8		0.02	0.04	8.61		15	0.03	1.09
1/7/2007	CLIF07	83			7.00	54	350		8						62		
3/4/2007	CLIF07	80		75.45	8.00	57	0		6.2						17		
4/1/2007	CLIF07	74		153	9.3	90.0	250		8.00						20		4.3
5/6/2007	CLIF07	87	31	47.4	10	92.0	50	0	8.00						15		3
6/3/2007	CLIF07	82		20.21	7	85.0	150		8.30			0.21	4.36			0.05	1
7/1/2007	CLIF07	74		29.47	9	94.0	1000		7.90		0.23	0.21	14.30		<15	0.04	
8/5/2007	CLIF07	74			8	91	1900	3800	8.30		0.32	0.52	0.76		17	0.07	3.17
9/9/2007	CLIF07	80		14.13													
10/7/2007	CLIF07	78			5	53	200	800	7.83		0.08	0.12	0.3		16	<.3	2.50
11/4/2007	CLIF07	74			6	49	0	500	8		0.04	0.23	0.42		<15	0.05	
12/2/2007	CLIF07	77			10	90	0	500	8.2		0.03	0.04	0.48		<15	< .02	1.92
1/6/2008	CLIF07	83			10	77	0	3000	8.4		0.03	0.04	13.00		15	< 0.02	1.67
2/3/2008	CLIF07	83		26.34	12	86			8.5						<15		
3/2/2008	CLIF07	86			6	49	0	2000	8.41		0.22	0.19	13.1		25	0.03	1.25
4/6/2008	CLIF07	93			11	105	0	0	8.64		0.12	0.15	9.66		20	0.02	1.87
5/4/2008	CLIF07	86		22.61	8	77	300	0	8.78		0.02	0.05	7.27		15	0.03	1.14
6/12/2004	DUCK01	74		16.35	4.83	60	0		8.83				22		39		
3/20/2005	DUCK01	78.5		11.66	12	92	0	700	8.6	7.9	0.15		4	0.014	17	0.11	
4/16/2005	DUCK01	81		25	12	120	0	3500	7	12.3	1.32		3.7		17	0.13	
6/29/2005	DUCK01	39.5		17.1	7	87	500	16050	8.6	0.1	0.18	0.12	3.2		18	0	
7/21/2004	DUCK01	77		6.79	6.5	95	2333		8				2.2		91		
8/24/2004	DUCK01	35		0	2.25	31	2500		8.25				0		16		
11/22/2004	DUCK01						200										
11/30/2004	DUCK01						700										
12/1/2004	DUCK01						1500										
12/6/2004	DUCK01						190										
12/7/2004	DUCK01						1500										
2/19/2005	DUCK01	72		28.6	11.5	84	800	8000	8.1	7.4	0.4		1.4		25		
5/22/2005	DUCK01	80	22	23.4	8	86	0		8.2	1.5	0.32		4	0.102	15	0.38	
10/16/2005	DUCK01																
2/5/2006	DUCK01																
3/5/2006	DUCK01																
4/2/2006	DUCK01																
5/7/2006	DUCK01																

