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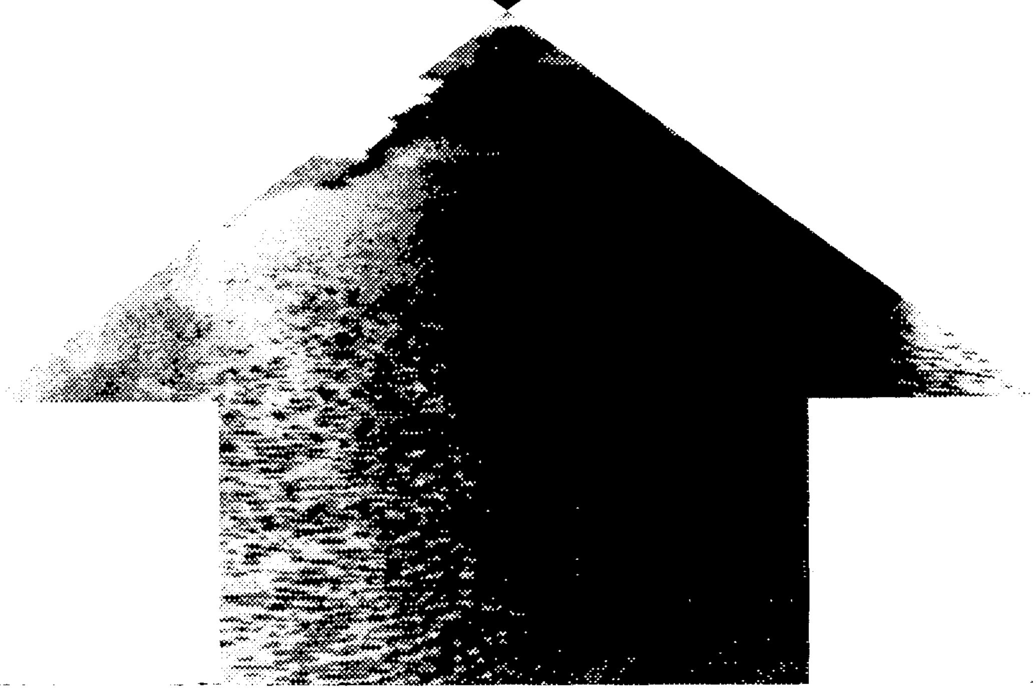
ENVIRONMENTAL IMPACT OF LAND USE ON WATER QUALITY

(A WORK PLAN)



EPA-G005103

ENVIRONMENTAL IMPACT OF LAND USE on WATER QUALITY (A WORK PLAN)

BLACK CREEK STUDY
MAUMEE RIVER BASIN
Allen County, Indiana

PLANNING PHASE - WORK PLAN

Reduction of Sediment
and
Related Pollutants
in the
Maumee River
and
Lake Erie

Prepared by

ALLEN COUNTY SOIL AND WATER CONSERVATION DISTRICT

In cooperation with

U.S. ENVIRONMENTAL PROTECTION AGENCY
Region V - Chicago, Illinois

U.S. DEPARTMENT OF AGRICULTURE
Soil Conservation Service
Agricultural Research Service

