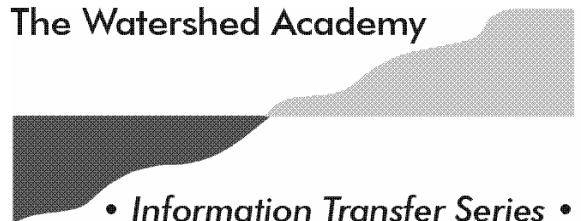




Big Darby Creek Case Study: A Profile of Watershed Threats and Protection in a Midwest Landscape

The Watershed Academy



• *Information Transfer Series* •

**BIG DARBY CREEK CASE STUDY: A PROFILE OF
WATERSHED THREATS AND PROTECTION IN A MIDWEST LANDSCAPE**

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Acknowledgment

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The team is most grateful for the support and assistance of a host of persons, far too many to name here, especially for the extensive time given us in interviews. Teri Devlin and Wes Beery of the Ohio Chapter of The Nature Conservancy were particularly helpful in guiding us to sources of information. We thank you all!

Summary

In late 1996 an EPA team examined the threats to the stream system and watershed context of Big Darby Creek, Ohio, and the responses to those threats over the past 30 years. Big Darby Creek is widely recognized for its environmental health and high biological diversity in a heavily farmed midwest agricultural landscape. The team sought to understand how and why the threats and responses occurred, and how stream quality has been maintained.

Three major threats and responses are presented in this report.

(1) Proposals in the late 60s and early 70s to dam the main stem of the Big Darby would have destroyed or adversely affected large portions of its natural habitat and severely stressed its biota. The threats were successfully countered by an energetic, scientifically informed coalition of citizens and landowners; this was accompanied by successful action by the Ohio Department of Natural Resources to designate Darby streams as a Scenic River.

(2) In 1988-90 agricultural practices that contributed to introduction of nutrients, sediment and pesticides into the stream system and degraded stream corridor habitat and stream flow patterns became perceived to be the greatest threat to the Darby system. In response, considerable effort was made to change agricultural practices by government agencies at both the federal and state level and private organizations. Increased resources produced much action; however, their effect measured in improved aquatic system conditions has not been established.

(3) In recent years suburban residential development and its infrastructure have rapidly increased in parts of the watershed, creating threats of modification of the flow regime of the stream system and increased loadings of sediments, nutrients, and toxics, as well as habitat destruction. Development interests were little involved in Darby protection efforts. These threats did not appear to be under good control, and appeared to be especially serious.

Many factors and forces affected the action taken (or not taken) to respond to these threats to the Darby system. Aiding the response were considerable scientific knowledge, good publicity and knowledge of the special virtues of the system, and many public and private agencies and organizations participated in addressing threats to the Darby, devoting substantial resources to the effort. Both voluntary and regulatory approaches had success in certain cases, but in others, were less successful. Whatever the reason, the stream system and the watershed appear to have held their own through 1996.

I. Introduction

This report presents the results of a 1996 inquiry by an EPA team into the circumstances and events that affected the natural environment of Big Darby Creek and its supporting watershed, just west of Columbus, Ohio. In the inquiry, which covered the 25-30 year period ending in 1996, the team investigated both the threats to the aquatic values and resources of the watershed, and also the way in which watershed inhabitants, organizations and various levels of government responded to them.

The results of the inquiry reported here will, it is hoped, offer insights and information valuable to readers of diverse experience and needs, from different places and institutions, who are engaged in the protection and restoration of watersheds. Every watershed is unique, but threats similar to those experienced by the Big Darby Creek watershed occur in many other watersheds. Comparable responses to threats may produce good results. The report is intended to make the team's experience available for use by a broad audience of readers. Readers will have to consider whether the threats and circumstances of their watersheds are comparable, and the approaches promising.

The report is presented in the following order. Part II introduces the reader to the natural and political setting of the Big Darby Creek watershed, and its special values. Part III is a short account of the events and circumstances threatening and protecting the watershed; it provides an historical framework for detailed discussion later in the report. Part IV elaborates the various kinds of threats the watershed experienced—the stresses affecting the environment and their human sources.

Parts V and VI continue with detailed discussions of the information available to the team. Part V narrates and comments on the major clusters of threats and responses in the watershed: those relating to proposed damming of Big Darby Creek, to agricultural practices and to residential development. It identifies factors and groups involved in creating and responding to particular threats. Part VI then considers such factors and forces (e.g., scientific knowledge, organizations, availability of resources, local government) separately, and comments on their apparent significance in the Big Darby Creek setting.

Part VII adds concluding observations to those already set out in earlier chapters of the report regarding threats, why and how they occurred, and what can be concluded about their containment.

A further word about the information upon which the report is based. The most important element is information obtained in face-to-face interviews conducted by team members. Additional information came from telephone interviews and inquiries and a substantial number of documents. Virtually all of the information relates to the situation and events as they were seen in late 1996. While the persons interviewed were intended to represent a broad sample of information sources and perspective, they were recommended by or through team members' connections. The interviews reflected opinion as well as information. Neither can team members' personal opinions be excluded. The report strives, nevertheless, to present an objective and balanced view of events.

II. The Watershed Setting

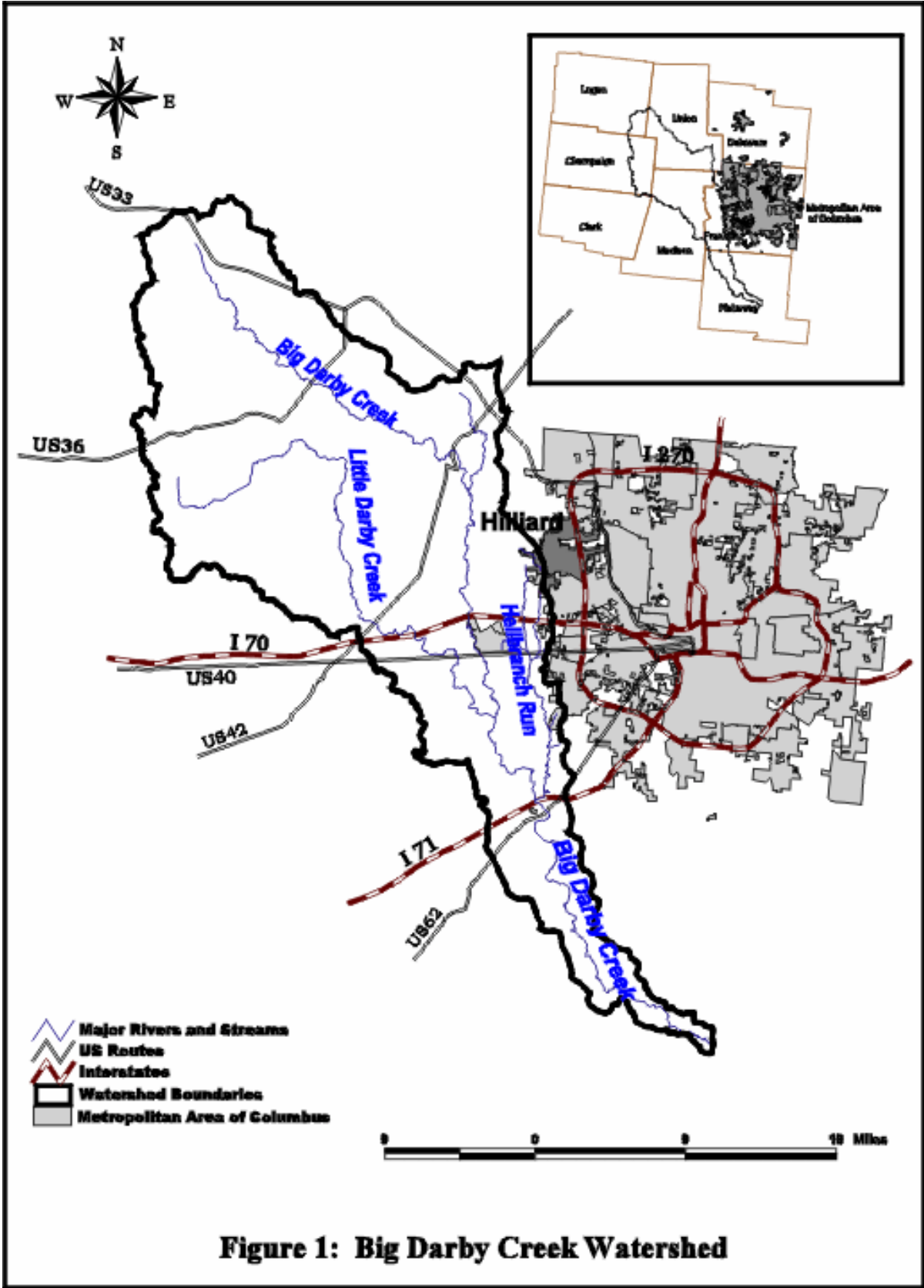
The watershed of Big Darby Creek, 560 square miles in area, lies west of the rapidly growing metropolitan area of Columbus, Ohio. The eastern edge of the watershed is about 10 miles from downtown Columbus. The main stem of the Creek runs from north to south a distance of 88 miles until it joins the Scioto River, which in turn flows south into the Ohio River (see Figure 1). The Big Darby's principal tributary is Little Darby Creek, which joins the Big Darby from the west. Hundreds of miles of smaller tributaries enter Big and Little Darby Creeks. Most of the watershed is flat to gently rolling, with somewhat steeper slopes in some portions, especially to the north in the Big Darby headwaters. The soils vary in composition and quality (mostly silts and clay, with some sand and gravel), but are generally rich. Much of the land drains poorly due to soil composition and low surface gradient.

Settlement of the watershed began in the mid- to late-1700s. Most of the original prairie, savannah and woodlands have long since disappeared. By the mid 20th century the watershed had become almost entirely devoted to farming (about 85 percent in agriculture in 1990, with an additional 7 percent forested). Starting in the latter part of the 19th-century wetlands were drained by ditching and tiling, and converted to agricultural use. Along some parts of the streams' floodplains, particularly in the lower portion of the Big Darby main stem, farmland is protected from flooding by levees.