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
6/4/2006	DUCK01																
7/2/2006	DUCK01	64		8.42	6.50	75	200	0	8.5						15		
8/6/2006	DUCK01														<15		
9/10/2006	DUCK01	67		2.79	5.25	58			7.8								
10/1/2006	DUCK01																
11/5/2006	DUCK01																
12/3/2006	DUCK01																
1/7/2007	DUCK01																
3/4/2007	DUCK01																
4/1/2007	DUCK01																
5/6/2007	DUCK01																
6/3/2007	DUCK01	42			6.5	85.0	1000		7.25			0.38	2.05		<15	0.10	2.5
7/1/2007	DUCK01				7	81.0	2200	3000	8.00		0.35	0.34	1.69		<15	0.05	< 5
8/5/2007	DUCK01				4.5	56	1300	5000	7.00		0.52	0.41	3.16		55	0.11	2.81
9/9/2007	DUCK01	41			6	73	3050	10000	7.6		0.2	0.33	2.34		17	0.11	4.53
10/7/2007	DUCK01	29			10	117	0	4000	7.7		0.20	0.20	0.73		25	<.3	3.60
11/4/2007	DUCK01	38			9.5	92.5	500	3000	8.37		0.04	0.29	0.24		50	0.04	6.64
12/2/2007	DUCK01																
1/6/2008	DUCK01	44			9.5	72	100	2100	8.5		0.23	0.18	8.86		20	0.04	3.92
2/3/2008	DUCK01																
3/2/2008	DUCK01																
4/6/2008	DUCK01																
3/20/2005	DUCK02	65		8.43	12	94	0	1000	8.5	4.6	0		4.3	0.033		0.05	
4/16/2005	DUCK02	68		11.14	12	115	0	3800	8.7	6.7	1.7		4.5		15	0.01	
6/29/2005	DUCK02	76.5		14.25	9.5	107	9150	4550	8.5	6.1	0.14	0.12	2.5		15	0	
6/12/2004	DUCK02	64	25	19.38	7.5	95	0		9				33		40		
7/21/2004	DUCK02	45		0.58	8	110	1200		9				4.4		7		
8/24/2004	DUCK02	39		0.57	5.25	71	4000		8.75				0		60		
11/22/2004	DUCK02						900										
11/30/2004	DUCK02						627										
12/1/2004	DUCK02						1500										
12/6/2004	DUCK02						391										
12/7/2004	DUCK02						4600										
2/19/2005	DUCK02	68		22.1	12	87	0	32800	8.2	8.2	0.2		1.5		15		
5/22/2005	DUCK02	80	24	27.6	11	115	600		8.5	0.2	0.17		5.2	0.015	15	0.14	

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
10/16/2005	DUCK02																
2/5/2006	DUCK02																
3/5/2006	DUCK02																
4/2/2006	DUCK02																
5/7/2006	DUCK02																
6/4/2006	DUCK02																
7/2/2006	DUCK02	62		10.75	8.00	95	800		9						15		
8/6/2006	DUCK02																
9/10/2006	DUCK02	65		3.31	9.75	113			8.5						<15		
10/1/2006	DUCK02																
11/5/2006	DUCK02																
12/3/2006	DUCK02																
1/7/2007	DUCK02																
3/4/2007	DUCK02																
4/1/2007	DUCK02	56			7.5	78.5	100		8.30						70		2.5
5/6/2007	DUCK02																
6/3/2007	DUCK02	58			8	100.0	1500		8.25			0.18	2.60		<15	0.08	0
7/1/2007	DUCK02				7.5	87.0	1000	3000	7.60		0.15	0.14	21.40		<15	0.10	< 5
8/5/2007	DUCK02				10.5	140	100	3000	9.50		0.52	0.62	1.60		15	0.57	4.93
9/9/2007	DUCK02	41.5			12	150	150		9.55		0.2	0.26	3.35		16	0.06	7.54
10/7/2007	DUCK02																
11/4/2007	DUCK02																
12/2/2007	DUCK02																
1/6/2008	DUCK02	53			9.5	72	500	2000	8.25		0.05	0.06	8.33		<15		1.64
2/3/2008	DUCK02																
3/2/2008	DUCK02																
4/6/2008	DUCK02																
4/17/2005	FALL 01	78		31.82	12	116	400	99999	8.4	7.7	1.58		6.9		15	0.04	
3/20/2005	FALL01	64.5		11.87	12	92	0	450	8.4	7.4	0.19		3.3	0.02	15	-0.01	
6/29/2005	FALL01	70.5		15.65	8.5	99	500	14800	8.4	1.3	0.19	0.16	3.2		15	0	
7/17/2005	FALL01	69		4.63	8	106	0	56800	8.3	2.5	0		0.4		15	0.23	
8/22/2004	FALL01	67		1.84	7.67	94	300		9		0.18		0		15		
9/24/2004	FALL01	62	8		2.5	33	100		9		0.27		0		15		
10/30/2004	FALL01	63		25.76	6.67	79	0		9.17		0.27		1.1		15		
11/20/2004	FALL01	67		55.61	5.67	55	350		8.5		0.53		2.2		15		