PURDUE UNIVERSITY
Cooperative Extension Service
Agricultural Experiment Station

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MAY 1973

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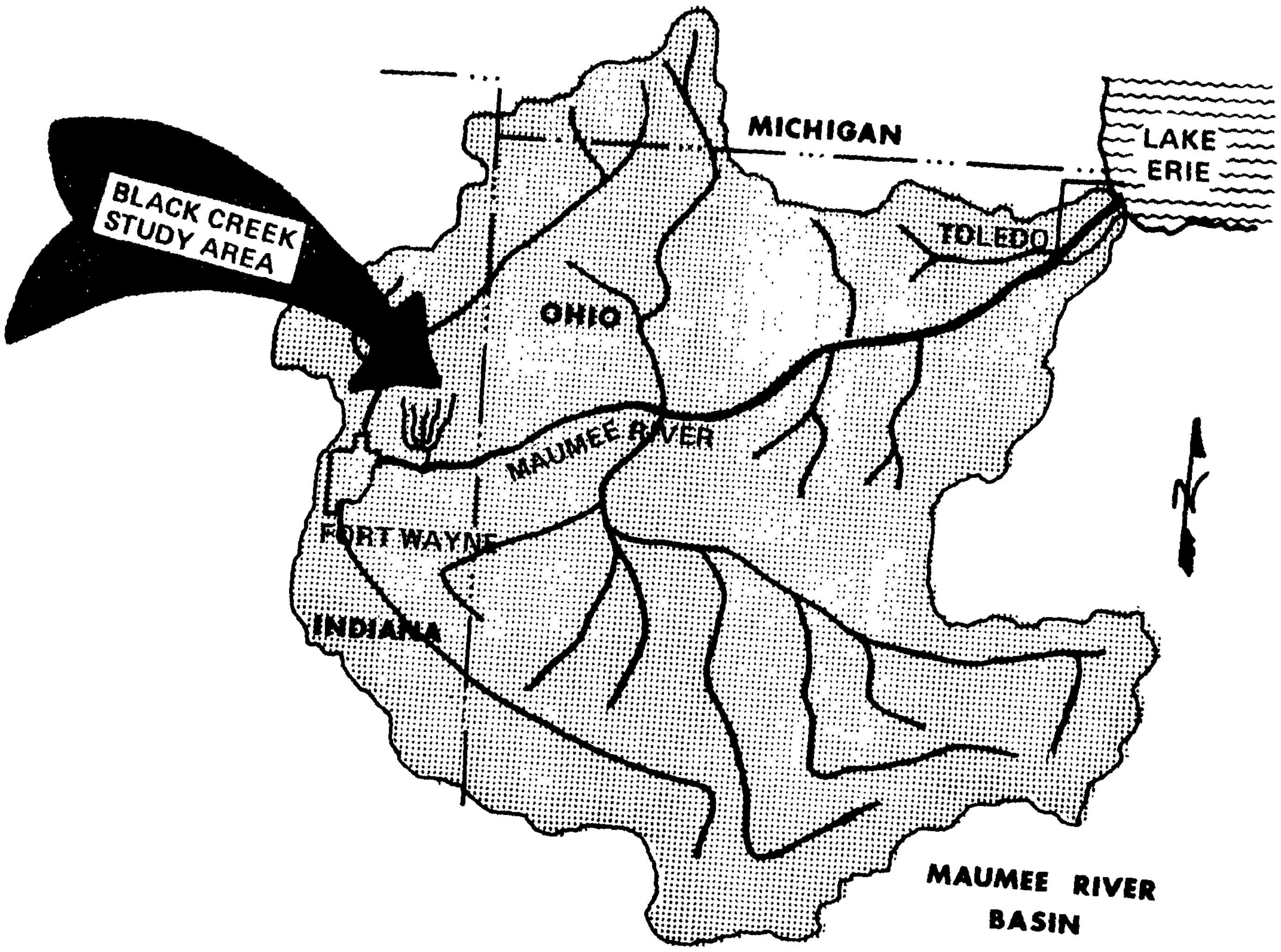
LOCATION MAP



Abstract

An investigation of the Maumee Basin was conducted to determine the characteristics which would be necessary to conduct a meaningful demonstration and research project on a small watershed. The Black Creek Watershed in Allen County Indiana was selected for this project. An investigation of the Black Creek Area identified land treatment measures, which will significantly reduce the sediment contribution from this watershed to the Maumee River. Monitoring sites were selected within the watershed and a plan of investigation which will lead to a projection of results of the demonstration project to the basin was developed. Also developed were a series of scientific studies to aid in the understanding of the mechanisms involved in the treatment of the watershed. A work schedule for treatment was developed and specific areas of concern identified.