Land use, although predominantly agriculture (primarily corn and soybean row crops), includes rural towns and residences, an expanding road system, a small amount of industry (notably the Honda complex at the watershed divide at the north end of the watershed), a correctional institution, and rapidly expanding suburban development in the eastern portion of the watershed. Land ownership is almost entirely private.

Big Darby Creek is among the most ecologically healthy stream systems in Ohio and the midwestern Corn Belt. Big Darby and Little Darby Creeks are not pristine, but (unlike most midwestern Corn Belt streams) most stretches have remained in fine condition despite conversion of the watershed to agricultural use, maintaining much of their original character. Character and condition vary from one section to the next. The upper portion of the Big Darby main stem contains more riffles; the central portion features a mix of pools, riffles and runs; the lower portion contains more pools. The stream corridors are forested in considerable part. The natural flow of the main streams is substantially unimpeded by damming. Water quality, biota and aquatic system condition are excellent in large portions of the streams, though impaired in some stretches due to pollutant discharge, surface runoff, ditching, channelization and streambank deterioration. A few tributaries are substantially degraded.

The watershed supports a rich aquatic life (almost 100 fish species and 40 mussel species). Many species are rare. Among them, one fish and two mussel species have been listed as endangered under the Endangered Species Act. The stream and the watershed are highly valued by watershed inhabitants and others for their aesthetic and recreational qualities as well.



The terrestrial portion of the watershed has, of course, changed almost completely, though there is still considerable diversity of flora and fauna and some prairie remnants and their associated plant species continue to exist. Now further change in land use is occurring rapidly. Suburban development and residential building are rapidly converting agricultural land, especially in the eastern part of the Darby watershed. The values associated with an agricultural society are also changing. Pressures on local government are increasing.

Politically, the watershed comprises substantial parts of six counties (and a very small part of a seventh). Approximately 40 township and municipal governments within the counties perform zoning and other functions, and the county governments also play a major role in land use planning, zoning, development approval and other functions that affect watershed protection. Two state agencies, the Ohio Department of Natural Resources (ODNR) and the Ohio Environmental Protection Agency (OEPA), have major resource protection roles in the watershed. Principal federal government agencies contributing to watershed protection include agencies of the U.S. Department of Agriculture, U.S. Environmental Protection Agency (USEPA), and others.

III. Short History of Recent Developments Affecting the Big Darby Watershed

Part III provides a brief narrative framework for the detailed description and analysis of events in Parts V and VI.

Scientific and Analytical Studies. Studies of the fishes and mussels of the Darby streams that disclosed their richness were conducted by Ohio State University (OSU) scientists in the middle decades of the century. Surveys and evaluations of biota (fishes, mussels, macroinvertebrates) by scientists in Ohio state agencies and others continue to the present; they are the major basis for the state's biological water quality standards for the Darby streams. In 1972 the U.S. Fish and Wildlife Service (USFWS) designated the Scioto Mad Tom, a very rare fish once found in the Darby, as endangered under the federal Endangered Species Act. Two mussel species (the Northern Riffle Shell and the Northern Club Shell) have also been designated as endangered. Studies to identify the principal sources of sediment discharge to the stream system have been conducted by OSU faculty and students.

Proposals to Dam the Big Darby and Reaction. There have been three proposals to dam the Darby; none have gone forward. In the 1960s, the U.S. Army Corps of Engineers proposed a flood control dam on the Big Darby; it was abandoned for geological reasons. In the late 1960's the City of Columbus began planning a water supply dam and reservoir on the Big Darby. This proposal encountered heavy grassroots opposition, led by the Darby Creek Association. In 1974, the Ohio Department of Natural Resources (ODNR) proposed to designate the Darby a Scenic River under state law; this would have the effect of prohibiting the dam. Columbus challenged the constitutionality of the state law and lost. In 1984, after protracted controversy, substantial portions of Big and Little Darby Creeks were designated a state Scenic River. Columbus again considered damming the Darby for water supply in 1988, but dropped the proposal. In 1994, the same portions of the Big and Little Darby were designated as Scenic under the federal Wild and Scenic Rivers legislation.

Growing Public Awareness and Appreciation of the Special Value of the Darby. Public awareness of the Darby's value increased with the controversies about damming, the Scenic River designations, and the circulation of information about the extraordinary biological content of the streams. Much press and other publicity was given to the Darby watershed as one of the best Midwest agricultural watersheds, and to the outstanding beauty of its landscape. These impressions were augmented by OEPA's designation of large portions of the Darby waters as "exceptional warm water habitat", and in 1991, by The Nature Conservancy's declaring the Darby to be one of its "Last Great Places."

Developments in Agriculture. Over recent decades (1970s, 1980s) agricultural patterns in the Darby watershed shifted, with a decrease in cattle and hay production and an increase in row crop (corn, soybeans) production. This shift was accompanied by farming larger acreages and cultivating closer to field edges and streams. In 1991 U.S. Department of Agriculture (USDA) farm agencies and others long active in the watershed joined together to propose that USDA establish the watershed as a "Hydrologic Unit Area" (HUA). Selection of the Darby watershed as an HUA resulted in additional resources and collaboration, and stepped up attention to improving agricultural practices in the watershed. Aggregate USDA resources, augmented by assistance and resources from Ohio state agencies, USEPA and others, rose substantially, and more attention was directed to avoiding adverse environmental effects of farming on the Darby streams. A new organization, Operation Future Association, sought the participation of farm leaders. Considerable numbers of people and amounts of money have been devoted to change and resolution of agronomic and environmental issues in the 1990's.

Existing Institutions and New Organizations. An extensive array of public and private institutions participated in protecting the Darby streams and watershed over the past 30 years. The government organizations (or their predecessors) have generally existed throughout the entire period, though their programs and policies substantially evolved and changed. Their functions have included technical and financial support and education as well as regulation. Federal organizations notably included agencies of the USDA, agencies of the U.S. Department of the Interior, and recently the USEPA. At the state level, many programs of ODNR and OEPA have been major participants, as have units of county, municipal and township government.

The principal nongovernmental institutions, on the other hand, have been newly created or newly involved since 1970. They include the Darby Creek Association, Operation Future Association, and The Nature Conservancy; the newest structure is the Darby Partnership. Cooperation and interplay among organizations public and private has risen, especially in the last decade.

Residential Development into the Watershed. Rapid extension of suburban residential development and related infrastructure into the Darby watershed is now generally recognized as the most significant threat. Until recently, effort to protect the Darby focused largely on problems associated with farming; suburban expansion got little attention. Residential development in the watershed is principally occurring in the part nearest to Columbus, east of the main stem of the Big Darby. It involves both individual residences and large developments (and at least one city, with

commercial structure), built on formerly farmed land. Developers and their associates have been little involved in Darby environmental organizations and efforts to protect the watershed.

Industrial Development. Construction of a very large, multiunit Honda plant that recently employed 12,500 people was begun in 1979 at the northern crest of the watershed. Whether it will be followed by significant similar industrial development there or elsewhere in the watershed is unknown.

IV. Nature of the Threats to the Watershed and Its Aquatic Resources

This part briefly describes the principal anthropogenic threats to the watershed identified by the team and the major sources and stresses that comprise these threats. The threat information is not quantitative, and estimates of threat severity are based mainly on the opinions and judgment of individuals interviewed. Stresses on the watershed, especially its riparian corridors, streams and natural aquatic systems, arise from a range of human sources. Natural sources of stress, such as drought and windstorm, can also have severe effects on natural systems, but they are not the subject of this study. A particular stress may arise from several sources. For example, nutrients may enter streams from both agricultural runoff and discharge from human waste treatment facilities. And a single source category may be responsible for many different stresses to the natural systems of the watershed. For example, residential development may cause both hydrologic modification and sediment stresses. The paths of cause and effect that trace stresses from sources through intermediate steps in the environment until they affect the objects of protection are often complex.

With this context, the most important stresses on the watershed, its systems and individual components are sedimentation; interference with the natural flow regime (i.e., changes in stream flow levels and timing); physical habitat alteration or destruction and changes in geomorphology; and pollution by nutrients, pesticides and other chemicals. Other stresses include temperature change and competition from exotic (non-native) plants and animals.

The major sources of these stresses in recent years and for the near future appear to be residential construction and urbanizing land use (and related infrastructure and development), and agricultural practices. Other sources of stress are industrial and commercial development, waste management, gravel mining and quarrying, highway transportation, and introduction of exotic species. Note that the relative significance of stresses and sources has shifted with the passage of time. A threat strongly and effectively addressed, like the proposed dams, has given way to a threat newly arising and not well addressed.

It should also be kept in mind that in a stream system such as the Darby, upstream stresses and damage may affect everything downstream. The damage to Hellbranch Run (channelization) in the eastern part of the watershed will adversely affect the condition of the main stem of the Big Darby below their junction.

The following paragraphs elaborate briefly on the sources and the stresses they create, as well as some of their actual or potential adverse impacts.

Agricultural Threats. Until recently, agricultural land use practices have been thought by many to present the greatest overall threat to the Darby watershed and its natural systems. (Others largely credit the historical agricultural use of the watershed with preserving its aquatic systems; they also believe that converting agricultural land to suburban residences will increase threats to the streams.) The following groups of agricultural practices appear to have contributed to the stresses identified:

Tillage practices. Conventional or traditional tillage practices result in stormwater runoff that delivers excess sediment to the Darby. The runoff and sediment also carry nutrients and pesticides.

Drainage practices. Ditching and tiling to drain the wet Darby watershed soils and tributary channelization accelerate runoff to the streams, changing the flow regime, facilitate the transport of nutrients, pesticides and sediments, and destroy habitat, and may affect instream temperature.