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
7/18/2004	FALL01			4.03	8.67	103	0		9		0.23		3.67		37		
2/20/2005	FALL01	76.5		38.36	8	61	150	5800	8.15	10.3	0.23		1.8		15		
5/22/2005	FALL01	80.5	20	56.47	9	98	2400		8.4	0.8	0.44		3.6	0.015	15	0.2	
10/16/2005	FALL01	59		0.80	7.00	72			8.00	24.90	0.40		0.40		<15	0.00	
2/5/2006	FALL01	78		121.22	11.50	79	400		7.10	0.80	0.61		8.40		20	0.34	
3/5/2006	FALL01	71		27.10	11.00	79			8.10						15		
4/2/2006	FALL01																
5/7/2006	FALL01	74		28.83	11.00	110	200	8600	8.50	2.70	0.37		5.20		15	0.15	
6/4/2006	FALL01	78	35	39.83	6.67	80.3	200		8.2	15.3	0.46		1.80		17	0.32	
7/2/2006	FALL01	80	24	4.73	9.50	112	0	0	8.5				8.8		<15		
8/6/2006	FALL01	78		2.40	9.00	115	100	4100	9	19.2	0.57		0.5		<15	0.14	
9/10/2006	FALL01	72		1.57	7.00	75			7.75				1.1	0	<15		
10/1/2006	FALL01	76	25	2.30	8.50	85			8				8.8	0	<15		
11/5/2006	FALL01	77		23.39	9.50	78			6.5				22	0	<15		
12/3/2006	FALL01	82			6.50	50			6.25						19		
1/7/2007	FALL01	81			7.00	57	1800		6.5						68		
3/4/2007	FALL01	81		58.54	10.00	76	100		6.25						15		
4/1/2007	FALL01	76			7.5	84.0	300		7.00				8.00		60		4.5
5/6/2007	FALL01	84	24		10	105.0	0	50	7.75				13.20		<15		1
6/3/2007	FALL01	53			5	63.0	200	3000	7.50			0.09	1.40		<15	0.08	2
7/1/2007	FALL01	81			8	90.0	200		7.50		0.16	0.16	16.40		<15	0.08	< 5
8/5/2007	FALL01			0	7	84	1600	5000	8.40		0.15	0.19	0.38		17	0.05	2.86
9/9/2007	FALL01	49			2	22	3800	4000	8						16		0
10/7/2007	FALL01	58			3.5	36	0	4000	7.5		0.46	0.66	0.67		17	0.92	3.30
11/4/2007	FALL01	50			2	17	300	1100	6.75		0.16	0.78	0.54		18	0.04	0.67
12/2/2007	FALL01	62			4	32	1000	3000	6.96		0.63	2.05	2.15		25	< .02	0.01
1/6/2008	FALL01	77			12	82	1500	2000	6.8		0.06	0.07	11.30		<15	0.03	0.81
2/3/2008	FALL01	76			11	90			6.79						<15		
3/2/2008	FALL01	75			9.5	78	0	1100	7		0.29	0.22	13.3		20	0.03	1.07
4/6/2008	FALL01	75			9.5	87	100	1000	7.4		0.19	0.2	9.34		19	0.02	1.05
5/4/2008	FALL01	75			10	100	0	0	7.75		0.05	0.06	3.79		<15	0.04	1.62
8/22/2004	MID01	62		0.21	6	75	600		9		0.12		0		15		
9/24/2004	MID01	76	18	0.01	4.33	54	1500		9		0		0		15		
10/30/2004	MID01	80		3.69	6.67	75	0		8.67		0.23		2.2		15		
11/20/2004	MID01	82		43.92	6	58	0		8				22		15		