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I. INTRODUCTION

This document constitutes the final report on the first phase of a five-year project being undertaken under a grant from the United States Environmental Protection Agency to the Allen County, Indiana, Soil and Water Conservation District for a program to evaluate methods for reduction of sediment and related pollutants in the Maumee River and Lake Erie by control of soil erosion in a selected demonstration watershed.

This report, and the accompanying plan of work, are the result of investigation of the Maumee Basin and of watersheds within Allen County, Indiana which approximate the physical, geologic, and socio-economic characteristics of the basin. For the selected demonstration watershed, an intense analysis of land treatment methods which it is believed will reduce soil erosion has been carried out, by the Soil Conservation Service of the Department of Agriculture under a contract with the Allen County District. Concurrently, Purdue University Scientists, also operating under a contract between the District and the University, have developed a detailed research plan and have identified sites within the target watershed where monitoring activities can be conducted.

The proposal submitted to the Environmental Protection Agency by the Allen County District for this demonstration and research project called for a six-month planning phase during which time an appropriate watershed which is representative of the Maumee Basin would be selected. Currently, Purdue University scientists were to select appropriate monitoring sites within the target watershed so that an assessment of the effect of land treatment could be obtained. In addition, Purdue was to develop a research plan involving controlled experiments on small plots of land to gain precise information on the effects of various agricultural practices. Purdue was also scheduled to begin a detailed sociological study in an attempt to assess the attitudes of individual landowners--the factors that appear to convince persons to participate in the program and the factors which may preclude participation of others.

The proposal also called for a study during the planning phase by the Soil Conservation Service to determine the types of land treatment which would be applied in the target watershed, the volumes of each type of treatment to be applied and a general time table for the installation of these practices over the life of the project.

Each of these goals has been accomplished and are described in detail in this report and the accompanying Plan of Work.

After a field study of the Maumee Basin, a review of existing data on the basin, and development of criteria for selection of a target watershed, an 18.8 square-mile area in northeastern Allen County, designated the Black Creek Study Area, was selected.

The area closely mirrors the Maumee Basin. It is described in detail in Section 4 of this report.

Immediately after selection of the Black Creek Study Area, personnel of the Soil Conservation Service and the Allen County Soil and Water Conservation District began a study of soil maps of the area and field investigations. The result of this study is a description of the area in terms of soil type and in terms of land use capabilities. This description has, in turn, allowed Soil Conservation Service technical and engineering specialists to predict by volume the types of land treatment that will be needed in the study area and to develop a schedule for the installation of this treatment by the end of the fourth year of the project period. These descriptions and results are included in Section V of this report. Purdue University has identified specific monitoring sites at which data will be collected to evaluate the effects of the total program and to aid in scientific studies of the watershed itself and in projections to the Maumee Basin.

Purdue Scientists have also developed a research plan for the project utilizing the selected watershed as a base for detailed plans for more definitive studies on small plots utilizing a rainfall simulator. Results of the watershed evaluation and the small plot work will be projected to the entire Maumee Basin. Both the monitoring scheme and the research plans are spelled out in detail in the accompanying work plan which is Part B of this report.

In addition to the investigation of the physical and geologic characteristics of the Maumee Basin and the Black Creek Study Area, a preliminary sociological evaluation has been made. Data collected by Purdue University will furnish the basis for analyzing the impact of the project on the people of the study area. Most of this data is contained in Section IV of this report. Plans to utilize this data and to collect additional data on an on-going basis as the project is conducted so that a meaningful analysis of the factors which contributed to the success or failure of efforts to convince individuals to participate in the land treatment program are outlined in the plan of work.

Following the six-month planning period, the Allen County Soil and Water Conservation District, Purdue University, and the Soil Conservation Service are convinced that the program is a viable one.