Reduction of riparian corridor and streamside vegetation. Clearing and cultivating closer to the streams reduces capability to filter and retain sediment, pesticides, and nutrients, as well as constituting direct alteration/destruction of habitat. Tree canopy removal is also a source of higher instream water temperatures.

Use of fertilizers and pesticides in crop production; manure management. Careless or excessive use of chemicals adds to nutrient levels and toxic contamination of the aquatic systems. Poor manure use and storage increase nutrient loading.

Other riparian and streambed alteration. Allowing cattle to use stream banks and the streams themselves destroys the banks with attendant loss of habitat and vegetation, increases sediment loading to the streams, and adds nutrients. Running farm equipment through the streams and removing natural obstructions also alter aquatic habitat.

Urbanization. Rapidly increasing construction and human habitation in parts of the Darby watershed are considered to be the greatest current and future threat to the watershed, its streams and its natural systems—as well as a threat to its aesthetic and social values. The adverse effects of residences and their accompanying "infrastructure" of commerce, roads and local government facilities are more difficult and take longer to reverse than those of the farmland uses they replace.

Construction of buildings, roads, etc. Runoff during construction is thought to result in the worst surface erosion and heaviest sediment loss to the Darby streams because of exposed surfaces and frequently ill-protected operations. Construction also has the effect of eliminating habitat; this is especially dangerous in riparian areas close to the Darby and its feeder streams.

Postconstruction stormwater runoff. A product of completed development is a damaging increase in impermeable surfaces and corresponding decrease in the surface area that will absorb, store and filter surface water. This increase (from houses, roads, commercial and

government buildings, parking lots), especially when added to the rapid delivery of runoff by storm sewer systems, means that more stormwater arrives at Darby waterways faster, and with less opportunity for stormwater contents to be trapped and neutralized. The levels of sediment and a variety of chemicals (metals and toxic compounds from the streets, lawn care nutrients and pesticides, etc.) entering the streams may be vastly increased. The natural hydrologic flow of the streams is altered. The streams become "flashy," with peak flood flows higher and quicker and low flows lower, sometimes leading to alteration of aquatic habitat and stream morphology as well.

Disposal of domestic sewage. As population and residential density increase, so will sewage volume and disposal systems. These systems, depending on physical, economic and other variables, will be either sewage collection and treatment facilities of many types or on-site systems, again of many types. Many of the former may discharge into the Darby or one of its tributaries, contributing additional nutrient loads directly. The on-site systems (from farm as well as nonfarm residences), if overloaded or improperly maintained, will also release nutrients that may eventually reach the stream system, either in surface or groundwater. At current rates of residential development, nutrient loads to these systems and from them can be expected to increase substantially. There have been sporadic local problems even with the relatively low rate of discharge by existing sewage treatment plants.

Water supply dams and reservoirs. Construction of water supplies reflects the estimated needs of increasing populations, which may or may not be resident in the Darby watershed. This threat, though of great concern in the past, appears not to be of substantial concern today. Dams and reservoirs, if built in the Darby watershed, would drastically change the natural flow regime and water temperature of the stream and would destroy aquatic and riparian habitat.

Other Threats.

Industrial and commercial development, represented in the watershed by the Honda complex on the watershed divide at the Big Darby headwaters, presents stresses similar to those caused by residential development—sedimentation, flow regime alteration, nutrient and other pollution and habitat loss—as well as toxic chemicals. Large areas of impermeable surfaces and concentrations of people and cars created by such development will accelerate runoff and increase the delivery of sediment and pollutants to receiving streams whether in the Darby or another drainage. These facilities will also increase waste loads to sewage treatment systems, and could also discharge industrial wastes to streams. Industrial development can also be expected to stimulate residential and road construction.

Quarrying. Quarrying and gravel mining increase sedimentation and destroy habitat, especially if located in or adjacent to streams.

Highways. Highways (especially large arteries such as the interstate and federal highways and major state roads) present the stresses of sedimentation, habitat destruction and flow

regime alteration during their construction, expansion and thereafter. Highway drainage contains a variety of toxics. A spill at a stream crossing, depending on its size and content, could destroy the stream's biological systems for great distances and periods of time.

Landfills. Inadequately designed or operated landfills (whether built to serve residential or industrial needs) may contribute various types of wastes and stresses to the stream system.

V. Response to Threats

Part V describes and analyzes in more detail how the principal threats to the watershed were addressed. Although Part V refers to resources and other factors affecting outcomes, separate discussion of these factors is deferred to Part VI.

Proposals to Dam the Creek. The first organized efforts to protect the Darby stream system were prompted by the prospect of two dams being built in the main stem of Big Darby Creek. In 1968, the US Army Corp of Engineers (USACE) proposed to build a flood control dam in the lower portion of the watershed. This project would have resulted in the flooding of approximately 670 acres. During this same period, the City of Columbus began to acquire land farther upstream for a proposed water supply reservoir. The reservoir would have involved the use of about 4,000 acres of land for the reservoir itself and for adjacent parklands.

The dam proposals met with opposition. Notably, during the winter of 1971, a group of local residents organized themselves as a committee of the local chapter of the Sierra Club to oppose the dams. These residents were motivated by concerns related to both the dams' threat to the Big Darby's aquatic resources and the potential loss of land or damage to land by the dam and reservoirs. By June 1972, this group had evolved into a separate, incorporated organization called the Darby Creek Association (DCA), which has remained active in the watershed to the present. DCA was influential in mobilizing opposition to the dams by providing information about their potential impact during a series of public meetings. Aerial photographs taken by a member of DCA and showing the special character of the watershed and the extent of the dams proved especially useful for this purpose.

Concurrent with this controversy, the ODNR decided in February 1974 to designate Big Darby Creek a state Scenic River under Ohio's Wild, Scenic and Recreational River Act. Designation would give the Director of ODNR approval authority over certain public projects (such as the proposed dams) in unincorporated areas within 1000 feet of the stream if they would modify the stream's flow. In response, the City of Columbus sued, challenging the constitutionality of Ohio's Wild, Scenic and Recreational River Act. There followed a series of court battles between the city and ODNR and environmental organizations who supported the Act.

In 1978 the Ohio Supreme Court declared the Act constitutional. In 1984, 86 miles of the Big and Little Darbys were formally declared a state scenic river. The Court ruling was a clear victory for opponents of the dams, and the dams have never been built. USACE officially gave up its plans for a flood control dam in 1978 (in part due to poor geologic conditions in the watershed), and

Columbus chose to pursue an alternative water supply source instead of the proposed reservoir. In 1988 Columbus once again considered the Darby as a potential site for a reservoir, but the watershed was eventually removed from consideration, based in part on its "unique environmental quality." Portions of the Big and Little Darbys have subsequently (1994) been designated Scenic Rivers under the federal Scenic Rivers legislation.

A notable side effect of the USACE dam not being built was an increase in the size of the Battelle-Darby Creek Metro Park. This park, located just above the confluence of the Big and Little Darby Creeks, opened in 1962, covering only about 300 acres. Shortly after the USACE abandoned its plans to build a flood control dam, the Metro Park system acquired the USACE lands (about 800 acres). The Metro Park system was able to acquire other adjacent lands, eventually expanding the size of the park to approximately 3,000 acres (including about five contiguous miles of river corridor on both banks). The park as expanded contains important habitat for a variety of the watershed's native animal and plant species, provides recreational opportunities, and is an invaluable resource in educating people about the significance of the Darby ecosystem.

Agriculture. From the late 1980s through the early 1990s, virtually the entire focus of environmental protection in the watershed was on agriculture.

There were approximately 1,200 farms in the Big Darby Creek watershed in 1996. Farms in the upper watershed, where the terrain is somewhat steeper, average about 60 acres in size; farms in the flatter, lower portion of the watershed are larger, with an average acreage of approximately 300 acres. One farm in the watershed is as large as 4,000 acres. The primary crops are corn, soybeans, wheat, and hay, with less livestock farming than there used to be, and little apparent diversification into other crops. Most of the farms are family-owned, some with absentee owners (one estimate: about 10%), and there are several large corporate farms.

The impacts on the Darby stream system from farming activities during most of the 20th century seem to have been relatively benign. A large percentage of the Big Darby main channel and its tributaries has remained in relatively good health. This seems to have resulted from a number of circumstances, including the natural terrain of the watershed, which in some places limited the extent to which farmers could cultivate adjacent to the streams.

Prior to the 1990s, the primary organizations working on agricultural issues in the Big Darby Creek watershed were the USDA Natural Resources Conservation Service (NRCS; its predecessor was the the Soil Conservation Service), the USDA Farm Service Agency (FSA, its predecessor, the Agricultural Stabilization and Conservation Service), the Ohio State University Extension Service (OSUE), and the county soil and water conservation districts. These agencies focused their efforts at the county level (rather than the watershed level); all six counties have substantial areas outside the Darby watershed. Most of the agencies had offices in each county, and individual agents within each county have worked with farmers both within the Darby watershed and in other watersheds. All of these agencies have continued to operate their programs on a full county basis.

These agencies provided a variety of services to farmers. NRCS personnel provided technical assistance to individual farms on how to design and implement best management practices, helped farmers prepare farm plans to preserve soil and protect water, and also helped develop plans for entering acreage into the Conservation and Wetlands Reserves programs. OSUE personnel provided educational services to farmers on new production methods, as well as how to market their crops. FSA primarily handled the financial aspects of most of USDA's agricultural assistance programs. The purpose of all these activities was to help farmers improve crop yields while at the same time minimizing soil erosion and other impacts on the environment. With few if any exceptions, these agencies have not been responsible for implementing regulatory controls on farmers.

In the mid- to late 1980s, persons working for these agencies, as well as others in the watershed, began to grow concerned about the impact that farming might be having on water quality in the Big Darby Creek watershed. This apparently was due in part to the perception that the watershed was being farmed more intensively (i.e., more land under cultivation, including acreage nearest to the streams), as well as a growing awareness of the unique character of the Darby and the potential threats that agriculture posed. In response to these concerns and a concern that controls on agriculture might result, efforts were begun or strengthened to address the impact of agriculture on the Darby.

