Mill Creek Watershed Action Plan Final Draft

UPPER MILL CREEK WATERSHED MANAGEMENT PLAN

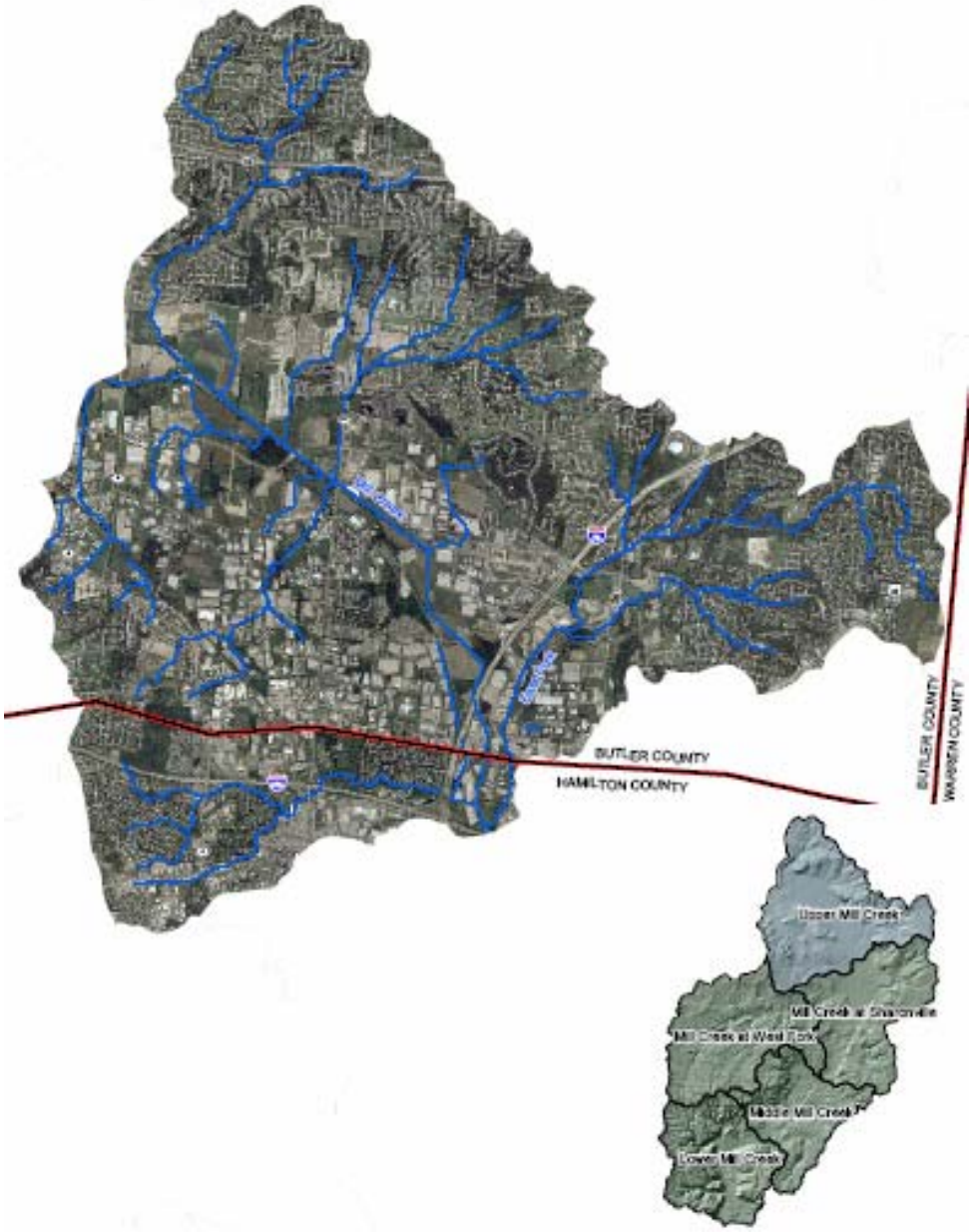
Submitted to:

OHIO ENVIRONMENTAL PROTECTION AGENCY

Submitted by:

MILL CREEK WATERSHED COUNCIL OF COMMUNITIES

DECEMBER 2005



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ACKNOWLEDGEMENTS

This document results from the collaborative effort among the many communities and stakeholders in the Upper Mill Creek sub-basin. The following individuals have participated in its development:

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*The official name changed to Mill Creek Watershed Council of Communities in 2005.

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1. INTRODUCTION

1.1 The Mill Creek Watershed Action Plan Framework

This document presents the watershed action plan (WAP) developed for the Upper Mill Creek (UMC) sub-basin of the Mill Creek watershed located in southwest Ohio.[1] The goal of the UMC WAP is to address causes and sources of water quality impairment and habitat degradation within the watershed and to recommend restoration and protection goals. The final outcome of the UMC WAP is an itemization of problems, priorities and action items identified and supported by local watershed communities and stakeholders.

Action plan development for the Mill Creek watershed was initiated as part of the implementation strategy for the Mill Creek Total Daily Maximum Daily Load (TMDL) process undertaken by the Ohio Environmental Protection Agency (OEPA). The Mill Creek TMDL, prepared by the OEPA and submitted for approval to the United States Environmental Protection Agency (USEPA) in 2004, focuses on attainment of water quality standards (WQS), both chemical-specific and numeric biological criteria, that would result in eventual removal of the Mill Creek (Southwest Ohio) from the OEPA's 303(d) list of impaired waterways. Water quality and biological assessments indicate that non-attainment of WQS is in part due to nutrient and organic enrichment, and habitat degradation. The causes of impairment are stated to correspond to the non-attainment of biocriteria. As such, the primary focus of OEPA's Mill Creek TMDL is on the reduction of nutrient loadings.

System-wide biological attainment based solely on nutrient reduction is likely not possible given the complexity of the Mill Creek system. Other conditions and constraints in the Mill Creek watershed must be taken into consideration including, but not limited to, flooding, channelization, erosion, storm water runoff impacts, riparian corridor loss, public health issues, lack of recreational opportunities, and local economic conditions. The complexity of the Mill Creek watershed lends itself to a more comprehensive watershed approach recognizing that there is not a single solution, but a myriad of actions that can be taken at the local level to improve the quality of the Mill Creek and its tributaries.

Accordingly, the UMC WAP contains both elements essential to address TMDL goals and those needed to provide a more comprehensive approach to stream and aquatic health as well as public health and enjoyment of the Mill Creek watershed. The multi-dimensional nature of the UMC WAP is illustrated by the range of plan goals listed below:

- Improve habitat through riparian restoration;

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[1] This plan addresses one of five (5) 14-digit HUC (Hydrologic Unit Code) basins that comprise the Mill Creek watershed. Addressing watershed impairments and issues at this level is in accordance with current Ohio EPA policies for watershed action plan development.

- Reduce sediment loading for the basin;
- Reduce nutrient loading towards meeting TMDL-specific goals for the basin;
- Stabilize stream banks using bio-engineering techniques;
- Restore natural stream functions where channel alterations have occurred; and
- Improve stewardship of local streams and watersheds through public education.

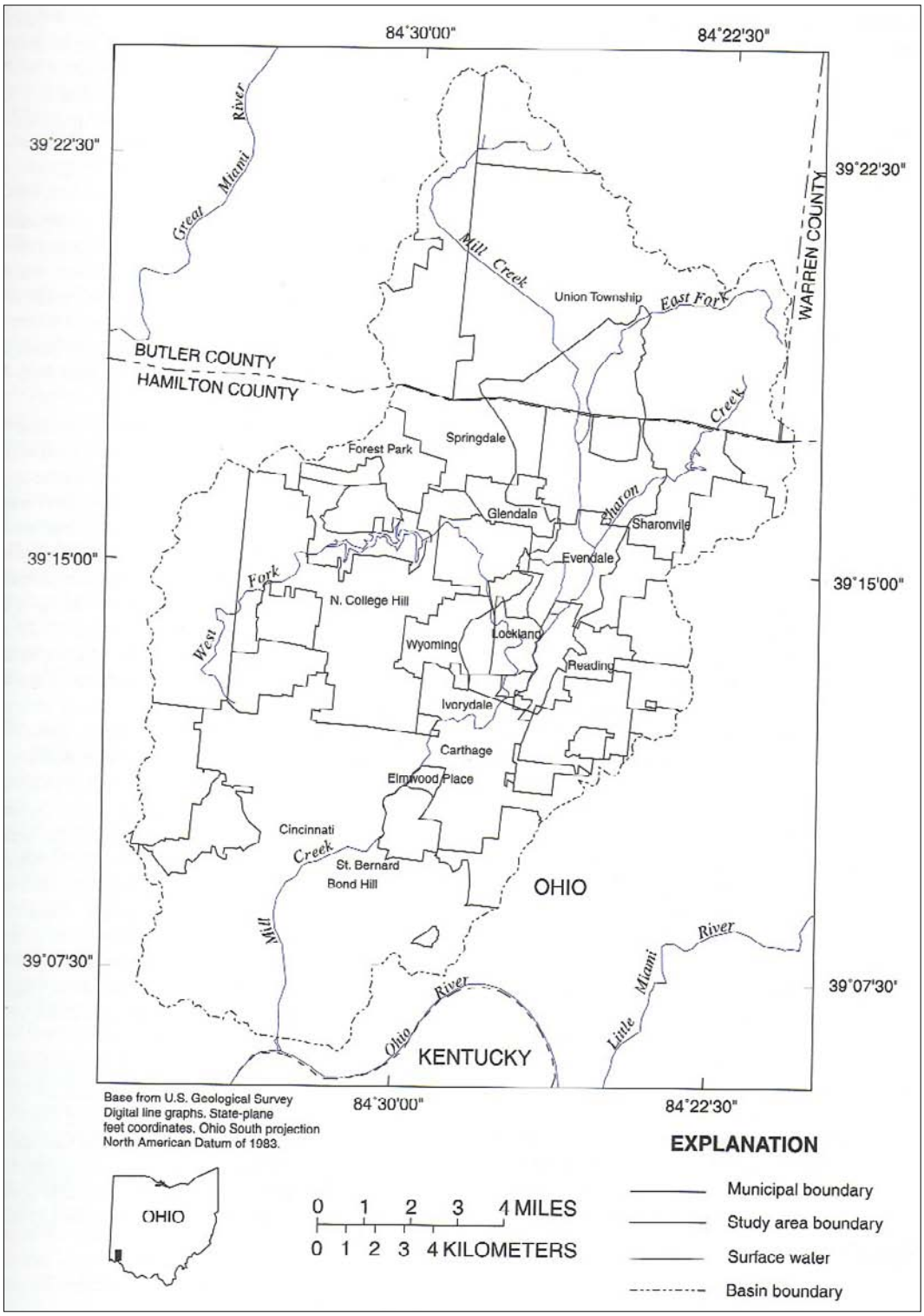
The stated goals for restoration and protection of the UMC streams appear to be diverse in nature yet tend to overlap in function. For example, increasing public awareness about polluted storm water runoff through outreach and education can initiate changes in daily behaviour that will reduce pollution and improve water quality.

The UMC WAP has been prepared in accordance with the OEPA's guidance document titled *"A Guide to Developing Watershed Action Plans in Ohio"* (1997) as updated by USEPA guidance in 2003 to include the expanded Appendix 8 criteria. This format has been modified slightly, with the knowledge and approval of OEPA and the Ohio Department of Natural Resources (ODNR), to create a plan that is more readily understandable and lends itself to easier implementation. The primary modification combines the Watershed Impairment, Restoration and Protection Goals sections in a more succinct and less redundant format.

1.2 Overview of Mill Creek Watershed

The Mill Creek Watershed is located in southwestern Ohio. Figure 1.1 shows the Mill Creek watershed boundary, the major streams and some of the watershed communities. The Mill Creek flows 28.1 miles from the headwaters in southeastern Butler County through central Hamilton County to its confluence with the Ohio River. The Mill Creek is a predominately urban watershed that drains an area of 166.2 square miles. It is located in the Interior Plateau Ecoregion. Along its course, the stream has an average gradient of 11.9 feet per mile (ODNR, 1960). Most of Mill Creek flows atop a buried valley aquifer composed of highly permeable sands and gravel from past glacial deposits and outwash. Major tributaries include the East Fork, Sharon Creek, Beaver Run, Town Run, Congress Run, Cooper Creek, Amberley Creek, West Fork Mill Creek, Bloody Run, Ross Run and West Fork. These tributaries, as well as several smaller ones, enter Mill Creek from the hillsides that characterize the watershed. They are generally underlain by thinly inter-bedded shales and limestone bedrock except for the lower reaches at the confluences with Mill Creek. The average gradient for the major tributaries is 51.8 feet per mile.

Figure 1-1 Mill Creek Watershed



Aquatic life uses for the streams in the basin reflect the high degree of urban/industrial development that has occurred. Mill Creek is currently designated Warmwater Habitat (WWH) from headwaters in Butler County to river mile (RM) 7.9 in Hamilton County and Modified Warmwater Habitat (MWH) for the remainder of its length.

Portions of West Fork and Ross Run have also been designated Limited Warmwater Habitat (LWH) because of modifications to the streams and the number and density of discharges they receive. The rest of the major tributaries are designated WWH. Streams and lakes encompassed in publicly owned park systems are by definition classified as State Resource Waters.

Figure 1.2 shows the Mill Creek watershed. The 11-digit hydrologic unit code (HUC) for the watershed is 05090203-010. There are five major watersheds designated in the Mill Creek watershed and their 14-digit HUC identifiers are: the Upper Mill Creek/East Fork/Beaver Run (05090903-010010), the Sharon/Cooper Creek (05090903-010020), the West Fork Mill Creek (05090903-010030), the Mid-Mill Creek (05090903-010040) and the Lower Mill Creek (05090903-010050).

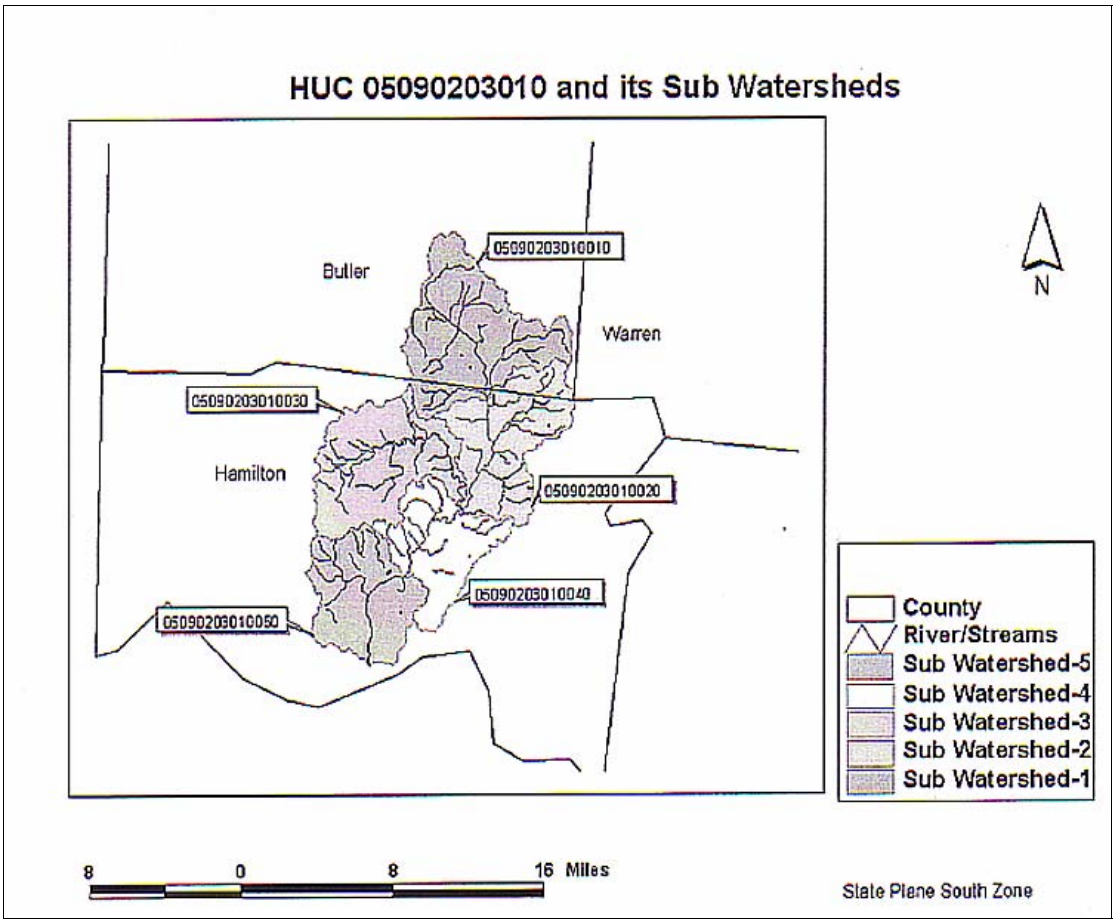
Cities in the Mill Creek Valley with populations greater than 10,000 include Cincinnati, Forest Park, North College Hill, Norwood, Reading, Sharonville and Springdale. (USGS, 2002) The Mill Creek watershed drains an area of 166.2 square miles which encompasses all or portions of 37 political jurisdictions.

Approximately 450,000 people currently live within the Mill Creek watershed boundaries. At present, populations in residential areas in the southern and central portions of the watershed are declining as residents move to the suburban and rural areas to the west, north and east. Older industrial areas have also seen a decline in industries and businesses. Communities along the central and southern Mill Creek industrial corridor in Hamilton County, with a few notable exceptions, are predominantly lower income with aging housing stock and with a declining tax base.

1.3 Upper Mill Creek Watershed (HUC-1)

The Upper Mill Creek, East Fork Mill Creek and Beaver Run (UMC) watershed is the focus of this WAP. It represents the headwaters of Mill Creek. Figure 1.3 shows the delineated watershed boundaries of the Upper Mill Creek watershed. The UMC watershed is identified as USGS HUC-1 within the Mill Creek Watershed and it consists of the drainage area to two major streams with Ohio 305(b) list identification numbers WBID# 62-30 and WBID# 62-31. The UMC as delineated is approximately 30,000 acres.

Figure 1-2 Mill Creek Watersheds (Ohio EPA Mill Creek TMDL Report)



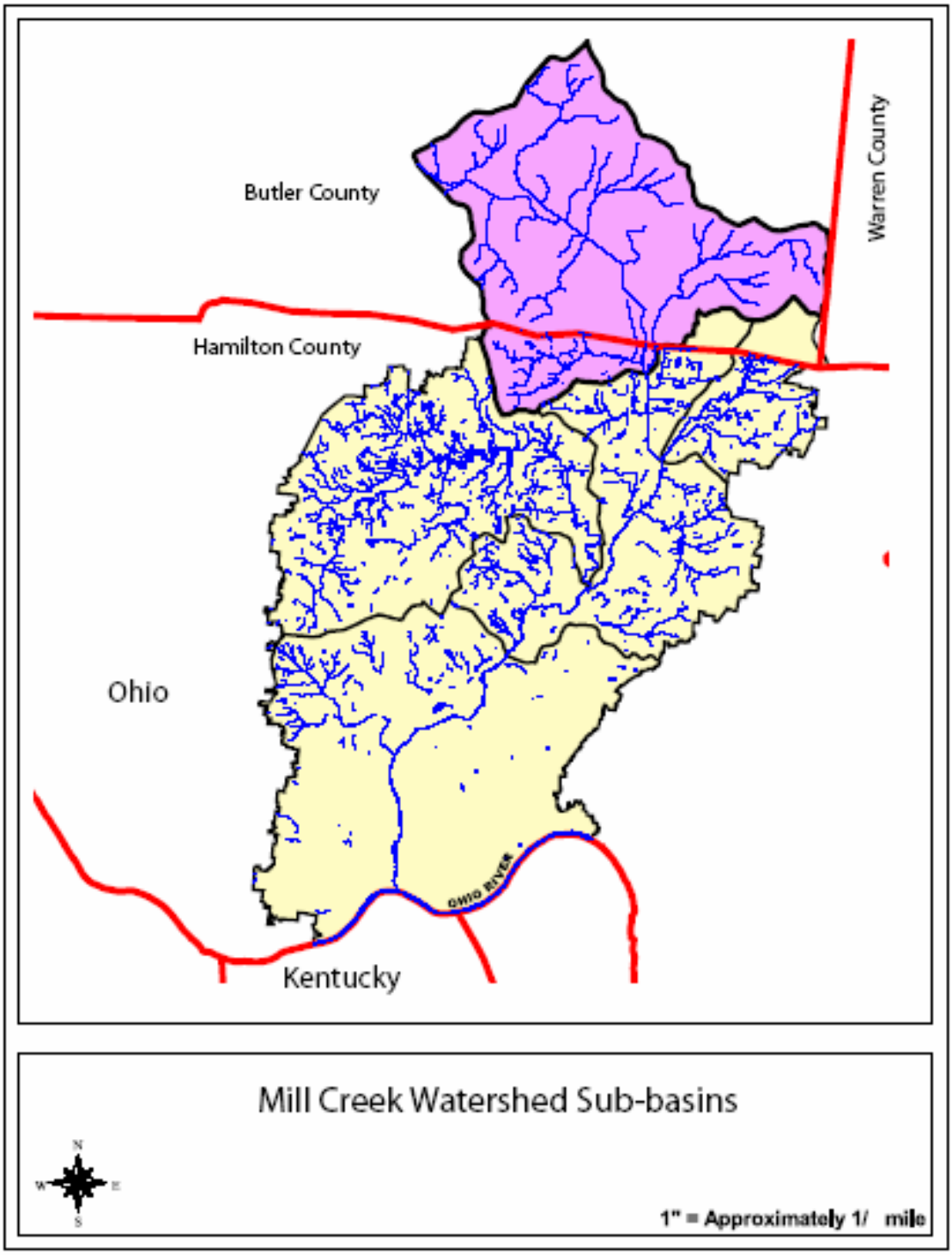
The following subsections provide additional information on the Upper Mill Creek watershed.

1.3.1 Counties and Incorporated/Unincorporated Areas

The Upper Mill Creek watershed encompasses approximately 45 square miles (29,000 acres) in southeastern Butler County and northern Hamilton County including portions of the following political jurisdictions: West Chester, Liberty, and Fairfield Townships and the Cities of Fairfield and Hamilton in Butler County, and Forest Park, Sharonville, Springdale and Springfield Townships in Hamilton County.[2]

[2] A very small portion of the watershed, in the extreme southeastern-most corner, is located in the City of Sharonville.

Figure 1-3 Upper Mill Creek Sub Watershed (HUC1) - shaded



1.3.2 Special Districts

Parks

Park ownership and development in the Upper Mill Creek watershed is coordinated amongst MetroParks of Butler County, West Chester Township Parks, Recreation & Cultural Arts Department, and the Liberty Township Parks Committee. As the upper watershed experiences rapid growth, park departments are making efforts to expand the park system. Butler County agencies are working jointly with other public and private entities to establish the Port Union-Gilmore Ponds Conservation Corridor. The Corridor will include open space protected lands as well as preservation and use of the towpath along the historic Erie Canal as a recreational trail. (A map of the conservation corridor appears in Section 3.) The Butler County effort, spearheaded by West Chester Parks, Recreation & Cultural Arts, has been successful in receiving Clean Ohio Funds for land acquisition in the Corridor. West Chester Township further demonstrated its commitment by placing a 1.95-mill park levy on the November 2003 ballot to help create West Chester's Emerald Bracelet park system – a series of park properties focusing on the historical and cultural resources of the community and linked by greenways and multi-purpose trails. Even though the levy failed to pass, funding from diverse sources continue to support the park system development and are listed in Section 3 of this document. A broader effort exists among the jurisdictions between the Little Miami River and Great Miami River to create the Miami 2 Miami Connection – 80 or more miles of multi-purpose trails and bike lanes that connect the two river systems' recreational uses and present healthier transportation opportunities. Various political jurisdictions and agencies are participating in the Miami 2 Miami initiative and completion of the trail connection is anticipated in five years.

Schools

School districts within the watershed include Lakota Local School District (Liberty and West Chester Townships), Hamilton City School District, Fairfield City School District (Fairfield and Fairfield Township), Winton Woods City School District (Forest Park), and the Princeton City School District (Springdale and Sharonville).

Sewer Districts

The Upper Mill Creek Regional Water Reclamation Facility (WRF) is a regional wastewater facility with a large collection system providing service in West Chester, Liberty and Fairfield Townships. The Butler County Department of Environmental Services (BCDES) operates the Upper Mill Creek WRF. In recent years, southeastern Butler County growth has rapidly added population and economic development to the watershed. In response to economic development trends, Butler County Board of Commissioners responded in 2000 with an expansion of the, Upper Mill Creek WRF. The

Upper Mill Creek WRF serves as the primary method of wastewater treatment for the Upper Mill Creek Watershed in Butler County. Since its construction in 1977, the Upper Mill Creek WRF has replaced and eliminated nearly 25 package treatment plants that previously discharged into Mill Creek waterbodies. Now, public access to the regional wastewater collection system is widespread which has substantially increased the quality of treatment and receiving waters.

On-Site Systems

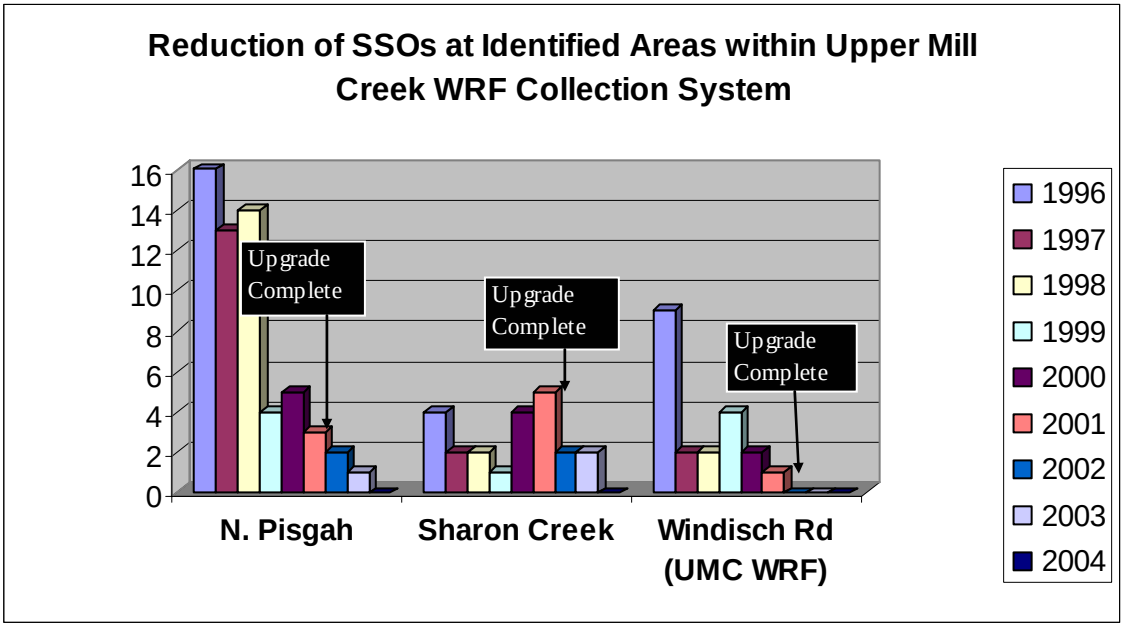
According to the Butler County Department of Environmental Services (BCDES), approximately 100 residences in the Upper Mill Creek watershed have on-site, non-mechanical sewage disposal systems (septic tank/leach field). None of these is known to have a direct discharge to a surface water source. While Butler County does not have a routine inspection program for these systems, if a system is identified as failing (via complaint or other means of notification), the owner will be ordered by the Health District to repair or replace it.

Sanitary Sewer Overflow (SSO) Elimination

Over the past five years, BCDES has voluntarily developed and implemented an aggressive county-wide CMOM (capacity management, operation, maintenance) program designed to identify, classify, prioritize, minimize and ultimately eliminate SSOs from the sewer collection systems that are tributary to the County's Publicly Owned Treatment Works. BCDES' program consists of (1) the establishment of a systematic inspection program for pump stations and cleaning and inspection of sewer lines; (2) the connection of each pump station in Butler County to BCDES' Supervisory Control and Data Acquisition (SCADA) system; (3) the installation of new, larger pump stations with backup power; (4) the development and implementation of a program for sewer modeling and annual TV camera inspections of sewer lines; (5) the installation of parallel relief sewer lines for flood-prone areas in Butler County; and (6) the implementation of a county-wide manhole rehabilitation/replacement program.

As a result of such an aggressive program, all SSOs within the Upper Mill Creek collection system have been eliminated. Specifically, the three critical SSOs identified within the system – Windisch, North Pisgah and Sharon Creek – were eliminated via improvements to infrastructure and maintenance practices, at a cost of over $8 million over five years (Figure 1.4). Countywide, the Department currently spends over $500,000 per year on labor and operation and maintenance activities related to SSO prevention.

Figure 1-4 Number of SSOs by year associated with the three identified problem areas within the Upper Mill Creek WRF collection system[3]



In the Hamilton County portion of the UMC watershed, most of the area is served by Hamilton County Metropolitan Sewer District (MSD). There are a total of 1541 on-site sewage systems in the entire Mill Creek watershed which are authorized by the Hamilton County and City of Sharonville Departments of Health. The number of Hamilton County on-site sewage systems in the UMC is not known from the available information, but it is believed to be a very low percentage.

Soil and Water Districts

Both Butler and Hamilton Counties have separate but similar Soil and Water Conservation Districts (SWCDs). The Districts are subdivisions of the state of Ohio, and are assisted by the Butler County and Hamilton County Commissioners, respectively, the Ohio Soil & Water Conservation Commission, and the Ohio Department of Natural Resources through the Division of Soil and Water Conservation. Technical assistance for conservation practices is provided without charge by the Districts through the United States Department of Agriculture, Natural Resource Conservation Service (NRCS) personnel. Generally, the objectives of the SWCDs include:

- Reduce soil erosion loss on both urban and agricultural lands;
- Improve water quality by serving as a resource base for water quality data and educating the public concerning stormwater management and erosion control;

[3] Year of final upgrade is noted for each.

- To increase both the rural and urban communities' awareness of the value, need, and ways of conserving our natural resources;
- Promote woodland and wildlife management by local landowners;
- Conduct a strong informational and educational program in the schools and with the general public; and,
- Provide adequate funding, personnel and equipment to meet the future needs of district operations.

Agriculture

While a small portion of the watershed is still considered agricultural, various agencies provide assistance to area farmers to help promote environmentally friendly agricultural practices. The SWCD's provide agriculture land planning and engineering assistance including assistance regarding grassed waterways, pastureland, cropland, manure management, farm ponds, woodland, wildlife, surface and subsurface drainage. The Districts facilitate all the USDA Cost-Share Farm Programs. Soils data for applicants of the Current Agriculture Use Valuation (CAUV) is also provided from SWCD offices. In addition to SWCD's, farmers receive technical assistance through the USDA, Natural Resources Conservation Service and Ohio State Co-operative Extension Offices. Additionally, a proposed 319 Non-Point Source Reduction grant is targeting some agricultural areas to provide educational outreach to farmers through a co-operative partnership between Butler SWCD and the Mill Creek Watershed Council.

Regional Planning Organizations

Regional planning in the Mill Creek Watershed is accomplished through the efforts of the Butler County Department of Development, Hamilton County Regional Planning Commission (RPC), and OKI Regional Council of Governments. Political jurisdictions within each county may also have their own planning, zoning and development departments, boards or commissions.

Butler County

The Planning Division within the Butler County Department of Development oversees regional planning in Butler County for the Butler County Board of Commissioners. The Planning Division is responsible for providing land use planning strategies for Butler County, including the unincorporated areas of the Butler County's Mill Creek Watershed. The day-to-day tasks of the Planning Division involve a variety of activities including; Land Use Planning, Subdivision Regulations, Zoning, Floodplain Regulations, and Airport Zoning Regulations.

In 2000, the Planning Division completed the Butler County Land Use Plan 2000, which reflects physical development opportunities and constraints inherent in the County's natural

setting and existing development pattern. The Plan defines the generalized land use patterns that have occurred in Butler County to this point in time, and indicates the general direction and magnitude of new development in the future. In effect, the Butler County Land Use Plan 2000 represents, among other things, a statement of desirable future balance within the County between types of development and is an indication of the direction in which Butler County should be moving in order to achieve balanced land use relationships.

In the early 1990s, Butler County Department of Development helped to form the Butler County Land Use Coordinating Committee (LUCC) to help facilitate planning initiatives throughout the County. The LUCC Committee receives support from the Butler County Department of Development but is a separate endeavour that crosses political boundaries to assist planners and local jurisdictions in achieving continued economic success through the appropriate and efficient use of the county's land, its infrastructure, and its transportation system.

Hamilton County

Similar to Butler County Department of Development, the Hamilton County Regional Planning Commission (RPC) serves the Hamilton Board of County Commissioners by providing advisory planning services to the unincorporated areas of the County. The Commission's various planning activities include programs for subdivision compliance, community planning, development review and census/data and information systems. The Commission monitors development trends, evaluates current policies, and updates the Hamilton County Master Plan and related regulations for zoning, subdivision of land and traffic circulation. The Commission is responsible for determining consistency of development proposals with adopted plans for township areas. Land use control responsibilities also include development review for consistency with zoning regulations, subdivision rules, and thoroughfare plans.

OKI Regional Council of Governments

The Ohio-Kentucky-Indiana Regional Council of Governments (OKI) is a council of local governments, business organizations and community groups committed to developing collaborative strategies, plans and programs which will improve the quality of life and the economic development potential of the Tri-state. Board Members consist of top elected officials from each of the political jurisdictions within the regional tri-state boundaries. Their Land Use Planning Committee seeks to provide communities with the tools to integrate planning efforts with greenspace and other resources that affect a regions quality of life. OKI has traditionally provided staff support to the Mill Creek Watershed Council and has helped raise awareness for the improvement of the Mill Creek Watershed.

Phase II Stormwater Communities and Districts

The entire Upper Mill Creek Watershed is required to comply with the NPDES Phase II Stormwater Regulations which went into effect March 2003. In Butler County, the Butler County Board of Commissioners created a Butler County Stormwater Management District with the Butler County Engineer's Office managing the development of the stormwater management plan and the day-to-day operations. The Butler County Stormwater Management District includes all unincorporated areas within Butler County including areas within West Chester, Liberty, and Fairfield Townships. The cities of Hamilton and Fairfield have developed their own stormwater management plans and are utilizing existing city Public Works departments for implementing their stormwater requirements. Springfield Township and the City of Sharonville are participating in the Hamilton County Regional Stormwater District – an entity created to implement Phase II requirements on a county-wide basis. The Cities of Forest Park and Springdale, in Hamilton County, also have separate stormwater management plans and are separately complying with Phase II regulations using existing city services. Copies of the Phase II permits are available from the jurisdictions and/or stormwater districts.

1.3.3 UMC Demographics

The population of the Upper Mill Creek watershed is approximately 62,000 based on 2000 Census data. The majority of the population in the Upper Mill Creek watershed is located in Butler County representing approximately 80% of the population in the county[4].

Residential development in the Mill Creek headwaters has boomed in recent history. The population in the three townships (Fairfield, Liberty and West Chester) that comprise the majority of the watershed acreage has increased 476% in the last four decades.[5] Projections provided by the OKI Regional Council of Governments in their 2000 Traffic Analysis Zone (TAZ) model, indicate a 317% population increase in Fairfield, Liberty and West Chester Townships by the year 2030.

1.3.4 History of Land Use in the Upper Mill Creek Watershed

Prior to occupation by Native Americans, the Upper Mill Creek and East Fork region consisted of densely forested land with healthy populations of elk, deer, beavers, wolves, bear and foxes. The original human inhabitants of southwest Ohio were Native American tribes. In the late 1780's, settlement of Fort Washington (now Cincinnati) began at roughly

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[4] Population estimates were derived from 2000 Census data. Where census data bisected the watershed boundary the population for the area in the UMC watershed was distributed based on population density. The portion of Hamilton County in the UMC watershed was estimated based on adjacent population density of areas with similar development.

[5] Source: Derived from data presented in the Ohio State University Extension, The Exurban Change Project website (http://aede.osu.edu/programs/exurbs/Pdf/Tables/Butler.pdf), accessed in July 2003.

the same time as one of the first explorations of the area between the Great Miami River and Little Miami River by a white party under the direction of John Cleves Symmes. (*A History and Biographical Cyclopeaedia of Butler County Ohio*, Western Biographical Publishing Company, 1882.) In 1791, construction of Fort Hamilton, in Butler County, began on the shores of the Great Miami River. Butler County was formed and organized in 1803. Between 1803 and 1828 the county population grew from 11,071 to about 26,000 (Western Biographical Publishing Company, 1882, pp. 119-120.).

Industrial development along the Mill Creek began in Hamilton County in the late 1700s with the Mill Creek serving two purposes: a transportation corridor and a mechanism for waste disposal. At one time, the Mill Creek also provided the best route for agricultural commodities produced in communities to the north to markets on the Ohio River. Initial industries along the Mill Creek included lumber and grain mills, distilleries, slaughterhouses and stockyards. Other early agriculturally based industries included paper and wool mills, wagon and box factories. (Hedeen, 1994) Over the next two centuries development continued northward along the Mill Creek.

Early accounts of the area containing the headwaters of the Mill Creek, in Butler County, indicate evidence of poor land use management in the Mill Creek Valley area by farmers. Dr. Daniel Drake, a physician in Cincinnati, stated in a book he wrote in 1815, "Too much reliance is placed on the extent and fertility of their fields by the farmers, who in general, consider them a substitute for good tillage. They frequently plant double the quantity they can properly cultivate, and thus impoverish their lands and suffer them to become infested with briars and noxious weed. The preservation of the forests of a country should be an object of attention in every stage of settlement; and it would be good policy to clear and plant no more land in a new country than can be well cultivated." (Western Biographical Publishing Company, 1882. p. 57) Other early land uses in the Upper Mill Creek Valley include saw mills, grist mills, fulling mills, looms, distilleries, coopers and mercantiles. A saw-mill existed in 1836 at the "head branch of Mill Creek" on the line dividing Fairfield and Liberty Township. (Western Biographical Publishing Company, 1882.)

At present, land use in the Mill Creek valley is about 63% urban, 22 % agricultural and 12% forested (United States Geological Survey, 2002). Today, the Mill Creek corridor in Hamilton County is highly industrialized. Land use patterns along the major tributaries in Hamilton County includes a mixture of residential, commercial, light industrial, recreational, and parkland or green space. Butler County land use has shifted from primarily agricultural to residential, commercial and light industrial. Significant commercial and residential development is occurring within the headwaters in Butler County. Pockets of agricultural and rural areas remain in the Upper Mill Creek, West Fork Mill Creek and Mid-Mill Creek subwatersheds; though these are rapidly disappearing (refer to Section 3.1.4 for detailed land use information).

1.3.5 Existing Management Plans and Strategies

The Mill Creek WAP, when completed, will replace the Mill Creek Watershed Management Plan published in July 1995 and revised in November 1995 by the OKI Regional Council of Governments.

Other management plans and strategies for the watershed that pertain to the Upper Mill Creek watershed are contained in the following documents:

- Draft Mill Creek TMDL Report (Revised report was submitted by OEPA to the USEPA for approval in 2004.)
- Draft Mill Creek TMDL Nutrient Nonpoint Source Load Reduction Report (Mill Creek Watershed Council, June, 2003);
- Regional Phase II Stormwater Permits for Butler and Hamilton Counties and the Permits for those political jurisdictions who did not join the regional groups: the City of Forest Park, the City of Springdale, the City of Fairfield and the City of Hamilton. (Copies of the Phase II permit applications and their associated implementation strategies are available from the OEPA.);
- Butler County Flood Damage Reduction Regulation, June, 2002;
- Upper Mill Creek Drainage and Detention Study, FMSM Engineers, March, 2000; and,
- Mill Creek Greenway Master Plan, June, 1999.

2. WATERSHED PLAN DEVELOPMENT

Development of the UMC WAP was a collaborative effort between Mill Creek Watershed Council, Butler County Department of Environmental Services and local communities and stakeholders. The following section provides an overview of community involvement in the development of the WAP.

2.1 Watershed Groups

2.1.1 Mill Creek Watershed Council

On August 26, 1993, the Hamilton County Environmental Action Commission formed a steering committee to address the creek's condition and future. A watershed management approach was adopted. On June 21, 1995, representatives of 17 political jurisdictions met on the banks of the Mill Creek and signed a unique and historic intergovernmental agreement. They pledged to work together to save the creek and its drainage area. The Mill Creek Watershed Council (MCWC) was formed.[6]

The Mill Creek Watershed Council is a publicly funded, non-profit corporation representing the 36 political jurisdictions in the Mill Creek watershed. In 1995, MCWC incorporated in the State of Ohio as a nonprofit corporation. The Council has a Code of Regulations (bylaws) filed with the State of Ohio. The Council acts as a forum for making watershed-based decisions by convening and coordinating meetings and projects related to the improvement of the Mill Creek. Through these forums, the Council invites public input on watershed-related issues. The full council meets quarterly at locations throughout the watershed and publishes a quarterly newsletter, *Voice of the Mill Creek* and maintains a website (www.millcreekwatershed.org).

The Council's mission is to promote the improvement of the Mill Creek Watershed to create integrated environmental, aesthetic, recreational and economic benefits for present and future generations. Their vision is for the Mill Creek, once again, to be a resource and asset for the communities in the watershed. The Mill Creek Watershed Council is an umbrella group that serves as a regional coordinator and catalyst for Mill Creek watershed improvements in Hamilton and Butler counties.

The Council achieves its goal through networking and coordination, promoting cooperation and communication among the numerous government jurisdictions and private organizations in the watershed. The Council serves as a focal point for watershed-wide government initiatives and ensures comprehensive public participation in decision-making affecting watershed communities. In all its actions, the Council recognizes the

[6] In 2005 the Council voted to adopt a new name: Mill Creek Watershed Council of Communities.

interconnection among environmental, economic and social needs, and ensures that consideration is given to all benefits and consequences of a project.

The MCWC Executive Committee is comprised of the three council officers and ten members at large. The Executive Committee coordinates activities of the committees and provides oversight of council activities. The council has one full-time staff person the executive director, who is responsible for day-to-day operations and one part-time staff person, who is accountable for completion of short term projects. The executive director is the key point of contact for council activities. Council activities are conducted primarily through its committees which meet at the discretion of the committee chair. Current committees include Water Quality, Flood Damage Reduction, Watershed Awareness, Recreation and Economic Development. Ad hoc committees are formed on an as-needed basis. Committee membership is open to members and the general public. Committee activities are reported at Council meetings and in the quarterly newsletter.

The Watershed Council's membership is broad-based with representatives from political jurisdictions, community organizations, government agencies, business associations, industries, universities, environmental organizations, recreation groups and interested individuals. The positions and contacts of many of the members give them substantial capabilities for influencing decisions concerning council objectives. Each member or member organization has one vote. Policy decisions are made at Council meetings by consensus or by the Executive Committee if decisions are needed at times between Council meetings.

2.1.2 Upper Mill Creek Watershed Work Group

A UMC WAP work group was formed in late 2001 as an ad hoc committee whose efforts were coordinated by the MCWC Water Quality Committee. Elected officials and administrative officials from watershed jurisdictions and key decision makers from other stakeholder organizations were invited to participate in the development of the UMC WAP. The organization responsible for the only regulated point source (for 303(d) listed impairments) in the basin, the Butler County Department of Environmental Services (BCDES), were also invited to participate. Appendix A contains a copy of the initial invitation letter.

The MCWC Executive Director and the Chair of the MCWC Water Quality Committee coordinated the UMC meetings and development of the watershed WAP.