As a result of the proposed program, it is anticipated that meaningful data will be obtained from the study area which can be extrapolated to the Maumee Basin specifically and other river basins generally on:

1. the relative success of various existing erosion control techniques in improving water quality

2. the effect of various land use and agricultural practices on erosion and the resulting effect on sedimentation and water quality

3. the types of incentives that will convince individual landowners to voluntarily participate in erosion control programs including an assessment of the need for and possible success of legislation to achieve this end.

In addition, the proposed program should result in enhancement of the general environmental quality of the study area because of the application of land treatment which will reduce erosion. This should result in an improvement of the water quality of the upper Maumee Basin.

II. SELECTION OF STUDY AREA

One of the most important tasks undertaken during the six-month planning phase of this program was the selection of a study area which would accurately represent the Maumee Basin.

It was proposed that the study area contain no more than 20,000 acres which represents less than one percent of the total land area in the basin. Because of the small size of the study area in comparison to the basin, it was necessary to find a study area which was similar to the basin in characteristics of soil type, land use, cultural practices, and anticipated future land use.

In addition to these requirements, it was considered necessary to select the study area such that it would be possible to both monitor gross results and to conduct the necessary small plot experiments proposed in the study.

To facilitate the selection of the most representative study area, the following general criteria were used:

1. The study area should include lake bed and upland soils which are reasonably representative of much of the total Basin.

2. Sufficient drainageways should be present so that monitoring stations can be installed to evaluate erosion and sedimentation both from upland areas as well as where the channel enters the Maumee Basin.

3. Present land uses and cultural practices should be comparable to those of the total Maumee Basin.

4. The anticipated future land uses should be typical of those expected throughout the Maumee Basin.

5. The physiography of the study area should facilitate the separation of runoff between agricultural areas and land under other uses.

6. It is desirable to have court ditches in the area with long time records.

7. The study area should drain directly into the Maumee River.

8. The area should be up to 20,000 acres in size.

A. The Study Area

The area selected as most nearly satisfying these criteria is the 12,038 acres which drain into Black Creek in northeastern Allen County (See Map 1). Section III and Section IV of this report give detailed information about the Maumee Basin and the selected area respectively. The following is a general discussion of the similarities between the basin and the area selected for study.

The area contains both soils and land uses which are representative of the Basin. Black Creek Study Area contains 36 percent upland soils of the silty clay loam till of the Ft. Wayne moraine in the Blount-Morley-Pewamo association. Soils are 39 percent Blount, 38 percent Morley and 16 percent Pewamo with only 7 percent minor soils.

Below the upland, in a belt about 1-1/2 miles wide, on the lake plain is an apron of medium-textured sediments underlying the Rensselaer-Whitaker-Oshtemo association comprising 25 percent of of the watershed. Poorly drained Rensselaer and Whitaker make up 28 and 21 percent respectively, and excessively drained Oshtemo 6 percent. Soils like well drained Martinsville and Belmore comprise the remaining 45 percent.

Toward the outer edge of this apron is a small association making up 5 percent of the watershed where sandy loams overlie clays at less than 3 feet. This area in the Haskins-Hoytville association contains 34 percent poorly drained Haskins, 31 percent poorly drained Nappanee, and 35 percent minor soil areas.

On the main lake plain itself comprising 29 percent of the watershed is the very level high clay (40-50 percent clay in subsoils) Hoytville-Nappanee association. About 48 percent is dark poorly drained Hoytville, 23 percent is light colored Nappanee and 29 percent is of minor soils.

Alluvial soils of overflow bottomlands comprise only 5 percent of the watershed and occur mainly along the lower reaches of the Black Creek in the four miles before it enters Maumee River. Narrow bodies occur in the upland as along Wertz Drain and the main stem of Black Creek southwest of Harlan. In this Shoals-Eel association, Shoals soils comprise 44 percent, Eel 20 percent and minor soils 27 percent.

These five soil associations comprise a range of soil conditions varying from those with 50 percent subsoil clay to those with less than 10 percent. Surface soils range from silty clays to loamy fine sands.