A major element of increased effort to address agricultural threats began in 1990 when USDA agency personnel realized that the Big Darby watershed potentially met USDA's requirements for designation as a federally recognized Hydrologic Unit Area (HUA). USDA's HUA program was designed to direct special effort and support to watersheds adversely affected by agricultural activities. A proposal describing the need for protecting the watershed was submitted, and in 1991, the Big Darby was selected as an HUA by USDA. This resulted in extra funding to increase staffing of the USDA agencies operating in the watershed. An additional 2.5 to 3.5 (depending on the year) NRCS personnel were made available in the watershed by HUA funding compared to pre-HUA levels. These personnel included an NRCS Agricultural Coordinator (funded in part by The Nature Conservancy) and an NRCS Water Quality Coordinator devoted solely to HUA activities in the watershed.

HUA status also provided \$60,000 per year to cover additional OSUE staffing (matched at \$30,000 by the State of Ohio). This funding permitted OSUE agents to form the Operation Future Association.

The HUA designation also produced additional cost-share funding to farmers to implement best management practices. For example, farmers could be reimbursed on a per-acre basis for using conservation tillage or for installing grassed waterways or filter strips. These funds, administered by FSA, totaled approximately \$600,000 between 1991 and 1995. NRCS agents helped farmers write detailed proposals. FSA County Committees made the final decision on awarding funds. It is not apparent to what extent the County Committees targeted these funds to high-threat watershed areas.

Another important effect of the HUA designation was to focus efforts on a watershed, rather than county, basis. Although the designation didn't change the institutional structure of the agencies, it did focus effort on the watershed and on cooperation among personnel in neighboring counties.

Darby farmers have also participated in other USDA programs that do not appear to have been augmented by the HUA. At one point approximately 11,000 acres were enrolled in the Conservation Reserve Program (CRP). (The Conservation Reserve Program is a voluntary program that offers long-term rental payments and cost-share assistance to take cropland out of production and to establish resource-conserving cover on environmentally sensitive cropland or marginal pastureland.) Darby farmers have also enrolled approximately 300 acres in USDA's Wetlands Reserve Program (WRP), another voluntary program whose aim is to restore and protect wetlands on private property. Some Darby landowners have also participated in USDA's Forestry Incentives Program, which provides cost-share monies to help with tree planting and timber stand improvements.

Also in 1991, several OSUE agents and farmers began to form a task force to address environmental and economic issues facing farmers in the watershed, in part due to the increased attention the Creek was getting for its scenic and ecological attributes. Many farmers were afraid that this attention, coupled with criticism of agricultural nonpoint source pollution, might eventually lead to regulation of agriculture. OSUE agents selected approximately 20 to 30 farmers in the watershed whom they considered to be farm "opinion leaders" (i.e., those who would have influence with other farmers). This group of farmers and OSUE personnel evolved into an incorporated nonprofit organization called Operation Future Association (OFA), whose goal is to "link economic and environmental soundness to improve the quality of life in the agricultural community of the Darby Creek watershed."

OFA sponsored many kinds of activities, among them:

- < Canoe trips in the Darby for a mix of farmers, scientists, environmentalists and others to display the Darby's resources and the need to protect the streams. Approximately 15 trips with more than 500 participants have been conducted since 1992.
- < Field days attended by local farmers to address both environmental and agricultural topics, including conservation tillage and nutrient and pesticide management.
- < Seasonal newsletters with information on OFA, available cost-share programs, and related activities in the watershed

Of the above OFA activities, perhaps the one most often mentioned and thought effective by persons interviewed for this report was the canoe trips. These trips allowed farmers, conservationists, scientists, local decision makers, government officials, and media representatives a chance to meet and share their ideas and concerns regarding protecting the Big Darby and to learn about its special biologic character. Presentations by biologists and other scientists, including the use of fish electroshocking, emphasized the unique ecological nature of the creek. Several persons interviewed stated that many farmers who participated in these trips had never before realized the diversity of the species present or the unique condition of the stream. Also important were the achievements of

highly regarded members in setting examples of farming practices both productive and environmentally protective.

Many persons interviewed credited OFA with raising an awareness and appreciation for the ecological condition of the Big Darby for farmers and with facilitating a better working relationship among the different stakeholder groups concerned with the watershed. Several persons interviewed thought that before the early 1990s there was a somewhat antagonistic relationship between farmers and environmentalists, but that OFA resulted in many farmers (especially those active with OFA) communicating and collaborating with environmentalists a great deal more.

In 1991 the Darby Partnership (originally called Darby Partners) was formed by persons from approximately 40 federal, state, and local agencies, nonprofit organizations, and private agencies that shared an interest in protecting the watershed. The Partnership directed its attention first on agricultural issues. The Partnership has provided a structure for the exchange of information and a way to dovetail activities. More recently, members have formed teams to deal with specific agricultural problems. Part VI discusses the activities of the Partnership.

Other routes to agricultural change were furnished by federal and state agencies. In 1995 the OEPA Division of Environmental Financial Assistance made available approximately \$9 million of low-interest loan money from the Ohio State Revolving Fund (SRF). These funds were available to those farmers who develop "whole farm plans" that are certified by either the NRCS or the farmer's county soil and water conservation district. Farmers have used those loans for the purchase of no-till drills, high-residue field cultivators, field sprayers, yield monitors, and windbreak plantings. By the fall of 1996 approximately \$1.2 million had been loaned to farmers farming an estimated 7,500 acres.

USEPA, OEPA and local soil and water conservation districts have made funds available through three grants under section 319 of the Clean Water Act. The total cost of these projects is approximately \$500,000, of which approximately \$300,000 was provided by USEPA and \$200,000 by OEPA and the local counties. These funds have been used for an extensive forested filter strip program, as well as several urban and agricultural best management practice demonstration projects.

The Nature Conservancy and ODNR's Division of Forestry have also cooperated with the Top of Ohio Resource Conservation and Development (RC&D) Project to plant trees via the Tree Resource Establishment and Enhancement Service (TREES) Program. TREES is a program started in 1994 that helps landowners locate professional vendors for tree planting and maintenance services. Landowners can be partially reimbursed for the cost of planting these trees through a variety of programs, such as USDA's Forestry Incentives Program and ODNR's Darby Filter Strip Incentive Program.

What results did these activities produce? Designation of the Darby as an HUA, together with programs and resources regularly available from USDA and the other efforts identified above, seem to have engendered a great deal of activity beneficial to the watershed. According to HUA annual reports, accomplishments through 1996 included:

- < Between 1991 and 1996 conservation tillage in the watershed increased from an estimated 45,000 acres to approximately 111,000 acres.
- < In 1996, sediment entering the streams from farms was estimated to have been reduced by 25,000 tons from an historical average of 125,000 tons/year.
- < Nutrient and pest management plans were applied on 14,650 acres.
- < 136 acres of filter strips were installed.
- < 191 acres of grassed waterways were planted.
- < 17,783 feet of fencing were installed along the Darby and its tributaries.
- < 321 acres of trees were planted.
- < 14 water and sediment control basins (WASCOBs) were installed.

Several observations can be made. First, the work of the organizations described above succeeded in producing an awareness in the farm community of the ecological significance of the watershed and potential threat posed by farming. This awareness appears to have contributed to the implementation of improved farming practices. It also appeared that the extent of farmer involvement and change in practices has been uneven across the watershed. Second, the changes in agricultural practices have relied almost entirely on the voluntary actions of individual farmers. No regulatory controls existed for agricultural activity. Farmers appear to have been motivated by a combination of personal concerns for the watershed, the examples set by farmer “leaders”, peer pressure, economic interests, and the threat of regulatory control. They also benefitted from the availability of a large amount of funding. Finally, no direct scientific evidence has been found to link these changes in agricultural practices to conditions in the aquatic resources of the streams.

The economic climate for farmers in the watershed during the 1990-1996 period appears to have been relatively favorable, so that farmers were in a better position to purchase new equipment and try new practices. In addition, the extent to which farmers converted to more environmentally friendly farming practices seems to have been part of a fairly widespread trend (i.e., it was happening outside the watershed as well). In the early 1990s John Deere came out with a more efficient drill that seems to have accounted for at least part of the switch from conventional to low- or no-till farming. Use of advanced technologies for more efficient application of fertilizer and pesticides also seems to have been part of a general farming trend during this period. Thus, technical innovation and favorable economic conditions seem to have encouraged environmentally preferable farming methods.

Residential Development and Suburbanization. Construction of housing and related suburban development is a relatively new threat to the integrity of the watershed and the Darby streams. This change in land use is currently considered the major threat to the watershed. Whether and how well the threat can be limited cannot be foreseen.

Building nonfarm houses in the Darby countryside is not a new phenomenon. What is new is the pace of conversion of agricultural land to residences and towns, and related commercial and municipal structure. Until the most recent decade there were a small number of towns that appear to have served principally as centers for the agricultural community. Now there are small cities and much construction of housing and suburban centers in the eastern edge of the watershed in Franklin

County, as well as growing housing development at the northern, upstream edge of the watershed near the Honda plant. Substantial extension to other parts of the watershed can reasonably be anticipated.

The perception of development as the major threat to the Darby appears to be very recent as well. As noted above, almost the entire focus in protecting the watershed in the late '80s and early '90s related to agricultural threats.

Both the phenomenon and the perception reflect a number of possible contributing factors. Columbus and the central Ohio area surrounding it are rapidly growing and appear to have a pro-growth attitude. Suburban development is extending in many directions from Columbus, not just toward the Darby. Visions of life in a rural or suburban setting and the beauty of the watershed undoubtedly attract many homebuyers from the city. An extensive network of interstate and other major highways make commuting longer distances feasible, whether to jobs in downtown Columbus or to jobs in other urban or rural locations where new businesses and jobs are being created.