UMC work group meetings were attended by representatives from the following watershed partners:

- Butler County Department of Environmental Services
- Butler County Department of Development

- Butler County Planning Department
- Butler County Engineer's Office
- Butler Soil and Water Conservation District
- City of Fairfield
- City of Forest Park
- City of Hamilton
- City of Springdale
- City of Springdale Health Department
- Fairfield Township
- Liberty Township
- Liberty Township Parks Committee
- West Chester Township Planning and Zoning Department
- West Chester Township Parks and Recreation Department
- Biohabitats, Inc.
- Fuller, Mossbarger, Scott and May, Inc.
- Gilmore Ponds Conservancy
- Metro Parks of Butler County
- Mill Creek Restoration Project
- Mill Creek Watershed Council
- Ohio Environmental Protection Agency – Southwest District Office
- XCG Consultants, Inc.

BCDES, the organization responsible for operation of the East Fork Waste Water Treatment plant, attended all WAP meetings and assisted with plan development. BCDES also provided funding for field assessments, impairment identification and quantification, and technical support for creation of the plan. These funds were used as match to an Ohio EPA Section 319 Nonpoint Source Grant awarded to the Mill Creek Restoration Project.[7]

It should be noted that all watershed jurisdictions are defined as urban areas and are therefore subject to the Phase II storm water regulations. It is anticipated that participation in this regional WAP will help these communities meet portions of their permit requirements.

The mission of the UMC WAP work group was to create a regional, community-based watershed action plan that addresses issues related to the Mill Creek and its tributaries located within the Upper Mill Creek and East Fork watershed. Elected officials from each community, or their designees, participated in the process as representatives of their respective constituencies.

[7] The Mill Creek Restoration Project was not actively involved in creation of the WAP document submitted in 2003.

Decision making was accomplished through consensus by workgroup members present at each meeting. Every item requiring decision was discussed thoroughly during the course of at least one, and often two or three, meetings. Between meetings, community and stakeholder representatives were asked to share group work products with other members of their communities or organizations to receive additional input. The UMC workgroup unanimously approved a draft Upper Mill Creek watershed action plan matrix. This is presented as an appendix to this document.

2.2 Upper Mill Creek Watershed Action Plan

2.2.1 Plan Development

The UMC Work Group community representatives attended a meeting sponsored by the Mill Creek Watershed Council on September 24, 2001, to learn about the WAP development process and to identify stream-related issues within the watershed. In 2002 and 2003 the group formally met eight times with the goal of creating an action plan to address those issues. These meetings took place on June 18, 2002; August 3, 2002; October 15, 2002; November 13, 2002; January 21, 2003; February 6, 2003; and March 3, 2003.

The WAP development process followed throughout these meetings was intended to create a regional, community-based watershed action plan that addresses issues identified in the Mill Creek and its tributaries in the Upper Mill Creek watershed. The WAP was also patterned after guidelines presented in the OEPA "*Guide to Developing Local Watershed Action Plans in Ohio*".

The first several meetings focused on documenting existing watershed-related issues identified by OEPA and others – including those known to work group members. A review of existing information revealed that many portions of the watershed, particularly the uppermost reaches and smaller tributaries, had not been evaluated in a formal manner. Two actions were taken to address these data gaps: stream walks conducted by community officials and staff and a professional preliminary inventory of the entire watershed.

Community representatives toured their respective stream segments in December 2002 and January 2003. The objective for these field visits was two-fold: perform a visual inventory of the headwater streams and document current conditions via photographs and citizen qualitative habitat evaluation forms.[8] The photograph in Figure 2.1 shows two community representatives, (Liberty Township Trustee Christine Matacic and OKI Regional Council of Governments Planner Bruce Koehler) conducting a field assessment in Liberty Township. Copies of the photographs and evaluation forms are available from the Council office.

[8] A side benefit of these field visits was increased personal interest in stream issues by community leaders.

Figure 2-1 Upper Mill Creek stakeholders conducting field assessment in December 2002.

Between December 17th and 21st, 2002, XCG Consultants, Inc., using funds provided by BCDES, performed a detailed watershed assessment to identify sources of impairments and opportunities for watershed improvements. This inventory of conditions included many of the first order streams that had received little prior attention. Figure 2.2 is a photograph of a channelized reach of the Upper Mill Creek taken during the 2002 stream condition inventory. (Results of this effort are presented in greater detail in Section 3.4.)[9]

After data collection was completed, the UMC work group began development of a series of proposed actions to address identified issues and impairments and an implementation strategy for their completion. These were eventually combined into a detailed action plan matrix that was unanimously approved by the group. This matrix was shared with the state resource agencies at that time.[10]

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[9] An additional field assessment took place in late 2004 to document conditions in areas undergoing intense development.

[10]The UMC WAP matrix is a detailed document that identifies each of the watershed goals and associated objectives, specific actions to be taken by communities and other stakeholders, implementation leaders for each of the proposed actions, and time frames for completion. The matrix is included in Appendix D. Watershed goals include improved water quality and habitat, water quantity management, reductions in erosion and sedimentation, and stream restoration and regeneration and increased stewardship by watershed businesses, residents and property owners. The matrix also includes goals, objectives and actions that address public education and outreach associated with WAP actions.

Figure 2-2 Upper Mill Creek channelized reach – 2002 stream conditions inventory.

Once the action matrix was complete, MCWC staff created the first draft of the WAP with the matrix as its centerpiece. The draft WAP was reviewed by work group members and the MCWC water quality committee in during the summer of 2003. This plan was forwarded to the OEPA in October 2003 for review and endorsement. Extensive comments from OEPA and the Ohio Department of Natural Resources (ONDR) on the first draft plan were presented to MCWC in March 2004. The current WAP incorporates substantive revisions made to the original document based on OEPA/ODNR comments.

When the UMC WAP has been finalized a series of public meetings will be held to inform community residents and property owners of the plan's proposed actions and offer an opportunity for them to become involved in its implementation.

2.2.2 Plan Outline

The UMC WAP format follows the outline presented in Appendix 8 to the OEPA "Guide to Developing Local Watershed Action Plans" with one major modification: the Watershed Impairments and Restoration and Protection Goals sections have been combined to create a more user-friendly document that directly relates impairments, problem statements, goals and action items. To further simplify the process (and to avoid redundancy) the watershed has been divided into three basins associated with the Mill Creek Main Stem, East Fork Mill Creek and Beaver Run. The plan presents separate problem statements and proposed actions for each basin.

2.2.3 Commitment of Partners

In 2003, watershed communities and stakeholder organizations were asked to adopt resolutions or sign letters of support endorsing the plans for the Upper Mill Creek watershed. Appendix A contains a sample letter of resolution. The majority of the sub-basin area is covered by either a jurisdictional or county resolution or letter of support for items in the plan matrix. The City of Hamilton participated in plan development but did not submit a resolution. This has little impact on the plan as it has been determined that the portion of the streams lying within Hamilton's boundaries is no longer physically connected to the rest of the basin. Copies of these letters are available at the Mill Creek Watershed Council office. As mentioned previously, additional community meetings will be held after plan approval to address plan implementation.

2.2.4 Education and Outreach

The UMC WAP includes improving stewardship of local streams and watershed through public education as a separate goal which is incorporated in several of the tasks within the implementation plan to restore the watershed. For example, fact sheets, guidance, training programs and presentations to educate local decision makers, homeowners associations and commercial property owners about stormwater quality best management practices (BMPs) are suggested activities to complement the task of revegetating the riparian zone. The goal of public education and outreach is supported by tasks such as demonstrating "on-lot" water quality BMPs, implementing Phase II sedimentation and erosion controls, stabilizing stream banks using bioengineering, and constructing wetlands. Education of property owners will be accomplished through distribution of educational materials (via newsletters, websites, municipal offices, libraries, permit offices, newspapers and public access television) and through the development of BMP demonstration sites. The plan will be presented at public meetings to increase awareness among stakeholders, communities, residents and property owners.

3. WATERSHED INVENTORY

The following section includes an inventory of available data used to characterize the physical, biological, habitat and use characteristics of the watershed. A significant undertaking of the UMC WAP development was a field inventory of watershed features including channel type, substrate type, erosion areas, barriers, riparian cover and opportunities to enhance the watershed.

3.1 Description of the Watershed

3.1.1 Geology

Descriptions of the topography, geology, soils and glacial history of the Mill Creek Watershed are followed by descriptions particular to the Mill Creek headwaters area where information is available.

3.1.1.1 Topography

The Mill Creek flows about 28 miles through a 2-mile-wide valley from southern Butler County to its confluence with the Ohio River. The valley is generally broad and flat, bounded by glacial and alluvial terraces and relatively steep bedrock walls. The creek and its tributaries flow from the upland areas along the valley walls at altitudes of about 780 feet to the confluence with the Ohio River, which is an altitude of 444 feet. The average gradient of the valley along the course of the Mill Creek is 12 feet per mile. (Source: "Hydrogeology, Ground-Water Use, and Ground-Water Levels in the Mill Creek Valley near Evendale, Ohio," USGS, 2002, Water Resources Investigation Report 02-4167.) Major tributaries include East Fork Mill Creek, Sharon Creek, Beaver Run, Town Run, West Fork Mill Creek, Cooper Creek, Congress Run and West Fork Creek.

The Upper Mill Creek watershed is characterized by moderate to steeply sloping terrain in the upper reaches that drains to a wide, flat valley. The flat valley of the Upper Mill Creek is a crucial feature of the overall Mill Creek watershed because it provides a large amount of flood storage for stormwater runoff. However, it should be noted that access by floodwater to this floodplain is often restricted by farm levees or other embankments.

Elevations at the watershed rim are near 980 feet mean sea level (m.s.l.) while the lowest elevations are approximately 580 feet. Typical stream slopes are 1% in the upper reaches and 0.1% in the lower valley. Stream segments in the upper reaches of the watershed generally feature well-defined channels with steep banks, established riparian corridors, and meandering channels. Streambed materials in these regions include cobbles, and limestone and shale bedrock. In the lower valley, much of the main stem and East Fork channels have been straightened and the riparian corridor has been cleared as depicted in

the Figure 3.1 a photo showing the main stem channel near Muhlhauser Road. Streambed materials in these sections are predominately sand and gravel.

3.1.1.2 Geology

The Mill Creek lies within the Till Plains section of the Central Lowland physiographic province and the Interior Plateau Ecoregion. In general the Mill Creek Valley consists of shale and limestone bedrock of Ordovician age overlain by unconsolidated glacial outwash in the lowlands and/or till in the uplands of variable composition and thickness. The St. Peter Sandstone occurs at a depth of approximately 900 feet below land surface and is about 400 feet thick. Beneath the St. Petersburg Sandstone are undifferentiated dolomites and marbles. (USGS, 2002) New geotechnical studies to a depth of approximately 350 feet are currently being conducted, in conjunction with an ongoing Army Corps of Engineers flood damage reduction project, that are providing a more detailed picture of the structure and composition of unconsolidated materials and bedrock beneath the Mill Creek Valley.

Figure 3-1 Riparian corridor condition near Mulhauser Road (Butler County)

The bedrock in Butler County consists of interbedded limestones and shales of the Late Ordovician age. This system is characterized by soft, calcareous shales, interbedded with thin, hard limestone layers. (ODNR, Ground Water Pollution Potential of Butler County, Ohio, Report No. 11, 1991, after Spieker, A.M., 1968 Ground-water hydrology and geology of the lower Great Miami River Valley, Ohio, Department of Interior, USGS Professional Paper 605-A.) Bedrock in Butler County is overlain by glacial deposits generated over three eras of glacial advances (see Glacial History below).

3.1.1.3 Soils

Soils of the Mill Creek watershed are developed from four geologic soil materials: alluvium, residuum, glacial till and glacial outwash. The alluvial soils are those formed in materials transported and deposited by streams. Residual soils are common on hillsides and result from the weathering of limestone and shale bedrock. The predominant soils in upland areas formed in glacial till, which consist primarily of loam material deposited in the uplands by ice sheets. Loess, or silty material transported by wind, is common in the upper part of soils in areas of glacial till. Glacial outwash consists of gravel and sands deposited in valleys by retreating glaciers. Thick deposits of sands and gravels, with interbedded clayey till are found in Reading, Lockland and Evendale. Some glacial terrace gravels are also found in the valley. (USGS, 2002)

Soils that formed in two or three feet of loess over glacial till are dominant in the Upper Mill Creek watershed. They are variable in natural drainage characteristics. Except for the eastern part of the East Fork watershed, soils in the uplands are generally well drained. Russell and Miamian soils are deep to bedrock, and Wynn soils are moderately deep to bedrock. Miamian and Wynn soils formed in less than two feet of loess over glacial till. Poorly drained (Patton and Ragsdale) soils with a seasonal high water table at or near the surface are restricted to the relict valley in which the Upper Mill Creek and the lowermost portion of the East Fork run. Soils in the floodplains are generally well drained or moderately well drained. The somewhat poorly drained Fincastle soils and the moderately well drained Xenia soils are dominant in the relict valley and in the eastern part of the East Fork watershed. The well drained, moderately deep Eden soils are located on steep or very steep areas in the watershed. All of the common soils in the watershed are rated with a severe limitation for septic tank absorption fields because of slow percolation. Some are also severely limited because of a seasonal high water table, steepness, or flooding. (Soil Survey of Butler County, USDA Soil Conservation Service, January 1980)

Much of the surficial materials within the watershed have been disturbed by human activity over the last two hundred years. Detailed soil maps for Hamilton and Butler County are available through the county soil and water conservation districts. Digital soils information for Butler County is available at USDA's SSURGO website.

3.1.1.4 Glacial History

It is postulated that prior to the "Ice Age" the pre-glacial Licking River flowed northward through what is now the Mill Creek Valley. This river continued flowing northward to its juncture with the Eagle River (near present day Hamilton) which flowed north to the Teays River. The Teays River at the time flowed across what are now central Ohio, Indiana and Illinois until its juncture with the Mississippi. (Hedeen, The Mill Creek: An Unnatural History of an Urban Stream, 1994; Goldthwait, 1979) Three Pleistocene ice sheets have covered portions of Southwest Ohio with the first, the Kansan, occurring about 1.2 million years ago. The Kansan ice sheet blocked the northward flow of the pre-glacial Licking River and redirected it westward. The erosive action of the new river, called the Deep Stage Ohio, broadened the present day Mill Creek Valley.

The Illinoisan ice sheet, which covered the area approximately 400,000 years ago, established the present course of the Ohio River abandoning the prior northward flow for a westerly flow. The Mill Creek was formed at that time in the valley of the former Deep Stage Ohio and acted as a conduit for glacial meltwater to flow southward to the new Ohio River. (Hedeen, 1994)

The final ice sheet that impacted the region was the Wisconsin, which occurred approximately 70,000 years ago. The southernmost lobe extended down the Mill Creek Valley to the north of St. Bernard. Downcutting at the time through the existing Illinoisan till produced large terraces in the Mill Creek Valley. The City of Norwood rests on one of these terraces. The retreating Wisconsin glacier created outwash deposits containing large quantities of sand and gravel originating in northern Ohio and Ontario, Canada. Terraces created from these deposits underlie downtown Cincinnati. (Hedeen, 1994) Post glacial erosion by the Mill Creek has resulted in a shallow channel inscribed into the valley floor.

3.1.2 Biological Features

3.1.2.1 Threatened, Rare and Endangered Species

The Upper Mill Creek Watershed is home to important, rare and endangered species of animal and plant life. The Tiger Salamander is a native specie, considered somewhat rare in Butler County but is thought to breed in area wetland areas. Tiger salamanders have been confirmed to be in the general area of the Upper Mill Creek. A "metamorph or yearling" tiger salamander was observed at Gilmore Ponds in August 2003 and there are reports from local naturalists that an adult was found near Port Union and Route 4 bypass. In addition, the Leopard Frogs are believed to be within the Upper Mill Creek Watershed. In summer 2002, Leopard frogs were found throughout the Gilmore Ponds area, and in good numbers at the West Chester Wetlands along the Mill Creek and Miami-Erie Canal. The Indiana Bat, considered to be present but not confirmed in all Ohio Counties has been observed during its maternity summer months in Butler County.

In the Gilmore Ponds Interpretive Preserve near the Upper Mill Creek watershed boundary, several significant plant and animal species have been identified. The Kirtland Snake (*state threatened*) has been spotted at the Preserve as well as the Least Bittern (*state threatened*), Black-Crowned Night-Heron (*state threatened*), and Sora (*state specie of concern*). Significant endangered plant species such as the Burhead (*state endangered*), Mousetail (*state endangered*) and Pale Umbrella-Sedge (*state endangered*) are also found in the Preserve. A significant population of naturally occurring beaked burhead was identified in 2002 by local naturalists within the Port Union/West Chester Wetlands.

Wetland habitats are also known to draw an unusual collection of bird species. Historically, there's been a local breeding colony of black-crowned night herons in the Mill Creek Watershed. The colony has always stuck close to the Mill Creek, and has on occasion used Gilmore Ponds as its home base. The last time black-crowned night herons used Gilmore Ponds for nesting was in 1998. A few black-crowned night herons use Gilmore Ponds each summer and fall for feeding and roosting areas. Because of the proximity of Gilmore Ponds to the watershed, experts believe species such as the Black-Crowned Night Heron, the Green Heron, the Rusty Blackbird and the Sora travel within the Mill Creek Watershed.

There are no known threatened or endangered fish or macroinvertebrate species in the basin. Ohio EPA has conducted periodic monitoring of the sub-basin's fish and macroinvertebrate species as part of their five-year watershed evaluation process. Detailed information regarding these studies is available through the Ohio EPA.

3.1.2.2 Invasive Plant Species

Autumn-olive and Russian-olive

Autumn-olive and Russian-olive are non-native, deciduous shrubs or small trees that grow to 20 feet tall. Autumn-olive is native to China and Japan. It was introduced to the United States in 1830 and is distributed throughout the state. Russian-olive is originally from Europe and Asia. It was introduced to North America in the early 1900s and is found throughout Ohio. Historically these plants have been used for erosion control, strip mine reclamation, wildlife habitat, and in landscaping. Autumn-olive and Russian-olive aggressively out-compete native plants and shrubs. They grow rapidly and re-sprout heavily after cutting or burning. Both species are prolific fruit producers, with seed dispersal mostly accomplished by birds.

Canada thistle

Canada thistle is a slender, herbaceous, non-native perennial plant reaching a height of 2-4 feet. Despite its name, Canada thistle is not native to Canada or even to North America. It is native to eastern and northern Europe and western Asia, and was introduced to North

America in the 1600s. It has spread throughout all of the United States except the southeast. It is found throughout Ohio. The extensive root system of Canada thistle allows it to out-compete and displace many native species, especially in degraded prairies where native species are not well established. Spreading both by seed and rhizome, Canada thistle can create monocultures covering large areas. The wind-dispersed seeds may remain viable for 20 years or more, allowing it to spread quickly and making it difficult to eradicate.

Garlic Mustard

Garlic mustard is a non-native, biennial herb that grows 5-46 inches tall. Garlic mustard originated in Europe and was introduced to the United States for herbal and medicinal purposes. It was first recorded in the United States in 1868 in Long Island, New York. By 1991, garlic mustard had invaded 28 Midwestern and northeastern states. Garlic mustard can be found throughout the state of Ohio. According to Ohio DNR, garlic mustard aggressively out-competes native species in the understory of forests and woodlands. This plant begins growth in early spring and ends growth later in the season than most native species. As a result, garlic mustard shades out native wildflowers and out-competes native seedlings. Garlic mustard grows in dense clusters and can displace most herbaceous native plants within 10 years. Large quantities of seed are produced and can remain viable in the soil for up to 7 years. The seeds are dispersed by wind, water and transported by animals and humans.

Glossy Buckthorn and Common Buckthorn

According to ODNR, both glossy buckthorn and common buckthorn are non-native woody shrubs or small trees that can reach up to 20 feet in height. Glossy buckthorn and common buckthorn were introduced to North America from Eurasia as ornamental shrubs for fence rows and wildlife habitat and are still used in landscaping. These species are distributed throughout the northeast and north central U.S. Both species are frequent in the central and northern part of the state. Both glossy and common buckthorn have a wide habitat tolerance, rapid growth rates and extensive root systems. Both species produce abundant flowers and fruits throughout the growing season. Seeds are widely dispersed by birds. Once established, these species aggressively invade natural areas and form dense thickets displacing native species. They leaf out very early in the growing season and keep their leaves late into the fall helping to shade out native trees, shrubs and wildflowers.

Honeysuckle

Amur, Morrow and Tatarian honeysuckles are non-native, upright, deciduous shrubs that grow to be 6-15 feet tall. Amur, Morrow and Tatarian honeysuckles are native to China, Korea and Japan. Introduced into the United States in 1846 as ornamental plants, they have escaped cultivation due to high seed production and to the fact their seeds are readily eaten and dispersed by birds. According to Ohio Department of Natural Resources, these

honeysuckles are distributed throughout Ohio with Amur being more problematic in southwestern Ohio, Morrow in northern Ohio, and Tatarian throughout the state.

According to Ohio Department of Natural Resources, the problem with these vigorous shrubs is they shade out native vegetation, particularly in the woodland understory. They are able to out-compete native wildflowers for light and other resources. Bush honeysuckles green up earlier in the spring than most other plants, giving them an advantage over other species. Each produces abundant amounts of seed, which are spread by birds and other animals.

Local efforts to eradicate honeysuckle have included organizations and individuals organizing field events to physically remove the bushes roots and chemically applying an herbicide to minimize the likelihood of regeneration.

Japanese Honeysuckle and Asian Bittersweet

Both Japanese honeysuckle and Asian bittersweet are non-native, fast-growing trailing or climbing woody vines capable of covering large areas of ground or extending into the tops of trees. Japanese honeysuckle is native to eastern Asia and was introduced into New York in 1806 as an ornamental plant and ground cover. Now distributed over most of the southern and eastern United States, it is often planted as a source of food for wildlife. Asian bittersweet is also native to eastern Asia and was introduced into the United States in 1860 for ornamental purposes, for which it is still used in many areas. Having escaped from cultivation, it can be found over much of the eastern Midwest and Atlantic coast states. According to Ohio DNR, both species are found throughout Ohio but seem to be more prevalent in the southern part of the state. Japanese honeysuckle and Asian bittersweet are aggressive growers that can severely damage native plant populations by limiting needed sunlight, constricting nutrient flow in stems, and over-weighting treetops increasing the likelihood of wind damage. Both are prolific seed producers with the seeds often being dispersed by birds. The root systems are very persistent and capable of extensive root suckering. Plants tend to regenerate quickly after cutting. These vines are often able to out-compete native species for nutrients and water.

Multiflora rose

Multiflora rose is a thorny, non-native perennial shrub with arching branches that can form dense thickets. Multiflora rose was introduced from Japan, Korea and eastern China in the 1860s as rootstock for ornamental roses. In the 1930s, it was widely promoted as a "living fence" for soil conservation and in wildlife programs. It is found throughout the United States with the exception of the Rocky Mountains, southeastern coastal plains and western desert areas. In Ohio, multiflora rose has a widespread distribution in pastures, woodlots and noncrop lands. Thickets of multiflora rose can successfully displace native plant species. Multiflora rose reproduces from seed and by rooting from the arching stems. It has

been estimated that an average plant produces a million seeds per year, which may remain viable in the soil for up to twenty years.

Purple Loosestrife

Purple loosestrife is a dense, herbaceous, non-native perennial that grows up to 7 feet tall. Purple loosestrife occurs mostly in wetland environments, but when well established, it can survive drier conditions. Wetlands impacted by this plant include marshes, fens, wet meadows, stream and river banks, and lake shores. Purple loosestrife adapts readily to natural and disturbed wetlands. As it establishes and expands, it out-competes and replaces native grasses, sedges, and other flowering plants that provide a higher quality source of nutrition for wildlife. Purple loosestrife forms dense, homogeneous stands that restrict native wetland plant species and reduces habitat for waterfowl. Seed production is as prolific as the vegetative growth. Seeds are widely distributed by animals, machinery and people and in waterways.

Reed grass

The non-native strain of reed canary grass was introduced from Europe and Asia in the early 1800s. It was selected for its vigor as a forage crop and erosion control. In Ohio, reed canary grass is widespread throughout the state. According to Ohio DNR, reed canary grass reproduces vegetatively as well as by seed. It aggressively dominates an area and displaces the native vegetation replacing it with a monoculture of grass. This species of grass produces little in the form of shelter and food for wildlife, although it has been used for bank stabilization in wetlands and waterways. Seeds are easily dispersed by means of waterways, animals and people.

White and Yellow Sweet-Clover

Both white and yellow sweet-clover are erect, herbaceous, non-native biennials that are members of the pea family. White and yellow sweet-clover are native to the Mediterranean region, central Europe, and Asia. They were brought to the United States in the 1600s as a forage crop for livestock and for honey production. They are now found in all 50 states and are used as a soil builder because of their nitrogen fixing capability. They are also often planted as wildlife cover. Both sweet-clovers are found throughout Ohio especially near agricultural regions. The seeds of white and yellow sweet-clover have been shown to be viable for over 30 years. The plants are drought resistant and winter hardy. Because of their large size in the second year of growth, they tend to overtop and shade native sun-loving species. They are problematic in recovering prairies and savannas where they out-compete native species for water and nutrients.

3.1.2.3 Invasive Fish Species

There have been no known studies on invasive fish species in the area. Should any become available they will be appended to this plan.

3.1.3 Water Resources

3.1.3.1 Climate and Precipitation

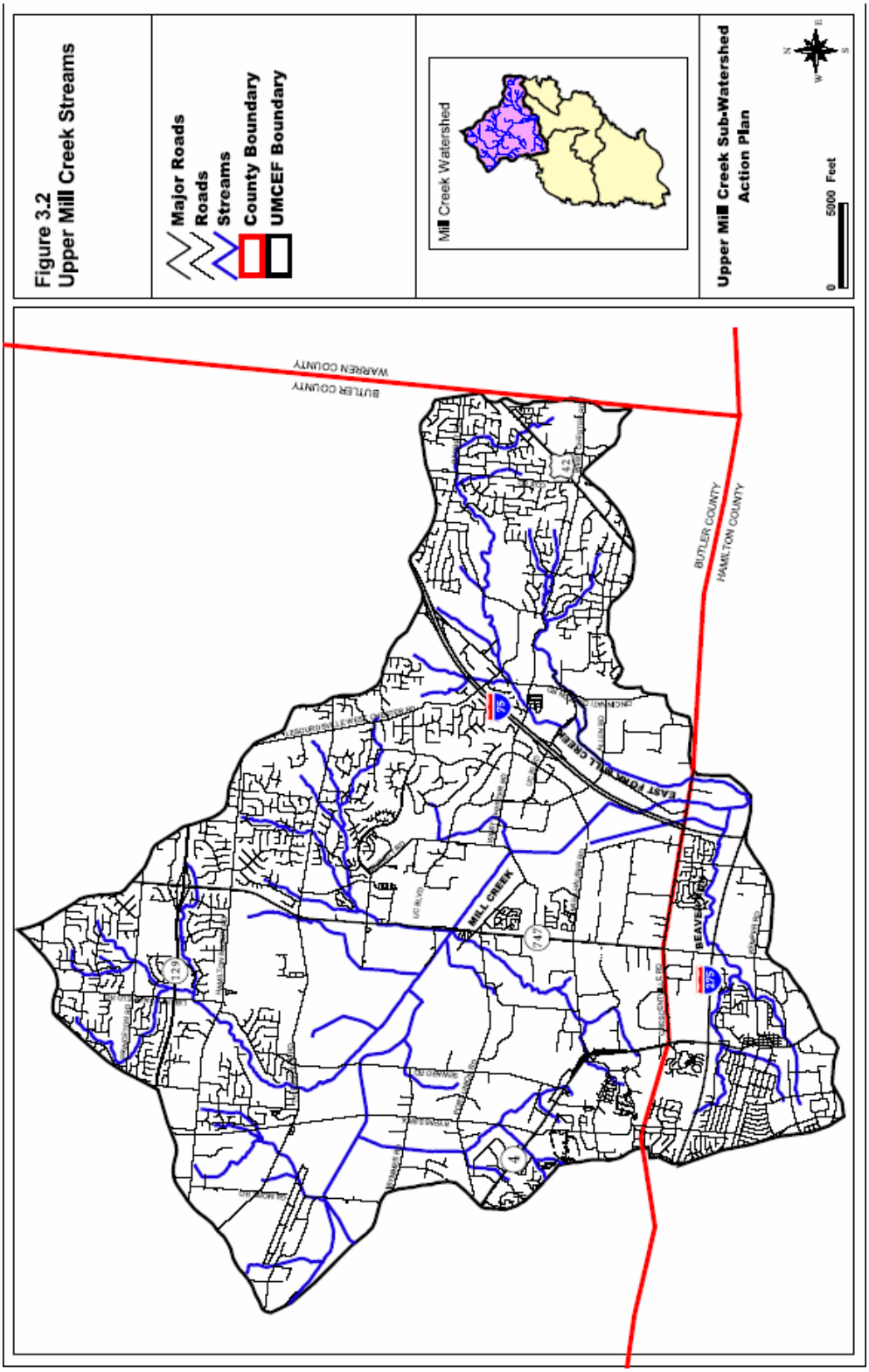
Cincinnati's climate is humid and temperate with hot and humid summers and moderately cold winters. Highest temperatures occur in July with an average of 76° F and lowest temperatures occur in January with an average temperature of 30° F. The highest recorded temperature was 105° F and the lowest recorded temperature was -22° F. The mean yearly precipitation is 40.7 inches with the wettest month in May and the driest in February. Rain occurs, on average, 132 days each year. The highest recorded 24-hour rainfall was 4.73 inches (for records prior to 2000). Pockets of higher rainfall amounts can occur on a yearly basis. (USGS, 2002)

3.1.3.2 Surface Water

There are two primary streams in the Upper Mill Creek watershed - the Mill Creek (main stem) and the East Fork. Figure 3.2 shows the primary streams in the UMC watershed. The headwaters of the Mill Creek (main stem) are located north of Princeton Road near Liberty Fairfield Road. The creek flows in an overall southerly direction 12.72 miles to its juncture with Sharon Creek in Hamilton County. The East Fork, which is 7.2 miles in length, begins near the Butler-Warren County line near US 42 and flows southwesterly to Crescentville Road approximately 1,400 feet east of the main stem. The Mill Creek main stem and East Fork join in Hamilton County approximately 2 miles south of Crescentville Road at RM 17.45. From this junction, the Mill Creek flows south for 16 miles through several communities, including the City of Cincinnati, to the Ohio River at Ohio River Mile 472.5. There are numerous first-order tributaries to the Mill Creek and East Fork Mill Creek in the watershed. Many are intermittent in nature and few, if any, have formal names.

The following information regarding habitat assessment, biological and water quality assessment have been provided by separate sampling and assessment activities conducted by Butler County DES and OEPA. The following is a brief summary of the available information.

Figure 3-2 Upper Mill Creek Watershed Streams



Habitat Assessment

The uppermost reaches of the UMC watershed are characterized by relatively intact stream channels and riparian borders, few chemical water quality problems and low new development pressure. The entire watershed is designated by the Ohio EPA as warm water habitat (WWH). Most of the upper areas were developed over 20 years ago and see very little new construction or redevelopment activity. In the upper reaches of the watershed (RM 24 to 27), the headwaters are unmodified except for localized impacts at bridge or utility line crossings or due to road expansion. Coarse substrates, moderate cover and fair to good channel development reflect relatively intact stream habitat and riparian corridors. A mean QHEI score of 62 indicates the habitat quality is suitable to support Warm Water Habitat (WWH) communities. (Figure 3.18 in Section 3.5.1, illustrates the designated use, biological attainment for specific stream segments and QHEI survey points for the entire UMC basin.)

In contrast, the lower segments of the UMC are threatened by increased development and urbanization impacts. Additionally, the watershed characteristics change dramatically between East Fork RM 3.2 – 1.9 and Mill Creek RM 24 – 22, in terms of gradient, stream substrate, sinuosity, riparian cover and streambank buffer as well as development patterns. As the creek runs south, parallel to the Miami Erie Canal and the railroad, channelization is more apparent and habitat shows signs of embeddedness and entrenchment. A QHEI score of 47.5 at Rialto Road (RM 21) was recorded in 2002, an increase from 40 in 1997, still below the QHEI WWH threshold score of 60.

In the East Fork Mill Creek, as an effort to achieve WWH biocriteria downstream of the Upper Mill Creek WRF, BCDES has installed habitat enhancement structures which consisted of approximately 25 Newbury riffles and six j-weirs in a one mile segment of stream. The habitat structures were designed to help flush sediment, reduce substrate embeddedness, increase instream dissolved oxygen levels and provide natural habitat for macroinvertebrate and fish. The structures were installed in 2000 and appeared to be suffering from upstream clearing, which slowed riffle movement and clogged some of the riffles. In 2002, after the clearing was removed riffles began functioning properly. OEPA's QHEI survey for the EFMC in its upper reaches at Keener Park was 80 in 1997 and declined, according to 69. In lower sections of the EFMC, QHEI was 53 in 1997 and 76.5 in 2002 at Allen Road, a 23.5 point increase. Still further down, OEPA also recorded QHEIs at Crescentville Road in 1997 and 2003 of 69 and 62.5, respectively and near the mouth in 1997 and 2002 of 64 and 62.5 respectively.

In their evaluation of QHEI data from 1997 and 2002, BCDES consultants suggest that the Newbury Riffles may be having a positive effect on the microhabitat of the stream. For example, analysis of OEPA QHEI data results, the maximum depth has been increased from 0.7-1m to >1m; riffle depth increased from 5-10 cm to >10 cm; riffle/run substrate was characterized in 1997 as unstable whereas in 2002 was recorded as moderately stable.

Additionally, OEPA's 1997 QHEI results indicated no cobble present whereas in 2002 OEPA field notes consistently notes cobble in habitat assessment documentation.

Biological and Water Quality Assessment

Mill Creek has been identified as a priority impaired water on Ohio's 303(d) list. Biological and chemical stream surveys were conducted throughout the basin in 1992 (Ohio EPA, 1994) and the upper and lower reaches of the main-stem of Mill Creek and in the East Fork Mill Creek in 1997 (Ohio EPA, 1998). Assessments were also conducted in 1999 (BCDES), 2000 (BCDES), 2002 (Ohio EPA and BCDES) and 2003 (BCDES). Stream biology was quantified using the Index of Community Integrity (ICI) for macroinvertebrates and the Index of Biotic Integrity (IBI) for fish. During the 1992 and 1997 surveys, good quality biological communities were limited to the most upstream headwaters of Mill Creek (RM.26.4) and East Fork Mill Creek upstream from the Upper Mill Creek Water Reclamation Facility (RMs 4.7- 1.9).

Macroinvertebrate Assessments

The 1999 biological data results collected by Butler County provide pre-habitat improvement conditions and document some pre-restoration macroinvertebrate stress. Analysis of the macroinvertebrate data from 2000, 2002 and 2003 of East Fork and Upper Mill Creek suggests a positive increase in overall stream quality compared to 1999, suggesting that improved water quality – along with the installation of in-stream riffles – has benefited stream biology. Improvement in ICI (Index of Community Integrity) scores between 1999 and 2003 include intolerant species identified at each sampling site whereas in previous years, very few if any intolerant species were observed. Ohio EPA data for 2002 and BCDES data for 2002 and 2003 suggest that macroinvertebrates were attaining (with a non-significant departure) at their bio-criteria levels for warm water habitat (WWH).

The more recent 2003 results seem to show some additional improvement in the stream biology; besides changes in habitat quality, this trend could also be related to water or effluent quality or increased dilution during the especially high flows encountered in 2003.

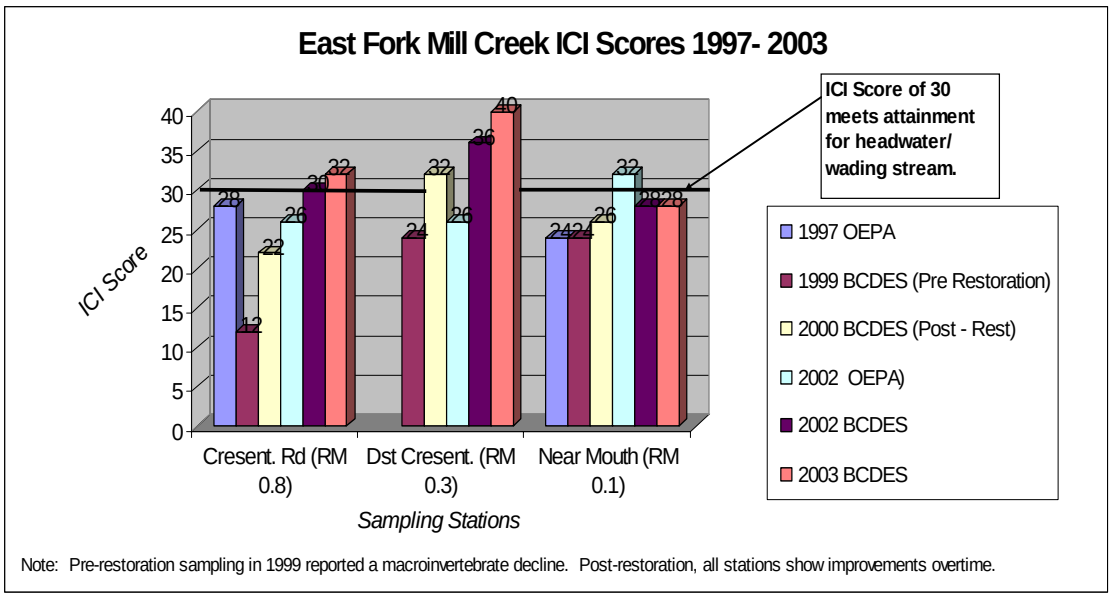
Included in Table 3.1 and Figure 3.3 below are biological data results from various sampling events conducted between 1997 and 2003. The data is presented as ICI scores, in both tabular and graphical form. Sampling events were conducted by either the Ohio Environmental Protection Agency or Woolpert LLP (on behalf of BCDES).

Table 3-1 ICC scores from three sites on East Fork Mill Creek downstream from UMC Water Reclamation Facility, 1007-2003

Year, Data source	Crescentville Road (RM 0.8)	Downstream Crescentville (RM 0.3)	Near Mouth (RM 0.1)
1997, OEPA	28	No data	24
1999, Woolpert	12**	24**	24**
Restoration Event: Installation of Newbury Riffles			
2000, Woolpert	22	34	28
2002, OEPA	26	26	32
2002, Woolpert	30**	36**	28**
2003, Woolpert	32	40**	28

**Woolpert data recalculated to fit OEPA data analysis methods

Figure 3-3 ICI scores from three sites on East Fork Mill Creek downstream from Upper Mill Creek Water Reclamation Facility, 1997-2003



Fish Assessments

Both BCDES and Ohio EPA sampled fish in 2002 and/or 2003, finding fish communities in the poor to very poor range (IBI = 17-22) as well as communities in the marginal range (IBI = 30-32). All recent sampling events indicate that fish remain below WWH threshold levels and have declined since 1997 in both the Main Stem upstream of the confluence of

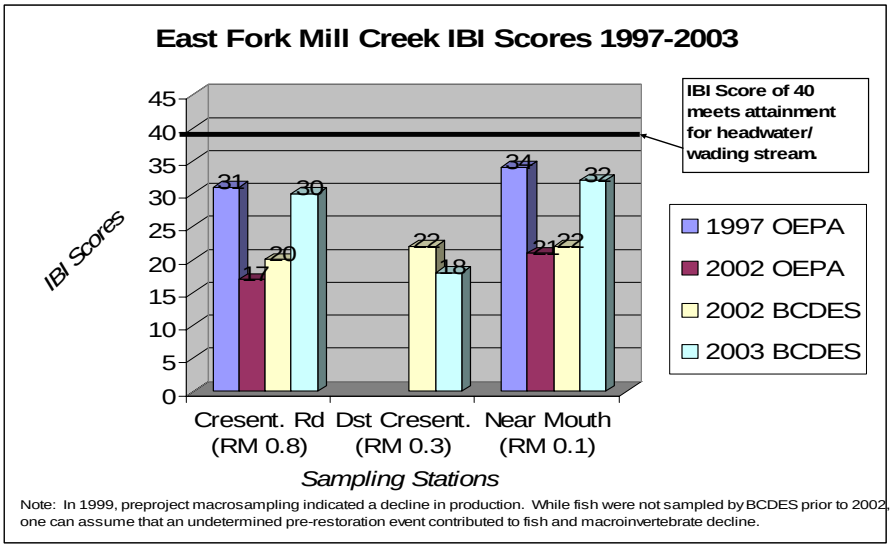
East Fork and into the East Fork. Included in Table 3.2 and Figure 3.4 below are biological data results from various sampling events conducted between 1997 and 2003. The data is presented as IBI scores, in both tabular and graphical form. Sampling events were conducted by one of two entities: Ohio Environmental Protection Agency; or Woolpert LLP (on behalf of BCDES).

Table 3-2 IBI scores from three sites on East Fork Mill Creek downstream from Upper Mill Creek Water Reclamation Facility, 1997-2003

Year, Data source	**Crescentville Road (RM 0.8)**	**Downstream Crescentville (RM 0.3)**	**Near Mouth (RM 0.1)**
1997, OEPA	31	-	34
Crescentville Road bridge replacement, riparian denuding and major log jam (2002)			
2002, OEPA	17	-	21
2002, Woolpert	20**	22**	22**
2003, Woolpert	30**	18**	32**

**Woolpert data recalculated to fit OEPA data analysis methods

Figure 3-4 IBI scores from three sites on East Fork Mill Creek downstream from Upper Mill Creek Water Reclamation Facility, 1997-2003



Conclusion

Coordinated efforts and projects to improve water quality within the Mill Creek are identified in the Mill Creek TMDL and the 5-year Watershed Action Plan (WAP). As projects and programs are implemented to minimize nonpoint source pollution contributions and point source loadings, attainment of water quality standards is the ultimate goal.

Future assessments of water quality and stream health will be conducted in 2012 and 2105 by OEPA, as outlined in the Mill Creek TMDL.

3.1.3.3 Wetlands

There is little data on wetland quantities and quality within the Upper Mill Creek watershed. A study conducted in the 1990's indicated only 0.6 combined square miles in Fairfield, Liberty and West Chester Townships were recognized as wetlands. (Source: Ohio State University Extension, The Exurban Change Project, accessed in July 2003 on the internet at the following website: http://aede.osu.edu/programs/exurbs/index.htm.) A wetland map is currently under development and will be incorporated on completion.

The Gilmore Ponds area, originally called the "Big Pond" is a large wetland investigated as part of a Butler County Upper Mill Creek Drainage and Detention Study. Gilmore Ponds is a low-lying area near the intersection of Bypass 4 and the Miami-Erie Canal. This is a low swampy area, which at one time consisted of two 60 acre ponds. Storm drainage from this area may have originally flowed both eastwardly to Mill Creek and westerly towards Pleasant Run. Records suggest that:

> *"the water of these ponds, before construction of the M&E Canal, when they were raised by heavy rains found an outlet through Pleasant Run to the river. To facilitate this drainage, the State in 1826 excavated a ditch."* During construction of the canal, *"an embankment was thrown up from the canal across the valley of Pleasant Run to the high ground so as to turn the water of said run into the "Swamp" and from thence it found its way into one of the branches of Mill Creek."* [11]

A City of Fairfield report notes:

> *"approximately 1,500 additional acres located north of the old M&E Canal have been diverted into this system which causes serious overloading of the (General Motors) ditch and adds to the "Pleasant Run Creek problem." From what we have been able to determine, the area formerly drained to the Mill Creek via the old M&E Canal. Then a small dam was constructed across the canal which forced the flow back toward the city of Hamilton and into a 30" pipe which is totally inadequate to handle the flow. At some time the dike of the canal was cut to allow the excess storm water to reach the General Motors Ditch. The 1955 USGS maps do not show a drainage way between the canal and the General Motors Drainage Ditch. The 1965 maps do show such a drainage way."*

After careful evaluation initiated by the 2000 Butler County Upper Mill Creek Drainage and Detention study, the Gilmore Ponds portion of the watershed west of Alternate SR 4

[11] Upper Mill Creek Drainage and Detention Study, FMSM. January 2000 citing the 1875 Butler County Atlas.

was excluded from the watershed. The study found that a significant portion of this 8.2 square mile area does not appear to drain either to the Mill Creek or to Pleasant Run. Storage in this area should be maintained to ensure that flooding conditions downstream on the Mill Creek or Pleasant Run are not worsened.