Only the Paulding and Latty clay areas having over 50 percent clay in the subsoils and Ottokee and Granby, on the deep sand deposits of the north part of the lake plain east of Archbold, are not represented in the Black Creek Watershed.

For the purpose of studying general hydrology and runoff characteristics this watershed should be ideal to represent Maumee Basin.

By comparing percentages by land capability classes and subclasses for the Maumee Basin with those for lands in the Black Creek Study Area, it is evident how closely this watershed represents conditions in the Maumee Basin as a whole. Table A-1 illustrates this comparison.

TABLE A-1
Land Capability Comparisons - Maumee Basin and Black Creek Study Area

Capability Class Subclass	Percent of Land Area In Different Land Capabilities	
	Maumee Basin	Black Creek Area
I	0.9	2.4
IIe	7.4	12.6
IIIe	3.5	3.0
IVe	1.4	1.3
IIw-IIIw	82.6	79.6
IIs-IIIs-IVs-VIe	4.2	1.1
	100.0	100.0

The Maumee Basin is an area of intensive farming, producing corn, soybeans, wheat, sugar beets, speciality crops including tomatoes and others for canning. Amount of land in tillage-rotation varies from about 75 to 90 percent, being least in the more rolling counties and greatest in the counties which are mostly in the lake plain. Wooded land ranges from 5 to 19 percent among counties, being greatest in sandiest ones, and permanent pasture is generally low. The two most urbanized counties are Lucas (Ohio) where 43 percent is occupied by Toledo and its environs and Allen (Indiana) where 12 percent is in Ft. Wayne and its surroundings.

More than 95 percent of the Black Creek Study Area is devoted to agricultural uses. This includes nearly 81 percent in cropland, 4 percent in pasture, 7 percent in woodland, 4 percent in other agricultural related uses and 4 percent in urban and built-up areas. This distribution of land use compares favorably with the land use in the total Maumee River Basin as shown in the following table:

TABLE A-2

Land Use Comparisons - Maumee Basin and Black Creek Creek Study Area

Land Use	Percent of Lands in Different Uses: Maumee Basin	Percent of Lands in Different Uses: Black Creek Study Area
Cropland	73	80.7
Pasture	4	4.3
Woodland	8	7.1
Urban & Built-up	9	3.6
Other	6	4.3
	100	100.0

As in the Maumee Basin, corn and soybeans are the major crops produced with an estimated 7,000 acres devoted to these crops. Small grains and meadow in rotation represent a correspondingly smaller amount of cropland acreage.

The scattered woodlands and the relatively smaller acreages of pasture and haylands in the Black Creek Study Area are typical of these land uses in the Maumee Basin.

Urban and built-up acreages for the study area are less, on a percentage basis, than for the total basin, since data for the basin includes the large population centers of Toledo and Lima, Ohio, and Ft. Wayne, Indiana. The Black Creek Study Area town of Harlan is fairly representative of the small towns and villages found in the Maumee Basin.

III. GENERAL DESCRIPTION OF MAUMEE BASIN

A. Historical Information

The Maumee Basin was one of the last areas of the Lake Erie Basin to be settled. Although Fort Wayne and Toledo were among the outposts established around 1800, it was not until the Erie Canal opened an easy water route to the region in 1825, that settlement of the Lake Erie region really flourished. The "Great Black Swamp" was the last area to be settled. Comprising the major portion of the Maumee Basin, this "Great Black Swamp" as it was once called, represents the area of the former glacial Lake Maumee.

It was primarily the German settlers, with their knowledge of farm drainage, that brought the black soils of the former lake bed into productive use. By the middle of the nineteenth century, the dense forests of this area had been cut and the most important agricultural lands opened to cultivation. These broad, flat lands now have one of the most extensive farm drainage systems in the nation.

The Maumee Basin is today the largest and most productive agricultural area within the entire Lake Erie region. Except for some suburbanizing influences in the Toledo, Lima, and Ft. Wayne areas, the Maumee Basin is almost entirely devoted to agricultural use.