The nature of the threats to the watershed posed by development and suburbanization were discussed in Part IV. The primary threat appears to be surface runoff, both during and after construction. Runoff carries sediment to the streams, together with nutrients, lawn pesticides, and other domestic and street system pollutants. After construction, runoff also alters the timing and volumes of the natural flow regime, especially as natural land cover decreases and impervious surface increases. In some cases, streams are seriously altered. To the disruption and pollution caused by runoff and alteration are added the effects of increased discharges from sewage treatment plants (and eventually from on-site systems) that handle the wastes from the increased population. The seriousness of these threats to various parts of the Darby stream system varies widely depending on local geography, population density, stormwater management, design and operation of sewage treatment plants and other factors.

Dealing with development threats appears to involve a sharply different situation and set of challenges from dealing with agricultural threats. Developers face very different time perspectives and risks. Their time involved in caring for the land is relatively short (time to acquire, pass a variety of regulatory hurdles, construct and sell or begin operation), but carries large costs and market risks as well as possibly large and immediate financial rewards. In many situations the developer is not local and has no further interest in the use of the land and its consequences. The developer probably enjoys little government support or subsidy. The farmer, on the other hand, has a continuing, long-term interest in the condition of his land, is subject to little regulation, and may well be able to find government support for his technical and economic needs. The farmer and his family before him have probably been in the watershed, perhaps on the same farm, for many years.

Farmers' attitudes toward development can be complicated. They resent new residents' complaints about farm practices. They are connected to the land, and its continued use for farming. But the value of their land for development is much higher than for farming.

The different situations of farmers and developers are further reflected in the apparent lack of involvement of suburban development interests in any of the voluntary institutions described in this report that work for protection of the watershed. Notably, the Darby Partnership (with its original heavy orientation toward agricultural practices) seems to have had no general representation from developers, builders, real estate financing and sales organizations, suppliers, and other parts of what might be thought of as the development community.

Until recently developers' context for shaping their plans and practices for environmental protection appears to have been almost entirely to meet legal and regulatory requirements, especially those found in land use planning, in zoning and development processes, and in permitting administered at the county or subcounty level.

There is no regulatory structure applicable to the watershed as an entity, as distinct from the political units within it. As noted above and described in Part VI, protection of the Darby from threats caused by residential development and suburbanization has taken place principally through regulation by these many, varied local townships, county and other government jurisdictions. At the most local level (i.e., township) this may consist of land use plan requirements, zoning, development approval, and on-site sanitary system approval. Some local governments also regulate runoff. (Ohio's "home rule" legislation allots much authority to the townships.) Different counties and townships have different approaches. Regulation of stormwater discharge, however, is a state function under the Clean Water Act, as is the permitting of discharging sewage treatment plants.

County and other local government action provides, at least in many cases, for citizen participation in the decision process, and organizations like the Darby Creek Association have participated and have encouraged citizens to do so. But dealing with protection on a case-by-case basis with the possibility of several proceedings relating to a single development is a time-consuming and difficult challenge for potential participants. Outcomes are affected by politics (at least in the case of elected officials with decision authority), resources available, know-how of the participants, and other factors. In some situations developer pressure and threats of litigation make local resistance especially burdensome and difficult. From one jurisdiction or decision unit to the next there may be great differences in the environmental knowledge, individual capability and philosophy of the local decision makers, as well as their knowledge about the watershed and its protection needs. It would be surprising if there were not substantial inconsistencies in protection of the watershed from one place to the next.

A certain amount of uniformity in runoff control was achievable through the application of general permits under the stormwater control requirements of the federal Clean Water Act, which applies to residential development of five or more acres as well as commercial development. It is administered in the Darby watershed by OEPA's Central District office for a much larger area that includes the watershed. The permit program emphasized control of runoff while ground is exposed during construction rather than tight planning for runoff management after construction is complete (see Part VI).

OEPA also is the permitting authority for sewage treatment plants discharging to the Darby waters. Permit limits are set to achieve the agency's water quality standards. While some violations occur strong efforts appear to be made to maintain compliance with these limits.

It should also be noted that several communication and education programs have been directed to responsible homeowner action regarding runoff in their yards and neighborhoods.

Several other possible approaches to protection from threats of suburbanization were mentioned by persons interviewed. They include clustering of residences, farm villages (clusters of residences on tracts of cultivated farmland), use of the State Revolving Fund to remedy failing septic systems, use of constructed wetlands, legislation to authorize land use planning on a watershed basis, and cooperative effort between developers and watershed protection groups to understand and find solutions for developers' problems that will also protect the watershed. As far as known, these proposals had not moved forward.

One new type of development had been commenced near the junction of Big and Little Darby Creeks. It set aside about two-thirds of its 600 acres in conservation areas protected by easements. It also incorporated various runoff controls and other measures for the protection of the watershed. Its nonpoint source control measures are partly financed by a low-interest loan from OEPA's State Revolving Fund.

An independent summing up or evaluation of the effectiveness of efforts to protect the stream system and the watershed from the threats of construction and suburbanization has not been discovered if it exists; the team's investigation does not permit such an assessment, or a forecast of future success.

Other Activities That Threaten the Watershed. Several other types of activities have adversely affected or threatened the Darby watershed and its streams in the past or now do so, though none to the extent of the three discussed above. These others will be briefly mentioned here.

Industrial Development. With the exception of the Honda facilities, the watershed seems to have escaped the effects of large-scale industrial or commercial development. This report cannot forecast the future, except to note the likelihood that Honda will attract some supporting commerce, just as it seems to have attracted some residential development. It is clear, however, that any large-scale industrial or commercial development carries obvious hazards to the watershed, and will encourage and produce more commerce, more roads, more houses, more runoff and resulting contributions of sediment and pollutants to the streams, as well as adding to alteration in stream flow and habitat.

Highways. The watershed is transected or bordered by three interstate highways and a network of state highways, many of considerable capacity. Whenever a highway crosses a stream, there exists the possibility of the kind of accident that can destroy the life of the stream (e.g., an accident resulting in the contents of a tanker spilling into the stream). No such accident was reported by persons interviewed, and no basis exists for estimating the likelihood of an event of this sort in future. Whenever a highway is being constructed or

modified at or near a stream, however, stream damage (biological, geomorphic, to the riparian zone habitat) is an immediate and likely threat. Design requirements and controls during construction have not been investigated for this report. As suggested elsewhere in the report, the better the highway system, the more likely that the pace of residential and commercial development will pick up in areas served by the system.

Gravel Mining. In the past, one such operation which was permitted by the county on one side of the Big Darby, but not the other, resulted in substantial damage to a segment of the stream. Future possibilities are not known.

Landfills. In the past one hazardous waste landfill eventuated in release of metals and organic compounds that reached a stream in the headwaters of the Big Darby with serious though localized effects on stream fishes and macroinvertebrates. How landfills (hazardous or not) will be authorized and controlled in the future has not been investigated for this report. In view of strengthening of federal legislation and regulation of waste disposal in recent years, a repetition of the event described above seems less likely.

VI. Factors Significant in Success of Response

Part VI presents the many forces, types of activities, resources and other factors that played an important role in the events described in Part V, and affect future threats to protection of the watershed.

Social, Economic and Other Factors

1. Social and Cultural Values of Those Who Live in the Watershed. In a time of transition, it appeared that these values had been changing and were mixed among the growing watershed population. No longer were they almost entirely those of a farming culture, though still predominantly so in many parts of the watershed.

Farm culture values and attitudes, though not uniform, emphasize the responsible independence of each farmer, an adherence to accustomed ways until change is proven and made economically feasible, and concern for the protection of each farmer's right to pursue his own interests, make his own decisions, and be free from interference by government as to how he uses his land. There is a strong desire to maintain farming and its way of life in the watershed. Some of the farmers in the watershed appear to have been progressive, open to new ways of doing and seeing things (such as cropping practices and the special character of the Big Darby), and to new relationships (like the core group in OFA). Others have not; proportions are unknown. Farmers' attitudes and values were what the HUA agencies, OFA and the Darby Partnership had to work with.

The nonfarming residents, increasing at a fast rate recently, appear to have values and attitudes different from the farming community. For many, awareness of the natural values of the watershed and a desire to protect the landscape (including the places where they lived) brought them to the watershed and motivated them to action (for example, in the activities of the Darby Creek

Association). Although information about the special quality of the watershed continues to be made known to new watershed suburbanites, it is not apparent to what extent concerns for the watershed are important to them and will motivate them to action in land use and watershed protection issues. The work and interests of many lie outside the watershed. Farm and suburban attitudes sometimes clash. Some farm practices (slow equipment on the roads, running equipment at night) annoy nonfarm residential dwellers.

2. *Economic Factors.* The watershed appeared economically prosperous. Signs of economic distress in farming or other parts of the watershed economy were not apparent, although some years have been better than others for farming.

Until recently, almost all the jobs in the watershed were in agriculture or associated business and in the agricultural towns, and economic prosperity therefore depended on agriculture. Protecting the watershed through changes in land use related directly to the economic interests of farmers, and changes in agricultural practices needed to be made economically attractive and feasible. The rapid adoption of low- or no-till production apparently took hold in large part because of its practicality and economic attractiveness. Farmers' willingness to undertake various environmentally beneficial activities such as the reforestation of riparian borders seems to have been made possible by public agency cost sharing.

More recently, an increasing amount of the income of watershed residents has come from nonfarming jobs outside the watershed. The economics of suburban community construction has become more important. The economic benefits of suburban development are not necessarily for those living in the watershed. Indeed, income from construction may go outside in large proportion.

While it is generally thought that most farmers would prefer to see their farms stay in agriculture, pressure on them to sell for development can be hard to resist, especially where older members of an aging farm population see their land as a "nest egg" for retirement. Acreage prices for development vastly exceed acreage prices for farming (in one reported case, by more than ten times).