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
7/18/2004	MID01			0.66	5.17	67	0		9		0.2		2.2		7		
2/20/2005	MID01	67		22.62	8.5	65	150	9250	8.1	8.5	0.51		0.5		15		
3/20/2005	MID01	57.5		7.1	12	92	100	2350	8.3	7.2	0.4		7.1	0.021	15	0.14	
4/17/2005	MID01	55		19.21	8	83	0	99999	8	5.7	1.86		9.9		15	0.03	
6/29/2005	MID01	58		6.16	8.5	99	100	7700	8.1	1.2	0.13	0.1	4.5		15	0.01	
7/17/2005	MID01	52		6.68	6	82	400	46000	7.8	1.4	0.03		0.6		15	0.13	
5/22/2005	MID01	56.5	26	8.79	8.5	94	400		8.3	0.9	1.44		7.2	0.055	15	0.32	
10/16/2005	MID01	54		0.38	6.00	66			7.60	18.10	0.43		0.50		<15	0.00	
2/5/2006	MID01	76		42.72	11.00	80	0		7.90	1.50	0.25		11.20		20	0.00	
3/5/2006	MID01	55.5		7.58	10.50	75			7.80						15		
4/2/2006	MID01																
5/7/2006	MID01	56		14.37	6.50	73	300		7.75	0.90			8.60		15	0.22	
6/4/2006	MID01	71	39	19.29	6.00	78	100		8.2	9.4	0.37		3.20		<15	0.35	
7/2/2006	MID01	52			6.50	90	400		8.2						<15		
8/6/2006	MID01	58.5		0.88	7.00	87	400	99999	8	16.9	0.63		0.6		16	0.19	
9/10/2006	MID01	57		1.37	7.50	85			8						<15		
10/1/2006	MID01	62	24		7.00	72			8.2						<15		
11/5/2006	MID01	61			9.00	78			8						<15		
12/3/2006	MID01	68.5			9.00	70			7.95						62		
1/7/2007	MID01	75			7.30	62	500		7.9						52		
3/4/2007	MID01	66			9.50	70.75	100		6						61		
4/1/2007	MID01	60			9.7	99.0	400		7.00						40		5.2
5/6/2007	MID01	56			7	71.7	0	200	8.20						<15		1
6/3/2007	MID01	61			6	78.0	1000		7.80			0.04	1.84		15	0.23	1
7/1/2007	MID01	56			7.3	84.0	1200		8.50		0.33	0.36	1.43		<15	0.05	6
8/5/2007	MID01	52.5			6	75.2	13200	5000	8.05		0.31	0.32	2.30		25	0.07	3.62
9/9/2007	MID01				3.5	40	40000	10000	7.2		0.12	0.12	2.58		<15	0.04	0.71
10/7/2007	MID01	48															
11/4/2007	MID01	32			5.3	49.2	200	3000	7.4		0.22	0.22	0.34		<15	0.03	3.43
12/2/2007	MID01	44			9	74	600	2500	7.4		0.05	0.06	0.81		<15	< .02	0.68
1/6/2008	MID01																
2/3/2008	MID01																3.92
3/2/2008	MID01	68			12	96	100	2000	7.7		0.19	0.14	14.6		16	0.04	1.61
4/6/2008	MID01	67.5			9	82	0	0	7.5		0.74	0.54	8.91		50	0.15	1.29
5/4/2008	MID01	64			11	120	0	0	8.4		0.04	0.05	5.68		<15	0.03	

Date Collected	Site	CQHEI	PTI	Flow (cfs)	Dissolved Oxygen	DO Saturation	Ecoli	Total Coliforms	pH	Chloride	Ortho phosphate	Total Phosphorus	Nitrate	Nitrite	Turbidity	Ammonia Nitrogen	BOD
7/1/07	CLIF01M				7.1	80.0			7.5		0.24	0.24	9.87		20	0.14	< 5
8/5/07	CLIF01M				5.8	70	600		8.50		0.07	0.09	0.73		16	0.04	
9/9/07	CLIF01M				5.7	65	500		7.5						<15		
10/7/07	CLIF01M				8.3	97	100	1000	8		0.02	0.02	0.48		<15	<.3	
11/4/07	CLIF01M				12	105	0	2000	7.5		0.02	0.01	0.62		<15	0.03	
12/2/07	CLIF01M				11	90	0	1000	8						<15		
1/6/2008	CLIF01M										0.14	0.18	12.80			< 0.02	
2/3/2008	CLIF01M										0.18	0.39	10.7			0.03	
3/2/2008	CLIF01M										0.43	0.34	12.2			0.03	0.87
4/6/2008	CLIF01M										0.78	0.58				0.03	1.2
5/4/2008	CLIF01M										0.05	0.08	4.84			0.04	2.17