Lakes and Reservoirs

At present, there are no large, natural perennial lakes within the Upper Mill Creek watershed. The Gilmore Ponds area contains several lakes – but as noted above – this area is believed to lie outside the Mill Creek Watershed except in the most extreme wet weather events.

There is little accumulated data on the location, size and nature of smaller manmade lakes and stormwater management features (such as retention and detention basins). On a resource-available basis, the Mill Creek Watershed Council will work with UMC communities and stakeholders to locate, inventory and existing stormwater management features such as detention and retention basins. The existing facilities were designed primarily with quantity control in mind with limited water quality control features. As part of the inventory process opportunities would be identified to retrofit facilities to provide more water quality control features.

3.1.3.4 Ground Water

Much of the Mill Creek Valley overlies a buried valley aquifer composed of highly permeable sands and gravel deposited during past glacial events. These aquifers tend to thin out laterally towards the Mill Creek Valley slopes. Two primary glacial outwash aquifers have been identified in the Mill Creek Valley – a deeper, confined aquifer (used historically for water supply) and an upper aquifer (40-60 feet below ground surface) rarely used to supply water. The shallow aquifer is not present in some areas of the valley. These two aquifers are typically separated by a leaky confining unit throughout the valley. Historical vertical gradients suggest that water flows from the upper into the lower aquifer through the leaky confining unit. Groundwater in the lower aquifer generally flows from north to south along the primary orientation of the Mill Creek. Insufficient recent data on the upper and water table aquifers exist to provide an accurate description of flow direction. (USGS, 2002) A water table aquifer layer containing discontinuous layers of outwash up to 30 feet deep is present in some parts of the watershed. The water table aquifer, when present, is often covered by till and soil. Evidence from 2001 flooding events in Hamilton County suggests that the water table aquifer is recharged by surface water infiltration.

Little data exists regarding aquifers in the northern portions of the Mill Creek Watershed. The principle aquifers in Butler County are located in sand and gravel outwash deposits in the buried valleys. Fine grained sediments within these outwash deposits limit vertical

hydraulic interconnection. Bedrock aquifers are limited to the interface between the outwash deposits and the weathered surface of the limestone bedrock. These typically have low yields. (ODNR, 1991) Very few active wells exist in this area limiting the data on which to base conclusions regarding flow direction.

Access to groundwater played a key role in industrial development and growth of municipalities in the Cincinnati area. Very little groundwater was ever used for residential consumption. Large distilleries first located in the region due to ready access of groundwater. Groundwater was also used historically for the pork-packing industry, paper mills and industrial process. Over-pumping of the aquifers by industry and local municipalities led to steep declines in the water levels of more than 100 feet by the 1950s. As demand for groundwater declined over time due to availability of water from the City of Cincinnati and private water suppliers the water levels in the lower aquifer has risen from 65 to 105 feet higher than they were in the mid-1950s. In a recent USGS report, most industries in 2000 reported that they use water derived from the Great Miami River valley. Three cities – Glendale, Lockland and Wyoming (all in Hamilton County and outside the Upper Mill Creek watershed) – produce municipal water from wells. (USGS, 2002)

Sole Source Aquifer Status

While the buried valley aquifers in the Mill Creek watershed remain capable of producing water for human consumption, the USEPA excluded it from sole source aquifer designation in 1988. The July 8, 1988 Federal Register (page 25671) includes the following statement about this exclusion:

> *"The designated area (Buried Valley Aquifer System of the Great Miami/Little Miami River Basins) does not include the Mill Creek Basin in Butler and Hamilton Counties. This basin contains a Class 1 aquifer, but the population in the drainage basin depends primarily on surface water for their drinking water supply. Although the communities of Wyoming, Lockland, Glendale and Reading do use ground water as their water source, they can connect to the Cincinnati water system if the aquifer becomes contaminated beyond levels commensurate with public health. When considered as a separate hydrologic system, the Mill Creek Basin does not meet the criteria established by EPA for sole source eligibility."*[12]

There is no source water assessment program (SWAP) for this area.

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[12] The July 8, 1988 Federal Register Notice includes the following from a May 18, 1988 public meeting in the Summary of Public Comments on page 25672: When considered as a separate hydrologic system, the MCB (Mill Creek Basin) Aquifer supplies only about 20% of the drinking water, with the majority of the population on surface water from the Cincinnati System. The area is highly industrialized, and a substantial portion of the recharge area is already occluded by development. The Mill Creek itself is highly channelized and, in many stretches, enclosed in a cement channel which prevents it from gaining flow in those stretches from ground water."

Pollution Potential Status

The 1991 Ohio Department of Natural Resources "Ground Water Pollution Potential of Butler County" map in Figure 3.5 shows the highest pollution potential index (161) in the low lying areas in the vicinity of the I-75 Union Centre interchange along the streambed and floodplains of the lower portions of the upper Mill Creek and the East Fork in West Chester Township. The stream and floodplains northwest of this area along the Mill Creek Main Stem have a slightly lower pollution potential index (148). These two areas overlie a buried valley system. The Gilmore Ponds area has an index ranging from 127 to 138. More upland areas have lower pollution potential indices ranging from 86 to 109. These areas consist primarily of glacial till overlying interbedded sedimentary rocks.

3.1.4 Land Use (Including Status and Trends)

3.1.4.1 Land Cover Description

Land use is rapidly changing in the Upper Mill Creek sub-basin. Table 3.3 presents the existing and proposed land use in the UMC watershed. Information is compiled from the Butler County Planning Department and from Hamilton County CAGIS data bases. These areas are presented graphically in Figures 3.6 and 3.7.

A review of the available information presented in Table 3.3 shows continued development across the entire UMC watershed and hardening of surrounding landscape in the area. The following general observations can be made:

- the agriculture/farmland land area has steeply declined; and,
- the urbanized areas (combining commercial, industrial, institutional, residential) will increase significantly with the proposed land use plans.

A brief discussion of each land use category follows.

Table 3-3 Existing and Proposed Land Use

Land Use Type	Existing		Proposed (Build Out)		% Change
	Area (ac)	Percent of Area	Area (ac)	Percent of Area	
Agricultural	5,860	20%	0	0%	-100
Commercial	1,740	6%	4,810	16%	+176
Industrial	5,520	19%	6,800	24%	+23

	Existing		Proposed (Build Out)		
Institutional/Office	2,050	7%	3,060	10%	+50
Residential	12,390	42%	13,160	45%	+6
Other (open space, transportation, etc)	1,740	6%	1470	5%	-15
TOTAL	29,300	100%	29,300	100%	0

Urban

Land use within the Upper Mill Creek watershed has changed significantly over the past 25 years from primarily agricultural to more urban usage. The current rate of development is particularly rapid with new roadway and commercial projects being built near the recently constructed Union Centre Boulevard and I-75 interchange. Urban land areas have increased in the last decade from 20 square miles to roughly 33 square miles or an increase of 66%.

Forest/Open Space

Much of the original forested areas within the watershed were removed first by Native American groups and later by settlers and farmers. The remaining forested areas within the Upper Mill Creek watershed are located primarily within designated parks and recreational areas, along stream corridors and in some residential areas. Many newer residential communities and commercial developments were constructed on former agricultural lands and have no forested areas or open space.

Figure 3-5 Upper Mill Creek Portion of "Ground Water Pollution Potential Map of Butler County"

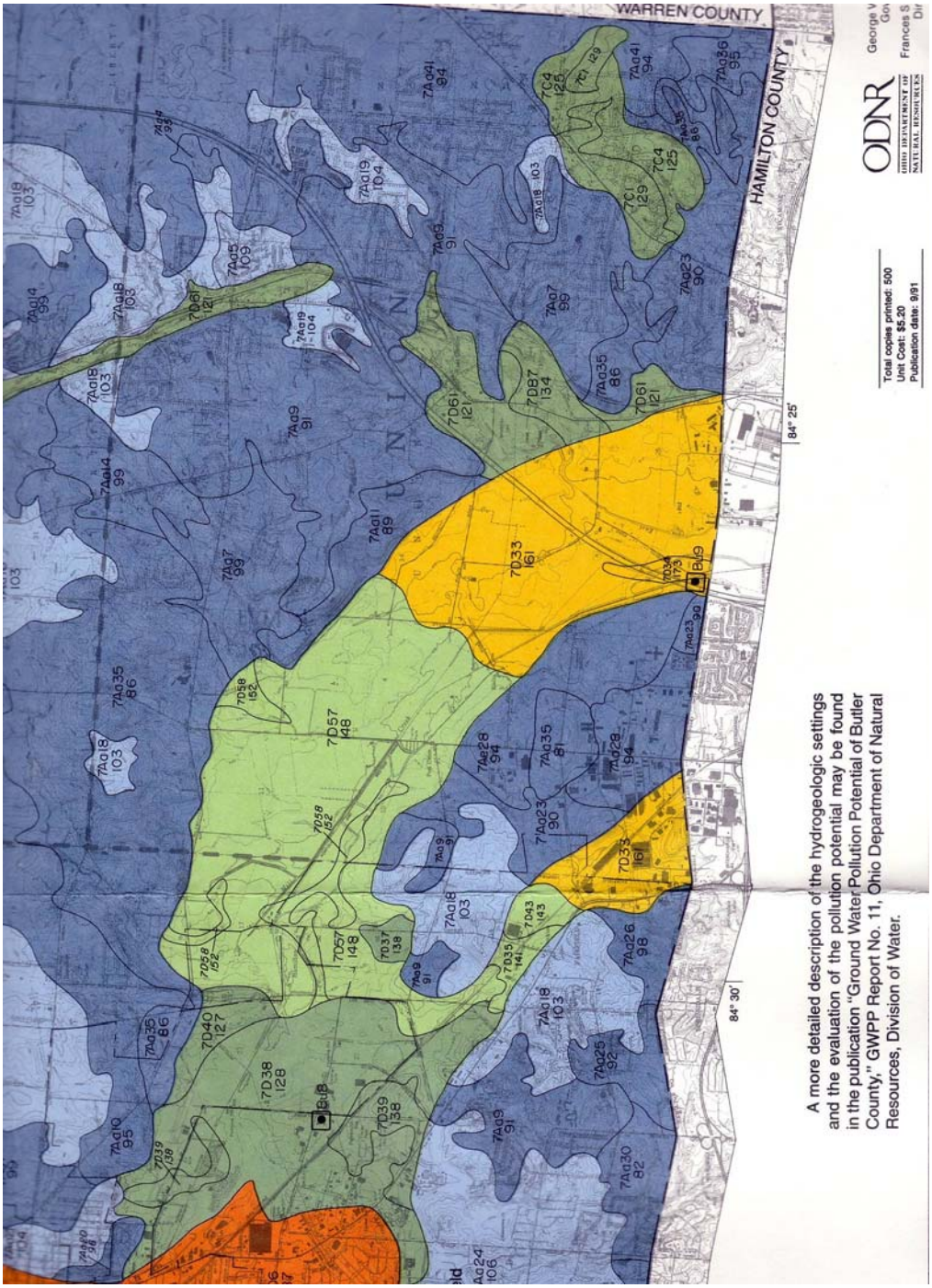


Figure 3-6 Existing Land Use Map – Upper Mill Creek Sub-basin

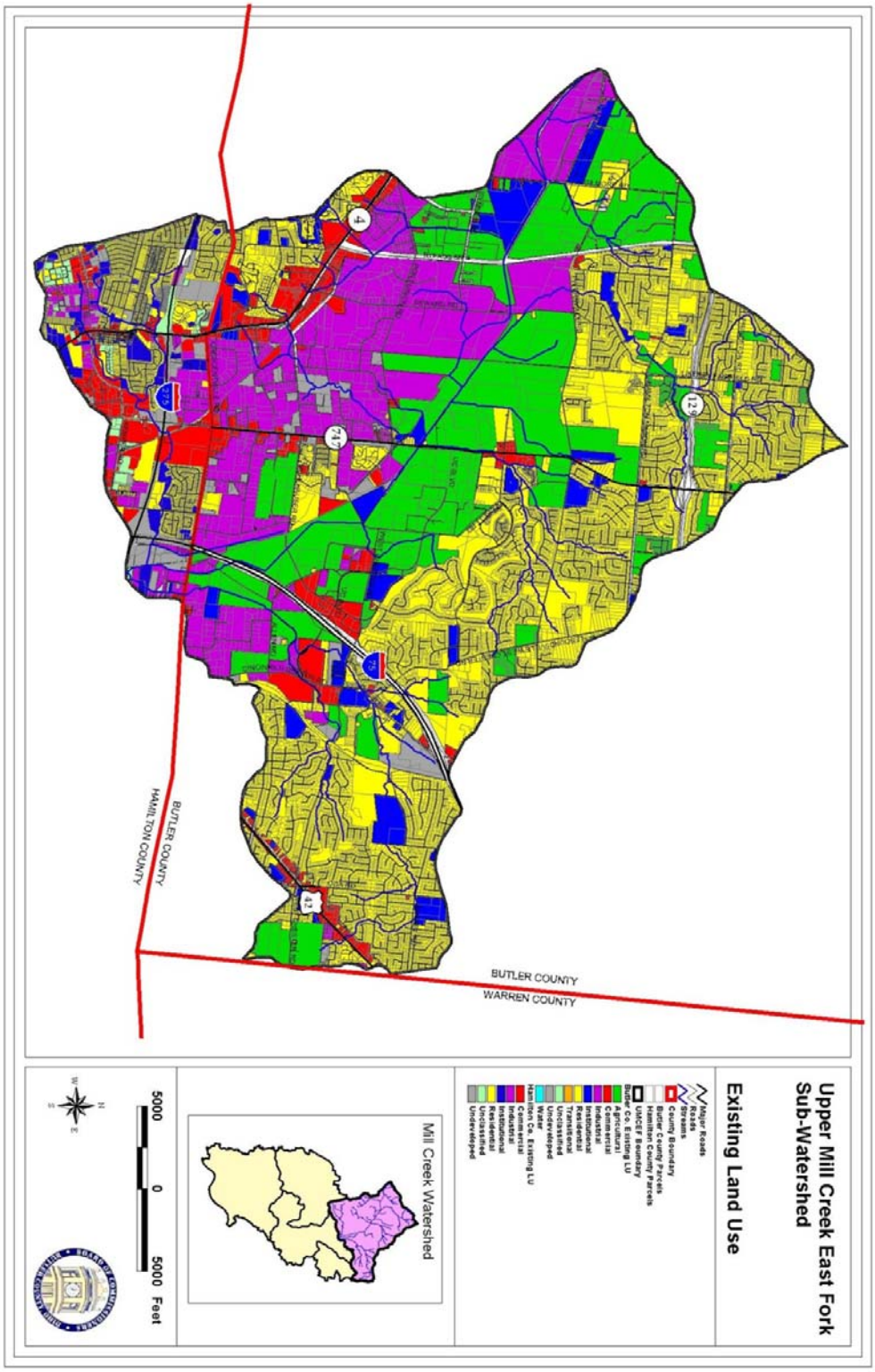
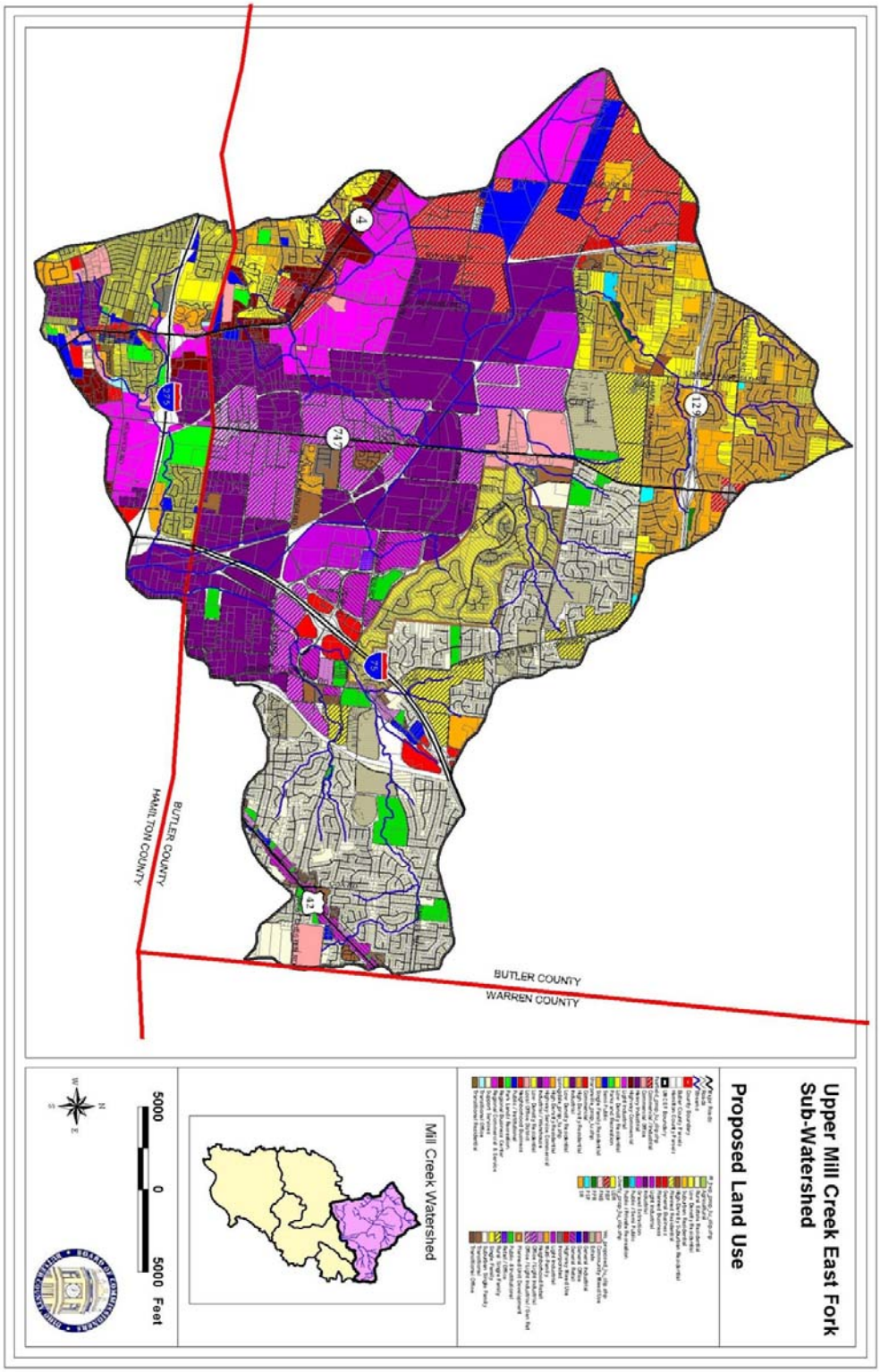


Figure 3-7 Proposed Land Use Map – Upper Mill Creek Sub-basin



Agricultural

The majority of the agricultural and open space use is located in the lower valley, which encompasses much of the Upper Mill Creek floodplain. Agricultural crops include soybeans, corn and hay. Many of the existing fields lie fallow as property owners attempt to sell their land. Cattle, sheep, chickens and horses are present in small numbers in the few remaining farms. Recent visual observations indicate one small feedlot present on the western bank of the Mill Creek west of its intersection with Seward Road.

Current zoning and proposed land use plans indicate that virtually all of the agriculture and open space will ultimately be converted to other uses. In the last decade alone agricultural areas have decreased 51 percent. Based on past development trends, it is likely that much of the lower valley will be developed in the next 5-10 years.

Water and Wetlands

There are no large, individual natural water bodies in the watershed. Small, manmade stormwater detention and retention basins exist in or near commercial and industrial facilities as well as some residential areas. The amount of water contained within these basins varies according to basin design and rainfall patterns. Very little acreage in the Upper Mill Creek watershed exists as wetlands. The study summarized in the above table indicates that only a very small portion (less than one percent) of the combined area of all three townships is composed of wetlands.

Impervious Surface

Increasing imperviousness in a basin is a good predictor of impaired water quality. The UMC watershed is rapidly urbanizing with open space being converted to residential, commercial and industrial land uses. The end result is ever-increasing impervious surfaces. At present, there are no detailed maps of impervious surface locations and percentages, but is expected that this information will be forthcoming as the Phase II storm water programs mature in the watershed communities. This information will be added to the plan when it becomes available.

3.1.4.2 *Protected Lands*

As the upper watershed experiences rapid growth, park departments are making efforts to expand the park system. Numerous Butler County agencies are working jointly with other public and private entities to establish the Port Union-Gilmore Ponds Conservation Corridor. The Corridor will include open space protected lands as well as preservation of the historic Miami-Erie Canal to link existing park areas to newly acquired park areas. The Butler County effort, spearheaded by the West Chester Parks and Recreation has successfully received Clean Ohio Conservation Funds for purchase and donation of over 150 acres of floodplain property for conservation purposes. They are in the process of

applying to the Clean Ohio Conservation Fund for the third phase of the project that will extend the existing 3.5-mile Port Union-Gilmore Ponds Conservation Corridor an additional 3.5 miles as it follows the main stem of Mill Creek and travels from State Route 747, east to Union Centre Boulevard.

In November 2002, Butler County Metroparks signed a long-term lease with the City of Hamilton for a 53-acre portion of Big Pond east of Bypass 4. Metroparks also received a 12-acre parcel behind Hamilton Fixture containing a settling pond – which was once part of Big Pond.

West Chester Parks and Recreation is also establishing the "Emerald Bracelet" – which entails the acquisition and development of seven keystone park areas strategically located throughout the Township. Funding for this project has been provided by corporations, including Procter and Gamble and Iams, the Township general fund, and non-profit organizations such as Quail Unlimited and Nature Works. In addition, the Park fund and the Community Foundation of West Chester-Liberty have given financial support for the project. As mentioned earlier, a broader effort exists between the Little Miami River and Great Miami River to create the Miami 2 Miami Trail. The Miami 2 Miami includes efforts from various political jurisdictions and agencies and is anticipated to be completed in five years.

West Chester Township has obtained conservation easements from developers for areas along the Mill Creek. The lands are part of the Port Union-Gilmore Ponds Conservation Corridor. A map of this conservation corridor is included in Figure 3.8.

3.2 Cultural Resources

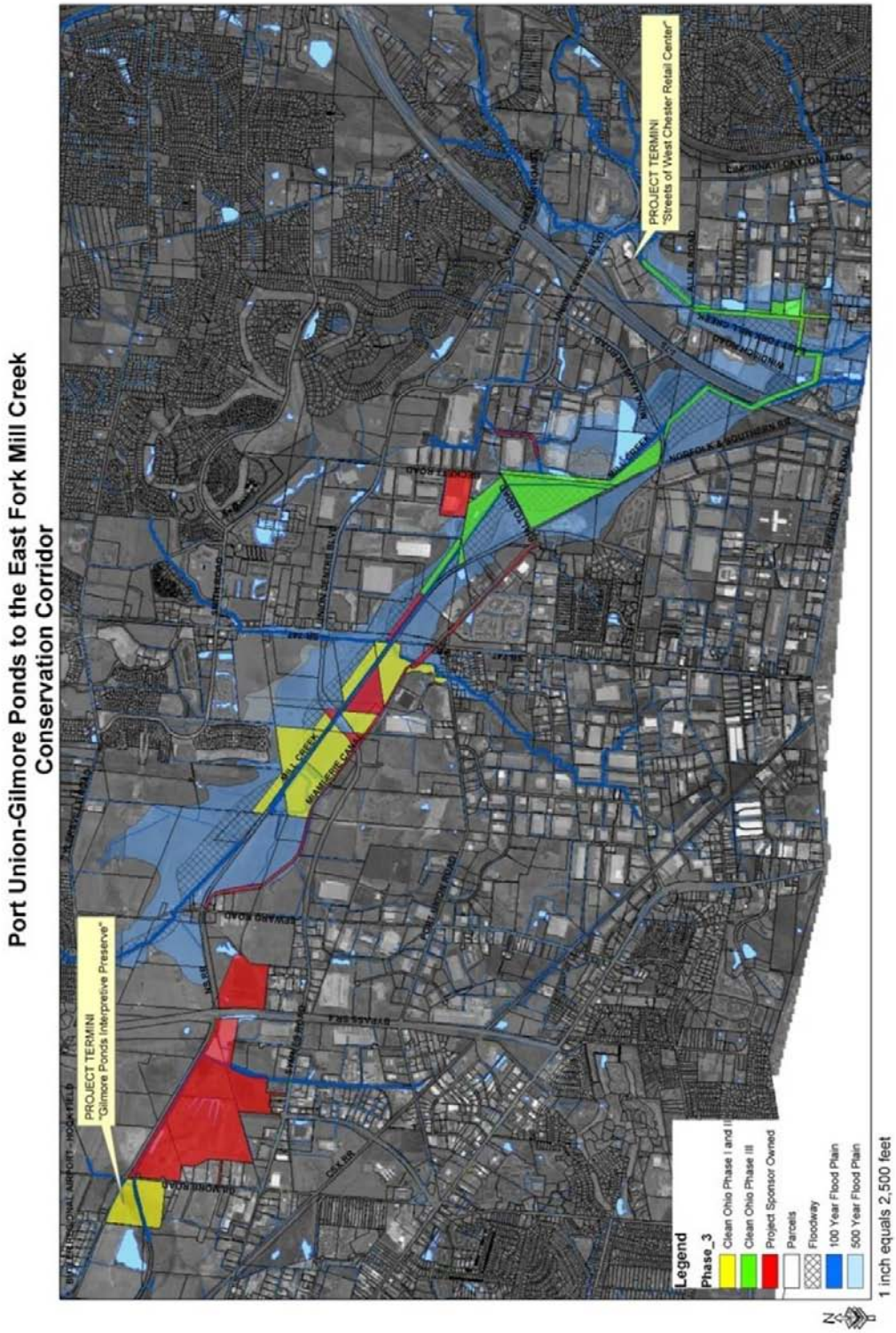
3.2.1 Native American Sites

An 1882 history of Butler County reveals that ancient mounds and enclosures existed in the 1800's in Butler County. Remnants of an Indian mound or enclosures within Section 8 in Fairfield Township were the only potential sites within the Upper Mill Creek.

3.2.2 Gilmore Ponds/Big Pond/Miami-Erie Canal

The Gilmore Ponds area is located in the City of Hamilton and is bounded on the west by Gilmore Road, partially on the south by Symmes Road and on the east by By-Pass 4. The area known today as Gilmore Ponds straddles two watersheds: the headwaters of the Mill Creek, which feeds into the Ohio River, begin about a mile to the northeast of the Ponds, and Pleasant Run, which runs into the Great Miami River, is just west of the Ponds. In the 1820s, the builders of the Miami-Erie Canal followed a path out of Cincinnati that followed the Mill Creek valley into the Gilmore Ponds area, and then into the Great Miami River valley north through Hamilton. At the time the canal was

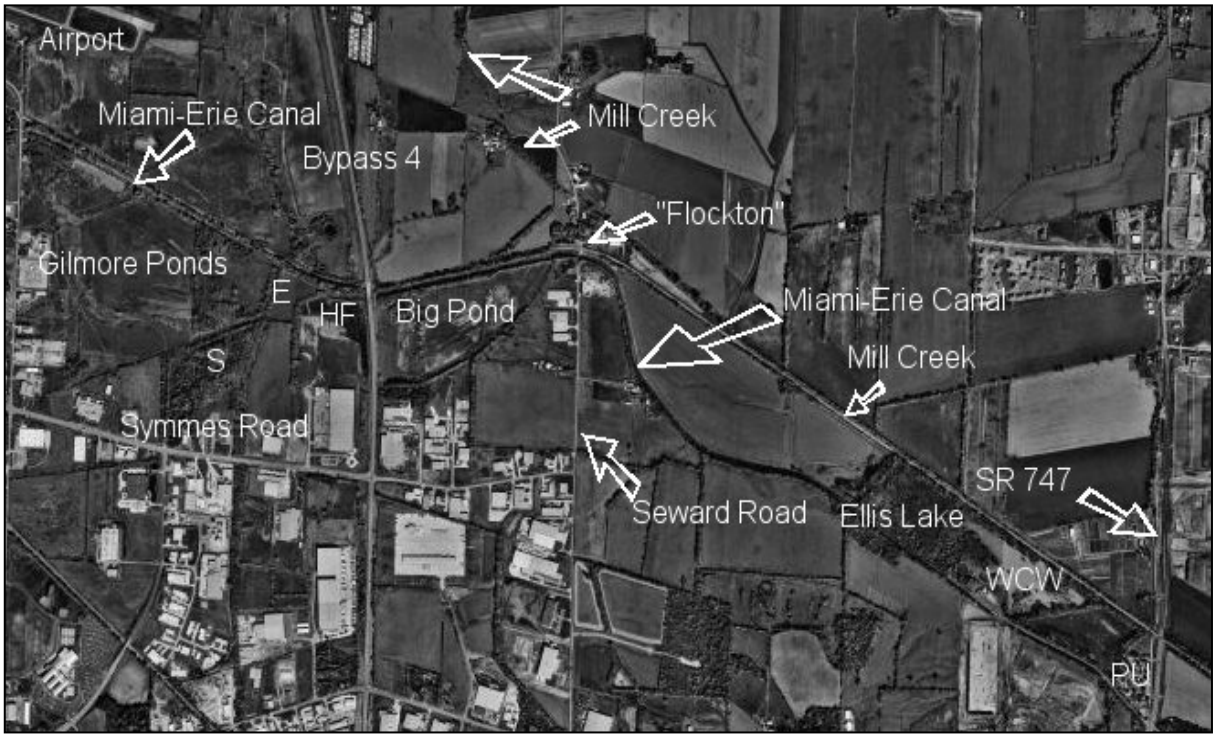
Figure 3-8 Upper Mill Creek Conservation Corridor Aerial Map



built, the site known today as Gilmore Ponds was on the western edge of a large swamp that the early settlers called “Big Pond.” Big Pond stretched east from Gilmore Ponds to approximately Seward Road. The Miami-Erie Canal formed the northern boundary of Big Pond. Figure 3.9 shows an aerial view of the Gilmore Pond Complex.

Figure 3.10 shows the location of Big Pond on a map dated in 1836. The bold, black line is the Miami-Erie Canal. The thin line running southeast to the left of section number 17 is the Mill Creek. It meets the canal near the spot labelled "Towpath Bridge," forming the butter knife. Notice, too, the "Drain from Pond" (at left) that runs through what is today Gilmore Ponds. This drain, a ditch, really, was the first attempt to drain Big Pond to the west into Pleasant Run. According to this map, Big Pond was fed directly by Walker's Run, which is depicted running north past section number 22 and into Big Pond above the letter "L." Walker's Run still exists, though it, too, has been ditched and now it runs east of South Pond into the Miami-Erie Canal in the northeast corner of Gilmore Ponds.

Figure 3-9 Aerial Photograph - Gilmore Ponds/Big Pond & Miami-Erie Canal



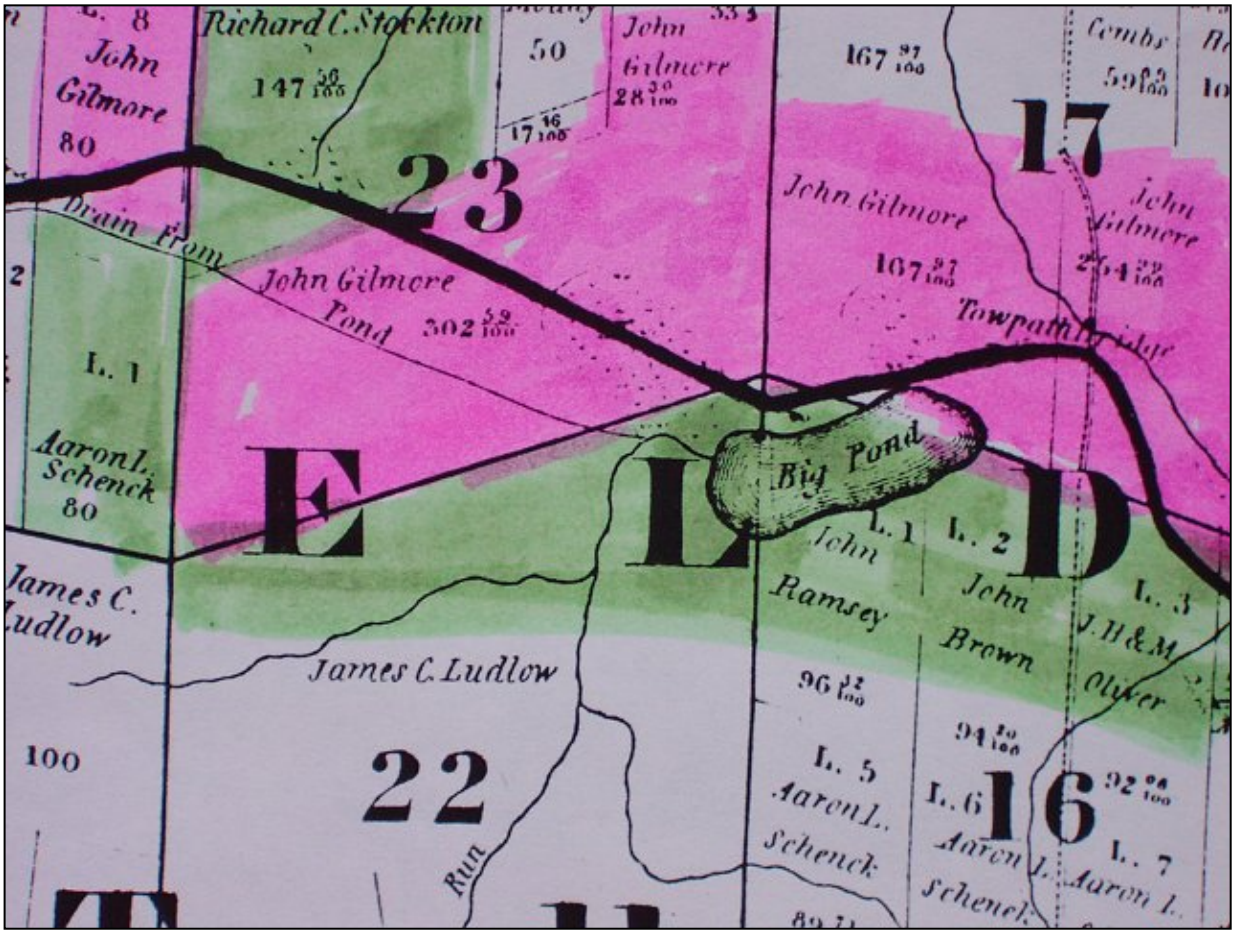


Figure 3-10 1836 Big Pond Historical Map

3.3 Previous and Complementary Efforts

The following is a list of historic and current initiatives in the UMC watershed designed to improve water quality:

- OKI Regional Council of Government's 2000 319 Grant includes wetland and floodplain restoration on the Upper Mill Creek east of Route 747 and south of the Liz Claiborne Warehouse site.
- Butler County Department of Environmental Services/Mill Creek Restoration Project 319 grant for Mill Creek streambank stabilization and in-stream restoration project at Route 747.

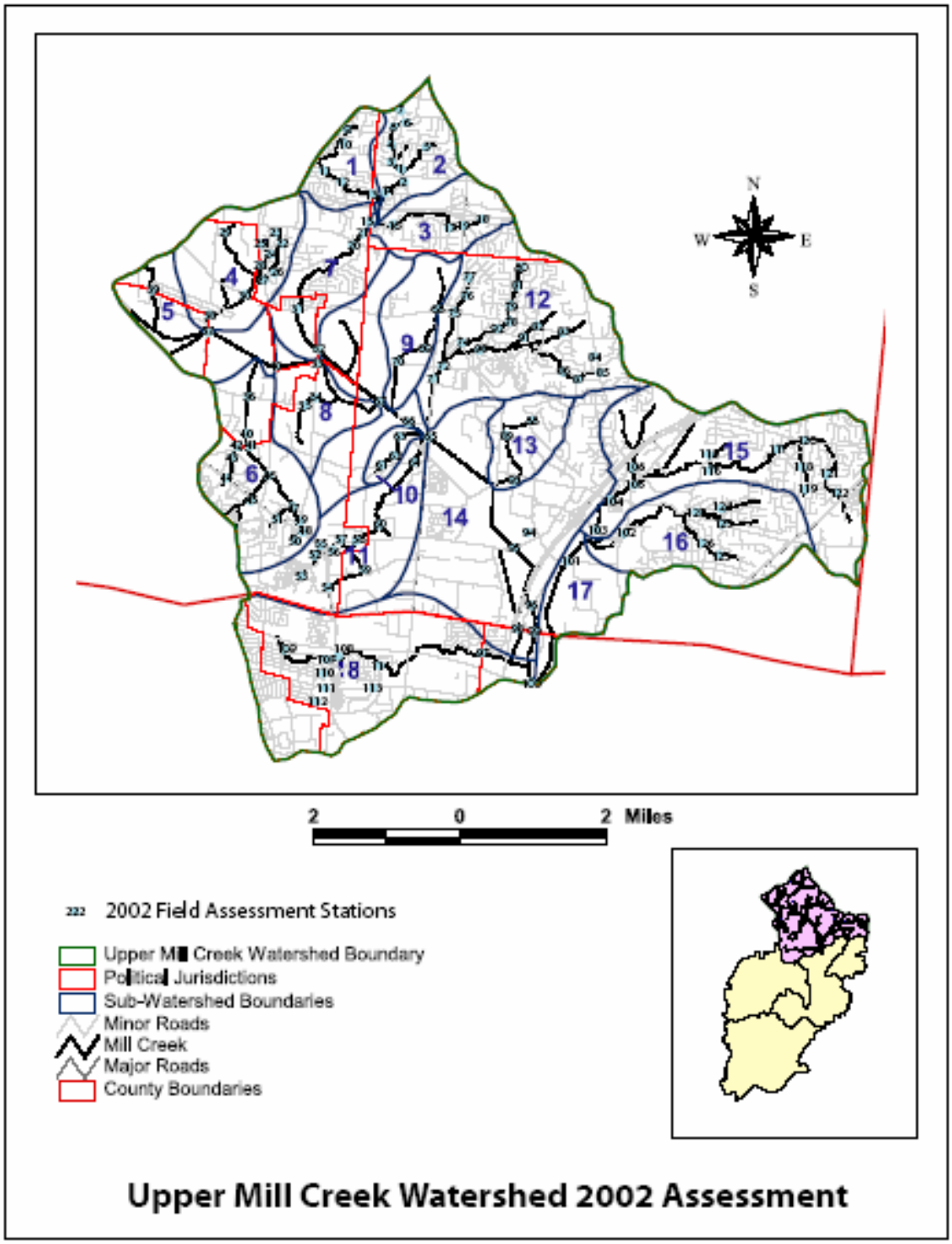
- Butler County Department of Environmental Services East Fork Mill Creek in-stream restoration project.
- Implementation of county and municipal stormwater quantity management requirements.
- To preserve the available storage of the floodplain, the Butler County Flood Damage Reduction June 10, 2002 Regulation includes 1:1 floodplain compensation, streambank buffer and Mill Creek Flood Levee regulations which it enforces.
- Implementation of Stormwater Phase II programs in the watershed. All watershed communities are subject to Phase II stormwater quality regulations.
- Port Union-Gilmore Ponds Conservation Corridor. This project has the potential to impact surface water quality over the greatest area within the sub-watershed. See Section 3.1.
- Butler County Department of Environmental Services, Mill Creek Restoration Project, Ohio EPA and Beckett Ridge Golf Club collaborated on a 319 project to restore and enhance a 1000 foot stretch of highly entrenched and unstable headwater stream using "geo-grid wrapped earth" bioengineering technology and geo-grid faced slopes.

3.4 Physical Attributes

A preliminary inventory of the UMC watershed was conducted in 2002 with the dual objectives of documenting existing stream and habitat conditions and identifying areas for potential for restoration or improvement. A description of the inventory, including parameters and features observed, and information pertinent to the results appears in section 3.4.1. To simplify describing the results of this effort, and for the remainder of this plan, the UMC watershed is divided into discrete three basins - the Mill Creek Main Stem, the East Fork Mill Creek and Beaver Run. The UMC watershed is further divided into 18 sub-basins to facilitate the compilation of information and identification of restoration opportunities. Figure 3.11 is a map showing the sub-basins and each of the field observation locations. In 2004, MCWC and ODNR staff, performed additional field assessments focused on regions within the UMC watershed that were experiencing heavy residential, commercial, retail and industrial development. A description of the data collection efforts and methodologies for related calculations appears in section 3.4.2. Observed conditions for each sub-basin within the UMC watershed are presented in full in Appendix E – with the 2002 information appearing first followed by updated 2004 assessment information in italics.

Conclusions from the assessments appear in Section 3.4.4. Copies of photographs from both assessment efforts are available at the Mill Creek Watershed Council office.

Figure 3-11 Upper Mill Creek Sub-basins & 2002 Assessment Locations



3.4.1 2002 Initial Inventory

The Butler County Department of Environmental Services commissioned XCG Consultants Inc. and ESG International to complete a study in the Upper Mill Creek Watershed. The following information was collected at each station, where possible: amount of woody riparian vegetation, channel type, substrate type, width, depth, evidence of erosion, barriers present, presence of algae, and other unusual features such as garbage. At most stations, a digital photograph was taken upstream and downstream.

The 2002 inventory included visitation of 127 stations throughout the UMC from December 17 to 21, 2002. Rain on two of these days, the 17th and 19th enhanced the inventory effort by allowing an opportunity to observe how local streams responded to wet weather events. This was particularly true on December 19th, when approximately 2 inches of rain fell. On the other hand, high, turbid flows in some areas precluded determination of substrate types.

At many stations, access was confined to road crossings. In these cases, the USGS maps were used to extrapolate conditions between stations, as the intent was to obtain as complete an inventory as possible. The USGS maps show areas of tree cover that could be used to estimate amount of riparian cover, and also have contour maps. The contours could be used to estimate substrate types, particularly when information was available upstream and downstream of a reach.

However, in a high proportion of the watershed, it was possible to either walk or drive between stations to understand conditions. Often streets were close enough together that the intervening creek could be seen, and in agricultural and industrial areas it was possible to either see long distances or to walk along the creek.

Opportunities for restoration were identified during the inventory. Although many areas could benefit from in-stream habitat restoration (such as vortex weirs or J-weirs) and additional riparian cover, emphasis was on restoration opportunities that would improve the flow regime and water quality. It is critical that better water quality and a more natural flow regime are achieved; limited benefits may be accrued from in-stream and riparian works if flows are flashy and water quality does not improve.

3.4.2 2004 Field Assessment

The 2004 field assessment was conducted by MCWC staff and ODNR on October 12, 14, and 25, 2004, during dry conditions. The basins experienced moderate rainfall between the last two field visits. The purpose of the follow-up assessment was to provide additional detailed characterization, location, and quantification of the contribution of potential sources that cause stream impairment. This assessment was intended to supplement the initial inventory completed in December 2002. The primary focus of the follow-up

assessment was to observe conditions on the portions of the Mill Creek main stem currently undergoing the most rapid land use changes. Twenty-three sites were selected to revisit based on significant land use changes due to increased pressure from residential, industrial and commercial development.