Other economic pressures on farmers propel land use toward development or the creation of larger farms. Apparently, it has become more difficult to farm small acreages profitably. But with larger acreages, more costly equipment is required, with greater risk associated with debt repayment for the equipment. (This also pushes farmers toward narrowing protective stream buffers so they can plant more land.) And the large investment to acquire sufficient acreage and equipment apparently makes it close to impossible for young farmers to begin farming on their own unless they inherit. That more farmland will be transferred to development and residential uses is inevitable, and farms will likely increase in size, thus changing threats and what must be done to deal with them.

3. *Other Factors.* Several other factors, some of recent origin, affect the threats to the watershed and ways to limit them.

It is notable that almost all the land in the watershed is owned privately, by individuals and businesses, irrespective of land use. Very little is owned by government or environmental

organizations, as compared to watersheds in the American West where federal and state government frequently own and control large portions of the landscape. (The outstanding and valuable exception in the Darby watershed is the Battelle-Darby Metro Park, used for recreational and educational purposes; it provides multiple benefits for protection of the watershed.) This means that attempts by government and environmental organizations to protect the watershed cannot be accomplished by direct action on their own land, but must involve regulation, persuasion, incentives, market forces, or political action to change the actions of large numbers of private owners in the watershed.

The Columbus, Ohio, area is one of rapid population and residential expansion. Living in the Big Darby watershed looks especially attractive to those leaving the city in light of its natural beauty and publicity about its special attractions. Added to this, an improved highway network makes it easy for watershed inhabitants to work in Columbus or commute well outside the watershed. These factors can be expected to increase development pressure.

Although it is hard to forecast industrial expansion into the watershed, the potential side effects are foreseeable. The extensive Honda plant complex at the watershed boundary at the head of the Big Darby main stem employs a large workforce that adds to residential development pressure. It also seems likely that suppliers and associated businesses will follow Honda.

Scientific and Other Studies; Communication

Over several decades information related to the extraordinary biological content and condition of the Big Darby watershed has been collected and used in many ways that have helped to protect the Big Darby. Communication of this information and other information about threats and how to protect the watershed has been widespread, and has led to a strong public support base for protecting the Darby.

4. Science, Surveys, Data Collection, Studies. There is a long history of data collection and academic investigation of the Big Darby, extending back at least to the 1950s, that catalogues its biological richness. Studies by Ohio State University scientists (Kaufman and Stansbery) on fishes and mussels go back to the time when the endangered fish, the Scioto Mad Tom, was identified in the lower Big Darby. Surveys of fish and mussels and use of the Creek by OSU faculty members as a location for teaching students have continued to the present. These studies have documented the extraordinary richness, biological diversity and rarity of the aquatic species, but raise questions about decline. Information produced by the studies has been used time and again in arguments for the protection of the watershed and in the development of organizations and programs for that purpose. OSU and other scientists helped form the Darby Creek Association and the Darby Partnership, and continued to participate in them.

Resulting in part from this early work and its scientific and academic legacy have been the biological surveys and the development of biological standards by OEPA for the Big Darby and other streams in Ohio. OEPA surveys of fishes, macroinvertebrates and habitat were conducted in the Big Darby watershed beginning in 1977; they have been repeated at intervals through 1992/93. This work has provided information on trends in the health of the biological communities in the Darby, as well as

the foundation for the stream classifications and biological water quality standards (indices for fishes, macroinvertebrates and habitat) applicable to the streams and stream segments of the watershed. These standards in turn provide a demanding basis for point source permitting and enforcement. A large portion of the stream segments of the watershed are classified as exceptional warm water habitat, reflecting their excellent condition, and providing a high level of protection from point source discharges.

A second type of study conducted by OSU faculty and students also contributed to protecting the Darby watershed. In a 1990 study, land use data, statistical and GIS techniques, and a computer model were used to identify locations in the watershed where agricultural activities were most likely to produce the highest risks of sediment and nutrient runoff to the streams. The study results were put to use by several of the organizations described in this part and their activities described in Part V. A second OSU study completed in 1994 in collaboration with an engineering firm addressed runoff in the rapidly urbanizing Hellbranch Run subwatershed in the eastern part of the Darby watershed. The results suggested possible severe deterioration (a conclusion also reached in OEPA's 1992/93 survey) and raised questions about the ability of the existing government regulatory structure to deal with the problem.

An ongoing scientific evaluation sponsored by USEPA and conducted with OEPA and others has been assessing ecological risk in the Big Darby watershed. This study will present and analyze the stresses affecting the Darby's aquatic ecosystems and the sources from which they originate. With hypotheses and tentative evaluations available, this study keeps attention focused on threats to the watershed.

The U.S. Geological Survey (USGS) has maintained a streamflow-gaging station on the Big Darby main stem in the lower portion of the watershed (below the confluence with Little Darby Creek) since 1922. Two stations were added on two of the most important tributaries (Hellbranch Run and Little Darby Creek) in 1992. Data from these stations can be used to assess changes in streamflow and suspended sediment loads. The USGS also sponsored a study addressing the response of aquatic biota to hydrologic disturbance in the watershed.

In spite of all the data and analyses available, however, there does not appear to have been much science to show how many of the threats, and changes in them, affected the streams' aquatic systems and biota.

5. Communication and Impact of Scientists and Scientific Information. Communication and resulting awareness of the scientific information showing the special nature of the Big Darby has been widespread and important. Such information was used by the Darby Creek Association in opposing the City of Columbus' water supply dam proposal; by the ODNR as a basis for the Scenic River proposal; and by the USDA agencies to support the proposed HUA. It was a reason for The Nature Conservancy's designation of the Big Darby as one of the "Last Great Places".

Communication of this information has been made in many ways, including the publication of scientific works, the canoe trips sponsored by Operation Future Association, and coverage in the

Columbus Dispatch. Educational efforts by several organizations both public and private have made scientific knowledge available to the community.

Overall, communicating the scientific information broadly over many years seems to have had much to do with creating widespread public sentiment and a strong lobby ready to oppose threats to the Darby. It lent credibility to efforts to fight threats to the stream system.

6. *Communication of Other Messages*. In addition to communication of scientific information about the exceptional ecological quality of the Big Darby's aquatic communities (and the accompanying aesthetic and recreational values), the communication of other information has been used to create an awareness of threats and problems in the watershed and how to deal with them. Private, state and federal institutions were all involved in this communication.

Communication by the Darby Creek Association as to the threat posed by the proposed Columbus water supply dam and reservoir and its likely impact and the protection value of the proposed Scenic River designation seems to have been one of its most important tools. DCA has also relied on communication in creating public response to development issues.

Several of the agricultural agencies used communication as a primary mode of achieving change in agricultural practices and land use. They showed the adverse impacts of certain practices and the availability of alternative methods and ways to pay for them. Operation Future Association used field days to demonstrate new technology that would reduce threats to the aquatic systems.

In recent years the Darby Partnership, in what is thought by some persons interviewed to have been its most important function, has provided the opportunity and means of communication. A broad representation of those working for protection of the watershed has met regularly for several years exchanging information primarily on agricultural threats and ways to deal with them.

Other examples of the use of communication include the newsletters of the Darby Creek Association and Operation Future; car tours of the watershed organized by OSUE; the publication and distribution to homeowners of the *Darby Book*, which explains problems and recommends practices to protect the streams; and the supplying of information to the media.

Education programs for schoolchildren have been conducted by several agencies, including NRCS and the ODNR Scenic Rivers unit and Division of Forestry. Activities at the Battelle-Darby Metro Park, in addition to providing recreation and direct access to the creek, have included educational opportunities for children.

These communication activities in the Darby appear to have played a significant role as tools for Darby protection.

Addressing Threats: Organizations, Resources and Planning

The variety and strength of organizations and extent of resources used by them to address threats to the Big Darby watershed were impressive. What they accomplished, however, they did without a common plan.

7. *Organizations.* Many organizations have undertaken to address threats to the Big Darby, generally in cooperation with other organizations. These organizations included government agencies at the federal, state and local levels and many private organizations. Their mass, energy and commitment to action accounted for a great deal of activity to combat threats and protect the watershed. No single organization dominated these activities.

Federal government agencies. The most extensive federal involvement has been by agencies of the USDA, specifically NRCS and the FSA. The USDA extension services were involved primarily through support for the OSUE.

NRCS and FSA (and their predecessors) have maintained representatives and offices in each of the six Big Darby counties for many years, as has OSUE. As described previously in Part V, NRCS personnel assist individual farm operators in various ways, including providing help in adopting new farm practices, preparing farm plans to preserve soil and protect water, and securing cost share payments. In at least two Big Darby counties, NRCS also assisted in planning and oversight of stormwater controls at residential sites. FSA administer cost share funding and the Conservation and Wetlands Reserve program arrangements and funding. NRCS, OSUE and FSA were the key actors in the Big Darby Hydrologic Unit Area program (see Part V). It was the aggregate effort, both under the regular USDA programs and the increment under the HUA, that made up the HUA program.

Other federal agencies played important contributory roles. The USEPA provided nonpoint source and other grant funding under the Clean Water Act to OEPA, which in turn awarded a portion to Darby recipients for various watershed protection activities. USEPA also initiated the ecological risk assessment mentioned above.

The National Park Service exercised its authority to designate portions of the Darby streams as a national Scenic River. The US Geological Survey collected flow and sediment data at three gaging stations. The US Fish and Wildlife Service listed one fish and two mussel species from the Darby as endangered under the Endangered Species Act (but with unknown effect on Darby protection).

Agencies of the State of Ohio. Many programs of two Ohio agencies, the Environmental Protection Agency (OEPA) and its Department of Natural Resources (ODNR), made contributions to protecting the Darby. OSUE, referred to above, also played a major part. The aggregate impact of state personnel, policy, program activity and funding was substantial.

Several units of OEPA participated in Big Darby protection. The biological surveys referred to above and the development of biologically based stream use classifications and criteria used in the state's water quality standards for Darby stream segments were accomplished by OEPA's monitoring and

assessment section over a period of many years. This work is widely recognized as an outstanding achievement in measuring and protecting the health of stream biological communities. Permitting and enforcement under the Clean Water Act are carried out by other OEPA units. OEPA is also responsible for the Clean Water Act stormwater discharge program, applicable to both residential and commercial development, and discussed below. OEPA manages the Ohio nonpoint source program, including the application of federal grant funds. OEPA also operates the state Revolving Fund loan program.