Appendix E: Point Sources in the Clifty Creek Watershed

NPDES Permits Held by Business/Organizations in the Clifty Creek Watershed

Permit Number	Permit Holder	County	Permit Type
IN0021075*	HARTSVILLE MUNICIPAL WWTP	BARTHOLOMEW	STANDARD
IN0032140*	ELKLAND HILLS ESTATES M.H.P.	BARTHOLOMEW	STANDARD
INR00A002	ARVIN EXHAUST	Bartholomew	STORM WATER
INR00C093	CUMMINS ENGINE CO., INC.	Bartholomew	STORM WATER
INR00F092	FEDERAL MOGUL CORPORATION	DECATUR	STORM WATER
INR00H027	HARTUP TOOL, INC.	Bartholomew	STORM WATER
INR00R076	ROADWAY EXPRESS INC #353	Bartholomew	STORM WATER
INR00S153	STONE CONTAINER CORP	Bartholomew	STORM WATER
INR00T038	KROOT CORPORATION	Bartholomew	STORM WATER
IN0040843	Royal View Subdivision	Bartholomew	STORM WATER
IN0049701	Otter Creek Golf Course	Bartholomew	STORM WATER
INR00U039	UNITED PARCEL SERVICE	Bartholomew	STORM WATER

*Active Permits

Underground Storage Tanks in the Clifty Creek Watershed

Program ID	Organization/Business	County
18144	Bartholomew County Commissioners	Bartholomew
4860	Kiel Brothers Oil Co Inc	Bartholomew
9117	Bigfoot Food Stores LLC	Bartholomew
9094	Bigfoot Food Stores LLC	Bartholomew
13798	School Transport'n / Maint Bldg	Bartholomew
18543	Lucky Star Mart	Bartholomew
18439	Johnson Oil Bigfoot #034	Bartholomew
13781	Finke's Store Inc	Bartholomew
13770	Otter Creek Golf Course	Bartholomew
13758	East Columbus Fire Department	Bartholomew
11667	Rock Tenn Co. Paperboard Products Div.	Bartholomew
10887	Reliance Electric Co	Bartholomew
9632	Beasley Produce Inc	Bartholomew
8204	Roadway Express Inc	Bartholomew

7249	Rainbo Bakery	Bartholomew
6571	Hinkle Sign & Graphics	Bartholomew
5646	Marathon Unit 2472	Bartholomew
5078	Kelly Leasing Inc	Bartholomew
3396	17th St Pump Station	Bartholomew
3309	Crystal Flash Petroleum #25	Bartholomew
1708	United Parcel Service Columbus	Bartholomew
13808	Smith L Francis School	Bartholomew
13810	Clifty Creek School	Bartholomew

Appendix F: Land Use Percentages for the 14-Digit Subwatersheds of the Clifty Creek Watershed