As in the initial inventory, the UMC watershed was divided into three basins, the Mill Creek Main Stem, East Fork Mill Creek and Beaver Run, and further broken down into 18 sub-basins to facilitate the compilation of information and identification of restoration opportunities. A map of these sub-basins is found earlier in this section.

The following characteristics were observed in each of the selected sub-basins: stream substrate; sinuosity; riparian cover; streambank buffer; the presence of algae, fish and other aquatic life; and evidence of dumping. Erosion in each observed reach was characterized using two methodologies: Rosgen classifications and lateral recession rate narrative descriptions. Erosion-related calculations were estimated in the field.

The Rosgen Classification scheme uses stream characteristics to assign channel classification categories. The general stream type descriptions for typical Rosgen Channel Types for the Upper Mill Creek watershed are characterized as follows:

- Channel Type B: Moderately entrenched, moderate gradient, riffle dominated channel with infrequently spaced pools. Very stable plan and profile. Stable banks. Moderate relief, colluvial deposition. Narrow, gently sloping valleys. Rapids predominate with scour pools.
- Channel Type F: Entrenched meandering riffle/pool channel in highly weathered material on low gradients with high width/depth ratio. Laterally unstable with high bank erosion rates. Riffle/pool morphology.
- Channel Type G: Entrenched "gully" step/pool and low width/depth ratio on moderate gradients. Narrow valleys or deeply incised in alluvial or colluvial materials. Unstable, with grade control problems and high bank erosion rates.

Lateral recession rates have been noted in narrative form as slight, moderate, severe and very severe based on the classification outlined in Table 3.9 below. The reference for the lateral recession rates was taken from Steffen, L.J. 1982. *Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. June 1999 Revision: Michigan Department of Environmental Quality – Surface Water Quality Division - Nonpoint Source Unit. EQP 5841 (6/99).

The 2004 descriptions provided in Appendix E include conditions noted at the time of the site visit, erosion characterization using Rosgen and lateral recession rate descriptions and factors that might influence observations.

Table 3-4 Lateral recession rates narrative descriptions

LRR (ft/yr)	Category	Description
.01-.05	Slight	Some bare bank but active erosion not readily apparent. Some rills but no vegetative overhang.
.06-0.2	Moderate	Bank is predominantly bare with some rills and vegetative overhang
0.3-0.5	Severe	Bank is bare with rills and severe vegetation overhang. Many exposed tree roots and some fallen trees and slumps or slips. Some changes in cultural features such as fence corners missing and realignment of roads or trails. Channel cross-section becomes more U-shaped as opposed to V-shaped.
0.5+	Very Severe	Bank is bare with gullies and severe vegetative overhang. Many fallen trees. Drains and culverts eroding cut and changes in cultural features. Massive slips or washouts common. Channel cross-section is U-shaped and streamcourse or gully may be meandering.

3.4.3 Field Assessment Summaries

Notes detailing observed conditions for each of the 18 UMC sub-basins during the 2002 and 2004 field assessments are included in appendix E to this plan. The 2002 narrative, taken directly from the consultants report, is presented first, followed by the 2004 update (for the 23 revisited sites) presented in italics. The information obtained during these assessments is also incorporated into the problem statements found in Section 4.

3.4.4 Conclusions: Field Assessments

The following is the narrative, in its entirety, of conclusions drawn from the 2002 field inventory and assessment.[13]

> Conditions in UMC are generally much better than in the Mill Creek watershed as a whole. There are still, however, some problems. Remediation of these problems will not only improve aquatic habitat in UMC, but also in downstream areas. Much of UMC is residential land uses, so that floodplain encroachment is much less of a problem than in some other watersheds of Mill Creek. Butler County has developed more recently than some reaches of Mill Creek. Consequently, there have been opportunities to install stormwater management facilities that help regulate stream flows.
>
> One problem appears to be high peak flows. These, in turn, cause localized erosion problems and increase nutrient concentrations through phosphorus attached to sediments. The high flows also result in widening of stream channels and scouring of the substrate. This results in very shallow water in the channel under baseflow conditions, and a structurally simple channel with limited pools and riffles. These modifications to the stream channel result in a lower diversity of invertebrate and fish species, and the low baseflow in widened channels contributes to warmer water

[13] The narrative appears un-edited as described by the consultant conducting the field work.

temperatures, again limiting the number of species capable of in habiting the stream.

There are a variety of other problems within UMC. Uncontrolled flows result in inputs of nutrients and other materials from non-point sources. In at least two locations, cattle wastes may be entering the creek system.

Much of the main stem of Mill Creek has been bermed so that flows are confined within a narrow, straight channel. This has several implications. This increases downstream water velocities and flows, as the creek cannot spill onto its floodplains during flood events. It is also detrimental to some of the wetlands that are on the floodplain, but separated from the creek. Flooding in riparian wetlands is a natural phenomenon that delivers critical nutrients to wetland communities. It also inhibits succession of wetland communities to more upland species or invasion by non-native species such as honeysuckle and buckthorn.

The amount of woody riparian cover is low in many reaches of the watershed. Riparian cover is important as it helps filter contaminants out of surface water and shades watercourses. In headwater areas, nutrients in the form of leaves are important. Lacking riparian cover, headwater areas may be fairly sterile and completely lacking in the group of benthic invertebrates that rely on terrestrial leaves for food. Large woody debris in streams is also important in providing shelter, and it often affects flows and creates pools. Even though riparian cover is important, provision of additional riparian cover is considered a relatively low priority compared to moderating flows.

Although the above may seem like a long list of problems, Upper Mill Creek is generally in much better health than downstream watersheds. In addition, there are significant opportunities for restoration in UMC, while opportunities in southern watersheds are more limited due to existing land uses.

There appear to be two very significant opportunities for restoration with Upper Mill Creek, but considerable study may be required to determine their feasibility. They are construction of a series of large stormwater management/wetland facilities at the confluence of the main stem of Mill Creek and the East Fork, and reconnecting the main stem of Mill Creek to its floodplain. Although the area around the mouth of Beaver Run was not observed, there may be opportunities for restoration in this area.

Facilities at the confluence offer real promise, particularly if wetland polishing cells are possible. This will particularly important for the East Fork, where summer low flows and nutrient concentrations are a concern. Although facilities in this area are of very high priority, if possible, it is necessary to understand the entire system before deciding on the design. Each sub-basin above here should be examined to determine how realistic the opportunities are and what benefit they will have for

water quality and quantity. For instance, there appear to be numerous opportunities in the main Mill Creek basin for constructing wetlands and stormwater management facilities, reconnecting the creek to its floodplain, and retrofitting existing facilities to improve water quality. If most of these can be realized, there would be not be as much need to treat quantity and quality of the main stem of Mill Creek at the confluence. On the other hand, there appear to be few good restoration opportunities on the East Fork, and perhaps facilities at the confluence should be dedicated to flows from this sub-basin.

Connection of Mill Creek to its floodplain should be a high priority, but it is realized that this may not be feasible in many areas. Where the creek will have access to existing wetlands that have been cut off from the creek, it should be determined what impact additional water will have on existing vegetation communities. For floodplain areas currently in agricultural uses, the type of wetland communities most desirable should be planned. In some areas, it may be useful to split the floodplain into cells where water levels and flows may be manipulated. This would allow controlled treatment of water quality by wetland plants and also has the potential to provide significant wildlife habitat.

The greatest emphasis should be on projects that improve creek flows or water quality. However, site specific projects such as erosion control, barrier removal, riparian plantings, and in-stream weirs and other habitat features should not be ignored. These are all beneficial at a local level and cumulatively contribute to the overall health of the watershed.

There are excellent restoration opportunities within the Upper Mill Creek Watershed. If a high proportion of these come to fruition, water quality and flow regimes within Butler County will be greatly improved. These improvements will also be beneficial to downstream areas of Mill Creek.

In 2004, rapid transformation of the remaining agricultural lands and open space continued to be evident. Extensive new residential, retail and commercial development sites were evident in the central portions of the sub-basin. Road building and widening efforts needed to accommodate higher populations in the region have had direct impacts on nearby streams through reduction in riparian corridor width and channel modifications. Nutrient and sediment impairments continued to threaten the health of local streams. Channelization, removal of riparian vegetation, habitat alteration, and urban runoff are sources of these impairments. Observations made during the 2004 assessment re-emphasized the need for implementation of efforts to reduce erosion, stabilize streambanks, improve riparian corridor, manage stormwater runoff, and educate the residents and local decisionmakers about best management practices to improve water quality in local streams.

3.4.4.1 Physical attribute summaries

Tables 3.5 through 3.9 summarize the number and linear feet of physical attributes as observed during the UMC field assessments.

Table 3-5 Stream length in UMC watershed

Stream Length in UMC Watershed

Area	Segments	Length (feet)
Butler County Segments	74	362,020
Hamilton County Segments	6	40,630
Total in UMC	80	402,650

Table 3-6 Riparian Zone

Riparian Vegetation Proximity	Segments	Length (feet)
1-5 yards	50	150,300
5-10 yards	17	30,700
10-20 yards	33	62,300
20-30 yards	18	26,300
>30 yards	35	79,600
None	70	246,500

Table 3-7 Substrate Type

Substrate Type	Segments	Length (feet)
Bedrock	1	725
Cement	6	8,620
Clay or Sand with Gravel	10	21,200
Cobbles and Boulders	14	43,270
Gravel with Clay or Sand	9	18,300

Substrate Type	Segments	Length (feet)
Gravel with Cobble/Boulder	22	87,750
Mostly Clay or Sand	50	165,400
Underground	3	6,150

Table 3-8 Channel Type

Channel Type	Segments	Length (feet)
Cement Channel	4	6,500
Channelized with One Bank Eroded	4	5,000
Channelized with Both Banks Eroded	2	2,350
Channelized with Natural	55	248,100
Natural Channel	21	72,400
Underground Pipe	20	29,100

Table 3-9 Erosion and Barriers

Erosion and Barriers	Segments	Length (feet)
Moderate Erosion	24	29,650
Severe Erosion	15	21,400
Perched Culvert or Concrete Slab	6	Na
Instream Drop	2	Na
Natural Waterfall	2	Na
Drop Structure	2	Na

Figures 3.12 through 3.16 illustrate the findings of the 2002 inventory regarding the physical attributes of the UMC watershed. The figures may have changed based on the 2004 observations and are subject to updates.

Figure 3-12 UMC Riparian Zones

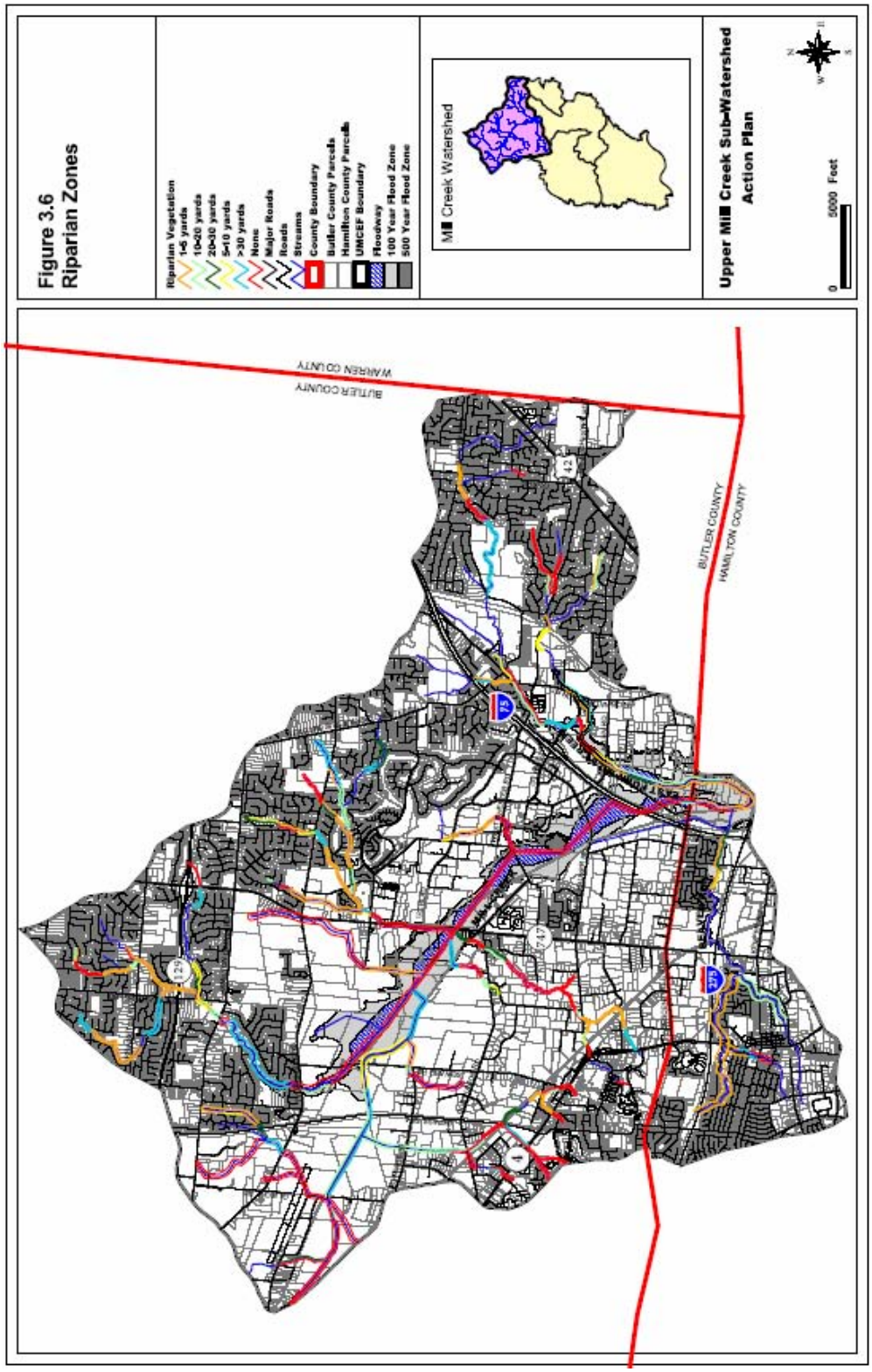


Figure 3-13 UMC Substrate Types

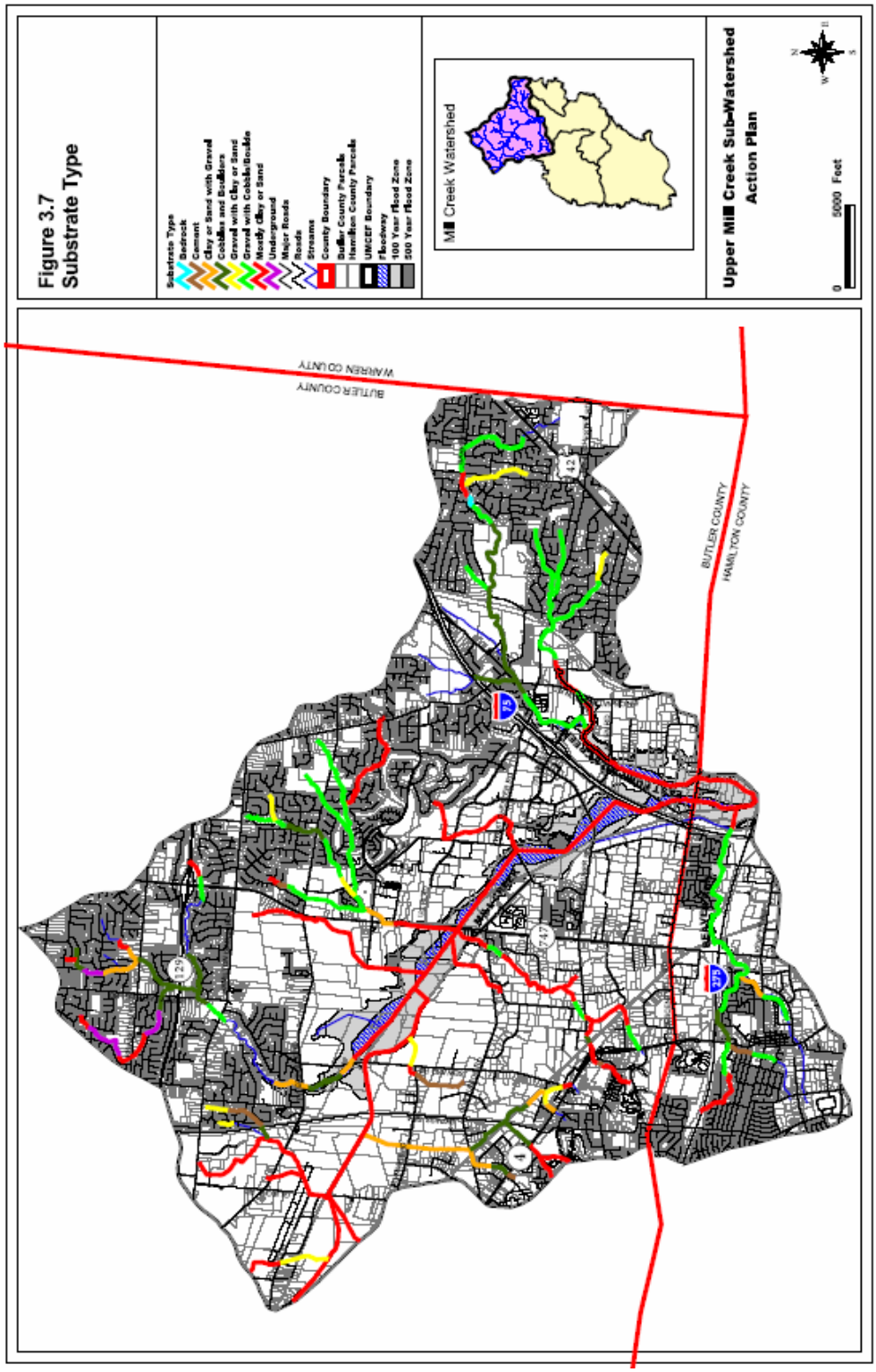


Figure 3-14 Channel Type

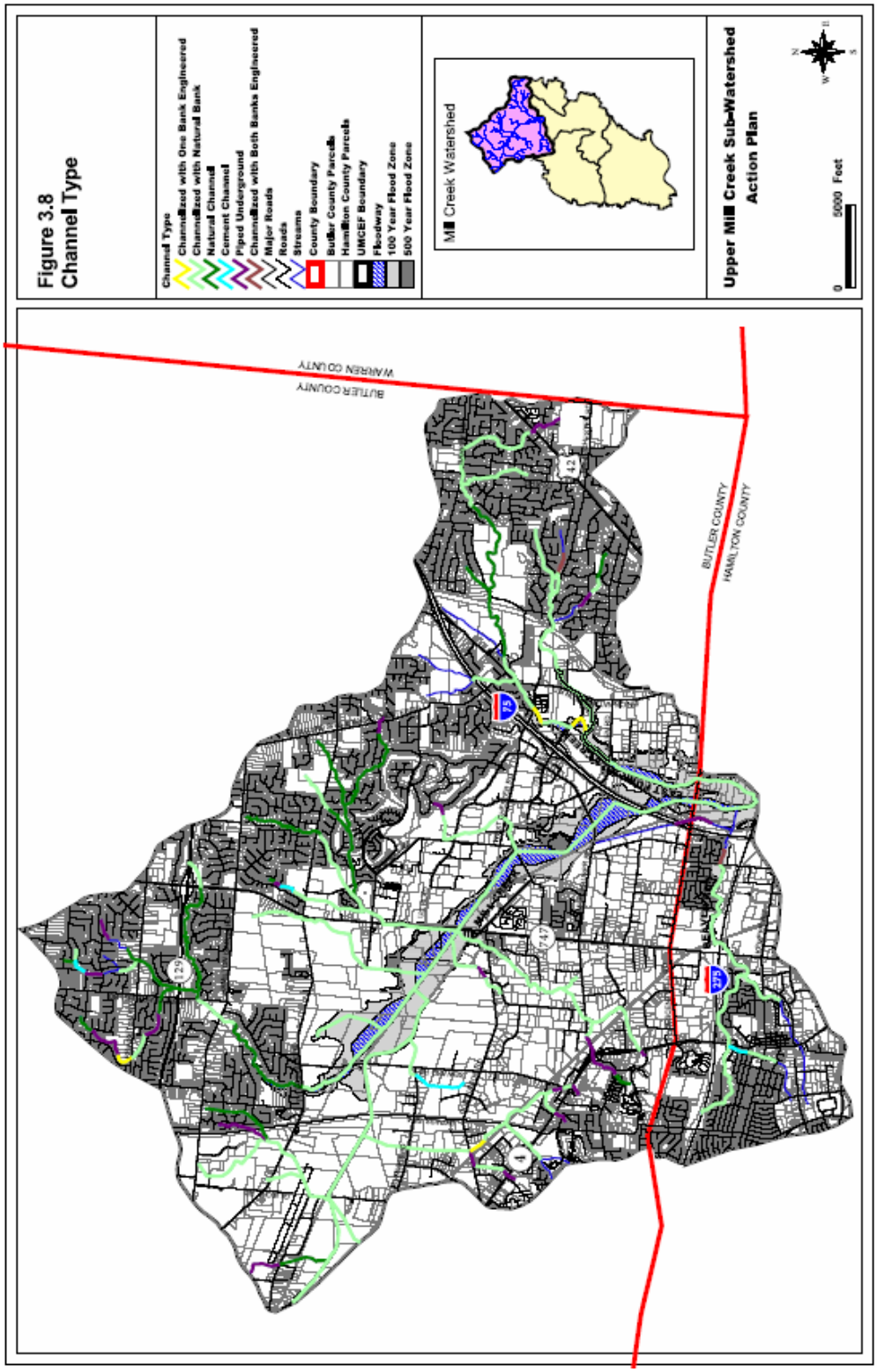


Figure 3-15 Erosion Zones and Barriers

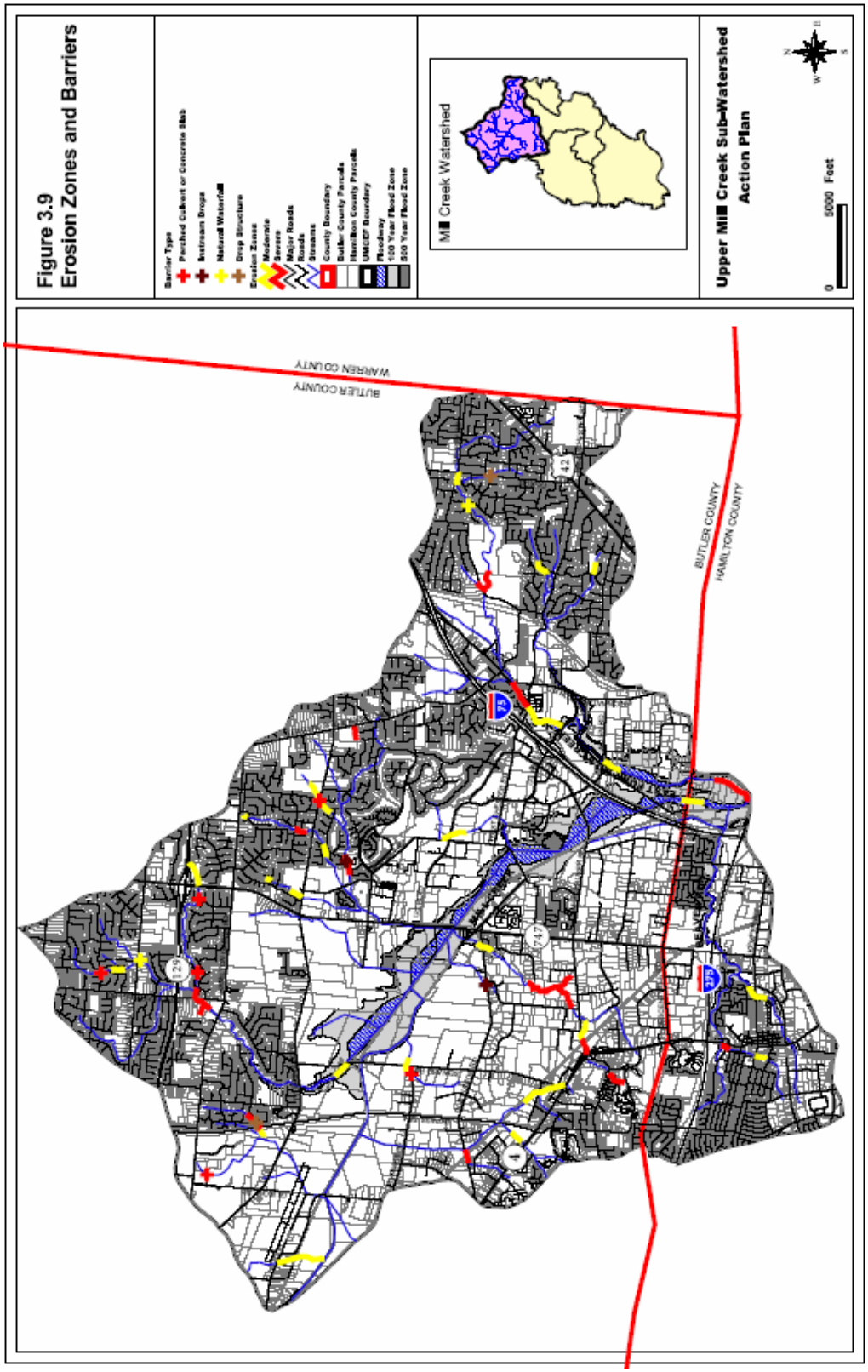


Figure 3-16 Floodplain

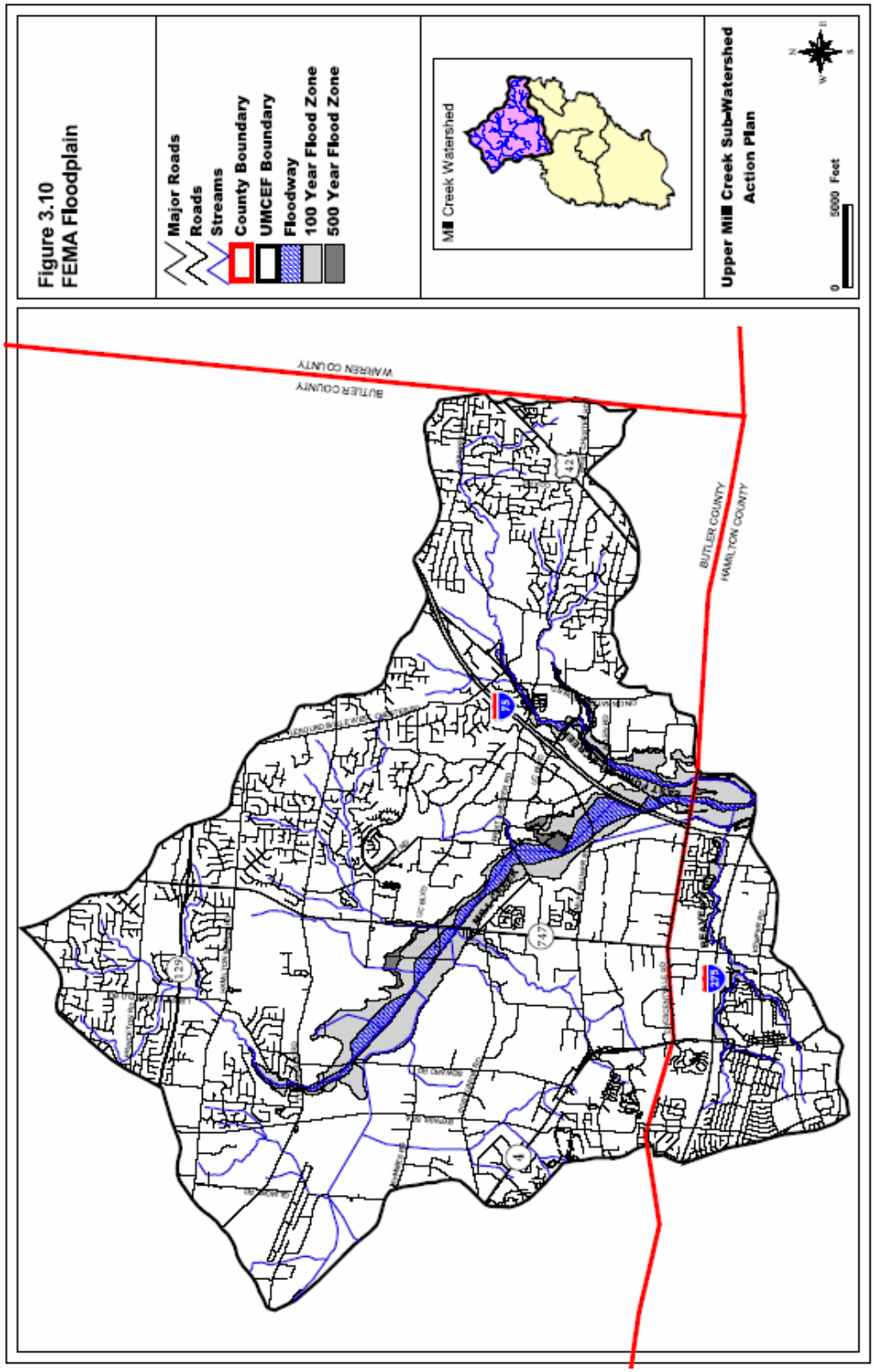


Figure 3.17 illustrates three different channel types in the main stem and some of the tributaries identified in the 2004 study area using the Rosgen Classification System. The observations were made from stream crossings on three different days. Specific sites, represented as points on the figure, were chosen based on stream accessibility at each crossing. Extrapolations were made between points to determine the stream type. Estimates were based on best professional judgment. More precise measurements should be taken prior to project implementation. These Rosgen stream channel types may indicate areas where the stream channel is unstable. Stability of the stream channel appears to have been impacted with changing land use in the last ten years.

This section does not summarize all restoration opportunities in UMC. Prior to implementing any restoration, it is recommended that a preliminary feasibility study be undertaken by the County. The opportunities discussed in this document are conceptual only at this point. County staff should look at the opportunities suggested to see how many are practical. Some may not be feasible due to land ownership or land use. For example, a park may be a suitable site for a stormwater management facility, but there may be compelling reasons to leave it as a park.

After this first cut is made, thought should be given to the effectiveness of the opportunities. For example, some sites suggested for stormwater management facilities may be too small to give effective treatment, so that costs may outweigh benefits. On the other hand, occasionally something relatively inexpensive may result in positive benefits. An example might be an end-of-pipe facility at the storm outlet at Liberty Fairfield Road in Sub-basin 1 that would remove solids.

Ohio water resource documents from 2002, 2000, 1998 and 1996 were reviewed in the preparation of this summary. Relevant excerpts from these characterize water quality conditions in the Mill Creek and its tributaries at those times. (Note: The format for these reports varied from year to year and is presented verbatim below.)

3.5 Water Resource Quality

3.5.1 Use Designations and Attainment Status

The Ohio Clean Water Act Section 303(d) List for Fiscal Years 1999 and 2000 lists the Mill Creek watershed with the highest impairment ranking relative to all listed watersheds with 39.9 impairment-weighted miles of stream. It states that at the time the 303(d) list was published 32% of the overall impairments are from point sources, 44% from nonpoint sources, and 24% are habitat related. The stream segments of concern for the UMC WAP are the Upper Mill Creek and East Fork Mill Creek and Beaver Run. These are listed in OEPA documents with water body identification numbers (WBID#) OH62 30 and OH62 31, respectively. Figure 3-18 is a map of designated use and biologic attainment for specific stream segments in the study area. The map also contains locations of OEPA Qualitative Habitat Evaluation Index (QHEI) survey points.

Figure 3-17 Channel types observed in Upper Mill Creek watershed

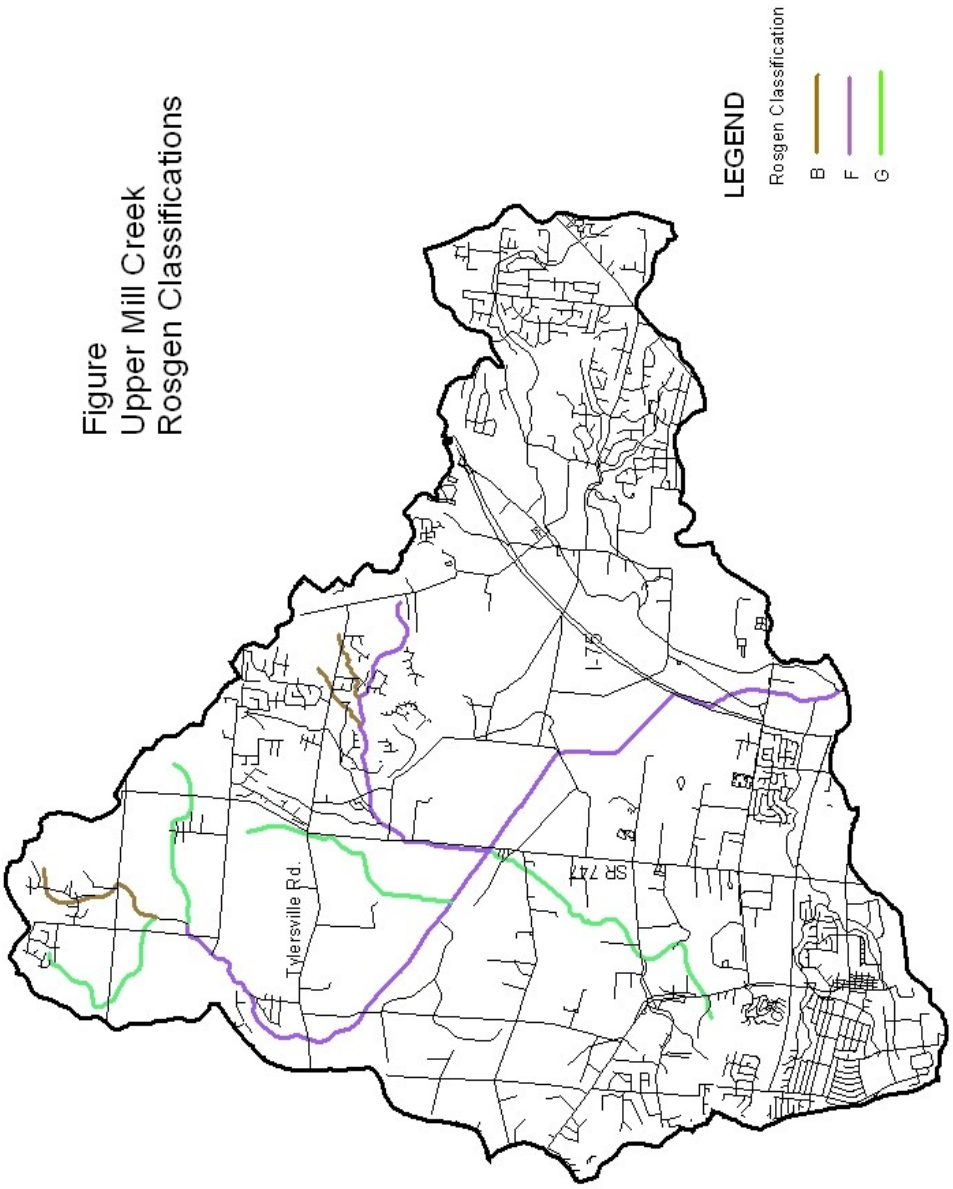
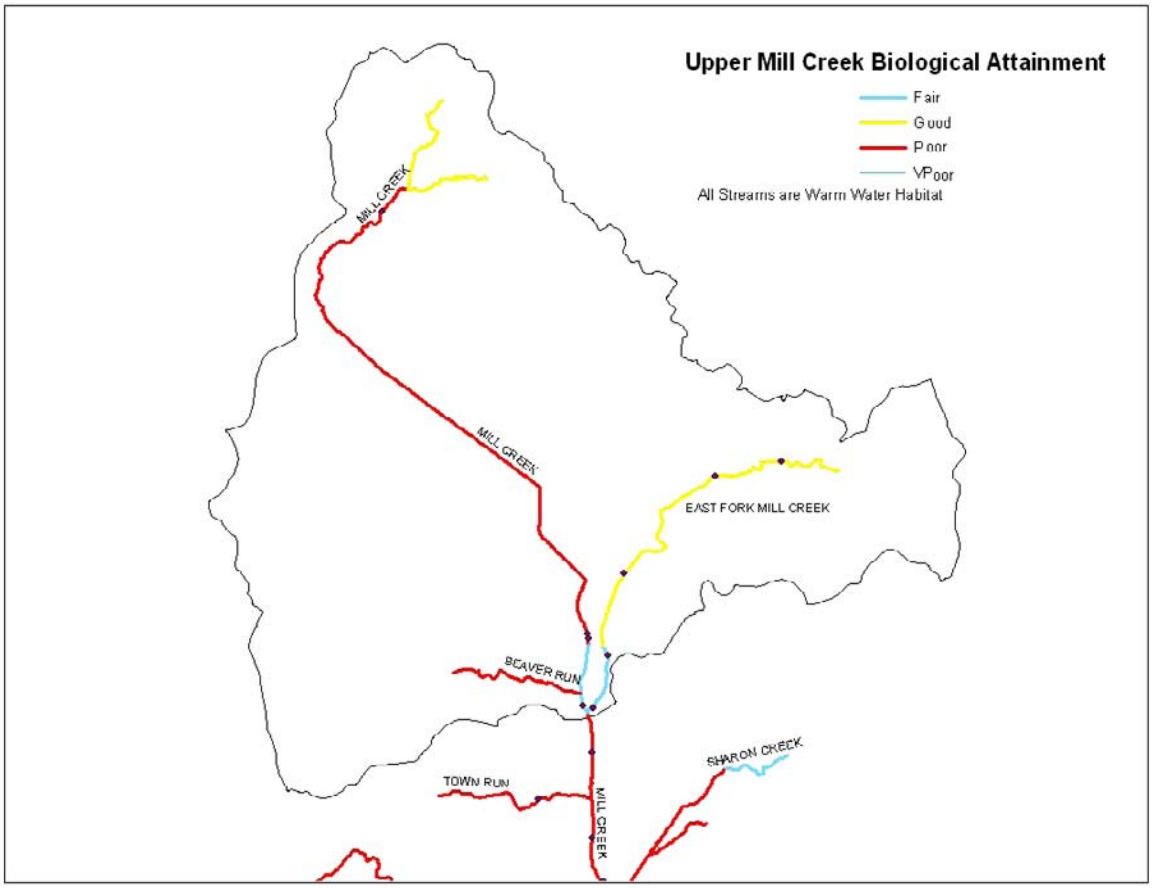


Figure 3-18 Upper Mill Creek Biological Attainment Map



Source: OEPA/SWDO, 2004

OEPA 2002 Integrated Report, Appendix C, Assessment Unit (AU) Summaries

Appendix B includes a copy of the AU summary for the entire Mill Creek watershed. From this report the aquatic life use designations for the Mill Creek Watershed, based on 1992 and 1997 sampling events by OEPA, include: warm water habitat (WWH), modified warm water habitat – channel modification (MWH-C), limited resource water (LRW), and limited warm water habitat (LWH).

The 2002 OEPA Integrated Report lists HUC Unit 05090203010 (Mill Creek) as an impaired waterway with the following attainment characteristics:

- Aquatic life use assessment: Small Streams (<50 square miles drainage) are 17.5 % in full attainment, 13.3% in partial attainment, and 69.2% in non-attainment; Large Streams (>50 square miles drainage) are 0% in full attainment, 5.6% in

partial attainment and 94.4% in non-attainment. The relative amounts of attainment reflected in the AU score are 0.09 in full attainment, 0.09 in partial attainment and 0.82 in non-attainment. The weighted AU scores (weighted by AU size) are 14.5 in full attainment, 15.5 in partial attainment and 134.6 in non-attainment.

- The recreation use assessment listed unknown impairments and no bacterial sites in the assessment unit.
- The fish consumption assessment indicates a "one meal per month" fish consumption advisory in effect for all Mill Creek species. The area designated for this advisory is from I-275 south to the Ohio River. A small portion of this area is included in the southernmost section of the UMC watershed.

OEPA 2000 305(b) Report for Rivers and Streams: Appendix D1

Appendix B contains relevant excerpts from the **OEPA 2000 305(b) Report for Rivers and Streams: Appendix D1.** This report contains use attainment information pertaining to the following stream segments in the Upper Mill Creek/East Fork watershed:

Mill Creek (Headwaters to Sharon Creek) WBID# OH62 30, River Code 23-001, located between Upper River Mile 28.35 and Lower River Mile 15.64, Segment Length 12.72 miles, USEPA Reach# 05090203014:

- Aquatic Life Use Designations – based on field data collected from June 1997 to October 1997: WWH, LWH
- Aquatic Life Use Attainment (in miles) – Full: 4.42, Full, But Threatened: 0 Partial: 1.00, and None: 7.30
- Narrative Assessment (in miles) – Good: 4.42, Fair: 1.00 and Poor: 7.30
- Causes of impairment (along with their relative magnitude/contribution of that cause – either high, moderate, slight or threat) are listed as: Other habitat alterations ("high" and "moderate"), nutrients ("high"), organic enrichment ("slight").
- Sources of impairment (along with their relative magnitude/contribution of that source) are listed as: Major municipal point source ("high"), nutrients ("high"), other habitat alterations ("moderate") and land development/suburbanization ("slight").
- Comments: Habitat modification has a pervasive influence throughout the lower 9 miles, but is most recent and severe in the Rialto Road area upstream from I-75 (RM 24 to 19). Improvement to partial attainment upstream from the East Fork may be related to repairs to a sewer overflow at river mile 19. Biological

communities continue in non-attainment downstream from the East Branch (East Fork). Nutrient increases associated with the Upper Mill Creek WWTP are noticeable for several miles downstream in Mill Creek.

East Fork Mill Creek WDID#OH62 31, River Code 23-006, located between Upper River Mile 7.10 and Lower River Mile 0.00, Segment Length 7.10 miles, USEPA Reach 05090203:

- Aquatic Life Use Designations – based on field data collected from June 1997 to October 1997: WWH
- Aquatic Life Use Attainment (in miles) – Full: 4.00, Full, But Threatened: 0 Partial: 0.50, and None: 0.50
- Narrative Assessment (in miles) – Good: 4.00 and Fair: 1.00
- Causes of impairment (along with their relative magnitude/contribution of that cause – either high, moderate, slight or threat) are listed as: Nutrients ("high")
- Sources of impairment (along with their relative magnitude/contribution of that source) are listed as: Major municipal point source ("high")
- Comments: Significant improvement in biological performance downstream from the Upper Mill Creek WWTP is attributable to an upgrade and expansion of the WWTP in 1993. However, continued partial and non-attainment is strongly linked to elevated nutrients. A risk analysis for phosphorous, nitrate-nitrite and ammonia revealed that all three increase into the high risk range downstream of the WWTP, and extended at least 3 miles downstream in Mill Creek. Further evidence of a nutrient based stress were compositional shifts in the macroinvertebrates and the biostimulatory effect manifested in a recent algal bioassay. Increased flow at existing nutrient levels may cause this problem to extend further downstream in Mill Creek.

Ohio Clean Water Act Section 303(d) List for Fiscal Year 1999-2000

The **Ohio Clean Water Act Section 303(d) List for Fiscal Year 1999-2000** published on April 1, 1998, Table 3 in the Ohio EPA report included a description of designated use attainments, attainment status, causes and sources of impairments, fish advisories and restorability. The following sections are pertinent to the UMC watershed.