At least six divisions of ODNR have participated to some degree in protection of the Big Darby watershed. Among them, the Division of Natural Areas and Preserves used its authority to designate segments of the stream network as a state Scenic River. ODNR's Scenic Rivers program monitors water quality at various Darby sites, using a macroinvertebrate index, with the help of volunteers and school groups, and works to increase understanding of the special character of the watershed. The Division of Forestry has participated in the program for stabilizing stream banks and planting forested buffers in riparian zone segments. The Soil and Water Conservation Division works with and provides financial support to the county soil and water conservation districts.

The Ohio State University Extension Service (OSUE) is a state counterpart of USDA's extension services. It has county offices in the Darby counties just as NRCS and FSA do. OSUE performs primarily outreach and educational functions for farmers and other inhabitants, including youth. It has promoted filter strips and conservation tillage, as well as better sewage disposal and land use. In the HUA, OSUE appears to have been the major partner of NRCS and FSA. Its personnel also led the creation of Operation Future Association (see Part V).

Local Government. As stated above, there is no government structure for the watershed as such, but there are myriad local government units.

Local government in the Big Darby watershed consists of six county governments; cities and unincorporated townships within the counties; and some special governmental units. Understanding exactly what each of them does or can do that relates to the protection of the watershed has been difficult. There appear to be considerable inconsistency and overlap, from one place to the next, in coverage and application of legal authorities; some of the inconsistency appears to relate to the extent to which the locality has experienced suburban expansion and associated pressure.

Basic county authorities and activities that bear on watershed protection include land use and related planning, zoning (when not exercised by townships), subdivision approval, control of on-site sewage disposal, and building permit and well approval. These functions are conducted by elected county officials directly or by various county boards and offices. Sometimes both county and township requirements apply. Townships (run by elected township trustees) have zoning authority, if they choose to exercise it, under Ohio home rule legislation and assume some other functions; they do not necessarily choose to do so. Take the example of the difference in functions performed by the three adjacent townships of Franklin County that lie along the Big Darby main stem: one has a comprehensive plan, but relies on county zoning; the second has its own zoning, but no general plan;

and the third has only county zoning. Very different land uses may result from one township to the next.

Each county also has independently elected soil and water conservation districts that perform conservation functions that affect the watershed. These districts, while a part of county government, also receive funding from the state.

Local governments have little or no control over farms and agriculture, but much direct regulatory power over development and construction. These powers are exercised by different offices and boards in different counties. The impression received is that governing bodies, offices and boards (especially in the case of township trustees) vary greatly in their attitudes and capabilities, particularly when put under pressure from development interests. And, especially in the case of elected officials, local tradition, politics, and responsiveness to the electorate and various interests are ever-present factors. Although the constituent community seems to have opportunities to affect decisions, the effectiveness of the constituent voice cannot be evaluated in this report.

One promising action taken in the Franklin County townships and in Pickaway and Union Counties is to limit or prohibit development and certain other activities within a zone next to the Big Darby, typically 120 feet on either side of the stream. This helps to protect the watershed by preserving habitat and limiting stream flow alteration and sedimentation.

The City of Columbus is a special case. Columbus is in Franklin County; it is not in, but is adjacent to, the Franklin County portion of the Big Darby watershed. It operates large water supply and sewer systems that it makes available under certain circumstances outside Columbus. Where these services are made available, as in the case of the City of Hilliard in Franklin County, they provide a major incentive for growth and development.

Another local structure is the Metropolitan Park District of Columbus and Franklin County (MetroParks), which governs the Battelle-Darby Metro Park (see Part V discussion). The District has authority to acquire more parkland in the watershed.

A quasi-governmental organization established under state law is the Mid Ohio Regional Planning Commission (MORPC), which has a limited, principally advisory, but sometimes influential, role in a variety of zoning, subdivision and planning decisions, mostly in Franklin County. Another regional planning commission assists township trustees in Logan, Union, and Champaign Counties by providing review and advice on the township zoning programs.

Thus, while the authorities of local government are sufficiently powerful to provide great protection to the watershed, especially in connection with residential and other construction and development, the powers are lodged in many places, appear to be exercised unevenly, and apparently have not been well coordinated—a most difficult situation for protecting the watershed.

Nongovernmental organizations. Over the past decades a group of private organizations were active and influential in the protection of the Darby. Described below are the four that seem to have had the greatest involvement and impact.

Darby Creek Association. DCA, formed in 1972, appears to be a true grassroots citizens' organization, without paid staff, whose founders were largely local watershed inhabitants. Their motivations included protecting their home landscape and land from being taken for the reservoir site. Organizers and members have included OSU faculty and OSU-trained scientists. DCA's role in combating the dam and supporting the designation of the Darby streams as an Ohio Scenic River are described in Part V. DCA is credited with being the progenitor organization in protecting the watershed. While it seems not to have had a major role in efforts to address agricultural threats, it conducts stream cleanups and continues to be involved in efforts to educate Darby inhabitants about the special value of their environment and remaining alert to threats to it. DCA is active in political issues and residential development decisions. It is represented but not especially active in the Darby Partnership.

The Nature Conservancy. TNC is a large national conservation organization dedicated to the preservation of biological diversity. In about 1990 TNC's Ohio office began to concentrate effort and resources on the Big Darby. Shortly thereafter TNC designated the Big Darby as one of its Last Great Places, recognizing the Darby's extraordinary assemblage of aquatic species and excellent condition. TNC owns and protects 600 acres in several parcels of land on the Darby main stem and the Little Darby, and it has devoted staff (one person in 1991, three in 1996) to the Darby project full time, with additional support from other staff.

TNC has performed many roles. It has been a major participant in addressing agricultural threats, working with the USDA agencies, OSUE and others. It applied for and administered the grant from the Kellogg Foundation for support of OFA. It investigated alternative crops, including increased hay production, handling and marketing.

TNC has continuously surveyed threats and conditions in the watershed. Its full-time river steward walks, flies over and inventories the entire stream and riparian system, locating pollution problems and their sources and finding ways to remedy them. He works with ODNR on stream bank restoration and conducts education and other functions.

TNC has helped finance surveys of stream mussel populations and OSU work to identify the location of greatest sedimentation threats, as well as additional USGS gaging stations. It supports a small research grant program for graduate students.

TNC appears to have had the only comprehensive strategy for protection of the watershed; it focused on protecting the aquatic systems and biodiversity. Especially important has been its role in organizing the Darby Partnership, and convening, facilitating and supporting its meetings and activities. TNC enjoys recognition in the community that works for Darby protection for what is viewed as its "neutrality," and the way it has facilitated the Darby Partnership. It is also known for

its ability to raise money, and to publicize the Darby through the press and through its contributions to direct publications for watershed inhabitants such as the widely distributed 1996 *Darby Book*.

Operation Future Association. OFA is considered in some detail in Part V. OFA has listed as members 150 farmers who farm an estimated 30 percent of the highly erodible land in the watershed. Its major achievements in regard to protection of the Darby seem to have been first, to bridge the gap between farmers and agriculture, on one hand, and environmentalists and others concerned about protection of the aquatic riches of the Darby streams, on the other. Farmers and stream protectors met, learned from each other, and began to develop common understanding and trust. Second, OFA and its farmer leaders publicized new agricultural practices and opportunities to a broad farm audience in the watershed.

Darby Partnership. Formation of the Darby Partnership in 1991 is described in Part V. The Partnership's principal concerns were agricultural threats and solutions. Many of the original participants were mid-level representatives of government agencies, whose support for the protection of Big Darby was sought. The Partnership has never had a formal structure or organizing document, nor a formal statement of goals or plan. It has no hierarchy, officers or staff, relying on volunteers. Partnership meetings occurred four times a year, called together and facilitated by TNC. Communication and networking were the vital functions of these sessions. No formal action was taken. Meetings were open to whoever wished to come. In effect, the Partnership was a loose congregation of organizations and people with a common interest in protecting the Darby watershed. It was the only broad interest/membership institution addressing threats to the Darby.

The Partnership evolved in several ways. Working-level agency people took the places of managerial-level agency representatives. Greater attention began to be paid to suburban development threats. These changes were accompanied by the voluntary formation, starting in 1995, of teams or committees of persons who wished to work together on particular protection-related activities. The first teams bore the names Stream Bank Management, Land Use, Communication, Education and Outreach, and Livestock. The teams were in a relatively early stage of development and operation at the time information was collected for this report.

The achievements and prospects of the Partnership are difficult to evaluate. Communication among the diverse membership and with those outside and the initiation of problem solving are clearly valuable and highly regarded. Persons interviewed were divided in opinion, however, about the effectiveness of the Partnership in other ways. Some pointed out what they perceived as weaknesses: among them, no way for the Partnership to make decisions and take collective action, over-representation of government agencies, and difficulty in giving credit where due. Also, the suburban development and construction sectors had not participated—indeed, might not be welcomed—in the Partnership. The absence of this group of stakeholders appears to have been a significant drawback in light of a high level of concern about stresses to the aquatic system from construction and suburbanization.

8. *Money and Personnel Resources.* Substantial numbers of people and amounts of money were invested in the protection of the Darby watershed over the years covered by this report, especially

from the late 1980s to 1996. Some of these resources came from continuing government programs conducted regularly in the Darby and elsewhere. Extra resources were found or set aside specifically for Darby watershed protection outside normal budget allocations and program and institutional frameworks. Also, regular program resources frequently were applied in a fashion that gave special priority to Darby protection. It has not proved possible to sum up total resources applied or to determine the extent to which they came from regular program budgets or incremental resources. The programs and organizations applying these resources are described elsewhere in this report. Insofar as information permits, this section describes the extra or special resources applied for Darby protection.