Land Use	Clifty Creek-Columbus	Clifty Creek-Newbern	Otter Creek	Sloan Branch	Duck Creek	Middle Fork	Fall Fork Anderson Falls	Fall Fork UNT	Fall Fork Headwaters	Clifty Creek Hartsville	Pond Branch	Buck Run	Clifty Creek Hwy 421	South Branch	Middle Branch
Water	0.4	1.0	0.0	0.0	0.7	0.4	0.4	0.1	0.1	0.1	0.0	0.0	0.5	0.0	0.0
Low intensity residential	14.7	0.3	1.2	3.0	0.4	0.2	0.0	0.0	0.2	0.7	0.4	0.8	0.1	0.1	0.2
High intensity residential	1.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Commercial	6.7	0.1	0.3	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.6	0.1	0.0	0.0
Deciduous forest	5.6	15.3	5.0	2.0	4.6	6.1	13.9	7.6	4.6	9.8	5.3	2.7	5.4	2.0	3.8
Evergreen forest	0.0	1.9	0.3	0.0	0.0	0.1	0.1	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Mixed forest	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Pasture/hay	30.4	33.8	38.6	23.4	25.8	21.0	26.3	21.0	16.8	22.7	16.2	17.9	24.3	16.5	20.2
Row crops	36.0	46.3	52.2	69.6	68.0	71.9	58.6	70.7	77.4	66.0	77.4	77.5	68.8	81.1	75.3
Urban recreational grasses	3.1	0.0	1.3	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Woody wetlands	1.7	1.2	1.0	0.3	0.5	0.4	0.7	0.4	0.4	0.6	0.5	0.5	0.7	0.3	0.4
Emergent herbaceous wetlands	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Appendix G: Action Register

Action Item	Cost Estimate	Potential Funding Source(s)
Train teachers in Project WET and Project WEBFOOT Curriculum.	Small - Moderate	SWCD, SWMD, Conservation Council, Indiana Project WET, Ducks Unlimited
Create and compile subject boxes specific to water quality issues.	Moderate - Large	SWCD, 319 Grant
Purchase resources for classroom use.	Moderate	319 Grant
Cultivate teacher relationships to encourage participation.	Small	319 Grant
Develop programming that meets time requirements and state standards.	Small	319 Grant
Engage students directly	Small	--
Incorporate hands-on activities	Small - Moderate	319 Grant
Allow for discovery, exploration, and excitement.	Small - Moderate	SWCD, 319 Grant, kidscommons
Follow-up field experience with a session involving analysis.	Moderate	319 Grant, kidscommons
Work in partnership with kidscommons Children's Museum and USGS to create a water quality exhibit.	Large	319 Grant, kidscommons, Private Donors
Encourage and assist schools to initiate Water Festivals	Moderate	319 Grant, Indiana Project WET, SWCD
Create an outreach package to be delivered to diverse groups.	Moderate	319 Grant, SWCD
Mentor Yearly Senior Projects	Small	--
Become involved in HIP program	Small	--
Involve students in water quality monitoring network	Small - Moderate	--
Support student led clubs and civic group efforts.	Small	--
Offer summer internship through project	Moderate	--
Offer cost-share for soil testing before nutrient application	Moderate	319 Grant, SWCD
Host urban/suburban BMP workshops.	Moderate	319 Grant
Develop and cost-share an urban/suburban demonstration project, highlighting innovative practice.	Large	319 Grant
Submit regular press releases	Small	--
Host radio spot, titled: "Your Watershed Moment"	Small	--
Develop and post a project website	Moderate	SWCD, 319 Grant
Maintain a booth at the Bartholomew & Decatur County 4H Fairs	Small	SWCD, 319 Grant
Sponsor floats in the Hope Heritage and Columbus Christmas Parades	Small - Moderate	SWCD, 319 Grant