Mill Creek (Headwaters to Sharon Creek) WBID# OH62 30 is designated WWH for aquatic life use with 3.6 miles in Full Attainment, 0 miles in Threatened Attainment, 0 miles in Partial Attainment and 9.1 miles in Non-Attainment; a Fish Advisory of 95% indicates that almost no fish should be consumed. Listed causes (and their level of significance): organic enrichment (high) and habitat alteration (moderate). Listed

sources of impairments (and their significance): combined sewer overflow (high) and hydromodification (moderate). A "high" potential for restorability is stated.

1996 OEPA Ohio Water Resource Inventory Appendix A-1

The **1996 OEPA Ohio Water Resource Inventory Appendix A-1** (published in 1997) listed the Aquatic Use Attainment status for the Mill Creek (Headwaters to Sharon Creek) WBID# 62 30 as having 3.6 miles in full attainment, and 9.1 miles as not supported. The East Fork Mill Creek WBID# 62 31 having 5.2 miles in full attainment and 1.0 miles not supported. The 1996 Water Resource Inventory Appendix A-2 listed Mill Creek (headwaters to Sharon Creek) causes of impairment (and their magnitude) as: Organic enrichment/DO (high) and Other habitat alterations (moderate), and sources of impairment as: Combined sewer overflow (high) and hydromodification (moderate). The same document listed East Fork Mill Creek causes of impairments as: Unionized ammonia (high), organic enrichment/DO (high) and pesticides (slight), and sources of impairment as: Municipal point sources (high).

3.5.2 Cause and Sources of Impairment

From available information presented in the OEPA's 305(b) and 303(d) lists the UMC watershed (HUC 1) has been identified with the following causes of impairment:

- Nutrient enrichment
- Other habitat alterations
- Siltation/sediment
- Flow alterations

Associated with the causes of impairment are the possible sources of impairment identified in the UMC watershed. Potential sources of impairment include the following:

- Channelization
- Streambank modification/destabilization
- Urban runoff /storm sewers
- Removal of riparian vegetation
- Agriculture
- Pasture land
- Non-irrigated crop production

3.5.2.1 Point Sources

The following is a summary of point sources identified in the UMC watershed:

Butler County Upper Mill Creek Water Reclamation Facility

The largest point source in the watershed is Butler County's Upper Mill Creek Water

Reclamation Facility (UMC WRF), located at River Mile 17.9, 1.09 on the East Fork Mill Creek. This facility discharges about 9 million gallons per day (MGD) of treated wastewater into the stream, with a total permitted capacity of 16 MGD.

Currently the facility is undergoing a major upgrade that will enable it to achieve new effluent quality nutrient standards effective January 2006. The upgrade will improve biological and chemical treatment processes for enhanced removal of nitrogen and phosphorus.

While these new effluent standards necessitate improved treatment, the following charts show that the UMC WRF has already achieved significant improvements in terms of nutrient removal. Figure 3.27 below is a chart of ammonia concentrations over time discharged from the UMC WRF. It shows a general decline in ammonia concentrations – a result of plant upgrades and operational improvements and modifications. Similarly, Figure 3.28 illustrates the actual loadings to the stream from 1997-2004. Butler County has made a marked improvement in reducing loadings even while flow has been slowly increasing.

3.5.2.1.1 Residential sewage systems

There are approximately 1541 residential sewage systems in the entire Mill Creek watershed in Hamilton County. Systems are inspected annually by the Hamilton County Health Department (1382) and by the City of Sharonville Health Department (159). The number of systems in the UMC watershed has not been specifically identified.

3.5.2.1.2 Semi-public facilities

Only 24 semi public facilities presently exist in Hamilton County in the Mill Creek watershed. These facilities are monitored by the Hamilton County Health Department. The total number of semi public facilities located in the UMC watershed is unknown.

3.5.2.2 Non Point Sources

The following is a summary of non-point sources identified in the UMC watershed:

- Approximately 100 residences have on-site, non-mechanical sewage systems in the UMC watershed in Butler County. Although none of the systems are known to have discharges, soil characteristics that limit the treatment of sewage in soil absorption systems are common in the UMC watershed. Slow percolation in the subsoil is common throughout the watershed, and some areas also have a seasonal high water table, steep slopes, or flooding hazards.

- Agricultural and livestock operations in the UMC watershed include the following:

  – Data from the Butler County Soil and Water Conservation District identify five livestock operators with a total of 275 head of livestock.

Figure 3-19 Ammonia concentration and flow from UMC WRF, 2000-present

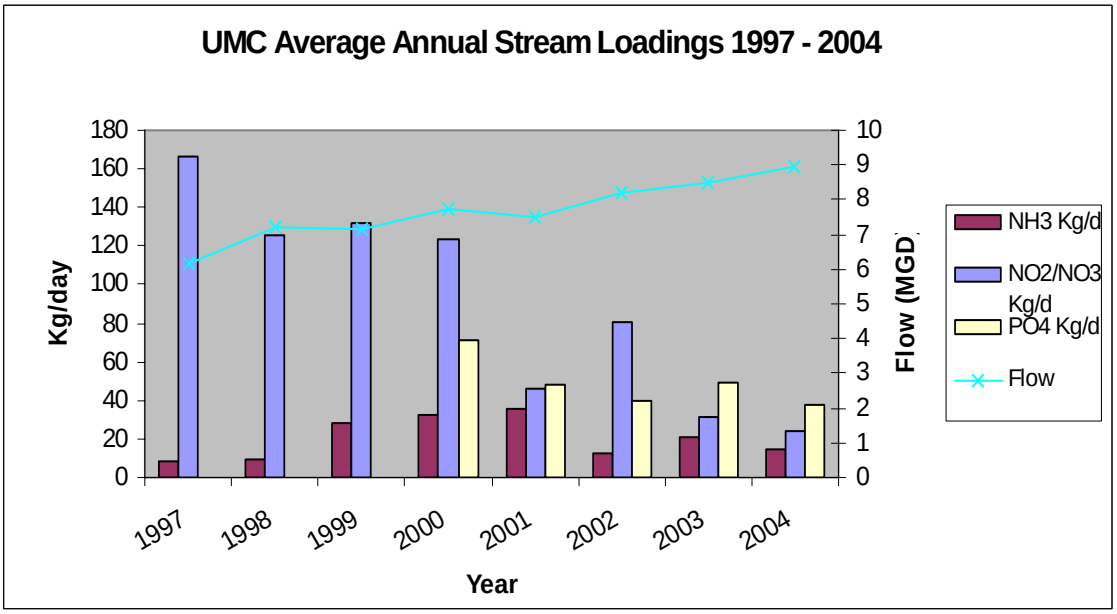
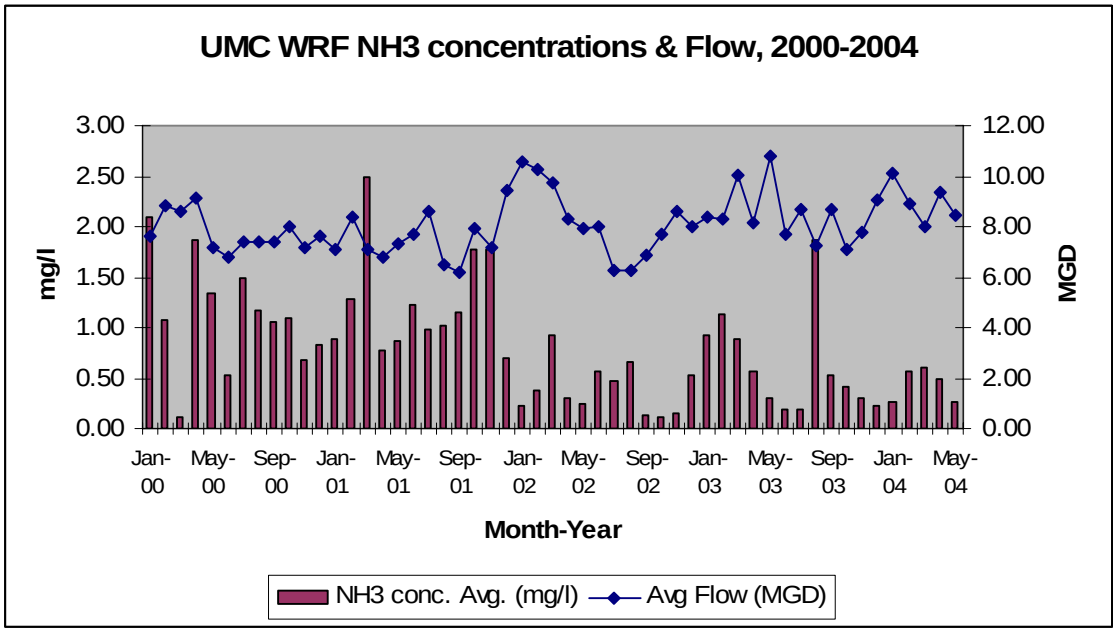


Figure 3-20 Annual stream loadings of NH3, NO2-NO3, and PO4 (and flow) from UMC WRF, 1997-present



- The watershed inventory identified one location for livestock to gain access to Mill Creek.
- Crop operations are limited to less than 1,000 acres in Butler County and are located on smaller farms. Most row crop has been converted to minimal till or no till cultivation practices. In the Hamilton County portion of the UMC watershed there is no information on possible operations. As this are is primarily residential land use it is unlikely there are any sizable livestock or crop operations.

- There is significant construction and stormwater runoff component in the UMC watershed. Between 1998 and 2002 a total of 5,237 housing permits were issued for Fairfield, Liberty and West Chester townships. The average annual number of permits over that time period was 1,047 demonstrating the continued growth and development in the UMC watershed. The runoff component is shown to have high sediment load as observed during the 2002 field inventory.

3.5.2.3 Status and Trends

Since the publication of the OEPA water quality report for this area in 1997, the Upper Mill Creek watershed has seen unprecedented growth. The headwaters region has been subjected to man-made habitat alterations through the removal of riparian zone vegetation for agriculture, and construction of new commercial, industrial and residential land uses. These land uses and associated activities have impacted headwater streams and added new stressors not captured in previous studies. Among impacts associated with these stressors include increased siltation, stream channel embeddedness, streambank erosion, and extensive channel and hydro modification. Many of these conditions were documented in the detailed stream inventory conducted in 2002 or revealed during stream inventories conducted by representatives from the political jurisdictions and stakeholders in January and February 2003. These stressors were also observed in the 2004 follow-up assessment. Since then, the Mill Creek valley has experienced a large proportion of commercial development at the Union Center exit off of I-75 and residential growth south of Tylersville Road and west of Highway 747. The field assessment conducted in fall 2004, was focused in these areas.

4. WATERSHED IMPAIRMENTS, RESTORATION AND PROTECTION GOALS, AND IMPLEMENTATION

4.1 Introduction

This section presents problem statements for impaired reaches, coordinated restoration and protection goals, and proposed implementation plans for the Upper Mill Creek sub-watershed. For the purposes of this plan, it has been agreed that the attainment goals for the Upper Mill Creek sub-watershed, in light of the fact that a majority of the streams within the sub-watershed have experienced man-made changes for over 200 years and will continue to do so based on ongoing and future development activities, should be changed to Modified Warm Water Habitat (WWH) rather than Warm Water Habitat (MWH). With this more realistic approach, the plan's proposed actions establish MWH as the target. In addition, the proposed actions and projects have been prioritized by the likelihood of implementation and that the end results for these actions are quantified where possible – based on readily available models and tools.

It is important to note that water quality improvement in the basin will depend on the effectiveness of implementation of a combination of actions where some are difficult due to the nature of the actions. For example, implementation of basin-wide Phase II storm water construction site erosion control and post-construction ordinances; or establishment of the Port Union Conservation Corridor – which will be a long term effort over a large portion of the sub-watershed affecting multiple tributaries.

Based on the complexity of factors affecting water quality and stream conditions in the Upper Mill Creek sub-basin and the above considerations, ODNR and OEPA representatives have agreed that the Qualitative Habitat Evaluation Index (QHEI) is the appropriate performance indicator for project's that impact the sub-watershed's streams. As a means of indicating progress in meeting TMDL nutrient goals, a methodology tool will be identified to correlate QHEI scores and stream nutrient levels. It is reasonable to expect, based on results from urban stream projects elsewhere in the state of Ohio that implementation of the proposed actions will result in an improvement of QHEI scores of a defined number of points. The estimated improvement value will be based on the outcome of two activities:

1. Actual QHEI scores associated with an existing nonpoint source reduction project within the sub-basin where re-establishment of the flood plain is expected to result in improved QHEI scores. Personnel qualified to establish these reference QHEI scores will visit the sub-basin and this project site within 6 months of endorsement of this plan to determine these values.

2. During this same time frame, the Mill Creek Watershed Council of Communities will solicit QHEI data from projects completed in other urban watersheds in Ohio to use as references.

For consistency throughout this WAP, the UMC watershed action plan is divided into the three main basins described earlier as the Main Stem of Mill Creek, East Fork Mill Creek and Beaver Run. These are further divided into the sub-basins presented in Figure 3.11.

Problem Statements

Location descriptions, background information, problem statements (which state the causes – as indicated in the 303(d) list - and sources of impairments) and action opportunities are included for each sub-basin. The problem statements contain estimated percent changes in nutrient loading calculated using a changing land use model used by the Ohio Department of Natural Resources. These model results are included to gain an indication of future trends in the load amounts rather than focusing on the actual quantity of the loads. The methods for calculating nutrient loads for changing land use and for load reduction calculations with the implementation of streambank stabilization BMPs are presented below. For basins where streambank erosion is a critical concern and impaired reaches have been identified, estimated nutrient and sediment load reduction statements associated with implementation of bank stabilization on those impaired reaches are presented within each problem statement. The methodology for estimating load reductions is presented below.

Methodology for estimating nutrient loads based on changing land use

Several steps were needed to calculate estimated percentages of change in nutrient loads for changing land use in the UMC sub-basins.

First, the sub-basins were hand-drawn on two existing maps produced by BCDES illustrating the existing land use in the UMC, shown in Figure 3.6 and the proposed land use in Figure 3.7. Since the TMDL did not provide load allocations by sub-basin, an estimated load for existing and proposed land use was made. Sub-basin boundaries were hand drawn using a reference map, "Upper Mill Creek East Fork Sub-basins" produced by XCG Consultants Inc. Percentages of land use designated for commercial, industrial, agricultural, and residential were then estimated for each sub-basin using the two BCDES land use maps. The estimated land use percentages were then incorporated as raw data into a USEPA Region 5 model urban runoff BMP worksheet. This worksheet was developed by Illinois EPA to estimate the affect of various urban stormwater BMP's on water quality. The spreadsheet provides the user with a calculated load discharged to surface waters for the pre-BMP condition, post-BMP condition and the actual load reduction calculated as a result of a particular BMP. For the UMC WAP, the calculated percentages were derived from the pre-BMP column. This was done so that the only variable which changed was land use. Future and existing BMP installations were not taken into consideration for this

exercise. The estimated land use acreage numbers were used along with an estimate of the percentage of the sub-basin that was storm sewered and the percentage not sewered.

The results from application of this model are presented in Table 4.1.[14] The table includes the percentage of change in Nitrogen (N) and Phosphorus (P) loading from existing to proposed land use conditions for each sub-basin.

Table 4-1 Predicted percentage change in pollution loads by sub-basin

Basin	Sub-basin	Acres	% Change	
			Total Phosphorous	Total Nitrogen
Main Stem	1	643	9.0	6.7
	2	913	13.7	10.2
	3	907	20.0	37.5
	4	1,429	129.6	157.7
	5	1,096	-8.9	3.1
	6	1,779	-2.1	27.7
	7	1,263	14.4	36.7
	8	878	2.3	36.3
	9	821	216.1	230.0
	10	224	25.3	37.3
	11	1,802	-9.0	12.7
	12	3,151	-10.4	-9.9
	13	683	114.5	172.8
	14	4,160	-44.1	-40.4
	Total:	19,749	-9.7	2.1%
East Fork	15	3,157	4.3	9.5
	16	1,969	30.7	41.5
	17	821	17.3	16.3
	Total:	5,947	13.8	19.5%
Beaver Run	Total:	3,604	-0.8	4.7%
UMC	Total:	29,300	-5.6	4.7

The difference in the results of the June 9, 2004, Mill Creek TMDL load allocations and the calculated loads using the Region 5 Model should be noted.[15] While these numbers do not agree precisely with the loads reported in the TMDL, they are useful for comparative

[14] The complete table, including estimated loads under present and future conditions is included as Appendix G to this plan.
[15] The Mill Creek TMDL load allocations table is included as Appendix H.

purposes. These estimated changes in loads have been incorporated into each of the problem statements.

Methodology for estimating impact of streambank stabilization on load reduction

The bank stabilization worksheet from a USEPA Region 5 model was used to estimate load reductions for P, N and sediment for proposed UMC watershed actions.[16] The length of the reach, lateral recession rate and bank height input parameters were estimated in the field. Soil textures were determined from Butler County's soil survey. The numbers were then applied to the worksheet to calculate load reductions. The calculated load reductions are included in the problem statements for potential restoration projects. A summary table of these estimated load reductions is presented in Table 4.6 following the problem statements.[17]

Methodology for estimating impact of riparian zone improvements of nitrogen load reduction

In the absence of an approved state model for estimating nutrient load reductions associated with riparian corridors for urban, estimates were obtained by applying a nitrogen removal efficiency to the expected nitrogen load for each of the identified impaired reaches. For this plan this percentage was based on a survey of available literature on riparian zone effectiveness. Eight studies in particular proved appropriate for use in this instance. Figure 4-1 graphically displays the conclusions of these studies with respect to nitrogen removal by buffers. Percentage ranged from a low of 30% (Kansas State University – 2001) to a high of 100% (Haycock et al. – 1993), with a mean value of 70.8%, a median of 76% and a mode of 99%. The median value of 76% was selected for this plan. As a starting point, the initial loads for the impaired reaches were assumed to be the bank-length related loads calculated for the streambank stabilization estimates.

Restoration and Protection Goals

The restoration and protection goals for UMC, which are based on the causes and sources found in the problem statements, immediately follow the problem statements listed for each of the three basins. Goals and objectives for watershed developed by community members in the original draft WAP have been incorporated into the goals and implementation plan of the final WAP where appropriate.[18]

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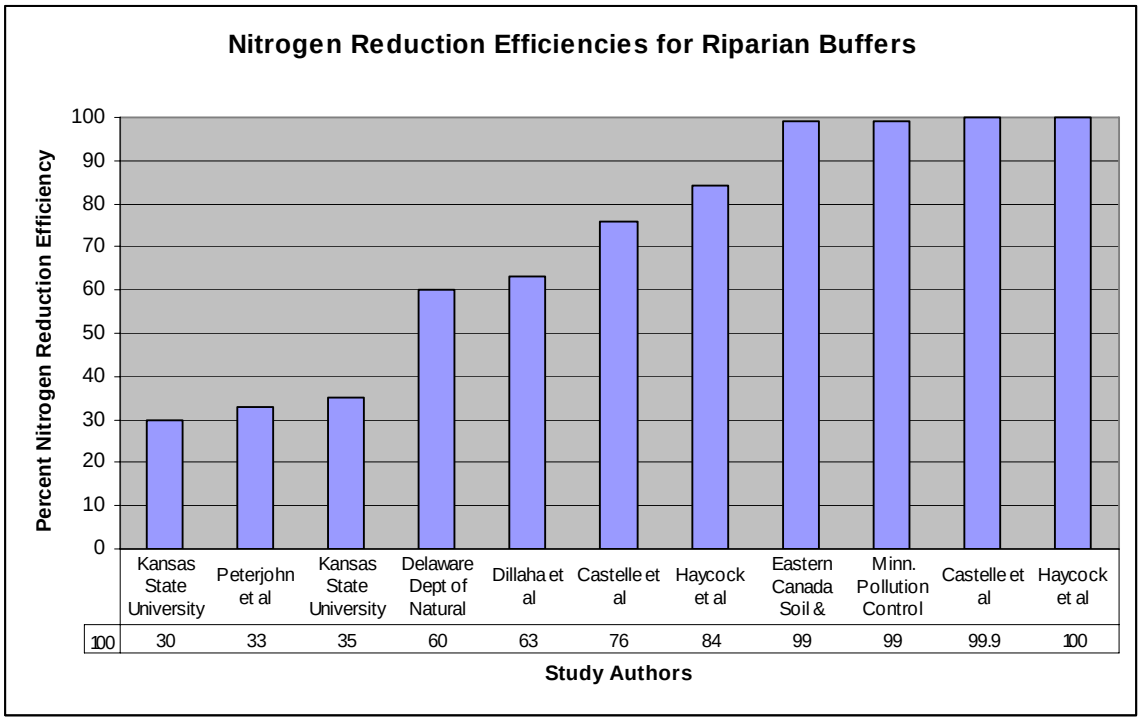
[16] This model is available on the Ohio Dept. of Natural Resources website.

[17] Note: The June 2003 "Mill Creek TMDL Nonpoint Source Pollutant Load Reductions Strategy" document, developed by XCG Consultants Inc. for MCWC for inclusion as part of the implementation strategy for the Mill Creek TMDL, used the same modeling technique and is included in its entirety as an appendix to this document.

[18] Watershed objectives in the draft WAP included developing healthy stream and aquatic communities, meeting water quality standards and use designations, controlling discharges, reducing stormwater impacts and re-establishing healthy hydrology, reducing erosion and sediment impacts on habitats and property,

Figure 4-1 Survey of research on nitrogen removal efficiencies of riparian buffers



Overall improvement in water quality within the UMC watershed for nutrients and organic enrichment as it relates to implementation of this plan will be based on progress towards attainment of the State of Ohio water quality criteria and the MWH use designations and targets identified in the OEPA Mill Creek TMDL report. As discussed above, performance with respect to meeting these goals will be assessed indirectly by QHEI scoring techniques for impaired reaches.

Habitat improvement will be measured through periodic stream evaluations using OEPA QHEI scoring methodologies. UMC partners will explore the possibility of using the new Headwaters Qualitative Habitat Evaluation Index methodology as an additional means of assessing habitat conditions. Improvement in channelization (e.g. increased sinuosity) and depth of riparian cover can be assessed by UMC partners using direct observation during periodic stream segment inventories.

Implementation

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reducing stream bank erosion, controlling sediment load, restoring natural features, enhancing stakeholder and public outreach programs, and enhancing stewardship among residents, businesses and property owners.

The final elements of Section 4 are the implementation plans for each basin including proposed task descriptions, applicable sub-basins, resources, responsible parties, time frame and performance indicators. Each task description indicates which restoration and protection goal(s) it supports.

4.2 UMC Problem Statements and Implementation Plans

Problem statements for each of the impaired sub-basins for which actions have been proposed are presented below.[19] These are grouped by basin: Mill Creek Main Stem, East Fork Mill Creek and Beaver Run. Since impairments within many of the sub-basins are similar, the proposed actions to address them are likewise similar. To avoid redundancy, proposed actions in this WAP have been combined into one plan for each basin. Applicable sub-basins have been noted where appropriate.

4.2.1 Mill Creek Main Stem Basin

The Mill Creek Main Stem in the Upper Mill Creek Watershed encompasses 14 sub-basins draining 50.4 square miles. The 12.7-mile long section of the Mill Creek flows southeast through the spectrum of land uses ranging from light industrial, pasture, commercial and residential.

4.2.1.1 Mill Creek Main Stem Sub-basins

Sub-basin 1

Background - This sub-basin originates north of Stoney Brook Drive. It starts off as a natural channel of fairly high quality, is piped underground by the time it reaches Carrington, reappears by Princeton Road, disappears underground again west of Forest Hill Road in the Weathered Oaks subdivision, reappears above ground east of Forest Hill and West of Springmeadow Road and continues above ground to its confluence with Sub-basin 2.

Land use is primarily established residential. Road construction and storm drain system modification to accommodate increased through traffic to new commercial and residential areas to the west is either underway or planned. The creek begins as a natural channel of fairly high quality, is piped underground by the time it reaches Carrington, reappears by Princeton Road, disappears underground again west of Forest Hill Road, reappears above ground between Forest Hill Road and Springmeadow Road in the Weathered Oaks subdivision and continues above ground to its confluence with Sub-basin 2.

[19] Actions proposed within these plans are not comprehensive but reflect those that are more likely to be implemented and that have the largest overall impact on impairments within the UMC watershed. Some actions are located in areas undergoing intense change at the time of the 2004 assessment. New actions may be proposed as additional impairments are identified and/or the likelihood that implementation of a new action increases.

Problem Statement – Excessive siltation and habitat alteration are impairing use attainment within the 643 acres. Sources of impairment include agriculture, urban runoff and storm sewers, channelization, removal of riparian vegetation and stream bank modification/destabilization. With expected future changes in land use, it is estimated that there will be a 9.0 percent increase (19 kg/yr) in Phosphorous (P) loading and a 6.7 percent increase (104 kg/yr) in Nitrogen (N) loading.

Figure 4-2 Storm sewer (at right) discharges runoff into creek at Liberty Fairfield Road – Sub-basin 1

Action opportunities – A 1140-foot reach north of Princeton Road, adjacent to Jayfield Drive is not meeting water quality designation due to siltation and habitat alteration. Implementation of bank stabilization BMPs on one bank north of Princeton Road could reduce 12.7 kg of P, 24.5 kg of N and 28 tons of sediment per year.

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 2

Background – These are the northern-most headwaters of the Upper Mill Creek sub-watershed. This sub-basin originates as a small intermittent tributary running through

private yards at Squaw Valley. It starts as a high-gradient stream about 1 ft wide and 2" deep. The sub-basin is primarily established residential. Figure 4.3 shows typical stream reach conditions within this sub-basin.

Figure 4-3 Downstream view at Squaw Valley – sub-basin 2 (2002 photo)

Problem Statement – Nutrients, siltation and habitat alteration are impairing use attainment within the 913 acres. Sources of impairments include channelization, urban runoff/storm sewers, removal of riparian vegetation and streambank modification/destabilization. With proposed changes in land use, it is estimated that there will be a 13.7 percent increase (39 kg/yr) in Phosphorous (P) loading and a 10.2 percent increase (224 kg/yr) in Nitrogen (N) loading.

Action opportunities - A 630-foot reach of the stream at Summerville Road, a 1195-foot reach south of Princeton Road, and a stream crossing on Princeton Road east of Liberty Fairfield Road are not meeting water quality designation due to nutrients and habitat alteration.

Implementation of bank stabilization at the Summerville Road reach could result in an estimated reduction of 3.6 kg of P, 7.3 kg of N and 8 tons of sediment. South of Princeton Road, it is estimated that bank stabilization along 1195 feet of bank would result in a reduction of 35.5 kg of P, 69 kg of N and 76 tons of sediment per year. Reductions for the third segment were not quantifiable.

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 3

Background – This sub-basin has been defined as the reach of originating just north of Highway 129 at the Highway 747 interchange to just below the confluence of the tributaries in watershed 1 and 2 at Liberty Fairfield Road. Land use is primarily residential with new homes being built on the few remaining parcels south of the new regional highway. At the westernmost end, the stream has been modified to flow through a very large, natural-bottom culvert under a new, elevated regional highway (Route 129). *Narrow riparian corridors exist in newer subdivisions. Problems with erosion varies with sites rated from slight to moderate-severe to very severe. Sedimentation from heavy urbanization is evident.*

Problem Statement – Siltation and flow alterations are impairing use attainment within the 907 acres. Sources of impairments include urban runoff/storm sewers and removal of riparian vegetation With proposed changes in land use, it is estimated that there will be a 13.7 percent increase (59 kg/yr) in Phosphorous (P) loading and a 37.5 percent increase (841 kg/yr) in Nitrogen (N) loading. Figure 4.4 shows one example of erosion and small-scale attempts at mitigation.

Action opportunities - A 1500-foot reach east of Princeton-Glendale Road and south of Route 129; a 60-feet reach upstream of the Cross Creek Lane stream crossing (south of Route 129 and east of Route 747) and a 150-200 foot reach on the downstream side of the same crossing are not meeting water quality designations due to siltation and flow alterations. Figure 4.5 shows eroded stream banks downstream of Cross Creek Lane.

Per year, bank stabilization along the identified 1,500-foot reach would reduce loadings by 16.4 kg of P, 32.7 kg of N, and 36 tons of sediment. Bank stabilization along 60 feet on upstream side of the Cross Creek lane crossing would reduce loads by 3.5 kg of P, 6.9 kg of N, and 9 tons of sediment. Bank stabilization along the 150 foot reach on the south side of the same crossing would reduce loads by 6.8 kg of P, 13.8 kg of N, and 18 tons of sediment.

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment.

Sub-basin 4

Background – This sub-basin has four branches. The western branch originates near Hamilton–Mason Road and flows through an industrial park, the central branch originates

between By-Pass 4 and Redcoat Drive, the eastern branch starts south of the Hamilton-Mason Road between Redcoat Drive and Morris Road, and the southern branch originates a bit north of Tylersville Road. The three northern tributaries merge north of Tylersville Road, and the southern tributary joins them at the airport. Land use in the sub-basin is a mixture of established residential areas east of By-Pass Route 4. Residential, commercial and industrial development is occurring west of By-Pass Route 4 and north of Tylersville Road. Actual surface water flow patterns in this basin

Figure 4-4 Temporary bank stabilization to address erosion east of Liberty Fairfield Road. Sub-basin 3 (2002 photo)

Figure 4-5 Streambank stabilization opportunity on the downstream side of the Cross Creek stream crossing.- Sub-basin 3.

have been extensively modified to the extent that there is some speculation that runoff here does not flow to the Mill Creek but either to the south in the Gilmore Ponds area or westward eventually to the Great Miami River.

Problem Statement – Flow alterations, other habitat alterations and nutrients are impairing use attainment within the 1,429 acres. Sources of impairments include removal of riparian vegetation, agriculture, channelization, other (berms) and flow regulation/modification. With proposed changes in land use, it is estimated that there will be a 129.6 percent increase (459 kg/yr) in Phosphorous (P) loading and a 157.7 percent increase (5386 kg/yr) in Nitrogen (N) loading.

Action opportunities - The 2580-foot reach south of Hamilton Mason Road, adjacent to Gateway Drive is not meeting water quality use designation due to flow alterations, other habitat alterations and nutrients. Some evidence suggests that streams in this sub-basin flow towards the Great Miami River. Bank stabilization along the 2580-foot reach south of Hamilton Mason Road could result in a reduction of 10.9 kg of P, 22.7 kg of N, and 24 tons of sediment per year.

There are significant opportunities within the sub-basin to create a series of storm water ponds and wetlands to regulate flows and improve water quality.

Immediately downstream of Tylersville Road, the tributary flows through a large, flat, old field. This is an excellent site for a constructed wetland. This could improve water quality as well as provide wildlife habitat.

At Gilmore Road, there is another opportunity for a wetland. There already is a wetland west of the creek, but the creek has become isolated from it. Connecting the creek to the wetland would assist in polishing water quality.

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Prior to implementing any actions in this sub-basin, confirmation of local surface hydraulics should be performed to verify its inclusion in the Mill Creek Watershed.

Sub-basin 5

Background - Sub-basin 5 contains the westernmost headwaters of the UMC sub-watershed, originating north and west of the regional airport. Some evidence indicates that waters in the Gilmore Ponds area either form an isolated basin or flow westward towards the Great Miami River. Land use in this sub-basin includes park space, recreational open

space, airport facilities and runways, and industrial. By-pass 4 inhibits flow into the Mill Creek Main Stem in all but the most extreme flooding events.

Problem Statement - Causes of impairment are flow alterations, other habitat alterations and nutrients. Sources of impairments include removal of riparian vegetation, urban runoff/storm sewers, agriculture, channelization, other (berms) and flow regulation/modification. Estimated future loads in this 1096 acre basin, based on proposed land use, indicate a 8.9 percent decrease (-59 kg/yr) in Phosphorous loading and 3.1 percent increase (186 kg/yr) in Nitrogen loading.

Action opportunities - At Gilmore Road, the creek is about 6 yards wide, with unknown depth. At this point, there was no apparent flow, with the creek apparently backed up. The railway and agricultural lands lie to the north of the creek, and there is a large swamp to the south of the creek. The floodplain of the creek has been cut off from this swamp by a berm about 1 yard in height. This berm prevents the creek from flowing into the swamp during periods of high flows. Consequently, this contributes to higher peak flows downstream, and also impairs the quality of the wetland.

There is an excellent opportunity to breach this small berm in places to allow the creek access to its natural floodplain. Additional study would be required before this is undertaken. The creek and wetland have been separated for considerable time. Some of the trees that have become established may not be tolerant of long periods of flooding, so it would be necessary to determine hydroperiods and whether these would have adverse

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality. Prior to implementing any actions in this sub-basin, confirmation of local surface hydraulics should be performed to verify its inclusion in the Mill Creek Watershed.

Sub-basin 6

Background - The sub-basin occupies the west-central portion of the UMC sub-watershed. It has four branches that all originate south of Dixie Highway (Route 4). Streams flow northwards in the sub-basin. Some evidence suggests that streams in this sub-basin flow towards the Great Miami River. Land use in this sub-basin is established residential, commercial and industrial and is relatively stable. The two easternmost and the western branches are piped upstream of Dixie Highway. The branches emerge south of the highway but are highly altered with some flowing to stormwater detention features. Many altered sections are channelized and appear to be over-widened some with naturalized banks, others barren. Evidence of high-water flows existed in almost all sub-basin branches and was apparent near Dixie Highway, Homer Way, Port Union Road and Symmes Road.

Problem Statement - Causes of impairment are flow alterations, other habitat alterations and nutrients. Sources of impairments include urban runoff/storm sewer discharges, removal of riparian vegetation, agriculture, channelization, other (berms) and flow regulation/modification. Estimated future loads in this 1779 acre basin, based on proposed land use, indicate a 2.1 percent decrease (-21 kg/yr) in Phosphorous loading and 27.7 percent increase (2839 kg/yr) in Nitrogen. Prior to implementing any actions in this sub-basin, confirmation of local surface hydraulics should be performed to verify its inclusion in the Mill Creek Watershed.

There may be opportunities to build stormwater management facilities and wetlands in the valley along the tributary coming in from the west. Additional stormwater management facilities that would also improve water quality could be constructed in the more industrialized portions. Riparian restoration would augment stormwater management upgrades to provide additional water quality benefits and nutrient and sediment load reductions.

Sub-basin 7

Background - This sub-basin contains the main stem of the Mill Creek from downstream of Liberty Fairfield Road crossing to the Seward Road crossing. The northern portions of the sub-basin (north of Tylersville Road) are primarily established residential with two nursing homes and a small horse boarding operation near Hamilton Mason Road. Agricultural properties on the southern end of the sub-basin are currently zoned to encourage residential and/or industrial development. The stream has been channelized through some reaches, particularly south of Tylersville Road.

The 2700-foot reach between stream crossings at Liberty Fairfield Road and Hamilton Mason Road is characterized by severe bank erosion. Soil loss from the stream banks in this reach has resulted in excess sedimentation downstream where stream velocity slows down. The 6400-foot reach located between Hamilton Mason and Tylersville Roads has adequate riparian cover in most areas but has water quality issues indicated by the presence of sedimentation, algae and oily sheens. A small horse boarding facility is located adjacent to the stream at the uppermost portion of this reach. Homes with lawns to the streams edge characterize the lowermost portions. Stream bank erosion is an issue where the riparian cover has been thinned. The 3100-foot reach along the Main Stem Mill Creek between Tylersville Road and Seward Road lies in one of the last agricultural land use areas within the UMC sub-watershed. Erosion is moderate to severe in this section and the riparian corridor is negligible or nonexistent.

Problem Statement – Nutrients and habitat alterations are impairing use attainment within the 1,263 acres. Sources of impairment include urban runoff/storm sewers, channelization, removal of riparian vegetation, and agriculture.

Action opportunities - Upstream development, stormwater and urban runoff are the probable sources for severe erosion along the 2700-stream segment between Liberty Fairfield Road and Hamilton Mason Road. Implementation of bank stabilization on a 2700-foot reach between the stream crossing at Liberty Fairfield Road and the crossing at Hamilton Mason Road will reduce 283.9 kg of P, 568.4 kg of N and 626 tons of sediment per year.

Agricultural practices, riparian removal, channelization, and urban runoff have resulted in non-attainment of use designations along a 3100-foot reach between Tylersville and Seward Roads. With proposed changes in land use, it is estimated that there will be a 14.4 percent increase (73 kg/yr) in Phosphorous (P) loading and a 36.7 percent increase (1513 kg/yr) in Nitrogen (N) loading. Stream bank stabilization along the 3,100 foot segment of the main stem between Tylersville and Seward Roads would result in reductions of 270 kg of P, 540 kg of N, and 596 tons of sediment per year.

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 8

Background - This sub-basin is a tributary that originates north of Tylersville Road and flows south into the main stem of Mill Creek. This sub-basin includes the lower portion of another tributary with headwaters formed by sub-basins 4, 5, and 6. This reach is located downstream of the lake at By-Pass 4. Land use in this sub-basin is primarily commercial/industrial and agricultural with planned conversion of agricultural land to commercial/industrial. Portions of the sub-basin are not meeting designated use attainment due to habitat alterations. Some reaches are channelized and include manmade in-stream structures. The riparian corridor is thin to nonexistent in some reaches. This stream was under flood conditions during the 2002 assessment. Evidence of past high water flows was observed.

Problem Statement – The causes of impairment in this sub-basin are siltation and flow alterations. Sources include channelization, removal of riparian vegetation and flow regulation and modification. With proposed changes in land use, it is estimated that there will be a 2.3 percent increase (13 kg/yr) in Phosphorous (P) loading and a 36.3 percent increase (1857 kg/yr) in Nitrogen (N) loading.

Action opportunities - Naturalization of the channelized portions of the stream would provide water quality and flood damage reduction benefits. Both would impact sediment and nutrient levels. Riparian restoration and protection would augment any stream restoration efforts and increase removal of nutrients and sediment. Stormwater management

strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 9

Background - This sub-basin consists of the area that drains to an unnamed tributary to the Mill Creek Main Stem, located south of Hamilton Mason Road, west of Princeton-Glendale Road (Route 747) and north of the Mill Creek main stem. The area consists of former agricultural land and open space being converted to single and multi-family residential and commercial/retail land use.

In 2002 extensive development was observed. Sub-basin roads were being constructed or widened to accommodate this growth. The 2002 assessment took place during an extreme wet weather event and flooding was evident. During the 2002 assessment. Figure 4-6 is a photograph showing flooding conditions at near townhouses located at the southern end of the basin. In 2004, several large subdivisions, ranging from multi-family to high end single family homes, were being developed in former agricultural land. Hundreds of homes were found to be in various stages of development. Figure 4-7 is a photograph of new residential development in this sub-basin. Completed properties include closely spaced large homes with new lawns, paved driveways and curb and gutter storm sewers. Vegetation had been removed from much of the remaining undeveloped land. Streets have been installed where additional houses will be built. It appears much of the remaining land will be filled in with new homes.

Figure 4-6 Flooded stream encroaching on new developments off Smith Road (2002 photo)

Figure 4-7 Photograph of recent residential development in sub-basin 9 (2004 photo)

Planned green spaces, with established paved walking paths and aesthetic tree plantings, were scattered through the completed portions of these developments – some encompassing small wetlands. It appears that some of these green spaces were being used for stormwater management – perhaps as detention ponds. Numerous storm water retention ponds have been constructed in the areas of new development. There is also a series of cascading stormwater management ponds that start at Tylersville Road and head southwards. Waterfalls between the ponds keep the water aerated. No vegetation had been planted on the perimeter of these ponds.

Newly developed lands have been stripped of vegetation prior to building. Previously vegetated areas are now covered with new impervious surface or lawns. This stream segment is not meeting water quality use designation due to habitat and flow alterations as well as siltation.

Problem Statement – Habitat alterations, flow alterations and siltation are impairing use attainment within the 821 acres. There is a lack of riparian corridor and the creek is experiencing heavy sedimentation. Sources include urban runoff/storm sewers, construction/development, and removal of riparian vegetation. Moderate to severe erosion is occurring. Based on anticipated future land use, it is estimated that there will be a 216.1 percent increase (269 kg/yr) in Phosphorous (P) loading and a 230 percent increase (3502 kg/yr) in Nitrogen (N) loading.

Action opportunities - The remaining riparian corridor along has been either eliminated on one or both sides or has been thinned to the point of being ineffective along a 1700-foot reach along a major tributary to the Mill Creek Main Stem that parallels Route 747 south of

Tylersville Road. Streambank erosion is moderate to severe in this reach. Implementation of bank stabilization BMP along the 1700-foot impaired reach would reduce 74 kg of P, 148 kg of N and 164 tons of sediment per year. Riparian restoration and protection along this reach would augment any streambank stabilization efforts and increase removal of nutrients and sediment.

Stormwater management strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 10

Background - This sub-basin is a small tributary that originates south of Port Union Road and flows northward into the main stem of Mill Creek. Land use in the sub-basin is primarily industrial. At Port Union Road, the channel has been straightened but is naturalized. Farther downstream, the channel is piped through one industrial area, and then resurfaces. The channel through the new industrial area has recently been reconstructed with meanders introduced into the low-flow channel. There is currently no riparian vegetation along this reach, with grass mowed to the shorelines, although trees have been planted. At the north end of the industrial area, the creek discharges down a cement chute into a large, natural wetland. The wetland is a mix of meadow marsh and swamp, and numerous trees have been planted in it recently. This wetland diffuses flows from the creek and also allows sediments to settle, thereby improving water quality.

Problem Statement - Siltation, flow alterations and other habitat alterations are impairing attainment within the 224 acres. Sources of impairment include flow regulation/modification and removal of riparian vegetation. With proposed changes in land use, it is estimated that there will be a 25.3 percent increase (30 kg/yr) in Phosphorous (P) loading and a 37.3 percent increase (425 kg/yr) in Nitrogen (N) loading. Bank stabilization along 1200 feet of streambank will result in a load reduction of 9.1 kg of P, 17.3 kg of N and 20 tons of sediment per year.

Action opportunities – The 1200-foot reach north of Port Union Road, west of Highway 747 is not meeting water quality use designation due to siltation, flow alterations and other habitat alterations. Existing stream restoration/naturalization efforts should be maintained. Riparian restoration and protection would enhance removal of nutrients and sediment from the impaired reaches of the Mill Creek. Stormwater management strategies and public education and outreach to new homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 11

Background - This sub-basin has two branches that originate west of the Dixie Highway and merge south of Mack Road. The stream runs northward and flows into the main stem

of Mill Creek. Land use is primarily established commercial and industrial. There is a small trailer park in the uppermost portion of the sub-basin. Extensive stream alteration (including areas where the stream is piped), moderate to severe stream erosion and high flow event characterize this basin. Evidence of localized stream stabilization efforts using concrete slabs and blocks were viewed during the assessments. The presence of algae indicates nutrient issues. At present, the area is undergoing light industrial development.

Problem Statement - Nutrients, siltation and flow alterations are impairing attainment within the 1,802 acres in this sub-basin. Sources of impairment include streambank modification/destabilization, flow regulation/modification, channelization and urban runoff/storm sewers. With expected land use changes, it is estimated that there will be a 9 percent decrease (-109 kg/yr) in Phosphorous (P) loading and a 12.7 percent increase (1473 kg/yr) in Nitrogen (N) loading.

Action opportunities - The 4886-foot stream reach located in the industrial area in the central and southern portion of this sub-basin, west of Highway 747 is not meeting water quality use designation due to nutrients, siltation and flow alterations. Implementation of bank stabilization along the 4886-foot reach described above will result in a reduction of 177.3 kg of P, 355.5 kg of N and 390 tons of sediment per year.

The entire reach through the industrial area would benefit from a series of weirs to improve flow regimes and create a series of riffles and pools. The weirs would be designed to direct flows away from stream banks to reduce erosion.