B. Physiography

The Maumee River Basin comprises 6,608 square miles, of which 1,283 are in northeastern Indiana, 4,862 in northwestern Ohio and 463 in southern Michigan. Approximately 4,229,100 acres are involved in 26 counties: 17 in Ohio, 6 in Indiana and 3 in Michigan. In Ohio, the Basin includes all of Allen, Defiance, Henry, Paulding, Putnam, Van Wert, and Williams Counties; substantial portions of Auglaize, Fulton, Hancock, Hardin, Lucas, Mercer, and Wood Counties; and smaller areas of Seneca, Shelby, and Wyandot. Within Indiana the Basin includes substantial portions of Adams, Allen and DeKalb Counties and smaller portions of Noble, Steuben and Wells Counties. The Michigan portion includes portions of Hillsdale and Lenawee Counties and a very small portion of Branch County.

The average annual rainfall for the Basin ranges between 28 and 36 inches. The mean annual temperature is about 50 degrees Fahrenheit with monthly means ranging between approximately 25-30 degrees in January and February and 70-75 degrees in July and August. The mean length of the freeze-free period ranges between 150 and 180 days for most of the Basin.

The Basin is roughly circular in shape, measuring about 100 miles in diameter. The Maumee River is formed at Ft. Wayne, Indiana by the confluence of the St. Joseph River and St. Marys River. The St. Joseph River rises in Hillsdale County, Michigan and flows southwestward. The St. Marys River rises in Auglaize County, Ohio and flows in a northwestward direction to Ft. Wayne where it turns abruptly to a northeastward direction before joining with the St. Joseph River to form the Maumee River. The Maumee River flows in a northeastward direction from Ft. Wayne, across the Basin to Toledo and its entrance to the Maumee Bay of Lake Erie. Two major tributaries, the Tiffin River and Auglaize River join the Maumee River from the north and south respectively, at Defiance, Ohio.

Topography ranges from a nearly flat featureless plain across much of the center and eastern portion of the Basin to rolling hills around portions of the Basins' periphery, especially in Michigan and Indiana. The altitude ranges from nearly 1150 feet (mean sea level) in Hillsdale County, Michigan to 570 feet at the mouth of the Maumee River. Local relief ranges from a few tenths of a foot over much of the area to nearly 100 feet in the rolling hills of Michigan and Indiana. The Maumee River flows in a tortuous channel entrenched some 25 to 40 feet below the lacustrine plain. The River is generally lacking any significant terrace or flood plain development.

The erosion rates of the Maumee River Basin are among the highest in the Great Lakes Basin. The estimated annual gross erosion exceeds 4-1/2 tons per acre. By contrast, the current estimated gross erosion rate for the entire Great Lakes Basin is about 2 tons per acre. Sediment yields in the Basin are relatively large as indicated by Waterville, Ohio gage data. From 1951 to 1958 nearly 1-1/2 million tons of sediment passed the Waterville gage annually. In addition, the sediment load in the River fluctuates greatly. For example, during a 3-day period in February, 1959, nearly one-half million tons of sediment passed the Waterville gage.

Physiographically, the Maumee River Basin is essentially a nearly level plain that represents a portion of the abandoned floor of glacial Lake Maumee which occupied the Lake Erie Basin in late Pleistocene time. Abandoned shoreline deposits diverge in a northeastward and southeastward direction from Ft. Wayne, Indiana. Dominant surficial deposits include lacustrine clays and sands and reworked, wave-scoured lake-bottom till. Bedrock consists predominatly of Silurian and Devonian limestones, dolomites and shales. Depth to bedrock in the Indiana portion of the Basin ranges from less than 50 feet to about 150 feet.