Action Item	Cost Estimate	Potential Funding Source(s)
Create an emotional message that is posted widely.	Moderate	319 Grant
Research state/federal policy.	Small	--
Post information and links on website.	Small	--
Distribute state/federally produced information on regulatory policy.	Small	--
Develop a distribution list.	Small	--
Create and distribute an e-newsletter.	Moderate	SWCD, 319 Grant
Offer modifications to conventional equipment so that it can be used for conservation tillage.	Moderate - Large	319 Grant
Research manure application options for conservation tillage.	Small	--
Research and/or create economic comparison (short and long term) projections relating to conservation tillage and soil types.	Small - Moderate	319 Grant
Research cover crop options for conditions in the watershed.	Small	--
Create a cost-share program designed to offset initial costs of cover crop implementation.	Large	319 Grant
Provide technical resources and/or contacts to producers for cover crop installation.	Moderate	319 Grant, SWCD
Coordinate outreach and advertising for use of cover crops and respective benefits.	Moderate	319 Grant, SWCD
Develop a list of existing conservation farmers.	Small	--
Request participation in network, providing incentives for mentor farmers.	Small - Moderate	SWCD
Create a list of new farmers and/or those interested in developing a mentor relationship.	Small	--
Provide opportunities for farmers to network (see following objective).	Small - Moderate	319 Grant, Private Sponsors
Grant an annual water quality award for outstanding conservation farmers.	Moderate	319 Grant, Private Sponsors
Plan dates during off-season.	Small	--
Research farmer preferred publications and advertise in advance.	Moderate	319 Grant
Request input from producers regarding specific topics and areas of conservation interest.	Small	--
Develop subject-specific agendas that avoid duplication or repetition of existing efforts.	Small	--
Recruit top-professionals in subject fields to lead workshops.	Moderate	319 Grant
Research Rule 5 regulations and implementation requirements.	Small	--
Participate in plan review process where applicable and stay informed on current political transitions.	Small	--

Action Item	Cost Estimate	Potential Funding Source(s)
Contribute to local planning committees (i.e. ordinance review, highway development, etc.)	Small	--
Initiate dialogue with INDOT regarding state highway projects through watershed.	Small	--
Compile a list of contractors, developers, builders, homeowner's associations, and highway officials that the service or reside in the watershed area.	Small	--
Develop relationships with highway, residential, commercial contractors.	Small	--
Offer specific professional workshops tailored to technical implementation needs for Best Management Practices.	Moderate	319 Grant, SWCD, Private Sponsors
Initiate participation in the Watershed Project from homeowner's associations.	Small	--
Develop and install a demonstration urban/suburban conservation project.	Large	319 Grant
Market existing conservation programs addressing gully erosion.	Small - Moderate	SWCD, 319 Grant
Assist site-specific pond development.	Moderate	319 Grant, Federal Programs
Assist livestock owners with the development of prescribed grazing plans.	Moderate - Large	319 Grant, SWCD
Develop outreach materials for diverse livestock interests.	Moderate	319 Grant, Federal Programs
Provide livestock owners with access to technical resources.	Moderate	319 Grant
Offset technical assistance and nutrient management planning costs.	Large	319 Grant, Federal Programs
When appropriate, incorporate streambank fencing.	Large	319 Grant, Federal Programs
Promote and install offsite water systems	Large	319 Grant, Federal Programs
Develop cost-share opportunities for watering systems and streambank fencing.	Large	319 Grant, Federal Programs
Restore streambanks with natural vegetation.	Large	319 Grant, Federal Programs
Compile cost/benefit analysis of grazing marginal pastureland along streambanks.	Small - Moderate	319 Grant
Research and promote implementation of native vegetation where applicable.	Small	--
Provide technical assistance and cost-share opportunities for streambank restoration.	Large	319 Grant, Federal Programs
Inventory existing corridors and Best Management Practices.	Small	319 Grant

Action Item	Cost Estimate	Potential Funding Source(s)
Market existing conservation programs to sensitive areas.	Moderate	319 Grant
Incorporate drainage concepts into educational seminars and workshops.	Small	319 Grant, SWCD
Create outreach materials on drainage concepts and alternatives to traditional methods.	Moderate	319 Grant
Participate when possible with local drainage boards and planning meetings.	Small	--
Compile current and historic maps of moist-soil environments and hydric soils.	Small - Moderate	319 Grant
Investigate relevant partnerships and facilitate collaboration for future project development.	Small	--
Encourage maintenance and enhancement of existing natural wetlands.	Small	--
Provide existing materials to interested landowners.	Small	--
Research and market existing wetlands / habitat conservation programs.	Small - Moderate	319 Grant
Research existing practices, relevant soil types, and slope.	Small	--
Determine practicality of application in watershed and potential for cost-share.	Small	--
Research recent technology offerings to reduce application rates and offer alternatives to nutrient/pesticide application.	Small - Moderate	319 Grant
Investigate cost-share opportunities for management plan development and conservation practices.	Small	--
Market existing conservation planning resources and programs.	Moderate	319 Grant, SWCD
Develop outreach methods specific to non-agricultural, commercial applicators.	Moderate	319 Grant
Market existing conservation planning resources and programs.	Moderate	319 Grant
Target outreach to areas that currently lack vegetative buffers.	Small - Moderate	319 Grant
Incorporate urban/suburban/rural residential segments into outreach.	Small	--
Provide educational workshops for Backyard Conservation and Soil Testing.	Moderate-Large	319 Grant, SWCD, Private Sponsors
Provide soil test kits to homeowners/residents.	Moderate	319 Grant
Support existing educational efforts by Cooperative Extension.	Small	--
Initiate dialogue with commercial lawn care companies, local landscape architects, and residential contractors.	Small	--