Stormwater management strategies and restoration of natural stream functions in modified sections would also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 12

Background – This sub-basin is located in the central portion of the northeastern corner of the UMC watershed with Tylersville Road bisecting the basin. It has five stream branches that eventually merge and flow southward into the main stem of Mill Creek at Highway 747. Land use is primarily established residential in the uplands portions. Mild to moderate stream bank erosion exists in the upland residential areas where landowners have removed riparian vegetation. Newer commercial, retail and multi-family residential land use is more prevalent along its major thoroughfares – Route 747 and Smith Road.

In 2004, on the western edge of this sub-basin, extensive road widening activities were taking place on Route 747 between Tylersville Road and Smith Road. At the northernmost end of this construction roughly 600 feet of the riparian corridor has been removed along the eastern streambank. The area was then filled in with soil to accommodate new elevated lanes along Route 747. A steep bank leads directly from the new road surface into the stream. A new retail strip mall has been built on formerly open space on the south and west side of the intersection of Route 747 and south of Hutzelman Way (a new road that

leads into the new sub-divisions in sub-basin 9). The unnamed tributary to the Mill Creek Main Stem flows behind this development. To the north of Hutzelman Way, vegetation has been removed from the previously open space in preparation for more commercial/retail development. A very narrow riparian corridor, roughly 1700 feet in length, borders the western edge of this area.

South of Smith Road, road widening activities on Route 747 continue to have an impact on another major tributary to the Mill Creek. This tributary, which drains from the Becket Ridge residential area to the northeast, crosses under 747 north of the Wendy's restaurant. Approximately 200 feet of riparian corridor on the eastern bank has been removed and replaced with a vertical concrete wall. Rip rap has been placed in the stream bed at the base of the wall. Road and bridge construction was underway.

South of that, roughly 2000 feet of riparian corridor on both banks has been thinned and/or removed from both stream banks. Minimal erosion control practices were in place. This former agricultural land was for sale at the time of the assessment.

Problem Statement - Siltation, flow alterations and other habitat alterations are impairing attainment within the 3,151 acres. Sources of impairment include flow regulation/modification, urban runoff/storm sewers and removal of riparian vegetation.

With proposed changes in land use, it is estimated that there will be a 10.4 percent decrease (-116 kg/yr) in Phosphorous (P) loading and a 9.9 percent decrease (-857 kg/yr) in Nitrogen (N) loading.

Action opportunities - The 5475 foot reach south of Tylersville Road to Smith Road, the 890 foot reach north of Tylersville Road to Senor Avenue, and the 2160 foot reach east of Beckett Road are not meeting water quality use designation due to siltation, flow alterations and other habitat alterations. It is estimated that bank stabilization on the 5475 reach will further reduce 60 kg of P, 119.1 kg of N and 132 tons of sediment per year. It is estimated that bank stabilization will reduce 12.7 kg of P, 25.5 kg of N and 28 tons of sediment per year on the 890 foot reach and reduce 31.4 kg of P, 62.7 kg of N and 69 tons of sediment per year on the 2160 foot reach.

A 2200-foot reach of a major tributary to the Mill Creek Main Stem that parallels Route 747 south of Smith Road is not meeting its water quality use designation due to habitat alteration and siltation. Streambank stabilization along the 2200 feet of banks where riparian vegetation has been removed near Route 747 will result in load reductions of 239.5 kg of P, 479 kg of N, and 528 tons of sediment per year.

Sub-basin 13

Background - This sub-basin contains a single creek that arises in the vicinity of Rupp Farm Road. Portions of the stream have been channelized and/or piped underground particularly in the central and southern portions of the sub-basin. Land use in this portion

of the sub-basin is established residential. Open spaces dominate the central portion of the sub-basin along Union Centre Boulevard – though these are being converted to commercial and recreational land uses. The southern portion of the sub-basin, near Beckett Road and West Chester Road, is commercial/industrial. Since the 2004 assessment, construction of ballfields has begun north of Union Centre Boulevard and west of Beckett Ridge Road. A new commercial strip mall is being constructed along the southern side of Union Centre in the same area. Construction activities can be added to potential sources of impairment.

Problem Statement – Flow alterations, nutrients, siltation and other habitat alterations are impairing attainment within this 683 acre sub-basin. Sources of impairment include flow regulation/modification, channelization and removal of riparian vegetation. With expected land use changes it is anticipated that there will be a 114.5 percent increase (176 kg/yr) in Phosphorous (P) loading and a 172.8 percent increase (2452 kg/yr) in Nitrogen (N) loading.

Action opportunities - A 950-foot stream reach originating at Lakota West Drive and ending at Union Centre boulevard and a 2700-foot reach originating at West Chester Road and terminating at its confluence with the Mill Creek Main Stem are impaired by flow alterations, nutrients and other habitat alterations.

Streambank stabilization along the 950-foot stream reach should result in a reduction of 7.3 kg P, 13.6 kg of N, and 16 tons of sediment per year. Streambank stabilization along the 2700 foot reach would result in a reduction of 20 kg P, 29 kg of N, and 44 tons of sediment annually.

Above Rupp Farm Road, there is vacant land near the creek where a stormwater management facility or wetland could be constructed. On the other side of the road, the land is agricultural, so there is additional room from stormwater management and wetland facilities. These types of facilities would be beneficial, as the stream exhibits peak flow problems.

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to homeowners and property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 14

Background – This sub-basin is defined as the main stem of Mill Creek from Seward Road downstream to the confluence with East Fork Mill Creek. The Mill Creek is highly channelized throughout much of this basin. The overall length of the southwest trending, channelized portion of the Mill Creek, starting at Seward Road and continuing to Rialto Road in sub-basin 14, is approximately 16,000 feet in length. The channelized stream takes a 2700-foot jog to the south at this point then continues to the southwest for 3300 feet until

it reaches Interstate I-75. This feature is readily visible on both paper maps and aerial photographs.

The north and central portions of this sub-basin, between Route 747 and Mills Road has continued its conversion from agricultural to industrial, commercial and residential land use. The northwestern corner is adjacent to the residential development areas in Sub-basin 9. It appears that this residential development will continue in this sub-basin as well. Heavy commercial, industrial and retail development is continuing in the east central portion of the sub-basin (on both sides of the Union Centre Boulevard/I-75 interchange). Figure 3.17 shows development in the central portion of the basin.

Figure 4-8 View of commercial and retail development south of West Chester Road in Sub-basin 14. (2004 photo)

Former agricultural properties in the remaining open areas are slated for development. The southwestern portion of this sub-basin is older commercial/industrial land use with in-fill development occurring throughout.

Problem Statement - The entire five miles of the channelized portion of the Mill Creek in the 4160 acres of this sub-basin are impaired by flow alterations, nutrients and habitat alterations. Sources of impairment include regulation/modification, agriculture, development/construction, and channelization. With proposed changes in land use from agriculture to industrial/light industrial along the Mill Creek corridor and to commercial and residential land use in the remaining undeveloped areas it is estimated that there will be

a 44.1 percent decrease (-1880 kg/yr) in Phosphorous (P) loading and a 40.4 percent decrease (-17,815 kg/yr) in Nitrogen (N) loading.[20]

Action opportunities - A 26,500- foot (5 mile) reach of the Mill Creek starting at Seward Road and extending to Interstate 75 is not meeting water quality use designation due to flow alterations, nutrients and other habitat alterations. Specific, smaller segments within this reach include a 5825-foot reach east of Highway 747 and a 600-foot reach by the Union Center Boulevard bridge.

It is estimated that per year bank stabilization will further reduce 274.9 kg of P, 549.3 kg of N and 606 tons of sediment on the 5825 foot reach and further reduce 6.4 kg of P, 13.2 kg of N and 14 tons of sediment on the 600 foot reach. Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to property owners should also have a positive, if not always quantifiable, effect on water quality.

The entire channelized portion of the Mill Creek in this sub-basin, is included in the Port Union Gilmore Ponds Conservation Corridor project which is described in further detail in Section 3.1. This conservation project includes plans to purchase and preserve open space within this corridor to allow opportunities to re-establish natural stream functions (including flood plains) within this corridor.

There are significant opportunities here to breach the existing berm and allow the creek access to the floodplain. This opportunity extends upstream to Seward Road and a considerable distance downstream. In addition, there may be sites where openings can be created under the railway so that the creek is connected to the adjacent wetlands under high flow conditions. Within the agricultural lands, there are opportunities to create wetlands to assist in assimilating excessive nutrients. If the hydrology of the creek through this area is allowed to progress naturally, wetland communities are likely to form on their own.

Near Mulhauser Road there is an agricultural field west of the creek and east of the railway track, and the creek is separated from this area by a berm. It may be possible to breach this berm to allow flood waters into this area. This would eventually result in the creation of wetland habitat that would help improve water quality. Ideally, some areas would be opened underneath the railway tracks to allow the creek to flood into the swamp on the other side of them.

Downstream, the creek is confined within berms 3 to 4 yards high. The eastern berm is slightly lower, and it appeared as though some water had spilled from the creek into the

[20] The decrease in nutrients may reflect model assumptions that nutrients are expected to decrease when agricultural land is changed to another land use. It is expected that nutrients and sedimentation associated development and changing land use will increase in the future, though this could not be readily captured in the simple model used for these calculations.

adjacent field. There is opportunity to breach the berm on both sides to reduce peak flows. If this is possible, wetland communities could be established here to improve water quality.

At the confluence with East Fork Mill Creek, the main stem is about 25 yards wide, and there is significant shoreline erosion. In the area between the two branches of the stream, there is a large, abandoned agricultural field that is in the order of 40 or 50 ac in size. This is an excellent area for creation of a series of stormwater management facilities and constructed wetlands. There is sufficient room that significant improvements in water quality could probably be realized, as well as shaving off peak flows.

As has been done with the lower portion of the East Fork, the main Stem of Mill Creek would benefit from in-stream weirs and erosion control measures.

4.2.1.2 Main Stem Mill Creek Goals

The following goals have been established for the Mill Creek Main Stem basin**:**

1. Improve habitat through riparian restoration.
2. Reduce sediment loadings.
3. Reduce nutrient loadings percent to meet Mill Creek TMDL HUC-1 goals.
4. Stabilize stream banks along impaired reaches.
5. Restore natural stream functions where channel alterations have occurred.
6. Improve stewardship of local streams and watershed through public education.

As discussed above, for the purposes of this plan, OEPA and ODNR have agreed that the attainment goals for the Upper Mill Creek sub-watershed, in light of the fact that a majority of the streams within the sub-watershed have experienced man-made changes for over 200 years and will continue to do so based on ongoing and future development activities, should be changed to Modified Warm Water Habitat (WWH) rather than Warm Water Habitat (MWH). With this more realistic approach, the plan's proposed actions should move the basin towards attainment of this MWH target.

4.2.1.3 Mill Creek Main Stem Implementation/Action Plan

The proposed implementation/action plan to address problems identified in the previous sections is presented in Table 4.2. The items identified in this plan were selected from the "action opportunities" identified in the sub-basin problem statements for the Main Stem Mill Creek Basin. Selection for inclusion as action items in plan was based on importance to the overall health of the watershed, likelihood of implementation, Each task consists of an action item or items that meets or supports some or all of the above stated goals, the sub-basins to which it applies, the resources needed for implementation, a proposed time frame and performance indicators. Tasks for the Mill Creek Main Stem basin have been assigned a unique number prefaced with "MC-".

Table 4-2 Implementation/Action plan for Main Stem Mill Creek Basin

Action Item Description & Goals Met	Applicable Sub-basins[21]	Resources	Implementation Lead(s) & Partners	Time Frame	Performance Indicators
MC-1: Establish baseline – QHEI scores for UMC watershed (Supports Goals 1, 2 and 3)	All	$2,000 for staff time and supplies for each sub-basin	MCWC lead with assistanc from ODNR/OEPA staff	Spring - Fall 2006	Written and visual documentation of riparian conditions; QHEI scoresheets; final list of priorities
MC-2: Revegetate/protect riparian corridors and educate public about importance of riparian zones to stream health (Goals 1, 2, 3 and 6)	All	$250,000 for plant materials, supplies and staff in each sub-basin	MCWC lead to identify funding sources (e.g. 319 and urban forestry grants) and assist basin communities/stakeholders with grant application process	Fall 2007- Fall 2009	Improved QHEI scores; 1 mile of re-vegetated riparian corridor
MC-3: Stabilize stream banks along impaired reaches using bioengineering techniques appropriate to urban settings (Goals 1, 2, 4 and 6)	1, 2, 3, 7, 9, 10, 11, 12, 13 and 14	$20,000 - 50,000 per stabilization project	BCSWCD, OKI, BCDES, MCWC and UMC communities will find funding & conduct	Spring 2006 – Fall 2008	Improved QHEI scores; Bioengineering techniques will be implemented in 25% of sub-basins
MC-4: Implement and enforce Phase II stormwater regulations: sedimentation and erosion controls during and post construction provisions (Goals 2, 3 and 6)	All	Phase II communities and stormwater district funds	Butler and Hamilton County Storm Water Districts and Phase II communities in UMC not belonging to those districts	Ongoing per OEPA permits	Improved QHEI scores (reduced sediment and nutrient load)
MC-5: Reduce and eliminate re-occurring sanitary sewer overflows (Goal 3)	All	$500,000 per year	Butler County Dept. of Environmental Services: Capacity Management, Operation and Maintenance Program	Ongoing	Improved QHEI scores; Eventual elimination of sanitary sewer overflows; reduced number in short term

[21] The applicable impaired sub-basins listed in this table correspond with the problem statements discussed above this table.

Action Item Description & Goals Met	Applicable Sub-basins[21]	Resources	Implementation Lead(s) & Partners	Time Frame	Performance Indicators
MC-6: Identify stormwater management structures for demonstration retrofits to include water quality and quantity BMPs – use demonstrations sites as educational opportunities (Supports goals 2, 3 and 6)	All	$30,000 – 50,000 per retrofit demonstration	Coordinated effort among UMC communities and stakeholders	2006-2009	Implemented retrofits in watershed sub-basin(s); reduced nutrient and sediment loadings by 20% in vicinity of retrofits
MC-7: Reconnect creek to flood-plain (Goals 1, 2, 3 and 5)	3 and 4	BCDES will fund regulations enforcement	BCDES via enforcement of their "2002 Flood Damage Prevention Regulations" Section 5.2-8	Ongoing	Improved QHEI scores; reduction in flooding events; reduced flood damages
MC-8: Continue development of Port Union Gilmore Ponds Conservation Corridor (Supports goals 1 – 6)	7, 10, and 14	$1.1 million	West Chester Twp Parks & Recreation will apply for Clean Ohio Conservation Funds	2006-2007	Improved QHEI scores in corridor; 150 acres purchased to preserve and protect Upper Mill Creek Watershed
MC-9: Map and develop a sensitive areas (wetlands, riparian corridors, etc.) protection plan (Supports Goals 1, 2, 3, 4, and 5)	All	$15,000 – 30,000 for staff time and materials	MCWC members will apply for 319 grant	2007 - 2008	Digital wetlands and sensitive areas maps; Plan creation and incorporation into jurisdictional planning documents
MC-10: Map man-made stormwater detention and retention ponds (Supports other tasks in basin)	All	$5000 for staff time and materials	MCWC and county agencies	2006-2007	Completed digital map of detention and retention water bodies
MC-11: Educate local decision makers throughout the watershed about storm water quality BMPs and storm water management practices that can be implemented locally to improve water quality and stream health (supports Goals 1 – 6)	All	$2,000 - 3,000 per training session to cover staffing, materials and supplies	OKI 2005 319 grant; MCWC in conjunction with UMC communities & Butler and Hamilton Storm Water Districts	Spring 2006-2007	At least 3 training sessions will be conducted

Action Item Description & Goals Met	Applicable Sub-basins[21]	Resources	Implementation Lead(s) & Partners	Time Frame	Performance Indicators
MC-12: Educate property owners about & promote use of "on-lot" water quality BMPs through demonstration sites and distribution of educational materials (supports Goals 2, 3 and 6))	All	$50,000 for each demonstration site; $1000 per basin for printing & distribution of educational materials	OKI 2005 319 grant; BCSWCD, OKI, BCDES, UMC communities and MCWC will find funding & conduct; Butler and Hamilton County Storm Water districts (part of Phase II)	2006-2008	Improved QHEI scores; Demonstrations conducted at 100% of sub-basins
MC-13: Conduct broad-scale water quality awareness campaign focusing on nonpoint source pollution (supports Goals 2, 3 and 6)	All	$3-5,000 for material development and printing, and staff time	MCWC lead with help of watershed partners	2005-2006	Distribute educational materials to 100% of local jurisdictions
MC-14: Conduct study to research the effects of public education on water quality (supports Goal 6)	All	$30,000 for project materials, sampling equipment, supplies and staff time	MCWC lead with help of watershed partners	2006-07	Completed study will guide direction of public education

4.2.2 East Fork Mill Creek

The East Fork Mill Creek in the Upper Mill Creek Watershed encompasses 3 sub-basins draining 9.4 square miles. The 7.1-mile long section of the East Fork Mill Creek flows southwest through established residential communities, light industrial development and recently converted commercial land use from agricultural. Minimal riparian protection exists. The primary point source of nutrients is the modern tertiary treatment facility serving southeast Butler County. It is the only regulated point source for nutrients in the watershed, the East Fork Waste Water treatment plant, is subject to an NPDES permit and is being addressed under the Mill Creek TMDL. (See section 3.5 for additional information regarding the treatment plant.) As this source of nutrients is addressed through other means, the proposed WAP focuses on nonpoint sources of pollution. Ninety-five percent of water pollution in the East Fork sub-basins is a nonpoint source from construction and development.

4.2.2.1 East Fork Mill Creek Sub-basins

Sub-basin 15

Background - This sub-basin contains the northern branch of the East Fork Mill Creek. Its origin is in the easternmost portion of the basin near Columbus-Cincinnati Road (Route 42) near the Butler County and Warren County line. Land use is primarily established residential on the eastern half of the sub-basin with commercial, municipal structures near the intersection of Barrett and Cox Roads. The western half is a mixture of residential, municipal, open space and forested lands. Interstate 75 separates the north westernmost region from the rest of the sub-basin. Some reaches have been channelized. High peak flows in this sub-basin have resulted in moderate to severe erosion in some reaches. Stones have been used to fortify the banks near West Chester Road. Bank stabilization using gabion walls were installed to address severe erosion in the western portions of the basin near Union Centre Boulevard.

Problem Statement – Flow alterations and siltation are impairing use attainment within the 3,157 acres. With expected changes in land use, it is estimated that there will be a 4.3 percent increase (46 kg/yr) in Phosphorous (P) loading and a 9.5 percent increase (857 kg/yr) in Nitrogen (N) loading.

Action opportunities - A 1320-foot reach near Barrett Road is not meeting water quality designation due to flow alterations and siltation. It is estimated that bank stabilization could reduce 201.8 kg of P, 403.6 kg of N and 444 tons of sediment on the 1320 foot reach per year.

Riparian restoration/protection and increased public awareness about healthy riparian corridors would increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 16

Background - This sub-basin consists of three small tributaries to the East Fork Mill Creek that converge at West Chester Road. Land use is primarily established residential with a business development at the western boundary. Many sections of these three tributaries are in a relatively natural state though small segments have manmade banks and/or stream bottoms. Riparain corridors in this sub-basin are in poor shape. This sub-basin experiences high peak flows and there are very limited opportunities to deal with them.

Problem Statement - Siltation is impairing use attainment in this 1,969 acre sub-basin. Sources of impairment include removal of riparian vegetation and, in the westernmost end, construction and development of commercial/retail businesses. Expected land use changes might result in an increase of 30.7 percent (156 kg/yr) Phosporous (P) and 41.5 percent (1984 kg/yr) Nitrogen (N) loadings.

Action opportunities - Riparian restoration and protection and increased public awareness about healthy riparian corridors would increase removal of nutrients and sediment. Stormwater management strategies and public education and outreach to property owners should also have a positive, if not always quantifiable, effect on water quality.

Sub-basin 17

Background - This sub-basin contains the lower stem of the East Fork Mill Creek from Allen Road at the northern end to the confluence of the East Fork with the Mill Creek north of Interstate 275 in Sharonville. Commercial/retail development is taking place along the northwestern edge of the sub-basin near the Union Centre/I-75 interchange.

In 2001, the last area observed in the main stem of East Fork was south of the industrial park down to its mouth at Mill Creek. Extensive restoration has occurred in this reach. A series of in-stream weirs has been constructed and shoreline erosion control has been undertaken. Shoreline plantings consist of live stakes, red-osier dogwood, basswood, sycamore, and honeysuckle. Some rocks have been placed to help stabilize stream banks. The weirs have been effective in creating a series of pools and riffles, and the planting have greatly improved bank stability. Nonetheless, significant erosion is still occurring, particularly around a sanitary sewer manhole in the creek.

In 2004, commercial/retail development was taking place in the northwestern corner of the sub-basin (near the Union Centre/I-75 interchange. A large theatre, restaurant and shopping complex have been built along the western bank of the East Fork Mill Creek south of Union Centre Boulevard. Roughly 100 linear feet of gabion walls have been built

along the streambank on the north end of this project. (Figure 3.18 shows the gabion walls under construction.) Two more phases of this development are planned to extend the project south to Allen Road. A mixed-use upscale residential/retail development is planned along the eastern bank of the East Fork in this area. This would impact roughly 2000 feet of the East Fork Mill Creek.

Figure 4-9 Gabion walls on East Fork Mill Creek at north end of Union Centre/Streets of West Chester development

Problem Statement – Siltation and nutrients are impairing use attainment in this 821 acre sub-basin. The sources of impairment include removal of riparian vegetation, stream bank modification and development. Expected land use changes could lead to an increase of 17.3 percent (83 kg/yr) Phosphorous (P) and 16.3 percent (733 kg/yr) Nitrogen (N) loadings.

Action opportunities - A 2000-foot reach of the East Fork Mill Creek east of this development is not meeting water quality use designations due to siltation and habitat alteration. Bank stabilization could reduce 118.4 kg of P, 236.6 kg of N and 227 tons of sediment.

Riparian restoration and protection would augment any streambank stabilization efforts and increase removal of sediment. Stormwater management strategies and public education and outreach to property owners should also have a positive, if not always quantifiable, effect on water quality.

4.2.2.2 East Fork Mill Creek Basin Goals

The following goals have been established for the East Fork Mill Creek basin:

1. Improve habitat through riparian restoration.
2. Reduce sediment loadings.
3. Reduce nutrient loading percent to meet Mill Creek TMDL HUC-1 goals/
4. Reduce nutrient loadings percent to meet Mill Creek TMDL HUC-1 goals.
5. Stabilize stream banks along impaired reaches.
6. Restore natural stream functions where channel alterations have occurred.
7. Improve stewardship of local streams and watershed through public education.

4.2.2.3 East Fork Mill Creek Implementation Plan

The proposed implementation plan to address problems identified in the previous sections is presented in Table 4.3. Each task consists of an action item or items that meets or supports some or all of the above stated goals. Tasks for the East Fork Mill Creek basin have been assigned a unique number prefaced with "EF-".

Table 4-3 Implementation Plan for East Fork Mill Creek Basin

Action Item Description & Goals Met	Applicable Sub-basins[22]	Resources	Implementation Lead(s) & Partners	Time Frame	Performance Indicators
EF-1: Establish baseline – QHEI (supports Goals 1,2 and 3)	All	$2,000 for staff time and supplies for each sub-basin	MCWC lead with support from OEPA/ ODNR staff	Spring – Fall 2006	Written and visual documentation of riparian conditions; final list of priorities

[22] The applicable impaired sub-basins listed in this table correspond with the problem statements discussed above this table.

Action Item Description & Goals Met	Applicable Sub-basins[22]	Resources	Implementation Lead(s) & Partners	Time Frame	Performance Indicators
EF-2: Streambank stabilization and stream habitat restoration (supports Goals 1-6)	17	OKI 2005 319 grant	OKI lead	2006 - 2007	Improved QHEI scores
EF-3: Revegetate/protect riparian corridors and educate public about importance of riparian zones to stream health (supports Goals 1, 2, 3 and 6))	All	$250,000 for plant materials, supplies and staff in each sub-basin	UMC communities and stakeholders will apply for 319 and urban forestry grants with assistance from MCWC	Spring 2006 – Fall 2009	Improved QHEI scores; 1 mile of re-vegetated riparian corridor
EF-4: Reduce and eliminate re-occurring sanitary sewer overflows (Goal 3)	All	$500,000 per year	BCDES Capacity management, operation and maintenance program	Ongoing	Eventual elimination of sanitary sewer overflows; reduced number in short term
EF-5: Map man-made stormwater detention and retention ponds (Supports other tasks in basin)	All	$5000 for staff time and materials	MCWC and county agencies	2006-2007	Completed digital map of detention and retention water bodies

Action Item Description & Goals Met	Applicable Sub-basins[22]	Resources	Implementation Lead(s) & Partners	Time Frame	Performance Indicators
EF-6: Map and develop a sensitive areas (wetlands, riparian corridors, etc.) protection plan (Supports Goals 1, 2, 3, 4, and 5)	All	$15,000 – 30,000 for staff time and materials	MCWC members will apply for 319 grant	2006 - 2008	Digital wetlands and sensitive areas maps; Plan creation and incorporation into jurisdictional planning documents
EF-7: Implement and enforce Phase II stormwater regulations: sedimentation and erosion controls during and post construction provisions (Goals 2, 3 and 6)	All	Phase II communities and stormwater district funds	Butler and Hamilton County Storm Water Districts and Phase II communities in UMC not belonging to those districts	Ongoing per OEPA permits	Improved QHEI scores; communities and storm water successfully meeting Phase II permit requirements
EF-8: Reconnect creek to flood-plain (Goals 1, 2, 3 and 5)	All	BCDES will fund regulations enforcement	BCDES via enforcement of their "2002 Flood Damage Prevention Regulations" Section 5.2-8	Ongoing	Improved QHEI scores; reduction in flooding events; reduced flood damages

Action Item Description & Goals Met	Applicable Sub-basins[22]	Resources	Implementation Lead(s) & Partners	Time Frame	Performance Indicators
EF-9: Educate local decision makers throughout the watershed about storm water quality BMPs and storm water management practices that can be implemented locally to improve water quality and stream health (supports Goals 1 – 6)	All	$2,000 - 3,000 per training session to cover staffing, materials and supplies	MCWC lead with assistance from local community representatives and soil and water conservation districts; Butler County Storm Water District Phase II permit compliance	Spring 2006-2007	At least 5 training sessions will be conducted
EF-10: Educate property owners about & promote use of "on-lot" water quality BMPs through demonstration sites and distribution of educational materials (supports Goals 2, 3 and 6))	All	$50,000 for each demonstration site; $1000 per basin for printing & distribution of educational materials	BCSWCD, OKI, BCDES, UMC communities and MCWC will find funding & conduct; Butler and Hamilton County Storm Water districts (part of Phase II)	2006-2008	Improved QHEI scores; Demonstrations conducted at 100% of sub-basins
EF-11: Conduct broad-scale water quality awareness campaign focusing on nonpoint source pollution (supports Goals 2, 3 and 6)	All	$3,000 for material development and printing, and staff time	MCWC will conduct as part of OKI 2005 319 grant	2006-2007	Distribute educational materials to 100% of local jurisdictions
EF-12: Conduct study to research the effects of public education on water quality (Supports Goal 6)	All	$20,000 for project materials, sampling equipment, supplies and staff time	MCWC lead with help from watershed partners	2006-2007	Completed study.

4.2.3 Beaver Run Basin

The 4.5-mile Beaver Run system is made up of two small tributaries that originate in the south. The main stream originates about half a mile west of Highway 4 and just north of I-275 and a second tributary originates south of Grandin Avenue in the area of Underwood Park. Combined they drain 4.74 square miles of Springdale; comprised of commercial, retail, residential, and industrial land use. The General Electric Golf Course, Avon, Tri County Mall, and two elementary schools are included in this sub-basin.

A streambank stabilization project along Beaver Run near Chamberlain Park in Springdale has been successfully completed since the 2002 assessment. The stabilized area and Beaver Run are Bioengineering techniques were used to stabilize streambanks to address severe erosion threatening nearby homes. Water quality and aquatic habitat improvement were noted on a stream-walk in June 2004. Figure 3.19 shows the stabilized stream section.

Figure 4-10 Completed Beaver Run 2004 streambank stabilization project

Problem Statement – Excessive siltation and nutrients are impairing use attainment within the 3,604 acres in this basin. The source of impairment is removal of riparian vegetation and urban runoff/storm sewers. With proposed changes in land use, it is estimated that there will be a 0.8 percent decrease (-15 kg/yr) in Phosphorous (P) loading and a 4.7

percent increase (928 kg/yr) in Nitrogen (N) loading. A bank stabilization project on the 730 foot reach south of Kemper Road would result in a reduction of 11.3 kg of P, 22.7 kg of N, and 25 tons of sediment annually.

Action opportunities - The 730 foot reach south of West Kemper Road and the 100-foot reach south of Crescentville, north of I-75, are not meeting water quality designation due to siltation and nutrients. Figure 4.2 shows a streambank stabilization opportunity near the Champion Window facility.

Figure 4-11 Streambank stabilization opportunity south of Crescentville Road near the Champion Window facility on Beaver Run

A bank stabilization project on one bank of the 100 foot reach south of Crescentville would reduce the loadings of P by 6.4 kg, of N by 13.2 kg, and would remove 14 tons of sediment annually.

4.2.3.1 Beaver Run Basin Goals

The following restoration goals have been established for the Beaver Run Basin:

1. Isolate contaminants/pollutants to known areas.
2. Apply best management practices to improve overall water quality.

4.2.3.2 Beaver Run Implementation Plan

The proposed implementation plan to address problems identified in the previous sections is presented in Table 4.4. Each task consists of an action item or items that meets or supports some or all of the above stated goals. Tasks for the Beaver Run Basin have been assigned a unique number prefaced with "BR-".

Table 4-4 Implementation plan for Beaver Run Basin

Action Item Description & Goals Met	Applicable Sub-basins[23]	Resources	Implementation Lead(s) & Partners	Time Frame
BR-1: Establish a water quality monitoring program – sampling 4 sites on a quarterly basis (supports Goal 1)	$800-$900 annually for lab analysis, staff time, and equipment	City of Springdale will follow USEPA QAPP, collaborate with City of Forest Park; General Fund	2006	Established funded monitoring program in place. Identified contaminants and their concentrations.
BR-2: Identify sources and work with polluter to implement appropriate BMPs (supports Goal 2)	$7,000 – 10,000 for analysis, staff time and equipment	City of Springdale will work with HCSWCD; General Fund	2007	Reduced sediment loadings by 20 %

4.2.4 Summary of potential actions for UMC watershed and basin

A summary of potential actions and tasks for prioritized reaches in the UMC sub-basins is provided in Table 4.5. These actions have been selected based on the severity of the observed impairment and the likelihood of implementation. Actions are identified for specific reaches by basin and for the sub-watershed as a whole. Table 4.6 provides estimates of nitrogen, phosphorous and sediment load reductions for those actions where such estimates are quantifiable – primarily streambank stabilization best management practices. For the remaining actions, load reduction calculations were not possible given existing models available for urbanized watersheds.

[23] The applicable impaired sub-basins listed in this table correspond with the problem statements discussed above this table.

Table 4-5 Summary of potential stream restoration projects

Basin Name; Sub-basin #	Stream Section Location Description	Impaired stream reach length (ft.)	Proposed action summary
Main Stem Mill Creek			
1	North of Princeton Road & adjacent to Jayfield Drive	1140	o Riparian improvement o Instream habitat restoration o Erosion control
2	Summerville Road	630	o Riparian improvement o Instream habitat improvement o Erosion control
2	South of Princeton Road	1195	o Riparian improvement
3	Upstream of Cross Creek Lane	150	o Riparian improvement
3	Downstream of Cross Creek Lane	60	o Riparian improvement o Erosion control
3	East of Princeton-Glendale/ south of SR 129	1500	o Riparian improvement
4	South of Hamilton-Mason Road adjacent to Gateway Avenue	2580	o Riparian improvement o Streambank Stabilizatrion
7	Between Tylersville Road & Seward Road	3100	o Streambank stabilization (severe erosion)
9	Tributary to main stem, parallel to Route 747 (south of Tylersville Rd)	1700	o Streambank stabilization o Riparian improvement
10	North of Port Union Road, West of SR 747	1200	o Streambank stabilization o Riparian improvement
11	Industrial area west of 747 (severe erosion)	4886	o Streambank stabilization o Erosion control
12	South of Tylersville Road to Smith Road	5475	o Streambank stabilization o Riparian improvement
12	North of Tylersville Road to Senor Avenue (severe erosion)	890	o Streambank stabilization o Riparian improvement
12	West of 747 south of Smith Road	2200	o Streambank stabilization
13	Lakota West Drive to Union Centre Blvd	950	o Streambank stabilization
13	West Chester to confluence with Mill Creek Main Stem	2700	o Streambank stabilization
14	East of SR to Rialto Road (General Motors property)	5825	o Streambank stabilization o Riparian improvement
14	Adjacent to West Chester Service Center – Beckett Road	2000	o Streambank stabilization o Riparian improvement o Flood plain restoration
14	Downstream of Union Centre Blvd. bridge	600	o Streambank stabilization
East Fork Mill Creek			
15	Barrett Road	1320	o Bank stabilization
17	Streets of West Chester retail/entertainment complex – south of Union Centre Blvd	2000	o Streambank Stablization o Riparian improvement o Instream improvements
Beaver Run			
Beaver Run	Downstream of Champion Window facility	100	o Streambank stabilization o Riparian improvement

Basin Name; Sub-basin #	Stream Section Location Description	Impaired stream reach length (ft.)	Proposed action summary
Beaver Run	South of crossing at West Kemper Road	730	o Riparian improvement o Streambank improvement
UMC watershed-wide actions:			
o Implementation and enforcement of Phase II stormwater regulations addressing sedimentation and erosion controls during and post construction provisions (all sub-watershed jurisidictions are subject to these regulations) o Reconnection of the Mill Creek to its floodplains via enforcement of the Butler County "2002 Flood Damage Prevention Regulations" Section 5.2-8 o Completion of the Port Union Gilmore Ponds Conservation Corridor along the Main Stem Mill Creek and East Fork Mill Creek o Conduct watershed-wide surface water quality awareness campaign o Education of elected officials, jurisdiction staff, property owners, and the public at large about effective best management practices for improving local water quality o Identify opportunities for stormwater management facility retrofits o Create maps of surface water features including sensitive areas and manmade water bodies.			

A summary of potential load reductions from streambank stabilization and riparian zone improvement projects identified in the problem statement narratives and in Table 4.5 is presented in Table 4.6. The total reductions compared to Mill Creek TMDL load allocations for nutrients are presented at the end of Table 4.6. These totals provided should give an estimate of potential nutrient and sediment load reductions that could be achieved if all listed streambank stabilization and/or erosion control projects were successfully implemented. Implementation of streambank stabilization on identified reaches within the basin would appear to successfully meet the annual TMDL load allocation for phosphorous. Table 4-6 shows that the combined effect of implementing the listed streambank stabilization actions should remove approximately 2000 kg/year of Phosphorous while the TMDL HUC-1 load allocation for phosphorous is 1684 kg/year. It is also apparent that reducing nitrogen loads would require both types of actions (streambank stabilization and riparian corridor improvement) in all listed impaired segments to move towards reaching the TMDL HUC-1 load allocation. Streambank stabilization could remove 3998 kg/year and riparian improvements another 3217 kg/year for a total of 7055 kg/year compared to the TMDL load allocation for nitrogen of 7938 kg/year or 91% of the annual goal. It is hoped that other programs and projects in place, such as implementation of the phase II stormwater construction and post-construction erosion control regulations, will assist in meeting the TMDL HUC-1 goal for non point source nitrogen.

It should be noted that this is not an exhaustive list of potential project opportunities but a first attempt at identifying projects that are technically feasible and have the likelihood of having a positive impact on nutrient loads within the UMC watershed. Habitat restoration have not been included in these estimates due to lack of readily available models to calculate potential load reductions for individual pollutants. The estimates also do not include educational and public outreach projects which, at present, cannot be quantified with respect to load reductions.

Table 4-6 Summary of estimated load reductions associated with potential bank stabilization and riparian corridor improvement projects in the UMC watershed[24] [25]

Sub-basin	Acres	UMC WAP Action Item Location	Impaired stream length (ft)	Estimated Nitrogen reduction (kg/yr)	Estimated Phosphorous reduction (kg/yr)	Estimated Sediment Reduction (tons/yr)	Estimated Nitrogen load (kg/yr)	Estimated Nitrogen reduction (kg/yr)*
		Streambank Stabilization or Erosion Control					**Riparian Corridor Improvement**	
1	643	North of Princeton Road & adjacent to Jayfield Drive	1140	24.5	12.7	28	24.5	18.62
2	913	Summerville Road	630	7.3	3.6	8	7.3	5.55
		South of Princeton Road	1195	69.1	35.5	76	69.1	52.52
3	907	Upstream of Cross Creek Lane	150	13.8	6.8	18	13.8	10.49
		Downstream of Cross Creek Lane	60	6.9	3.5	9	6.9	5.24
		East of Princeton Glendale Road/South of SR 129	1500	32.7	16.4	36	32.7	24.85
4	1429	South of Hamilton Mason Road adj. to Gateway Avenue	2850	22.7	10.9	24	22.7	17.25
7	1263	Liberty Fairfield Rd to Hamilton Mason Rd.	2700	568.4	283.9	626	568.4	431.98
		Tylersville Road to Seward Road	3100	540	270	596	540	410.40
8	878	None proposed at this time						0.76
9	821	Tributary to main stem, parallel to SR 747	1700	148	74	164	148	112.48
10	224	North of Port Union Road, West of SR 747	1200	17.3	9.1	20	17.3	13.15
11	1802	Industrial area west of SR 747	4886	355.5	177.3	390	355.5	270.18
12	3151	South of Tylersville Road to Smith Road	5475	119.1	60	132	119.1	90.52
		North of Tylersville Road to Senor Avenue	890	25.5	12.7	28	25.5	19.38
		East of Beckett Road, southern tributary	2160	62.7	31.4	69	62.7	47.65
		West of SR 747, south of Smith Road	2200	479	239.5	528	479	364.04
13	683	Lakota West Drive to Union Centre Blvd	950	13.6	7.3	16	13.6	10.34
		West Chester Road to confluence with Mill Creek Main Stem	2700	39	20	44	39	29.64
14	4160	East 747/ Rialto Road (General Motors property)	5825	549.3	274.9	606	549.3	417.47

[24] Estimated load reductions are calculated for bank stabilization only. Additional reductions may result from riparian improvement and instream habitat improvement.

[25] Does not include nonpoint source public awareness, public outreach projects for which load reductions cannot be quantified.

Sub-basin	Acres	UMC WAP Action Item Location	Impaired stream length (ft)	Estimated Nitrogen reduction (kg/yr)	Estimated Phosphorous reduction (kg/yr)	Estimated Sediment Reduction (tons/yr)	Estimated Nitrogen load (kg/yr)	Estimated Nitrogen reduction (kg/yr)*
		Adjacent to West Chester Service Center - Beckett Road	2000	237	118	227	237	180.12
		Downstream of Union Centre Blvd bridge	600	13.2	6.4	14	13.2	10.03
15	3157	Barrett Road	1320	403.6	201.8	444	403.6	306.74
16	1969	Residential riparian corridors	2000				236	0.76
17	821	Streets of West Chester Retail/Entertainment Ctr - South of Union Centre Blvd.	2000	236.6	118.4	227	236.6	179.82
Beaver Run	3604	Downstream of Champion Window Facility	100	13.2	6.4	14	13.2	10.03
		South of crossing at West Kemper Road	730	22.7	11.3	25	22.7	17.25
Totals			**49331**	**3998**	**2000.5**	**4344**	**4234**	**3217.84**
		TMDL HUC-1 Load Allocations		**7938**	**1684**	**NA**		**7938**
		TMDL Load Reduction Percentage		**50.37%**	**118.79%**			**41%**

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4.3 Reasonable Assurance

Implementation of the UMC plan is assured through several means. In 2003, political jurisdictions and stakeholders either adopted a resolution in support of the UMC action plan items or submitted a letter indicating their support for the actions proposed in the original matrix. Copies of these resolutions or letters from the Butler County Commissioners, Butler County Department of Development, Butler Soil and Water Conservation District, the City of Fairfield, Liberty Township, and West Chester Township are available at the Mill Creek Watershed Council office. These communities have been provided an opportunity to review this revised plan. Per instructions by the state, the letters of resolution regarding plan revisions have not been obtained. As directed, once the plan is endorsed by the State of Ohio, public meetings in the Upper Mill Creek communities will be held to inform residents and other stakeholders about the proposed projects and to secure project partners.

Reasonable assurance is provided through implementation of the Phase II Stormwater requirements and the permits filed with the OEPA in March 2003. All jurisdictions within the watershed are included in the Phase II program and are either partners in their respective county-wide stormwater or have submitted individual jurisdiction permit applications to the OEPA. Included with these permits is a plan to implement actions that will address construction site runoff and pollution prevention, municipal pollution prevention, detection and elimination of illicit discharges to surface water bodies, and education and outreach to residents about means to reduce nonpoint source pollution. Successful implementation of these measures should have a positive (if not immediately quantifiable) impact on surface water quality in the Mill Creek and its tributaries, including the nutrient impairments identified within the UMC watershed.

The Butler County Department of Environmental Services, through a permit with the Ohio EPA, is addressing point source discharges from its Upper Mill Creek Water Reclamation Facility located on the East Fork Mill Creek – the only point source in the watershed. Currently the facility is undergoing a major upgrade that will enable it to achieve new effluent quality nutrient standards effective January 2006. The upgrade will improve biological and chemical treatment processes for enhanced removal of nitrogen and phosphorus.

In addition, Butler County has adopted an ordinance intended to restore and protect floodplains on properties located adjacent to the Mill Creek in the unincorporated areas of the county. Among the actions included in this ordinance are creation of a stream buffer and notching existing levees along the Mill Creek. These actions should reduce the impairments associated with channelization and manmade structures, reduce erosion and sedimentation, restore of some natural stream functions, protect or restore riparian corridors and their functions and should have the overall effect of improving water quality by reducing nutrient load and sedimentation.

West Chester Parks and other UMC stakeholders are committed to implementation of the Port Union Gilmore Ponds Conservation Corridor which will restore/protect riparian habitat within the UMC watershed.

Finally, the Mill Creek Watershed Council has offered its services to assist with implementation of the UMC WAP action items and to provide resources, such as its newsletters, website and public meetings, necessary to publish and distribute educational and plan evaluation and reporting materials. The Council will also work with UMC implementation leaders to identify sources of funding and assist, when requested, in the preparation of grant or other forms of funding applications.

4.4 Funding Sources

Project funding is included in the implementation plan. Application for traditional sources of funding, such as Section 319 Nonpoint Source Pollution grants from the State of Ohio, Clean Ohio Conservation Funds, and community foundations will be performed based on availability for those eligible action items identified within the implementation plan that require significant funding levels. Non-traditional funding sources will be pursued as opportunities arise. Structural activities, such as stormwater retrofits, will be funded on a local basis as needed through traditional capital improvement funding programs or grants.

Other sources of funding, such as Urban Forestry grants and contributions from non-profit environmental groups and organizations, will be explored on an as needed basis by UMC group members with the assistance of the Mill Creek Watershed Council. Some activities will require little or no additional funding (such as publication of educational materials on existing websites, newsletter articles or public presentations) and will be the responsibility of the identified implementation leaders. UMC stakeholders will also seek to partner with existing entities such as school districts,

community organizations, local parks or with local businesses to reduce costs associated with plan implementation.

Funding for activities related to implementation of Phase II stormwater regulations will be provided by the county-wide stormwater districts or the Phase II jurisdictions not participating in these districts.