To the resources otherwise available to NRCS, FSA and OSUE offices in the Darby counties, the HUA designation resulted in the addition of between 2.5 and 3.5 (depending on the year) extra personnel to NRCS for watershed protection for several years. Additional support for OSUE staffing (from the HUA and OSUE itself) amounted to \$90,000 per year for four years. The HUA also helped support 4 to 5 AmeriCorps positions in NRCS activities in 1995-1996. Extra cost share funding of \$600,000 for the 5-year period 1991-1995 was provided through FSA.

USEPA provided a total of about \$300,000 over several years in Clean Water Act Section 319 nonpoint source control grant funding through OEPA; approximately \$200,000 in matching funds was added for a total of \$500,000. USEPA also provided about \$225,000 in additional funding under Section 104(b)(3) of the Clean Water Act to assist state (OEPA) and local government in developing urban stormwater runoff controls. This funding was augmented by a 25 percent state match.

The State of Ohio was a major source of resource support. Its programs and organizational units that addressed Darby watershed problems are covered in other sections. It seems clear that extra portions of its ongoing programs' resources went to the Darby, such as those devoted to the protracted process of designating the Darby as a Scenic River (and later monitoring its progress). Especially notable as incremental funding for protection of the watershed was the availability of \$9 million from the State Revolving Fund low-interest loan program. By 1996, approximately \$1.2 million had been loaned for a variety of nonpoint source control projects.

The local soil and water conservation districts also provided support. In 1993 the Union County SWCD allocated \$50,000 for livestock waste management and filter strip projects and the Franklin County SWCD allocated \$20,000 for an urban stormwater demonstration project. Staff time from each SWCD was also used for designing and implementing best management practices in the watershed and helping to estimate the extent of conservation tillage each year.

The Nature Conservancy has been an important contributor of both dedicated staff and money. Over the time covered in this report, TNC devoted up to three full-time staff to the Darby with contributions from other staff. TNC has also committed money for a variety of purposes: mussel monitoring, studies of alternative crops, studies to locate and evaluate sedimentation sources, support of USGS gaging stations, support for the Darby Partnership and for the *Darby Book*, and riparian

land acquisition. Total money commitment has been estimated at \$1.1 million, of which \$300,000 has been used to support scientific studies.

Other special contributions to Darby protection include a grant from the Kellogg Foundation (\$266,000 to support Operation Future Association) and a grant from Honda to support the OSU 1994 study of urban nonpoint water pollution in the Hellbranch Run subwatershed.

All told, though total amounts cannot be fixed, substantial special resources or allocations of regular program resources were applied to understand, monitor and protect against the threats to the Darby. In the aggregate, these resources have permitted a great amount of activity that has enriched what is known about the watershed, and likely effected changes in land use that should add significantly to the protection of the streams' aquatic systems and riparian corridors.

9. Plans. Relatively little broad and arguably no comprehensive planning has been identified for the protection of the values of the Big Darby watershed, though much planning affecting the Darby has been carried out for local areas and in separate programs and projects within the watershed. As mentioned above, TNC prepared comprehensive watershed-wide strategies to counter threats to the biological diversity of the watershed, especially in its aquatic systems, including approaches to threats, partners and the like. In the preparation of applications for the HUA, the applicants did watershed-wide planning, primarily relating to agricultural issues; but no comprehensive plans resulting from application and approval have been identified. The Ohio Scenic River application also included some watershed-scale planning. Except perhaps for the HUA application, these planning events do not appear to have involved wide participation.

Limited planning and plans would also include the land use and other plans of the counties, annual planning in the operating programs of many government agencies that included work in the Darby watershed, and planning for specific projects in the watershed.

Mandatory and Voluntary Approaches to Addressing Threats

In general, mandatory approaches to reducing threats in the Big Darby watershed—that is, by direct application of law or pursuant to regulation—have mostly related to housing construction and real estate development, and the commercial development and waste management that accompany them. Few if any legal restraints appear to have affected agricultural practices and the use of agricultural land; there, approaches to change were education, demonstration, persuasion, and incentives such as cost sharing and other assistance. Both the mandatory and the voluntary approaches appear to have been essential.

10. Approaches Using Legal Requirements and Regulation. As noted above, local government requirements apply to land use, zoning, subdivision development, and housing construction, as well as to other development and construction, with some special provision for the riparian corridor. Decisions made here can make a great difference in the amount, character, and speed of precipitation runoff to streams, resulting in hydromodification, sedimentation, and pollution in the stream network. Local requirements also govern the use of wells and on-site human waste disposal systems

such as septic fields, where there are no public water supplies or sewer systems. To what extent this aggregation of authorities has protected the watershed and the stream system is unclear. It has not been effective in checking suburbanization.

Regulation of discharges from sewage treatment plants and a program to control stormwater are carried out by OEPA under the Clean Water Act. There are about 40 permitted sewage treatment plants (most of them very small) that discharge to the Darby system; permits are issued that will meet the Darby's water quality standards. Although violations with adverse impact occur, they appear to be carefully tracked and at least in most cases have not produced significant long-term adverse effects. The overall success of stormwater controls administered through general permits is not clear. This program focuses heavily on controlling sediment runoff from exposed soil during construction, with less attention to stormwater runoff after construction is complete and exposed ground is vegetated.

Regulation and impact under other provisions of law include the effect of the Scenic River designations discussed in Part V, possible but unknown impacts of Endangered Species Act designations, and unknown benefits of the wetlands protection provisions of Section 404 of the Clean Water Act. Ohio will eventually consider preparing Total Maximum Daily Loads for segments of Big and Little Darby Creeks and certain of their tributaries that have been listed under section 303(d) of the Clean Water Act. Load allocations and plans to meet them might involve reduction of nonpoint source contributions to the streams.

11. Voluntary Approaches. All environmentally beneficial change in agricultural methods and land use was voluntary. No farmer was forced to adopt new cultural methods or to alter the uses of his farm. If he changed, it was because he was persuaded (sometimes with a little peer pressure) that it was in his interest or protective of the Darby to do so. In some cases, financial assistance made the difference in persuading him to change, even to take land out of production. In many cases it was a combination of persuasive demonstration plus technical assistance and cost sharing that went into change. See for detail other parts of this report regarding Operation Future Association, changes in cultivation methods, the reforestation of riparian land, and other important actions in agriculture.

Another type of voluntary action was widespread and important: joining together and working as a part of various institutions for the benefit of the values of the watershed. This joining together was a hallmark of DCA, HUA, OFA, and finally the Darby Partnership and its working teams.

VII. Some Final Observations

This part offers some concluding observations about the protection of Big Darby streams and watershed as of the end of 1996—what has been accomplished and how—together with prospects for the future.

- < Most of the Darby stream system was in good to excellent condition during the time period covered by this report. This appears to have resulted largely from the watershed's natural characteristics—topography, geology, soils, hydrology, and the like. The intense agricultural use

of most of the land of the watershed appears to have harmed the streams and their natural communities in occasional places but overall very little. In comparison to what other land uses might have done, agricultural use is thought to have protected the stream system.

- < Defeat of the City of Columbus's proposal to dam the Darby to create a drinking water reservoir achieved crucial protection of large segments of the Big Darby and its natural communities. This was achieved through the combined efforts of grassroots opposition and state agency initiative. This was an early manifestation of wide, intense opposition to interfering with what was believed to be a special, valuable natural resource. This belief and support for Darby protection have continued to have considerable effect.
- < The extensive effort to change agricultural practices and land uses over the past decade had a wide variety of motivations (economic, resource protective, etc.). It has produced a great deal of action that should at least add to protection of the Darby aquatic communities from harm and probably improve them. A cause-and-effect relationship between agricultural change and stream condition has not yet been established by scientific studies. Nevertheless, a substantial and valuable increase in knowledge and concern for protection of the streams has occurred in the broadly defined agricultural community (farmers, government agencies).
- < The principal threat to the Darby, by virtually universal estimation, is increasing human habitation and residential and related construction and development. It is unclear whether this threat will be contained to an extent adequate to protect the special values of the Darby. There is no organization in which development interests participate with watershed protection interests to find solutions that balance development and watershed protection. The relevant economic, social, institutional and political factors, as well as the current approaches to resolving the threat, appear to be almost entirely different from those associated with agricultural threats.
- < The importance of widespread knowledge of the rare, special values of the Big Darby watershed and spreading public concern and support for its protection cannot be overestimated. Much scientifically based, respected information about the quality of the streams and the watershed's biology, widely communicated, together with the watershed's visible beauty have formed a potent continuing basis for organizing to oppose perceived threats to the watershed.
- < Another major strength underlying protection efforts in the Big Darby watershed has been the active involvement of a great many institutions with programs that include watershed resource protection. These organizations, both public and private, and with differing constituencies and primary purposes, have worked in various cooperative relationships, bringing to bear for Darby protection a substantial range of activities and amounts of money and people resources. They are not bound by a common plan. The common institution in which most participate, the Darby Partnership, is a communication and coordinating ground rather than a decision-making or action organization. Among the many participating organizations, an unusual role has been played by The Nature Conservancy, a private, nonprofit institution. TNC both conducted and gave substantial support to a broad group of scientific, investigative, protection and surveillance

activities; it has also been instrumental in creating, facilitating and supporting the Darby Partnership.

- < The federal Clean Water Act has been important in protecting the Darby watershed. Ohio's control of sewage treatment plant discharges and stormwater runoff, as well as its water quality standards, implement or derive from the Act. Clean Water Act programs also furnished substantial funding for watershed protection.
- < Whatever the reasons, the watershed seems to have held its own through 1996, with some improvements in land use and occasional difficulties, but without any striking improvement in or degradation of the stream system and its biological systems as a whole. The strength of this impression is qualified by the lack of availability of certain types of data. Whether the watershed will be well protected in the future is impossible to forecast, although the capacity to do so (organizations, programs, public attitudes, knowledge, etc.) appears to exist.