Action Item	Cost Estimate	Potential Funding Source(s)
Compile a list of commercial businesses and management contacts in the watershed.	Small	--
Develop outreach and training materials regarding commercial facility maintenance.	Moderate	319 Grant, SWCD, Private Sponsors
Continue educational and stormdrain marking programs.	Small - Moderate	SWCD
Support municipal stormwater program and ordinance development.	Small	--
Research stormwater Best Management Practices.	Small	--
Facilitate discussion and implementation of urban/suburban Best Management Practices.	Small	--
Promote installation of rain gardens.	Small - Moderate	319 Grant, SWCD
Increase distribution of existing educational materials.	Small	--
Foster cooperative partnerships with County Health Departments.	Small	--
Develop cost-share program to encourage maintenance.	Moderate - Large	319 Grant
Build relationships with local communities currently served by septic systems or package treatment plants.	Small	--
Provide professional/technical seminars focused on new construction, septic system design, and installation.	Moderate	319 Grant, SWCD
Research alternative practices in wastewater treatment.	Small	--
Develop a demonstration project to showcase a practical alternative treatment system for local conditions.	Large	319 Grant, SWCD, Private Sponsors
Utilize educational opportunities to promote proper waste disposal, specifically the Adopt-A-River program.	Small	--
Support existing efforts by County Solid Waste Management Districts, Recycling Centers, and civic groups.	Small	--
Increase distribution and marketing of educational materials concerning amnesty days, recycling options, and proper disposal methods.	Small - Moderate	319 Grant
Facilitate cooperative partnerships with County Solid Waste Management Districts and private waste removal businesses.	Small	--
Research sustainable systems of waste removal in rural areas.	Small	--
Increase the number of Amnesty Days.	Moderate	Private Sponsors

Action Item	Cost Estimate	Potential Funding Source(s)
Constantly recruit new volunteers and advertise upcoming workshops.	Small - Moderate	319 Grant
Host Hoosier Riverwatch Training Workshops.	Small	Hoosier Riverwatch
Train at least one volunteer to be a Hoosier Riverwatch Instructor.	Small	Hoosier Riverwatch
Publicize sampling results.	Small - Moderate	319 Grant
Continue to streamline sampling procedures.	Small - Moderate	319 Grant
Coordinate schedules.	Small	--
Digitally map all implementation sites.	Small - Moderate	319 Grant
Plan pre- and post-construction studies.	Moderate	319 Grant
Project load reductions and compare results.	Moderate	319 Grant
Research Total Suspended Solids for volunteer data collection.	Small	--
Improve flow measurements.	Moderate	319 Grant
Investigate methods for use with Project Spectrophotometer.	Small	319 Grant
Install a long-term, multiparameter probe in the existing USGS gage station in Hartsville.	Large	319 Grant, USGS

Cost Estimates include hours billed by professionals in addition to materials required.
Small = $0.00 - $1,500.00
Small-Moderate = $1,500.00 -$3,000.00
Moderate = $3,000.00 - $7,000.00
Moderate-Large = $7,000.00 – $12,000.00
Large = $12,000+