5. EVALUATION

The Action Plan to improve the UMC watershed is both comprehensive and a long-term commitment. As such, it is imperative that the progress toward attaining goals and specific water quality and biocriteria metrics are evaluated. Regular evaluations will ensure that it maintains direction and momentum.

The following evaluation techniques will be used to monitor and evaluate the progress of the watershed action plan:

- UMC project partners are responsible for reporting on the effectiveness of action plan items as well as to identify action items that have not been effective in meeting the watershed goals.
- Grant-funded projects will have an evaluation criteria built in to the application process that will be followed to fulfill requirements.
- Public outreach will also be an important component of the stormwater Phase II initiative as well as the action plan. Communicating and listening to local communities through organized meetings are an effective way of monitoring the impact of the program on the community.
- Political/Private outreach will also be a component of evaluating the effectiveness of the action plan. The involvement of local governments and the private sector in the plan implementation and funding will determine their interest and commitment.
- Evaluation will also be accomplished through the routine OEPA monitoring program of streams in Ohio on a five-year cycle. The effectiveness of action plan items should be evident in the water quality and biological assessments undertaken by OEPA.

The evaluation process will evolve as implementation of the action plan progresses. It is anticipated that a thorough review and assessment of the plan will occur as the plan enters the four and fifth year of implementation.

6. PLAN UPDATE AND REVISIONS

The UMC Watershed Action Plan provides an overall approach to improving and preserving water quality and habitat conditions in the UMC watershed. The plan needs to be flexible and respond to the local needs within the framework and recognize that project funding is required for success.

It is anticipated that the plan be revisited on an as-needed basis as part of the ongoing efforts of the local communities, project partners and stakeholders. The plan will be reviewed for the purpose of identifying future projects and providing background information necessary for application to potential funding sources. It will also be reviewed and updated on an ongoing basis as projects such as CSO mitigation, flood reduction, and Phase II implementation, are completed. As funding becomes available, the plan will be reviewed to assess basin needs and to plan for future projects and to seek partnerships.

As the implementation schedule reaches year five a more thorough evaluation and assessment of the action plan will be undertaken by the local communities, project partners and stakeholders. This assessment will form the basis for subsequent action items in the next five year cycle.

7. APPENDICES

The following documents are intended to supplement the material presented in the UMC watershed action plan. For larger documents, reproductions of the cover sheet or brief excerpts have been included here. Complete copies are available from the Mill Creek Watershed Council of Communities office.

7.1 Appendix A: Butler County Flood Damage Prevention Regulations

Regulations available on line at:
http://development.butlercountyohio.org/index.cfm?page=planFloodRegs_damagePrevention

FLOOD DAMAGE PREVENTION REGULATIONS

BUTLER COUNTY, OHIO

As Adopted: June 10, 2002

Butler County Board of Commissioners
Michael A. Fox
Charles E. Furman
Courtney E. Combs

Butler County Administrative Center 130 High Street, Hamilton, OH 45011
Phone: (513) 887-3413 Fax: (513) 785-3723

7.2 Appendix B: Initial Stakeholder Invitation Letter

June 10, 2002

Mr. Brian Elliff
West Chester Township
9100 Centre Pointe Dr., Suite 280
West Chester, OH 45069-4852

Greetings!

You are invited to attend the second Upper Mill Creek and East Fork sub-basin watershed action plan meeting scheduled for Tuesday. June 18th from 10:00 am to 12:00 pm at the Liberty Township Road Department complex off Liberty Road. (See enclosed map.) Your participation is critical to the success of action plan development process.

Our group met for the first time last September when we identified issues that are unique to the Upper Mill Creek and East Fork sub-basins of the Mill Creek watershed. Water quality, water quantity and erosion were the top three concerns identified by most participants. Other issues included public safety, lack of awareness and lack of intercommunity cooperation. The one item that the group continued to mention throughout the September meeting was the need to educate the people who live and work in our jurisdictions about watershed issues.

Since our last meeting, we have been working with the West Fork Mill Creek sub-basin on a model approach to developing the watershed action plan. At this time, we are convening meetings of the four other sub-basins in the Mill Creek watershed to share the results of the West Fork effort and to jump start the action plan development process in the remaining sub-basins. We are still optimistic that we can complete the entire watershed action plan development process by December 2002.

We encourage you to attend the meeting on June 18th or to send a representative in your place. If you have any questions regarding the meeting or the watershed action plan process, please call Nancy Ellwood at 513.563.8800 or send an email message to nellwood@millcreekwatershed.org.

Regards,

Nancy Ellwood
Executive Director, Mill Creek Watershed Council

7.3 Appendix C: Sample Letter of Support

(COMMUNITY/ORGANIZATION NAME)

LETTER OF SUPPORT FOR UPPER MILL CREEK AND EAST FORK ACTION PLAN

The Mill Creek and East Fork Mill Creek are integral parts of our community, portions of which have suffered in the past from misuse, neglect and pollution. We recognize that the improvement of the Mill Creek and East Fork, their stream banks, and the land along the stream, known as the "riparian corridors" will create economic, recreational, environmental and aesthetic benefits for present and future generations.

For the last twelve months, representatives from Upper Mill Creek and East Fork sub-basin communities and stakeholder organizations have worked with the Mill Creek Watershed Council to identify issues of common concern that relate to the Mill Creek and its tributaries.

Issues identified within the sub-basin include surface water and sediment quality, erosion, streambank stabilization, storm water management, habitat protection and restoration, litter and dumping, stream encroachment, flood damage, and public education and outreach. A series of actions to be taken and a timeline have been created by the sub-basin committee to address each of these concerns.

We recognize these actions will accomplish multiple objectives for sub-basin communities and will assist communities in complying with the U.S. Environmental Protection Agency's upcoming storm water management requirements, as authorized by the National Pollutant Discharge Elimination System (NPDES) Phase II Rule of the Clean Water Act.

At this time, the (COMMUNITY OR ORGANIZATION NAME) supports the efforts to implement the identified elements/actions proposed in the Upper Mill Creek and East Fork sub-basin watershed action. Furthermore, the (COMMUNITY OR ORGANIZATION NAME) agrees to coordinate this effort with neighboring communities, so as to create a regional resource.

_____ (Signature) _____

_____ (Title) _____

_____ (Date) _____

7.4 Appendix D: 2003 Upper Mill Creek Action Plan Matrix

(Printed at end of appendices due to larger format.)

7.5 Appendix E: 2002 and 2004 Field Assessment Notes

Notes detailing observed conditions for each of the 18 UMC sub-basins during the 2002 and 2004 field assessments are included as an appendix to this plan. The 2002 narrative, taken directly from the consultants report, is presented first, followed by the 2004 update (for the 23 revisited sites) presented in italics.

7.5.1 Mill Creek Main Stem Basin

Sub-basin 1

This sub-basin arises north of Stoney Brook Drive. It starts off as a natural channel of fairly high quality, is piped underground by the time it reaches Carrington, reappears by Princeton Road, disappears underground again west of Forest Hill Road in the Weathered Oaks subdivision, reappears above ground east of Forest Hill and West of Springmeadow Road and continues above ground to its confluence with Sub-basin 2.

Except for the reaches that are piped, this sub-basin is relatively natural. As would be expected in a natural stream, the substrate in the headwater, where gradient is low, is mostly fine materials (clay and sand). As water volumes increase, substrate becomes coarser downstream, being mostly gravel and cobbles at mid point, and cobbles and boulders near the mouth. Size of the creek increases marginally from a width of 1 yard and depth of 4 inches to a width of 1 yard and depth of 6 inches at Liberty Fairfield above the input from a storm sewer. Below Liberty Fairfield, the creek is over 2 yards wide.

Riparian cover where the stream was exposed was mostly in the order of 30 yards, except for at Princeton, where there were opportunities to widen the riparian zone.

There were no signs of erosion and the creek was running clear, despite the fact that it was raining hard during the inventory of this sub-basin. At Liberty Fairfield, a storm sewer enters the creek. Inflow from this storm sewer was very turbid. The natural flow in the creek above the sewer inflow was clear, but below the bridge, where mixing was complete, the water was so turbid that it was difficult to see the substrate.

With the exception of the storm sewer input, there are no major problems in this sub-basin. There are two opportunities for enhancement. The first is an end-of-pipe facility to remove silt from the storm sewer outfall. Water from the sewer flows above ground about 20 yards before it enters the stream.

A lower priority opportunity is widening the riparian zone along the creek at Princeton. The current riparian zone ranges from none where lawn is present to top of bank, to 3 to 5 yards of trees and shrubs.

In 2004, two stream crossings were assessed – Princeton Road and Liberty Fairfield Road. The creek at Princeton Road abuts residential backyards. The creek at this crossing has recently been diverted through a concrete culvert and the streambed lined with rip-rap as part of a road widening effort. The riparian corridor near the road has been removed. Approximately 30 feet north of the crossing, a narrow riparian corridor is present. Small trees and invasive Amur honeysuckle dominates the narrow riparian corridor. Under the Rosgen classification, this section of the creek is a G-type channel. No evidence of erosion was noted. (Note: No large wet weather events had occurred at this location since the stream was modified.)

Figure 7-1 Storm sewer (at right) discharges runoff into creek at Liberty Fairfield Road – Sub-basin 1

At the Liberty Fairfield Road crossing, residential properties abut the stream. A storm water culvert empties into a narrow tributary feeding into the creek on the west side of the crossing. Under the Rosgen classification, this section of the creek is a B-type channel. Slight erosion was noted. Banks appeared to be stable and the stream seemed to be healthy with vegetation on both sides of the banks and had a clear bottom on the west

side of Liberty Fairfield. On the west side of the crossing, the riparian corridor is missing along the south bank.

The causes of impairment are siltation and habitat alteration. Sources include urban runoff/storm sewers, channelization, removal of riparian vegetation, stream bank modification/destabilization and minor agriculture.

Sub-basin 2

This represents the northern-most headwater of the Mill Creek sub-basin. This sub-basin originates as a small intermittent tributary running through private yards at Squaw Valley. It starts as a high-gradient stream about 1 ft wide and 2" deep.

Figure 7-2 Downstream view at Squaw Valley – sub-basin 2 (2002 photo)

The main channel starts at Chablis near Mogul, where it is 1 yards wide and 1" deep, but there was evidence that flows frequently result in the stream being 2 yards wide. This channel has been straightened and downstream the channel is concrete and about 0.5 yards wide. The channel flows through a yard and a culvert through a berm at this point.

At Summerville, the tributary is piped underground, but resurfaces farther downstream. At Moselle near Chablis, the upstream channel was 1 yards wide, but downstream, it was 5 m wide. Water turbidity at this point was too great to determine water depth or substrate. By the time it reaches its mouth at Elvin Lane, this stream is 4 to 5 yards wide and 8" deep under normal flow conditions.

Another small tributary starts in this sub-basin farther east at Moselle near Willow Bend Drive. It is piped underground at its origin. At Princeton, it is above ground and has received flows from the western tributary in this system. Above the road, it is 3 yards wide and 4" deep. Downstream, it flows over a 6' high waterfall and the creek widens to greater than 10 yards.

Some problems are evident in this sub-basin. The streams are slightly flashy, with peak flows increasing fairly quickly in response to rainfall. Some erosion was noted, but it was not severe. Water becomes quite turbid in some reaches during rain events, and the presence of green algae suggested high nutrient levels. Riparian cover is low and non-existent in many reaches, and there are some barriers to movement.

There are some limited opportunities for restoration in this sub-basin. Downstream of Chablis at Mogul, the channel is concrete and there is already a berm in place downstream of this reach. It would be possible to naturalize this channel, create some wetland habitat, and also hold back peak flows in this location.

There are two potential barriers to movement in this sub-basin and it may be possible to rectify them. One is at Princeton where there is 6' drop over a natural bedrock lip. Due to the drop, the force of the water has widened the channel from an initial width of 1.5 yards to over 10 yards. It may be possible to create a series of weirs downstream to back up the water to the falls in small steps, and/or to direct water away from the shorelines and narrow the channel.

There is another small drop of 6" downstream of Moselle at Chablis. This is high enough that it may be a barrier to small warmwater fish species. This could be rectified through construction of one low weir to back water up. As a result of this drop in elevation, stream width increases from 1 to 5 yards.

In 2004, several stream crossings were observed in the older and more established subdivisions that are typical of the sub-basin. Observation at stream crossings found the creek banks to be fairly stabilized. Erosion rates varied with one site having no visible erosion, three having slight erosion and one experiencing severe erosion. Under the Rosgen classification, most of the creek in this section tended to be a B-type channel. Minimal sedimentation was found. It was noted that the creek lacked a riparian corridor at most of its crossings with backyards butting up to the creek banks. The most northern crossing was found to be an intermittent stream, upstream from a detention basin. There was a

noticeable absence of trees. The detention basins in neighbourhoods were found to be dry. Severe algae were visible at the Princeton Road crossing.

The causes of impairment are nutrients and habitat alteration. Sources include channelization, urban runoff/storm sewers, removal of riparian vegetation and streambank modification/destabilization.

Sub-basin 3

This sub-basin has been defined as the reach originating just north of Highway 129 at the Highway 747 interchange to just below the confluence of the tributaries in sub-basins 1 and 2 at Liberty Fairfield.

Near its headwater at Highway 129, it is piped under the highway and another tributary flows down a series of rocks on the southern side of the highway. Flow below this is diffuse for the first 30 yards, and then is in a well-defined eroded channel measuring 1' wide and 1' deep.

By the time it reaches Meier Lane, just upstream of Highway 747, it is 1 yard wide and 4" deep under normal flows, but bankfull is 6 yards wide and 2 yards deep. Some stream bank erosion is evident at this location. A ditch with an eroded clay channel flows into the stream just upstream of the road.

Downstream at Highpoint, the stream flows into a 3' cement headwall before entering a 6' culvert. Above this the stream is about 1 yard wide. It picks up significant flow downstream, probably from a storm sewer, with downstream width averaging 4 to 5 yards. Water depth could not be determined due to water turbidity.

At Hidden Oaks Lane, the channel is only 2.5 yards wide, but turbidity prevented determination of depth or substrate. A 1' drop from the mouth of the culvert at the downstream end is a barrier to movement of aquatic life. This drop increases water velocities and both banks are actively eroding downstream.

Mill Creek on Liberty Fairfield is at the lower end of Sub-basin 3 after it has received flows fm Sub-basin 1 and 2. This station was observed during a storm event, as were other stations in these three sub-basins. Flows were very rapid at this point, with the creek being 10 to 12 yards wide. The northern bank of the creek was 10 to 12 yards high and had significant erosion.

The main problem in this sub-basin is the flow regime, which is causing erosion in some areas. One small barrier was observed and this is also

contributing to erosion. Riparian cover is low along most of the watercourse.

There are some restoration opportunities in this sub-basin, especially in the Meier Lane area. Upstream of this road, the creek flows through a very large lot where there may be an opportunity to create a detention facility. If this is not feasible, the riparian cover in this reach could be greatly improved. Current riparian cover is restricted to a single row of trees on the north bank and lawn to top of bank on the south bank.

Another restoration opportunity exists where the ditch flows in. Immediately upstream of this, there is an old field area that does not have development potential. The ditch could be re-routed to this area to create a combination detention area and wetland.

At Hidden Oaks Lane, two or three small weirs could be constructed to eliminate the barrier that the culvert creates. At the same time, the stream banks could be stabilized.

In the reach near Liberty Fairfield, in-stream weirs would be beneficial to create a series of pools and riffles and to direct flows away from the banks. The creek at this point is too wide for its normal baseflow, so management that would confine the flows, stabilize banks and diversify habitat would be beneficial. Figure 7.3 is a photograph of a property owners attempt to address erosion along this reach.

Figure 7-3 Temporary bank stabilization to address erosion east of Liberty Fairfield Road. (2002 photo)

In 2004, two stream crossings at Mountainview Court and Lindley were observed with the east and west side of the crossings assessed. According to the Rosgen classification, the creek appears to be a G-type channel. A dry detention basin at Rock Springs Road was noted. Narrow riparian corridors in newer subdivisions were noted. Problems with erosion varied with sites rated from slight to moderate-severe to very severe. Trees had fallen in a section of the creek. Sedimentation from heavy urbanization was evident. Amur honeysuckle was present. Dumped yard waste was noted.

The causes of impairment are siltation and flow alterations. Sources include urban runoff/storm sewers and removal of riparian vegetation.

Sub-basin 4

Sub-basin 4 has four branches. The western branch originates near Hamilton–Mason Road and flows through an industrial park, the central branch originates between By-Pass 4 and Redcoat Drive, the eastern branch starts south of the Hamilton-Mason Road between Redcoat Drive and Morris Road, and the southern branch originates a bit north of Tylersville Road. The three northern tributaries merge north of Tylersville Road, and the southern tributary joins them on the airport.

The western tributary was observed only in the industrial park from Hamilton-Mason Road downstream to below McBride. The creek through this reach is a trapezoidal ditch about 2 yards deep and 2 yards wide. The channel of the ditch is completely choked with cattails and other wetland vegetation. Flow in the base of the ditch was about 2" deep when observed. Riparian vegetation consisted of 50 to 100 yards of grasses and herbaceous vegetation both sides of the creek.

Portions of the central tributary are piped underground, and it is underground where it crosses By-Pass 4. It is a small tributary about 1 yard wide in the upper reaches where it is exposed.

At its upstream end on Saratoga Road, the eastern tributary is 2yards wide and 2"deep above the road and 2 to 20" deep below it, where there is a good sequence of pools and riffles. Riparian vegetation is limited. Water from the subdivision east of Morris Road is collected in a storm water pond. Its outlet runs across Morris Road into the eastern tributary. The outlet channel is initially an open channel 8 yards wide and 1 to 10" deep. It flows into a storm sewer that discharges on the west side of Morris Road into a concrete channel 5 yards wide and 1.5 yards high. At By-Pass 4, the channel was 1 yards wide in riffles and 3 yards wide in pools, with water depths of 4 to 6". There was evidence that flows had been about 3' higher at this location.

At Tylersville Road, the three northern tributaries have coalesced to form a channel 3.5 yards wide and 18 to 24" deep. Above the road, the creek is a natural channel through a wooded ravine. Downstream, it has been straightened and flows through an extensive old field.

Just above its mouth at Gilmore Road, the creek is a manmade channel with naturalized banks except where the top has been lined with rocks. It was about 15 yards wide and varied in depth from 1 to 18" deep. There was considerable grass in the channel, suggesting that the normal channel was only 1 yards in width. Downstream, the creek was ponded due to the backwater effect from Sub-basin 5.

The main problem in this sub-basin is the flow regime, but it is not as severe as in many other sub-basins. There are significant opportunities to regulate flows and improve water quality in the sub-basin, as outlined below.

The entire headwater area of the western tributary is in an industrial basin. There are significant opportunities here to create a series of storm water ponds and wetlands to regulate flows and improve water quality.

Immediately downstream of Tylersville Road, the tributary flows through a large, flat, old field. This is an excellent site for a constructed wetland. This could improve water quality as well as provide wildlife habitat.

At Gilmore Road, there is another opportunity for a wetland. There already is a wetland west of the creek, but the creek has become isolated from it. Connecting the creek to the wetland would assist in polishing water quality.

In 2004, no additional assessment was conducted. The causes of impairment are flow alterations, other habitat alterations and nutrients. Sources include removal of riparian vegetation, agriculture, channelization, other (berms) and flow regulation/modification

<u>Sub-basin 5</u>

Sub-basin 5 is the westernmost headwater of UMC, originating north and west of the airport. At Bobmeyer Road and Ivy Land, the creek is piped upstream, but is a natural channel downstream. The channel was about 2.5' wide and 4" deep, but there was evidence of flows 1.5' higher.

Farther downstream along the creek, north of the railway, there is a low-lying agricultural field. This site would be an excellent spot for a detention area and wetland.

At Gilmore Road, the creek is about 6 yards wide, with unknown depth. At this point, there was no apparent flow, with the creek apparently backed up. The railway and agricultural lands lie to the north of the creek, and there is a large swamp to the south of the creek. The floodplain of the creek has been cut off from this swamp by a berm about 1 yard in height.

This berm prevents the creek from flowing into the swamp during periods of high flows. Consequently, this contributes to higher peak flows downstream, and also impairs the quality of the wetland.

There is an excellent opportunity to breach this small berm in places to allow the creek access to its natural floodplain. Additional study would be required before this is undertaken. The creek and wetland have been separated for considerable time. Some of the trees that have become established may not be tolerant of long periods of flooding, so it would be necessary to determine hydroperiods and whether these would have adverse impacts on existing vegetation.

At the lower end of what has been defined as Sub-basin 5, the creek flows into a large manmade lake. Water levels in this lake fluctuate considerably, but it ameliorates downstream flows. In essence, this lake controls flows received from sub-basins 4, 5, and 6. This, however, should not be a reason to ignore other restoration opportunities in these sub-basins. If upstream flows were better controlled, lake levels would fluctuate less and there would be opportunities to establish wetland vegetation around the lake that would help improve water quality.

It may also be possible to construct a wetland cell within this lake at the downstream end. If more stable water levels could be maintained within this cell and a longer residence period established, improvements to water quality could be realized.

In 2004, no additional assessment was conducted. The causes of impairment are flow alterations, other habitat alterations and nutrients. Sources include removal of riparian vegetation, agriculture, channelization, other (berms) and flow regulation/modification.

<u>Sub-basin 6</u>

This sub-basin has four branches that all originate south of the Dixie Highway. The most eastern branch is piped upstream of Dixie Highway, where a subdivision was being constructed at the time of the fieldwork. At the downstream side of the highway, it enters a cement channel 8 yards wide and 10' deep, with rounded banks. Farther downstream at Seward Road, the channel is straightened, but has naturalized banks. The channel

is about 4' wide and flows were 4 to 6" deep, with evidence of flows at least 1' higher. Downstream of Sosna Drive, the channel is piped underground for about 75 yards, bypassing a small cattail marsh (about 20 x 15 yards). Where it exits the pipe, the channel is dug with naturalized banks. There was evidence of flows 3' higher at this point.

The tributary that is second from the east is also piped upstream of the highway. The creek exists about 50 yards south of the highway into a pool of unknown depth that is 10 yards long and 5 yards wide. Downstream of the pool, the channel is 4 yards wide and 4" deep, with a reasonable series of riffles and pools. The channel, however, is too wide for normal flows in the creek. There may be opportunities for in-stream structures here. In addition, there is a drop of about 6" from the culvert into the pool, and this promotes widening of the channel. Weirs that backed up flows to the culvert would help narrow the channel and slow flows.

The two eastern tributaries join just upstream of Stockton. Just above the confluence, the eastern channel is 3' wide and 2 to 4" deep, with a gravel substrate; the other channel has similar depth and substrate, but is twice as wide. Just below the confluence of the creeks, the channel is 3.5 yards wide and 2" deep with gravel substrate. Although the stream banks were not eroding, there was evidence of flows 1.5' higher at this location. Below the road, the wetted channel was 2.5 yards wide and 2 to 4" deep, but the bankfull channel was 10 yards wide and 1 yard deep. Some erosion was apparent, and it was clear that the channel occasionally runs at bankfull, and probably had the previous day.

Immediately upstream of the confluence of these two creeks, there is an old field. This area provides opportunity for a stormwater pond and wetland.

At the upstream side of Dixie Highway, near Whitmore Lane, the next stream to the west flows into a stormwater management pond. The creek flows in down a riprap bank and the outlet of the pond is into a 2' bulkhead in front of a 6' culvert. This stream joins the other creek from the east in the vicinity of By-Pass 4. The creek at this point is natural and about 2.5 yards wide. The creek coming in from the east is also natural, although it may have been straightened along the railway. This stream is approximately the same size, and has forested riparian cover and a good series of riffles and pools. There may be opportunities to build stormwater management facilities and wetlands in the valley along the tributary coming in from the west.

The western tributary in this sub-basin is mostly piped above Dixie Highway. There is one 20-yards reach above the highway that is a cement

channel 2' wide and 6" deep. A similar channel flows down the southern side of the highway. The creek surfaces about 30 yards below the highway. The water here was murky and the channel was split into channels about 4' wide.

Behind the industrial buildings, there is vacant land where a stormwater facility and wetland could be constructed.

At Homeward Way, this creek is channelized with naturalized banks. The channel was about 3' wide and 4" deep, but there was evidence of much higher flows.

Along Port Union Road, the creek becomes a roadside ditch that goes underground at the railway. The channel here is eroding badly, with the channel cut to a width of 2.5 yards and depth of 2.5', although the stream was only 1 yard wide and 2 to 4" deep.

A little to the east along Port Union Road, the western tributary joins the other stream. It empties via a 5' culvert downstream of the road. Upstream of the road, the other tributary from the east is channelized, with cement blocks thrown in on the western bank and the other bank naturalized. The creek here is about 3 yards wide. Downstream, the channel is 4 to 8 yards wide and 16 to 24" deep. There was evidence that the water had been at least 3' higher. Presence of green algae suggested high nutrient levels.

The station at Symmes Road was the farthest downstream that the creek was observed in this sub-basin. The channel had been straightened, but the banks were naturalized. The channel varied in width and depth in riffles and pools, being 2 yards wide and 4" deep in riffles, and 5 yards wide and 30" in pools. There was evidence that the creek had been flowing 8' higher than it was when fieldwork was conducted.

In 2004, no additional assessment was conducted. The causes of impairment are flow alterations, other habitat alterations and nutrients. Sources include removal of riparian vegetation, agriculture, channelization, other (berms) and flow regulation/modification

<u>Sub-basin 7</u>

Sub-basin 7 has been defined as the Main Stem of the creek from downstream of Liberty Fairfield to Seward Road.

At Hamilton Mason Road and north of it, there are several restoration opportunities. The creek at this point is 10 to 12 yards wide and 1 to 16" deep. The channel is too wide for normal baseflow at this point, and

construction of in-stream weirs would be beneficial. Downstream of the road, there is a site where riparian cover could be improved.

On the north side of the road, there is a care center. There is a sharp drop from their parking lot to the creek floodplain, and this area provides opportunity for stormwater facilities and wetlands. North of the care center building, a small tributary runs through an old field. This tributary is about 3' wide and 15" deep and appears to be a natural channel. North of it, another watercourse flows into the main creek through a farm pasture. Significant erosion is occurring along this creek. This entire area is suitable for stormwater management and wetlands, and it could possible be designed with a flow-splitter to direct peak flows from the main stream into a wetland facility.

Between Hamilton Mason Road and Tylersville Road, the creek is mostly natural, flowing through a wooded area. At Tylersville, the channel is 3 to 4 yards wide and 4 to 18" deep. South of Tylersville, there are agricultural lands where stormwater management facilities could be constructed.

Land between Seward Road and Tylersville Road are agricultural. Just upstream of Seward Road, there is a pasture that supported a herd of cattle. It was unknown if these cattle had direct access to the creek, but it is likely that their wastes contribute non-point sources of nutrients to the creek. There may be opportunities to restrict cattle access to the creek (if cattle are currently allowed in it) and to manage wastes so that they do not reach the creek.

In 2004, three stream crossings - at Hamilton Mason Road west of Vinnedge Road, at Tylersville Road, and at Seward Road - were observed. They appear to be F-type channels under the Rosgen classification. At the Hamilton Mason Road crossing a section of the stream near the horse stables had been filled in with concrete and asphalt. A black oily substance in concentrated areas was present on the south side of the Hamilton Mason Road crossing during the site visit. A diversity of wildlife such as frogs, snakes, fish as well as traces of deer were present. Good riparian corridor is present in most of the area. Natural erosion is occurring at the Hamilton-Mason Road Bridge.

At the Tylersville crossing, residential land use exists to the north. A very narrow riparian corridor is present with mowed grass planted to the edge of the stream on portions of the east side. Slight erosion was observed at the Tylersville Road Bridge. Between the Tylersville and Seward Road stream crossings, agriculture, including crops and a small cattle feed lot,

dominate the land use patterns. The riparian corridor is sparse to non-existent through this 3100-foot reach. This land is currently for sale and is zoned for residential or industrial/commercial use. The stream is entrenched on both sides of the Seward Road crossing.

The causes of impairment are nutrients, grease and oil, and habitat alterations. Sources include urban runoff, pasture land, agriculture, channel modification and removal of riparian vegetation.

Sub-basin 8

This sub-basin includes a short tributary as well as the lower portion of another tributary with headwaters formed by sub-basins 4, 5, and 6. This is the reach downstream of the lake at By-Pass 4.

South of Symmes Road, the southern tributary is a concrete channel 18" wide and 3" deep. This is in an industrial park, and there is considerable room for a stormwater management facility and wetland. North of the road, the creek empties onto a cement platform 10' wide, and there is a 16" drop to the natural substrate. From there downstream, the creek has been straightened, but has naturalized channels. There was evidence that flows had been 6' higher at this location.

At Seward Road, the channel of the southern tributary was similar, being about 2 yards wide and 4" deep, with evidence of much higher flows.

The main tributary in this sub-basin was also observed at Seward Road. At this point, it is a short distance downstream of the lake at By-Pass 4. The channel has been straightened along the railway tracks. At this point the channel is about 15 yards wide, but with only a trickle of water in it. Most of the channel had filled in with cattails.

Near its mouth, the main tributary was observed under flood conditions. The creek was extremely turbid, but only about 3' wide. At this point, it flows into a swamp and ultimately the main stem of Mill Creek.

In 2004, no additional assessment was conducted. The causes of impairment are siltation and flow alterations. Sources include channelization, removal of riparian vegetation and flow regulation and modification.

Sub-basin 9

This sub-basin is a tributary that originates north of Tylersville Road and flows south into the main stem of Mill Creek. This stream was under flood conditions when observed.

At Tylersville Road, the water was above bankfull. The water was approximately 6 yards wide and very turbid, so that it was not possible to estimate depths. At Hutzelman in West Chester Village, the channel was 3.5 yards wide and flowing fast and very turbid. Downstream of this road, the stream was directed around a stormwater management pond and development to the west.

The final site where this stream was seen was at Smith Road. Upstream of the road, the creek was at top of bank, and above it downstream. Water was within a few inches of running into a new townhouse. This observation was made around 4 pm, and heavy rain continued until about 2 am the next morning. It is likely that this townhouse experienced flooding and that eventually a berm will be built along the creek to prevent this happening again. Figure 7.4 is a photograph showing flooding conditions at this location.

Clearing and grubbing was underway for a subdivision west of the creek, and this site was contributing sediments to the stream. Upstream of Smith Road, there were a series of stormwater management ponds. Although these are important in controlling flows from development, they limit opportunities to create facilities to manage creek flows.

In 2004, the area surrounding an unnamed tributary to the Mill Creek Main Stem, located south of Tylersville Road, west of Princeton-Glendale Road (Route 747) and north of the Mill Creek, was observed. This basin has been highly altered since the 2002 inventory. South of Tylersville Road and west of Route 747, several large subdivisions, ranging from multi-family to high end single family homes, were being developed in former agricultural land. The majority of these subdivisions are under one-year old. Hundreds of homes were found to be in various stages of development. Figure 7.5 is a photograph of new residential development in this sub-basin. Completed properties include closely spaced large homes with new lawns, paved driveways and curb and gutter storm sewers. Vegetation had been removed from much of the remaining undeveloped land. Streets have been installed where additional houses will be built. It appears much of the remaining land will be filled in with new homes.

Figure 7-4 Flooded stream encroaching on new developments off Smith Road (2002 photo)

Figure 7-5 Photograph of recent residential development in sub-basin 9 (2004 photo)

Planned green spaces, with established paved walking paths and aesthetic tree plantings, were scattered through the completed portions of these developments – some encompassing small wetlands. It appears that some of these green spaces were being used for stormwater management – perhaps as detention ponds. Numerous storm water retention ponds have been constructed in the areas of new development. There is also a series of cascading stormwater management ponds that start at Tylersville Road and head southwards. Waterfalls between the ponds keep the water aerated. No vegetation had been planted on the perimeter of these ponds.

There is a lack of riparian corridor and the creek is experiencing heavy sedimentation. Moderate to severe erosion is occurring. Under the Rosgen classification, it appears to be a G-type channel.

Causes of impairment are siltation and other habitat alterations. Sources include urban runoff/storm sewers, construction/development, and removal of riparian vegetation.

Sub-basin 10

Sub-basin 10 is a small tributary that originates south of Port Union Road and flows northward into the main stem of Mill Creek. This watercourse was under flood conditions when observed.

At Port Union Road, the channel has been straightened but is naturalized. It was 1 yards wide but depth could not be determined due to turbidity. Although it was flooding at this location, flows had evidently been 1.5' higher. Downstream of the road, there were several drops 12 to 14" high that are barriers to movement of aquatic life.

Farther downstream, the channel is piped through one industrial area, and then resurfaces. The channel through the new industrial area has recently been reconstructed with meanders introduced into the low-flow channel. There is currently no riparian vegetation along this reach, with grass mowed to the shorelines, although trees have been planted. At the north end of the industrial area, the creek discharges down a cement chute into a large, natural wetland. The wetland is a mix of meadow marsh and swamp, and numerous trees have been planted in it recently. This wetland diffuses flows from the creek and also allows sediments to settle, thereby improving water quality.

In 2004, no additional assessment was conducted. Causes of impairment are siltation, flow alterations and other habitat alterations. Sources include flow regulation/modification and removal of riparian vegetation.

Sub-basin 11

This sub-basin has two branches that originate west of the Dixie Highway and merge south of Mack Road. The stream runs northward and flows into the main stem of Mill Creek.

The southern branch is piped upstream of Dixie Highway. Downstream, it empties into a pool 8 yards long and 5 yards wide, with unknown depth. The water at this location was murky, and there was severe erosion to banks 8' high. Below the pool, the channel was 3 to 5' wide and 4" deep. Considerable amounts of cement and boulders had been thrown in the channel in an attempt to stabilize banks. By the time the creek reaches Dues Road, the channel is about 2 yards wide and varies in depth from 8 to 16". There was evidence that flows were occasionally 3' higher.

The northern branch originates south of a townhouse development at Citadel Drive. Upstream, the channel is natural, although stones have been placed in it to manage erosion. Erosion is severe above where the rocks have been situated. Gradient is very high in this area, down to Mack Road. The channel at this point is 1' wide and 4" deep and there is severe erosion father downstream to Mack Road. From Mack Road down to Dixie Highway, the creek is piped. An exception is just south of Dixie Highway where the creek flows through concrete channels though grassy swales that act as small quantity stormwater management facilities. It may be possible to retrofit these facilities to make them less flow through and create some wetlands that help polish water quality.

Downstream of Dixie Highway, the creek flows into a cattail detention pond that receives three outfalls. This facility is approximately 80 yards in length and 15 yards wide. From here, it goes underground and emerges on the other side of the railway tracks. It flows down a concrete chute about 10' wide; flow is very rapid and only about 1" deep. The creek drops about 30" into a pool, and then flows into a channel 2.5 yards wide of unknown depth. At Mack Road upstream of the confluence with the southern tributary, the channel is 2.5 yards wide and 4 to 6" deep, with moderate erosion.

A little farther east, the creek crosses Mack Road downstream of the confluence of the two branches of the sub-basin. At this point, the creek has been straightened, but has naturalized banks. The channel upstream of the road was about 3 yards wide and 8 to 10" deep. Thee creek flows into a concrete channel 15 yards long before reaching the culvert. The downstream channel is also straightened and naturalized, with concrete slabs having been through down the east bank in an attempt to stabilize it.

North of Mack Road, the creek flows through an industrial area. This is a dug channel that is severely eroding. Banks of the creek are eroded to heights of over 10'. The stream channel, seen under high-flow conditions, was 4 yards wide and 6 to 8" deep, but the bankfull channel was over 15 yards wide and 5 yards deep.

Another channel enters from the east. This is another dug channel that originates from a storm outfall about 75 yards upstream. Bankfull channel was about 10 yards wide and 5 yards deep, while the wetted channel was 3' wide, 4" deep, and flowing rapidly.

A second channel enters from the west. This is severely eroding, with the channel 8 yards wide and 2.5 yards deep. Water flows were 2.5 yards wide and 4 to 6" deep.

The entire reach through the industrial area would benefit from a series of weirs to improve flow regimes and create a series of riffles and pools. The weirs should be designed to direct flows away from stream banks to reduce erosion. Bank stabilization should also be undertaken.

At Port Union Road, the channel had been widened immediately upstream of the bridge to 1 yards, with a depth of 6" over a placed substrate of gravel and boulders. Farther upstream and downstream, the channel was 10 yards wide and deeper, but depth could not be determined due to turbidity.

Two stream crossings were observed undergoing light industrial development. One site was a large culvert where the creek flows under Mulhauser Road and the second was downstream, north of Mulhauser Road. Under the Rosgen classification, the stream was found to be a G-type channel and to have moderate sediment. The first site was found to be experiencing moderate to severe erosion while the second site was experiencing only slight erosion. Algae were present.

Causes of impairments are nutrients, siltation and flow alterations. Sources include streambank modification/destabilization, flow regulation/modification, channelization and urban runoff/storm sewers.

<u>Sub-basin 12</u>

This sub-basin has five branches that eventually merge and flow southward into the main stem of Mill Creek at Highway 747.

The western branch originates north of Westsands Crescent. At this point, it is a natural channel 18" wide and 4" deep. It was evident that flows had been about 1.5' higher here. Downstream of the road, it is piped

underground for about 30 yards, then emerges for a few yards north of Park Ridge, and then goes back underground. South of Park Ridge three channels empty into a basin about 40 yards long, 50 yards wide, and 7 yards deep. These channels are on concrete and are 2' wide and 6 to 8" deep. They join and flow into a 2' culvert and then the creek becomes a natural channel. There is opportunity to detain water in this basin and to have a wetland facility.

Downstream at Tylersville Road, this tributary has been straightened, but the banks have naturalized. Upstream of the road, the channel is 1 to 1.5 yards wide, but widens to 2.5 m below the road.

The next tributary to the east starts just above Falcon Lane. At this point, the channel appears to be natural. Another tributary that is not shown on the base map flows in from the east and crosses Pelican Drive before emptying into the main tributary. This channel is natural in appearance, except that the upstream landowner has placed stones on stream bends to prevent erosion. This stream is about 1.5 yards wide and 6" deep. At Senour Drive, the stream is still natural, except for 8 yards above the culvert where the channel is concrete. Some green algae here suggest that there are high nutrient concentrations. Downstream, there is significant erosion on the east bank. At Tylersville Road, the creek is still natural and has increased in size to 2.5 to 3 yards wide and 4 to 16" deep. By the time it reaches Ashford Glen Crescent, the stream has been straightened, but has natural banks.

Beckett Road was the station farthest downstream on this tributary and this is just above its confluence with the other eastern tributaries. At this point, the channel appears natural and is 4 yards wide and 4" deep. Overall, this tributary is in good shape with no major problems.

Immediately downstream of the road there is a triangle of land between the two tributaries that is mowed grass with no buildings. This area could be used for a stormwater management facility and constructed wetland.

The next tributary to the east originates above Tylersville Road. Upstream of the road, it runs through a yard, and downstream it has been straightened but has natural banks. Above the road, the creek is 1.5 yards wide and 6" deep, while it is 2.5 yards wide and 4 to 6" deep below the road. The only other station on this creek was at Crossbridge Drive. The stream is essentially the same size here at 3.5 yards wide and 4 to 6" deep. There are no significant problems along this watercourse.

The next tributary to the east was observed only at Tylersville Road. The channel appears to be natural here, and is 1.5 yards wide and 2 to 3" deep

above the road. Downstream, it drops about 4" from the end of the culvert into a pool 5 yards wide, 15 yards long, and of unknown depth. Below that, the channel is 1 to 2 yards wide and 4 to 6" deep. There appear to be no significant problems along this tributary.

The eastern tributary originates east of Lesourdsville West Chester Road. A tributary that is not on the base map was investigated along this road. Upstream, the channel was natural, but had mowed grass to the top of both banks. Downstream, there was significant erosion due to direct cattle access. Channel width increased from about 16" upstream of the road to 5 yards downstream. There is opportunity to restrict cattle access here and reduce non-point sources of pollution, as well as restore the stream banks.

At Lesourdsville West Chester Road, the main stream was piped underground. It resurfaces and was observed at two stations along Eagle Ridge Drive. The channel was natural along this reach, ranging in width from 0.7 to 2 yards wide and 6 to 12" deep. An exception was one pool 8 yards wide and 10 yards long. The water was slightly turbid and there was evidence that flows had been about 16" higher. Although erosion was negligible at this point, peak flows may be close to being a problem.

The next site downstream was on Crossbridge Drive. At this point, the three easternmost tributaries have merged, and the stream is about 3 yards wide and 4 to 8" deep. Upstream, the channel may have been natural, but this was uncertain. There was significant erosion through this reach and also a series of barriers 50 and 75 yards upstream. There are significant opportunities for placing in-stream weirs through this reach to eliminate barriers, enhance aquatic habitat, and remedy erosion problems.

Downstream of the road, there is an old field which is a potential site for a stormwater management facility and constructed wetland.

The next downstream station was at Beckett Road. At this point, the stream has been straightened, but has natural banks. Upstream, it is about 7 yards wide and 6 to 10" deep, but only 2.5 to 3 yards wide and 4 to 8" deep downstream.

As mentioned above, there is a triangle of land west of Beckett Road where there is potential for a stormwater management facility. If this appears feasible, it would be best to direct flows from the eastern (southern) tributary into it. The other tributary is more natural and does not exhibit the same extent of flows problems.

At Smith Road, all of the tributaries have joined to form a single stream. Observations were made a day following a large storm. The channel

appears to be normally 2.5 yards in width, but was 4 yards wide when observed, with a depth of 14 to 18". It was evident that flows had been at least 3' higher.

At bit farther downstream, the creek has been straightened to flow along Highway 747 before discharging into the main stem of Mill Creek. Observations were made during the peak of the storm. At this time, the creek was very turbid and flowing fast, but was still about 6' from overflowing its banks.

In 2004, a Beckett Ridge stream crossing and the location of an OEPA 319 grant-sponsored restoration project at the Beckett Ridge Golf Course were observed. On the west side of the crossing, point bars, riffles and pools were visible. Minimal sedimentation was observed. Good canopy was present. Under the Rosgen classification, the creek appeared to be an F-type channel. There were signs of backyards slumping into the creek. On the east side, minnows and a Blue Heron were observed. The channel type is B – F. There was a thin riparian corridor present with residential yards backing up to the stream; one yard was observed slumping. Minimal sedimentation was observed. One bank was noticeably steeper than the other with moderate to severe erosion.

On the western edge of this sub-basin, extensive road widening activities were taking place on Route 747 between Tylersville Road and Smith Road. At the northernmost end of this construction roughly 600 feet of the riparian corridor has been removed along the eastern streambank. The area was then filled in with soil to accommodate new elevated lanes along Route 747. A steep bank leads directly from the new road surface into the stream. A new retail strip mall has been built on formerly open space on the south and west side of the intersection of Route 747 and south of Hutzelman Way (a new road that leads into the new sub-divisions in sub-basin 9). The unnamed tributary to the Mill Creek Main Stem flows behind this development. To the north of Hutzelman Way, vegetation has been removed from the previously open space in preparation for more commercial/retail development. A very narrow riparian corridor, roughly 1700 feet in length, borders the western edge of this area.

South of Smith Road, road widening activities on Route 747 continue to have an impact on another major tributary to the Mill Creek. (This tributary, which drains from the Becket Ridge residential area to the northeast, crosses under 747 north of the Wendy's restaurant.) Approximately 200 feet of riparian corridor on the eastern bank has been removed and replaced with a vertical concrete wall. Rip rap has been

placed in the stream bed at the base of the wall. Road and bridge construction was underway.

South of that, roughly 2000 feet of riparian corridor on both banks has been thinned and/or removed from both stream banks. Minimal erosion control practices were in place. This former agricultural land was for sale at the time of the assessment.

Causes of impairments are siltation, flow alterations and other habitat alterations. Sources include flow regulation/modification, urban runoff/storm sewers, removal of riparian vegetation, and streambank/stream channel modification.

Sub-basin 13

This sub-basin contains a single creek that arises in the vicinity of Rupp Farm Road, where it appears to be piped underground. At Union Center Road, the channel has been straightened, but has natural banks. It varies in width from 1.3 to 1.7 yards; it is about 6" deep on the upstream side and 16 to 18" deep downstream. The water was turbid, and there was moderate erosion of the stream banks.

Above Rupp Farm Road, there is vacant land wither side of the creek where a stormwater management facility or wetland could be constructed. On the other side of the road, the land is agricultural, so there is additional room from stormwater management and wetland facilities. These types of facilities would be beneficial, as the stream exhibits peak flow problems.

The only other location where this creek was observed was in an industrial park south of West Chester Road. The channel here has been ditched, with rock groins spaced every other side of the creek at intervals of about 20 yards. This appears to have been effective in slowing down flows and preventing erosion. Some cattails were growing in and along the channel. Red-osier dogwood and witch-hazel shrubs have been planted within the high flow channel, and a single row of trees has been planted at the top of bank. The wetted channel when observed was 2.5 yards wide and about 16" deep; the bankfull channel was 20 yards wide and 6 yards deep. The water was turbid, indicating upstream flow problems.

In 2004, restoration project efforts, including tree plantings, were noted at the industrial park in the southwestern portion of the sub-basin. No additional assessment was conducted. Causes of impairment are flow alterations, other habitat alterations, siltation and nutrients. Sources include agriculture, flow regulation/modification and channelization. (Note: Since the 2004 assessment, construction of ballfields has begun

north of Union Centre Boulevard and west of Beckett Ridge Road. A new commercial strip mall is being constructed along the southern side of Union Centre in the same area. Construction activities can be added to potential sources of impairment.)

Sub-basin 14

This sub-basin was defined as the main stem of Mill Creek from Seward Road downstream to the confluence with East Fork Mill Creek.

Downstream of Seward Road, the creek has been channelized, but has natural banks. A berm along the north bank of the creek prevents it from flooding adjacent agricultural land. The southern bank has probably been raised as well to protect agricultural land. If some of the agricultural land could be secured or an agreement reached with the landowner, this would be an excellent location to breach the berms so that peak runoff would have access to the natural floodplain.

The next direct observations of Mill Creek were downstream at the overpass upstream of Highway 747. At this point, the creek is channelized and confined between the railway tracks on the south and a berm protecting agricultural land on the north. Less than half a mile upstream, the creek is not confined by a berm, and has access to its floodplain and wetland habitat. South of the tracks, both upstream and downstream of the road, there are large swamps and wetlands that normally would have been part of the creek's floodplain.

There are significant opportunities here to breach the berm and allow the creek access to the floodplain. This opportunity extends upstream to Seward Road and a considerable distance downstream. In addition, there may be sites where openings can be created under the railway so that the creek is connected to the adjacent wetlands under high flow conditions. Within the agricultural lands, there are opportunities to create wetlands to assist in assimilating excessive nutrients. If the hydrology of the creek through this area is allowed to progress naturally, wetland communities are likely to form on their own.

North of Mulhauser Road and east of the creek, there is a large stormwater management pond. This is a wet facility, and water levels fluctuate over 10' in it. This facility controls quantity of water flowing out of an adjacent industrial park but, other than removal of solids, likely does not improve water quality significantly. There may be opportunities to retrofit it and create a wetland cell that polishes water quality.

This stormwater management facility may preclude opportunities to connect the creek to its floodplain to the east north of Mulhauser. There is an agricultural field west of the creek and east of the railway track, and the creek is separated from this area by a berm. It may be possible to breach this berm to allow flood waters into this area. This would eventually result in the creation of wetland habitat that would help improve water quality. Ideally, some areas would be opened underneath the railway tracks to allow the creek to flood into the swamp on the other side of them.

Downstream, the creek is confined within berms 3 to 4 yards high. The eastern berm is slightly lower, and it appeared as though some water had spilled from the creek into the adjacent field. There is opportunity to breach the berm on both sides to reduce peak flows. If this is possible, wetland communities could be established here to improve water quality.

At the confluence with East Fork Mill Creek, the main stem is about 25 yards wide, and there is significant shoreline erosion. In the area between the two branches of the stream, there is a large, abandoned agricultural field that is in the order of 40 or 50 ac in size. This is an excellent area for creation of a series of stormwater management facilities and constructed wetlands. There is sufficient room that significant improvements in water quality could probably be realized, as well as shaving off peak flows.

As has been done with the lower portion of the East Fork, the main Stem of Mill Creek would benefit from in-stream weirs and erosion control measures.

In 2004, two stream crossings were observed: the first at the Port Union Railroad tracks and the second at Mulhauser Road west of Allen Road. Under the Rosgen classification, both crossings were F-type channels. Exposed roots were noted as the site was experiencing moderate to severe erosion. Channel was entrenched and the water was green and cloudy. Also noted was new industrial development on the east side of Highway 747 adjacent to the Liz Claiborne restoration site. There was evidence of beavers; frogs and minnows. The Liz Claiborne site and Cassinelli property are restoration sites in this sub-basin

The Mill Creek is highly channelized throughout much of this basin. The overall length of the southwest trending, channelized portion of the stream in the UMC watershed, starting at Seward Road and continuing to Rialto Road in sub-basin 14, is approximately 16,000 feet in length. The channelized stream takes a 2700-foot jog to the south at this point then continues to the southwest for 3300 feet until it reaches Interstate I-75. This feature is readily visible on both paper maps and aerial photographs.

The north and central portions of this sub-basin, between Route 747 and Mills Road has continued its conversion from agricultural to residential/commercial/industrial land use. The north-western corner is adjacent to the residential development areas in Sub-basin 9. It appears that this residential development will continue in this sub-basin as well. Stormwater management ponds typically occur on the larger newly developed properties.

Heavy commercial, industrial and retail development is continuing in the east central portion of the sub-basin (on both sides of the Union Centre Boulevard/I-75 interchange). Former agricultural properties in the remaining open areas are slated for development. Figure 7.6 shows development in the central portion of the basin.

Figure 7-6 View of commercial and retail development south of West Chester Road in Sub-basin 14. (2004 photo)

Stormwater management ponds are in place in the developed areas. Some areas under current development showed signs of poor runoff control – muddy roads and dirty runoff in drainage ditches. Runoff from these areas flows to either the Mill Creek Main Stem or the East Fork Mill Creek (along the central-eastern edge). The interchange itself has been landscaped including the use of pervious pavers in drainage ditches from the freeway exit and entrance ramps.

The southwestern portion of this sub-basin is older commercial/industrial land use with in-fill development occurring throughout.

Causes of impairment are flow alterations, nutrients and other habitat alterations. Sources include flow regulation, modification, construction/development, agriculture and channelization.

7.5.2 East Fork Mill Creek

The East Fork of Mill creek has been subdivided into three sub-basins: two that arise to the east and the lower part of the main portion of the East Fork.

Sub-basin 15

This is the northern branch, and it also originates the farthest east, on the other side of Cincinnati-Dayton Road, where it appears to be piped underground. The first station in this sub-basin was just downstream of here at Bluebird Drive. The creek is 1.3 to 1.7 yards wide and 3 to 4" deep here, with lawn on both sides of the creek to top of bank. At the junction of Cox and Barrett Roads, the creek is 2 yards wide upstream and widens to 4 yards after flowing over a 15-yards long area where the substrate and banks have been cemented into place. Although there appeared to be less flow at this location, water levels had been 1' higher.

Another tributary arises south of Toddy Avenue. This stream flows through yards here and is 12 to 18" wide and 4" deep, with some cattails and purple loosestrife in the high flow channel. At Brookdale, this tributary receives another little stream that is .5 to 1 yards wide and 2 to 6" deep. Upstream of the road, the creek runs into a drop structure and it is piped downstream.

At Ridgecrest, the two main headwater tributaries have joined. The upstream channel appeared to be natural, although it may have naturalized. The channel at this point is about 5 yards wide and 2 to 3" deep. This is the only area in Upper Mill Creek where exposed bedrock was observed in the stream bed. The creek runs over a natural bedrock waterfall about 2.5' high into a natural pool 18" deep. Downstream of the road, the channel widens to 6 to 15 yards, with depth of 6 to 18".

Downstream of here, the creek flows through an extensively-forested area where there is a high gradient. The main creek was observed off of Barrett Road. The channel is natural here, but severely eroding due to the high gradient combined with high peak flows. At this point, the stream splits

into two channels, each about 3 yards wide and 15" deep and running rapidly. The bankfull channel was 20 to 25 yards wide and 1.5 yards deep. There was evidence that the channel had been overtopped recently. Another tributary enters from the north at this point. It also was severely eroded. The wetted channel was 2 yards wide and 6 to 8" deep, but the bankfull channel was 10 yards wide and 2 yards deep.

Another tributary arises north of I-75, and was observed at Lesourdsville-West Chester Road. The channel here appeared to be natural, and was 2.5 yards wide and 4 to 14" deep upstream of the road, and 4 yards wide and 4" deep downstream. There was evidence that flows had been 16" higher. There is a triangle of agricultural land north of the road between the creek and I-75 that may be suitable for a stormwater management / wetland facility. There are also agricultural lands east of the creek that may also be suitable.

A station at Cincinnati-Dayton Road was on the main stem of the creek entering from the east. The creek through this reach had been straightened and mostly naturalized, although rocks had been placed in some areas along the shorelines above the road. The creek here was about 8 yards wide and 8 to 12" deep.

At West Chester Road, the upstream channel was 3 yards wide, but widened to 10 yards just above the bridge. Water depths were about 6" upstream and 1.5' at the bridge. The upstream channel had significant erosion. Downstream, the channel was 8 yards wide and 16 to 18" deep. The eastern shoreline had been hardened with stones for a short distance, and there was moderate erosion downstream of the bank protection.

North of West Chester Road and east of the creek, there is a shrubby old field that is a potential site for a stormwater management facility.

The downstream station in this sub-basin was at Union Center Boulevard. Upstream, the channel has been straightened but naturalized, although some large boulders have been placed near the bridge and along a bend on the east bank. The channel was about 8 yards wide and 12 to 16" deep, and exhibited moderate erosion. Downstream of the road, the channel makes a 90 degree turn into a high bank of gabion baskets. The channel on this side was 4 yards wide and 8 to 12" deep.

This sub-basin has some problems associated with high peak flows and erosion. Part of the problem is probably due to the development in the headwater area, but there are also areas of high gradient that contribute to erosion. Unfortunately, there are very limited opportunities to remedy these conditions on the main stem of this tributary.

In 2004, no additional assessment was conducted. Causes of impairment are flow alterations and siltation. Sources include agriculture and flow regulation/modification.

Sub-basin 16

This sub-basin consists of three small tributaries that join together along West Chester Road.

The northern tributary was observed only at Revere Run. Upstream, it runs through a yard where it has been channelized and has a cement bottom and mortared rock walls. The channel is 1 yards wide and 16" deep. The downstream channel is naturalized and about 1 yards wide and 4 to 6" deep.

The central tributary was also observed at only one station, at Wintergreen Drive. The channel was naturalized, although the 25 yards above the road had concrete slabs places along the banks and in the channel. Despite this, moderate erosion was occurring. The channel here was 1.5 to 3 yards wide and 8" deep. Downstream, the channel was more natural with no erosion. The channel was 2 yards wide and 8 to 12" deep.

The southern tributary arises east of Minuteman Way. The channel appears to be natural upstream of this street. The wetted channel was 1 yards wide and 2" deep, but had eroded to 2 yards wide and 16" deep. Downstream of the road, the wetted channel was 1 yards wide and 4" deep in a bankfull channel 3 yards wide and 2.5 yards deep. Erosion here was minor. Downstream at Hadley Drive, this tributary was piped.

At West Chester Road, the creek was observed downstream of the confluence of the northern and central tributaries, but upstream of the mouth of the southern tributary. The creek here is 1.5 to 2 yards wide and 4 to 12" deep. Erosion was moderate upstream of the road and minor downstream. The downstream bankfull channel was about 8 yards wide and 2 yards deep; there was evidence of it being full recently.

On the north side of the road, there is a small park (3 to 4 ac) along the creek. This area could possibly be used for a stormwater management facility.

The final station on this stream was at Cincinnati-Dayton Road, and all three tributaries have merged considerable distance upstream from this. The creek was naturalized with a channel 2.5 yards wide and 8" deep at this point. Another small stream that is not on the base map enters from the east at this point. It was also a naturalized channel, and was 1.5 yards wide and 2 to 3" deep.

This sub-basin also experiences high peak flows, and there are very limited opportunities to deal with them.

In 2004, no additional assessment was conducted. The cause of impairment is siltation and the sources are removal of riparian vegetation and construction at the western end near the Union Centre interchange retail development.

Sub-basin 17

This is the lower stem of the East Fork, from Allen Road downstream to the confluence with the main stem of Mill Creek.

At Allen Road, the upstream channel was 7 yards wide and depth could not be determined due to turbidity. There are stormwater management facilities on with side of the creek on the upstream side. Below the bridge, the channel was 13 yards wide with a depth of 12 to >18". Forty yards downstream of the bridge, the channel narrowed to 6 yards at a riffle.

At Windisch Road, the creek was still flooding when observed. The channel was about 25 yards wide and of unknown depth, but normal channel width was about 10 yards. Downstream, there are stormwater management ponds on the floodplain east of the creek, and this area was currently being stripped, presumably for development.

The last area observed in the main stem of East Fork was south of the industrial park down to its mouth at Mill Creek. Extensive restoration has occurred in this reach. A series of in-stream weirs has been constructed and shoreline erosion control has been undertaken. Shoreline plantings consist of live stakes, red-osier dogwood, basswood, sycamore, and honeysuckle. Some rocks have been placed to help stabilize stream banks.

The weirs have been effective in creating a series of pools and riffles, and the planting have greatly improved bank stability. Nonetheless, significant erosion is still occurring, particularly around a sanitary sewer manhole in the creek.

This reach of the stream was observed on April 4, 2001 as well as on December 20, 2002. During the first visit, dry-weather flows were experienced. The wetted channel was about 10 yards wide, flowing over a gravel substrate. The last visit was on a day following a 2" rain, and the wetted channel was 20 yards wide, but still confined within the stream banks. It was evident that some minor overflow of the west bank had occurred the previous day.

As mentioned in the discussion under Sub-basin 14, there is a large, abandoned agricultural field at the confluence of the main stem of Mill Creek and East Fork Mill Creek. This provides an excellent opportunity for construction of a series of stormwater management facilities and wetlands.

In that one of the concerns in UMC is nutrient loading from the water pollution control plant during low flow periods, it may be possible to divert low flows to a constructed wetland system to polish water quality before release to Mill Creek.

In 2004, commercial/retail development was taking place in the northwestern corner of the sub-basin (near the Union Centre/I-75 interchange. A large theatre, restaurant and shopping complex have been built along the western bank of the East Fork Mill Creek south of Union Centre Boulevard. Roughly 100 linear feet of gabion walls have been built along the streambank on the north end of this project. (Figure 7.7 shows the gabion walls under construction.) Two more phases of this development are planned to extend the project south to Allen Road. A mixed-use upscale residential/retail development is planned along the eastern bank of the East Fork in this area. This would impact roughly 2000 feet of the East Fork Mill Creek.

The causes of impairment are nutrients and siltation. The source is removal of riparian vegetation, stream bank modification and development.

Figure 7-7 Gabion walls on East Fork Mill Creek at north end of Union Centre/Streets of West Chester development

7.5.3 Beaver Run

Although two small tributaries originate in the south, the entire Beaver Run system has been treated as a single watershed.

The main stream originates about half a mile west of Highway 4 and just north of I-275. It was first observed at Glensprings Drive. The stream here appeared to have been channelized, but had relatively natural banks. Some large boulders had been strewn along the banks and in the stream bed. About 15 yards upstream of the culvert, the creek flows over a concrete apron. The channel was 1 to 2 yards wide and 6" deep. There was evidence that flows had been 18" higher, so peak flows may be a problem right from the headwater area.

A small tributary originates south of Underwood Park and Grondin. The stream has been channelized through the park, but has natural banks with lawn to top of bank on both sides. The channel was .75 yards wide and had water depths of 2 to 4". The banks were eroded, and the channel was 1' deep. There was evidence that the stream banks had been overtopped recently. Downstream of the road, the creek is piped underground for about 30 yards, and then it emerges in the church yard.

There is opportunity to construct a stormwater management pond and wetland facility in the park.

The creek then flows through the lawn on the property of the Springdale Presbyterian Church. The channel is naturalized after being straightened, but there is mowed lawn to top of both banks. The channel was .5 to 1 m wide and flowing 3 to 4" deep. There was evidence that flows had been at least 1 yard higher, indicating problems with peak flows.

There is opportunity for another stormwater management pond and wetland facility on the church property north of Kemper West Road.

Downstream of the road, the first 15 yards of the creek had the stones in the substrate and banks cemented into place. Below that, the channel was 3 yards wide and 6" deep.

Upstream of Cloverdale Avenue, the stream is naturalized and the channel was 2.5 yards wide and 2 to 3" deep. Erosion varied from slight to moderate. There was evidence that flows had been at least 18" higher. Downstream, there was a pool at the culvert 4 yards wide, 15 yards long, and 2 to 4" deep. Below the pool, there was a series of riffles and pools, with the channel narrowing to 1 to 1.5 yards with a depth of 4"

This same tributary was observed at its mouth at Glensprings Drive down to the Dixie Highway. Upstream of Glensprings, the channel was concrete, about 2.5 yards wide and with walls 1.5 yards high. When observed, the flow was ½ to 1" deep over the cement. Downstream of Glensprings, the channel had natural banks, although it had probably been straightened. It was 0.5 to 1.5 yards wide and 4 to 6" deep, with significant erosion on the west bank.

This tributary has high peak flow problems, but there may be opportunities to remedy some of the problems through stormwater management facilities near the headwater.

The main stream of Beaver Run was observed at the Dixie Highway where the tributary from the south flows in. Upstream at the confluence with the tributary, the channel had been straightened, but was naturalized. It was 2 yards wide and 2 to 6" deep, but there were signs that flows had been 1 yards higher. The presence of green algae below the confluence suggested high nutrient levels.

Downstream of the highway, the creek empties into a pool 12 yards wide and 20 yards long, with unknown depth. Below the pool, the channel narrows to 6 yards with a depth of 6 to 12". The banks were stable, but covered with concrete slabs.

The main stream was observed again at Neuss Avenue, west of Highway 747. At this point, the channel was 4 yards wide and 6" deep, with no to negligible erosion. There was evidence that flows had been at least 1 yard higher.

Another tributary arises south of Kemper Road. Upstream of the road, the channel is naturalized and ranges for 1 to 4 yards wide and 2 to 6" deep. The bankfull channel was about 12 yards wide and 2.5 yards deep. There was evidence that the stream had been running close to bankfull recently. Downstream of the road, the creek empties into a pool 2.5 yards wide, 15 yards long, and 16" deep, then goes into a series of riffles. The west bank was armoured with stone, cement, and a wooden wall, but erosion was occurring above the wall.

The final station observed in the Beaver Run Watershed was on the main stream at Chesterdale Road. Upstream of the road, the wetted channel was 3 yards wide and 8 to 16" deep. The north bank above the culvert was stabilized with cemented sand bags. The bankfull channel was approximately 20 yards wide and 2.5 yards deep, suggesting much higher flows. Downstream of the road, the wetted channel was 3 to 6 yards wide and 8 to 16" deep. The north bank was hardened with rocks 3' high, and

the bank was lined with rock inside this wall. The south bank was lined with concrete slabs. The bankfull channel was about 22 yards wide and 2.5 to 3 yards deep. There was evidence that the channel had been overtopped on the south bank.

Beaver Run has a problem of high peak flows throughout the watershed. In concert with high flows, there are some erosion and water quality problems. With the exception of the first tributary flowing in from the south, there are very limited opportunities to control flows and improve water quality.

One possibility is the potential for the stormwater management facilities and wetlands at the confluence of the main stem of Mill Creek and East Fork Mill Creek. This is downstream of the mouth of Beaver Run, so facilities here could help ameliorate flows out of Beaver Run.

The area in the vicinity of the mouth of Beaver Run was not observed. There may be an area on the floodplain where it is possible to construct wetlands or stormwater management facilities.

In 2004, the Champion Window site, northeast of the intersection of I-275 and I-75, was characterized by moderate to severe erosion. There was minimal tree canopy and light sedimentation. Under the Rosgen classification, the creek appeared to be an F-type channel. Point bars and meanders were evident.

A streambank stabilization project along Beaver Run near Chamberlain Park in Springdale has been successfully completed since the 2002 assessment. The stabilized area and Beaver Run are Bioengineering techniques were used to stabilize streambanks to address severe erosion threatening nearby homes. Water quality and aquatic habitat improvement were noted on a stream-walk in June 2004. Figure 7.8 shows the stabilized stream section.

The causes of impairment in this sub-basin are nutrients and siltation. The source is removal of riparian vegetation.

Figure 7-8 Completed Beaver Run 2004 streambank stabilization project

7.5.4 Conclusions: Field Assessment

The creek as a whole is degraded in locations. Problems are associated with high peak flows, low base flows, degraded water quality, lack of riparian cover, and encroachment into the floodplain. There are also site-specific problems such as channel hardening, barriers to movement of aquatic life, and stream-bank erosion.

Conditions in UMC are generally much better than in the Mill Creek watershed as a whole. There are still, however, some problems. Remediation of these problems will not only improve aquatic habitat in UMC, but also in downstream areas. Much of UMC is residential land uses, so that floodplain encroachment is much less of a problem than in some other watersheds of Mill Creek. Butler County has developed more recently than some reaches of Mill Creek. Consequently, there have been opportunities to install stormwater management facilities that help regulate stream flows.

One problem appears to be high peak flows. These, in turn, cause localized erosion problems and increase nutrient concentrations through

phosphorus attached to sediments. The high flows also result in widening of stream channels and scouring of the substrate. This results in very shallow water in the channel under baseflow conditions, and a structurally simple channel with limited pools and riffles. These modifications to the stream channel result in a lower diversity of invertebrate and fish species, and the low baseflow in widened channels contributes to warmer water temperatures, again limiting the number of species capable of in habiting the stream.

There are a variety of other problems within UMC. Uncontrolled flows result in inputs of nutrients and other materials from non-point sources. In at least two locations, cattle wastes may be entering the creek system.

Much of the main stem of Mill Creek has been bermed so that flows are confined within a narrow, straight channel. This has several implications. This increases downstream water velocities and flows, as the creek cannot spill onto its floodplains during flood events. It is also detrimental to some of the wetlands that are on the floodplain, but separated from the creek. Flooding in riparian wetlands is a natural phenomenon that delivers critical nutrients to wetland communities. It also inhibits succession of wetland communities to more upland species or invasion by non-native species such as honeysuckle and buckthorn.

The amount of woody riparian cover is low in many reaches of the watershed. Riparian cover is important as it helps filter contaminants out of surface water and shades watercourses. In headwater areas, nutrients in the form of leaves are important. Lacking riparian cover, headwater areas may be fairly sterile and completely lacking in the group of benthic invertebrates that rely on terrestrial leaves for food. Large woody debris in streams is also important in providing shelter, and it often affects flows and creates pools. Even though riparian cover is important, provision of additional riparian cover is considered a relatively low priority compared to moderating flows.

Although the above may seem like a long list of problems, Upper Mill Creek is generally in much better health than downstream watersheds. In addition, there are significant opportunities for restoration in UMC, while opportunities in southern watersheds are more limited due to existing land uses.

There appear to be two very significant opportunities for restoration with Upper Mill Creek, but considerable study may be required to determine their feasibility. They are construction of a series of large stormwater management/wetland facilities at the confluence of the main stem of Mill

Creek and the East Fork, and reconnecting the main stem of Mill Creek to its floodplain. Although the area around the mouth of Beaver Run was not observed, there may be opportunities for restoration in this area.

Facilities at the confluence offer real promise, particularly if wetland polishing cells are possible. This will particularly important for the East Fork, where summer low flows and nutrient concentrations are a concern. Although facilities in this area are of very high priority, if possible, it is necessary to understand the entire system before deciding on the design. Each sub-basin above here should be examined to determine how realistic the opportunities are and what benefit they will have for water quality and quantity. For instance, there appear to be numerous opportunities in the main Mill Creek basin for constructing wetlands and stormwater management facilities, reconnecting the creek to its floodplain, and retrofitting existing facilities to improve water quality. If most of these can be realized, there would be not be as much need to treat quantity and quality of the main stem of Mill Creek at the confluence. On the other hand, there appear to be few good restoration opportunities on the East Fork, and perhaps facilities at the confluence should be dedicated to flows from this sub-basin.

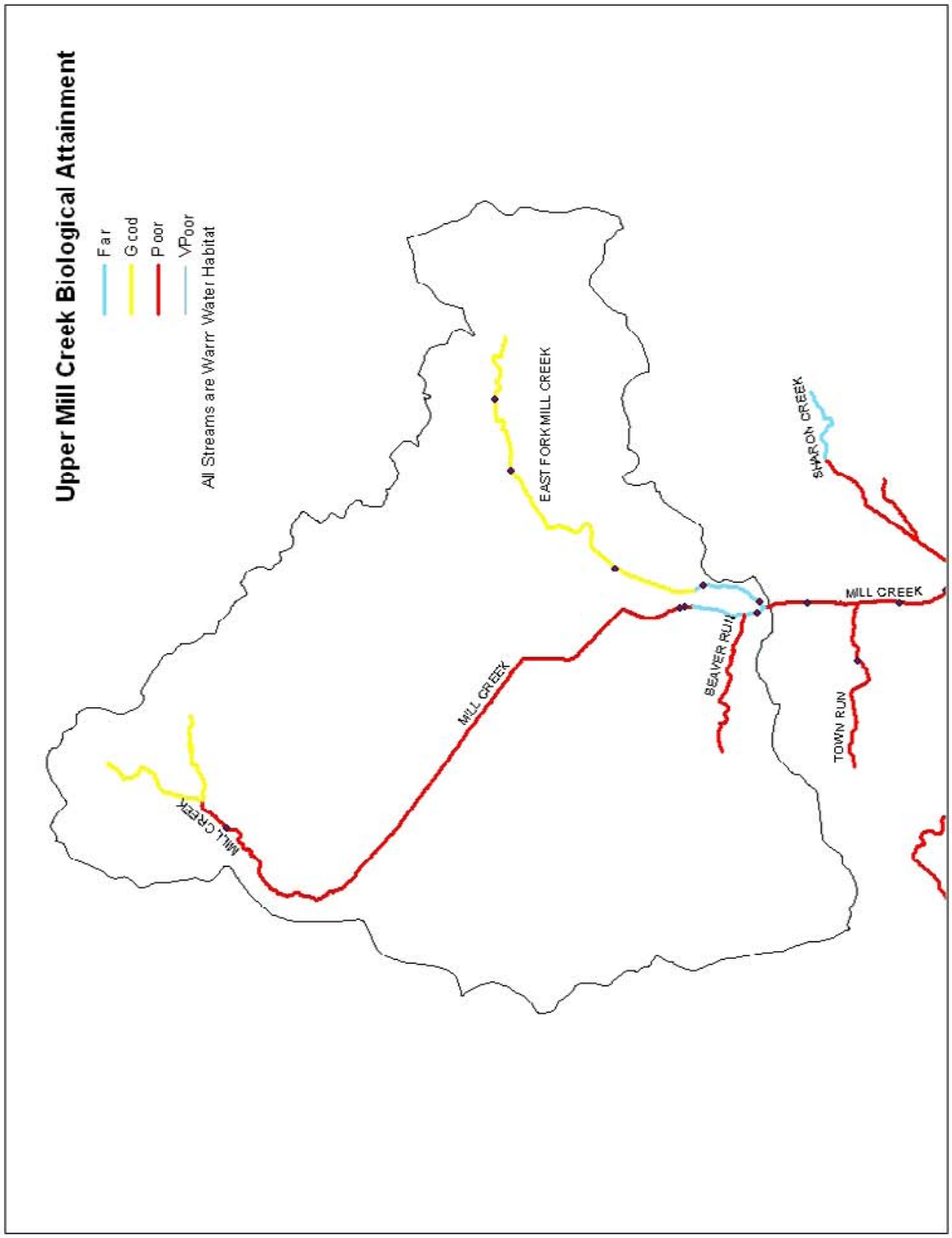
Connection of Mill Creek to its floodplain should be a high priority, but it is realized that this may not be feasible in many areas. Where the creek will have access to existing wetlands that have been cut off from the creek, it should be determined what impact additional water will have on existing vegetation communities. For floodplain areas currently in agricultural uses, the type of wetland communities most desirable should be planned. In some areas, it may be useful to split the floodplain into cells where water levels and flows may be manipulated. This would allow controlled treatment of water quality by wetland plants and also has the potential to provide significant wildlife habitat.

The greatest emphasis should be on projects that improve creek flows or water quality. However, site specific projects such as erosion control, barrier removal, riparian plantings, and in-stream weirs and other habitat features should not be ignored. These are all beneficial at a local level and cumulatively contribute to the overall health of the watershed.

There are excellent restoration opportunities within the Upper Mill Creek Watershed. If a high proportion of these come to fruition, water quality and flow regimes within Butler County will be greatly improved. These improvements will also be beneficial to downstream areas of Mill Creek.

7.6 APPENDIX F: USE DESIGNATION AND ATTAINMENT STATUS

Source: Ohio EPA Southwest District Office, 2005



7.7 APPENDIX G: Predicted percentage change in pollution load by sub-basin based on land use model

	Sub-basin	Load under existing conditions				Load under proposed conditions				Change	Change	% Change	
		N (lb/yr)	N (kg/yr)	P (lb/yr)	P (kg/yr)	N (lb/yr)	N (kg/yr)	P (lb/yr)	P (kg/yr)	N (kg/yr)	P (kg/yr)	TP	TN
Main Stem	1	3,442	1,561	454	206	3,672	1,666	495	225	104	19	9.0	6.7
	2	4,851	2,200	634	288	5,345	2,424	721	327	224	39	13.7	10.2
	3	4,952	2,246	649	294	6,807	3,088	779	353	841	59	20.0	37.5
	4	7,527	3,414	780	354	19,400	8,800	1,791	812	5,386	459	129.6	157.7
	5	13,430	6,092	1,426	647	13,841	6,278	1,299	589	186	-58	-8.9	3.1
	6	22,574	10,239	2,196	996	28,833	13,078	2,150	975	2,839	-21	-2.1	27.7
	7	9,101	4,128	1,128	512	12,437	5,641	1,290	585	1,513	73	14.4	36.7
	8	11,271	5,112	1,201	545	15,365	6,969	1,229	557	1,857	13	2.3	36.3
	9	3,356	1,522	274	124	11,076	5,024	866	393	3,502	269	216.1	230.0
	10	2,514	1,140	261	118	3,451	1,565	327	148	425	30	25.3	37.3
	11	25,588	11,607	2,676	1,214	28,835	13,079	2,435	1,104	1,473	-109	-9.0	12.7
	12	19,036	8,635	2,463	1,117	17,146	7,777	2,208	1,002	-857	-116	-10.4	-9.9
	13	3,128	1,419	339	154	8,533	3,871	727	330	2,452	176	114.5	172.8
	14	34,403	44,138	3,646	4,262	58,032	26,323	5,252	2,382	-17,815	-1,880	-44.1	-40.4
			103,454		10,830		105,584		9,784	2,130	-1,047	-9.7	2.1
East Fork	15	19,966	9,056	2,396	1,087	21,855	9,913	2,498	1,133	857	46	4.3	9.5
	16	10,542	4,782	1,121	508	14,915	6,765	1,465	665	1,984	156	30.7	41.5
	17	9,879	4,481	1,050	476	11,494	5,214	1,232	559	733	83	17.3	16.3
			18,319		2,072		21,892		2,356	3,573	285	13.8	19.5
Beaver Run		43,607	19,780	3,946	1,790	45,653	20,708	3,913	1,775	928	-15.0	-0.8	4.7
			141,553		14,692		148,184		13,915	6,631	-777	3.2	26.3

Table 12. TMDLs and allocations for the Mill Creek watershed*

Sub-water-shed	Existing Conditions			Percent Reduction	TMDL	TMDLs for existing discharge flow			TMDLs for point sources at design flow		
	NPS	PS**	Total			Natural	WLA***	LA	Natural	WLA****	LA
Dissolved Nitrogen (kg/year)											
1	28840	61260	90100	24%	68476	13980	46558	7938	13980	74195	7938
1+2	42860	63250	106110	13%	92316	20940	55028	16348	20940	82665	16348
3	Existing concentration is below target level; therefore, No reduction is necessary										
1+2+3+4	Existing concentration is below target level; therefore, No reduction is necessary										
Total	Existing concentration is below target level; therefore, No reduction is necessary										
Total Phosphorus (kg/year)											
1	18530	23200	41730	88%	5008	540	2784	1684	540	5548	1684
1+2	24520	24447	48967	67%	16159	860	8067	7232	860	13184	7232
3	Existing concentration is below target level; therefore, No reduction is necessary										
1+2+3+4	33400	24447	57847	42%	33551	1250	14179	18122	1250	18989	18122
Total	35900	24447	60347	34%	39829	1310	16135	22384	1310	20840	22384

* The CSOs, SSOs loadings are not included (see Section 4.5).

** Upper Mill Creek and Glendale WWTPs Mean annual reported value (1994 to 2001). Assume Glendale WWTP has TP concentration as Butler County.

*** To achieve this WLA at existing condition (8 MGD discharge flow for Upper Mill Creek WWTP and 0.5 MGD for Glendale WWTP) dissolved N should be limited to 4.2 mg/l, and TP should be limited to 0.25 mg/l.

**** Butler County WWTP has a design flow of 16 MGD. To maintain the nutrient target values, the nutrient concentration in the final increased discharged flow from existing to 16 MGD may have to be limited to target values (dissolved N 2.5 mg/l, TP 0.25 mg/l).

7.9 APPENDIX I: 2003 Non Point Source Load Reduction Report

EXCELLENCE IN ENVIRONMENTAL CONSULTING SERVICES

XCG File #6-1628-01

DRAFT REPORT

MILL CREEK
TMDL
NONPOINT SOURCE POLLUTANT LOAD REDUCTIONS

June 9, 2003

Prepared for:

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6/13/03

Full report available from the Mill Creek Watershed Council of Communities Office – 513-563-5800

Appendix D: Upper Mill Creek Action Plan Matrix – 2003 Draft

WATERSHED OBJECTIVES	Action Item	Deliverable	Implementation Leader(s)	Year 1	Year 2	Year 3	Year 4	Year 5
1. Water Quality and Habitat 1.1 Develop healthy stream & aquatic communities 1.2 Improve water quality in man-made ponds (e.g. Detention basins, farm ponds, etc.) & develop healthy pond aquatic communities 1.3 Meet water quality standards and use designations 1.4 Control discharges from wet weather sources 1.5 Control discharges from other sources 1.6 Maintain community health by meeting contact recreation goals in surface water bodies	a. Educate local decision makers (including planning and zoning officials, park officials, golf course managers) about storm water/water quality BMPs that can be implemented locally to improve local surface water and sediment quality.	Make presentations at 100% of the local jurisdictions	MCWC Butler County Department of Development	Locate existing BMP fact sheets, guidance & training that are appropriate to SW Ohio	Distribute storm water fact sheet to local planners & decision makers. Presentations to appropriate local officials.			
	b. Educate homeowners association (HOA) and commercial property owners about storm water/water quality BMPs that can be implemented locally to improve local surface water and sediment quality.	Begin outreach to homeowners association (HOA), homeowners and commercial developments.	BCEO w/ assistance of local communities and MCWC	Develop educational program	Outreach through Township newsletters, web site, HOA newsletters	Continued outreach. Complete inventory & develop a workshop designed for HOAs		
	c. Identify storm water management structures for demonstration retrofits to include water quality BMPs where feasible.	Demonstration projects of retrofitted stormwater management structures stormwater within the next 5 years, subject to available funding.	Coordinated effort by local communities on a voluntary basis.	Research retrofits in other areas that may be applicable to Southwest Ohio.	Identify and inventory storm water management structure retrofit opportunities (schools and municipal properties as potential site locations)	Identify funding sources for demonstration site(s)	Implement retrofits (public or private) and continue to look for funding	
	d. Educate sub-basin property owners about & promote use of "on-lot" water quality BMPs thru distribution of educational materials/demonstration sites.	Implement "on-lot" water quality BMPs on sub-basin properties. Track participation, educational materials distributed and practices implemented. Enhance Butler SWCD's Land Lab program with area schools.	MCWC, OKI, BCDES, BC SWCD, BCEO	Locate existing fact sheets & guidance related to "on-lot" BMPs appropriate to conditions in the sub-basin. Conduct surveys (SASE), use photos	Distribute educational materials to residents & property owners through newsletters, websites, municipal offices, libraries, permit offices, newspapers, & public access TV. Train appropriate municipal & township employers. Conduct field days to educate public about BMPs			

Appendix D: Upper Mill Creek Action Plan Matrix – 2003 Draft

WATERSHED OBJECTIVES	Action Item	Deliverable	Implementation Leader(s)	Year 1	Year 2	Year 3	Year 4	Year 5
	e. Develop a sensitive areas protection plan (riparian corridors, wetlands, etc)	Sensitive Area Protection Plan	Metroparks with assistance of MCWC (and interns)		Research existing sensitive area plans	Develop an inventory of sensitive areas	Incorporate sensitive areas plan in greenways system, riparian corridor and buffer zone (Phase 2) initiative plans	
	f. Reduce and eliminate re-occurring sanitary sewer overflows.	Overall reduction in re-occurring sanitary sewer overflows.	BCDES	Implementation of SSO Reduction and Elimination Plan, implement capital improvements as necessary				
	g. Implementation of a stormwater quality management program to address public education, public involvement, construction BMPs, post-construction BMPs, illicit discharge and detection requirements and good housekeeping for local governments.	Phase 2 implementation in 5 years	BCEO as the Stormwater Management District Butler County; Cities of Hamilton, Forest Park & Springdale.	See Phase 2 Plans for implementation schedule				
2. Flooding/ Water Quantity **2.1** Reduce stormwater impacts and re-establish healthy hydrology	a. Educate sub-basin property owners including homeowner's associations about & promote use of "on-lot" water quantity BMPs thru distribution of educational materials.	Implementation of "on-lot" water quantity BMPs on sub-basin properties.	BCEO BCSWCD	Locate existing fact sheets & guidance related to "on-lot" BMPs appropriate to conditions in the sub-basin	Distribute educational materials to residents & property owners through newsletters, websites, municipal offices, libraries, permit offices, newspapers, & public access TV. Train appropriate municipal & township employers.			

Appendix D: Upper Mill Creek Action Plan Matrix – 2003 Draft

WATERSHED OBJECTIVES	Action Item	Deliverable	Implemen-tation Leader(s)	Year 1	Year 2	Year 3	Year 4	Year 5
2.2 Protect life and property	b. Reduce flood damage during wet weather events	Floodplain buyout program for property owners with repetitive property loss due to flooding	Butler County Department of Development (Planning and Zoning), BCEO in partnership with local emergency management agency.	Obtain information from FEMA on buyout program and develop program for UMC Watershed	Provide information to property owners with repeated flood damage and implement as requested			
3. Erosion and Sedimentation 3.1 Reduce erosion and sediment impacts on habitats and property 3.2 Reduce stream bank erosion 3.3 Control sediment load	a. Correct severe bank erosion problems within the sub-basin where feasible and funding allows.	Implement streambank stabilization and erosion demonstration projects.	BC SWCD, BCDES, MCWC, OKI	Evaluate site-specific data collected and prioritize erosion and sedimentation needs.	Develop plans for demonstration sites and identify funding options.	Secure funding and implement sedimentation and erosion abatement plan		
	b. Educate builders, developers, engineers, architects and planners about erosion and sedimentation issues and how to help prevent/mitigate them	Workshops	BC SWCD, Butler County Department of Development, BCEO	Work with local organizations to identify target audience and content for educational materials	Locate existing educational materials & guidance with BMPs applicable to SW Ohio; coordinate with other sub-basins	Prepare and duplicate educational materials. Make presentations to local professional organizations		
	c. Work with remaining agricultural land users to encourage erosion and sediment control practices	Site contact and conservation plans	BC SWCD in partnership with Farm Bureau, Extension Office, NRCS, MCWC					

Appendix D: Upper Mill Creek Action Plan Matrix – 2003 Draft

WATERSHED OBJECTIVES	Action Item	Deliverable	Implementation Leader(s)	Year 1	Year 2	Year 3	Year 4	Year 5
4. Regeneration and Restoration 4.1 Restore natural features 4.2 Enhance recreational opportunity **4.3** Maintain natural hydrology	a. Create greenway system within the sub-basin	-Port Union-Gilmore Ponds Conservation Corridor -Miami 2 Miami Trail -West Chester's Emerald Bracelet -Liberty Township's Trails Initiative	Coordinated effort on a voluntary basis	Continue with existing greenway development plans, refining and identifying funding and priority sites for acquisition and/or donation. Implement acquisition transactions.		Incorporate results of sensitive areas inventory into plans		
	b. Protect and enhance existing terrestrial and aquatic habitat within the sub-basin.	Acquire land and easements, preserving park lands for regeneration opportunities	Coordinated effort on a voluntary basis	Support greenway initiatives by identifying funding and priority sites for acquisition, easements, and/or donation.				
5. Outreach 5.1 Enhance stakeholder and public outreach programs 5.2 Develop new partnerships	a. Develop new partnerships with schools, businesses and communities.	New partnerships and stakeholders	Coordinated effort on a voluntary basis	Outreach to local officials, schools, professional organizations, FEMA, HOAs, contractors, developers, and others as identified.				
6. Watershed Stewardship 6.1 Improve aesthetics of surface water features 6.2 Enhance stewardship among residents, businesses and property owners 6.3 Establish a watershed framework	a. Establish an informal or formal mechanism for continuing partnership with sub-basin communities	Continued momentum towards water quality improvement	MCWC	Quarterly or Semi-annual meetings to evaluate on-going progress				Meet to re-evaluate WAP
	b. Create a sub-basin report card to establish a baseline and measure and report watershed health.	Report Card	MCWC	Create report card format and establish baseline "grades" based on existing information			Start re-evaluation of sub-basin category "grades"	
	c. Distribute the sub-basin report card as a public education tool for elected officials, residents and property owners	Distributed Report Card	Coordinated effort on a voluntary basis with MCWC assistance		Design completed report card. Copy and distribute to political jurisdictions, post web-based report card.			Revise and distribute updated report card.

Appendix D: Upper Mill Creek Action Plan Matrix – 2003 Draft								
WATERSHED OBJECTIVES	**Action Item**	**Deliverable**	**Implementation Leader(s)**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
6.4 Identify and recognize other jurisdictions	d. Preserve floodplain storage for water quantity/quality activities and recreational opportunities, improving the stream/floodplain connection where feasible.	Improved utilization of floodplain for water quality/quantity and recreational opportunities	Butler County Stormwater Committee	Continue to enforce floodplain regulations and buffer ordinance, continuing with partnerships with parks and recreation to establish greenway corridors				
7. Funding 7.1 Identify and obtain funding sources 7.2 Coordinate funding sources	a. Obtain funding for WAP actions where appropriate.	Implementation Funds for demonstration/pilot projects	Coordinated effort on a voluntary basis	Identify potential funding sources for actions & apply for funding as needed.				