C. Economic Information

The Maumee River Basin is primarily agricultural, with more than 90 percent of the land in the Basin in agricultural use. Approximately 73 percent is in cropland, 4 percent in pasture, 8 percent in woodland, 6 percent in other agricultural related uses and 9 percent in urban and built-up areas. The principal crops grown are corn, soybeans, wheat, and oats, with some sugar beets. There are also significant acreages of vegetable crops and nursery stock produced within the Basin. Sales from livestock and livestock products account for about one-fourth of the income from farm sales.

Total population in the area is approximately 1,295,000, of which 50,000 reside in Michigan, 275,000 in Indiana, and the remaining 970,000 in Ohio. Toledo, Ohio and Ft. Wayne, Indiana, are the major cities with Lima, Findlay, and Defiance, Ohio being the other major population centers. The remainder of the Basin is primarily rural with a number of smaller agriculturally-oriented communities.

The principal industries are machinery, electrical and transportation equipment manufacture, metal fabrication, petroleum refining, and food processing. Major industrial centers within the Basin are Toledo and Lima, Ohio and Ft. Wayne, Indiana.

Toledo ranks as the nation's third largest railroad center, and the city's port, which is the ninth largest in the United States, is the world's largest shipper of soft coal. The Port of Toledo ranks second only to Chicago in size on the Great Lakes. Major products passing through the port include iron ore, farm products, machinery, and petroleum products. Lima, Ohio is the center of an oil distribution system for the Great Lakes and Eastern markets, while Toledo is the largest petroleum refining center between Chicago and the Eastern Seaboard.

D. Geology

The drainage basins of the St. Joseph and St. Marys Rivers which join at Ft. Wayne (where they reverse course and head toward Lake Erie) is largely controlled by glacial features of the Lake Erie glacial lobe. This lobe pushed across rocks mainly of limestone and shale and carried fine till material into present day northwest Ohio, northeast and east central Indiana and south central Michigan. During the last major stand of this glacial lobe, in its retreat some 10,000 years ago, the Fort Wayne moraine was deposited concentric to the front of the retreating lobe (See General Soil Map of Maumee River Basin Associations 1 to 4) and this dammed up a great body of water between it and the eastward retreating ice front of the lobe. This water body was named by geologists "glacial lake Maumee" and the land area once covered by it is known today as "the lake plain".

1. General Nature of the Lake Plain

Glacial lake Maumee did not remain long enough to influence all of the lake plain uniformly. In the west end and along the south border it merely reworked the glacial till beneath it, leveling the surface but leaving only a thin deposit of fine lake-laid sediments (Association 5). Similar areas occur in the central part of the basin northeast and east of Defiance. There are a number of areas where clays are overlaid by sandy or loamy sediments up to 3 feet thick (Associations 8 and 9).

In areas below the steep northeastern trending flank of the Ft. Wayne moraine, deltas of loamy materials were deposited in Lake Maumee composed of eroded debris from the uplands (Association 8). In this and similar border areas, temporary lake stages were recorded as beach ridges. In these areas the material deposited includes sandy and/or loamy beach ridges, deep loamy sediments on smooth deposits of sands and silts, and loamy sediments on level and depressed areas. Loamy sediments were deposited only thinly over lake clays or till by action of water or wind (Associations 8 and 9).

Near the center of the glacial lake Maumee, fine sediments were deposited most deeply as the retreating glacial lobe stood somewhat east of Defiance. Here in an east-facing crescent is an area known as the Paulding Basin (Association 7). These sediments in the Paulding Basin are higher in clay content than any other part of the Maumee Basin. This area was the center of what was once called the Maumee Swamp or Marsh. Beach ridges developed concentric to the receding lake borders just as they did at the Fort Wayne end of the glacial lake (Association 8).

Between Defiance and Toledo, clay loam till reworked by waters of glacial lake Maumee lies east of the Paulding Basin. The north flank of the lake plain is mantled with thick to thin sands (Associations 9 and 10). Sandiest areas occur just west of Bowling Green, southwest of Toledo and in the Wauseon vicinity (Association 10). In these same areas sandy loam and loam mantles only a few feet thick over clayey till or in thin mantles of loamy sand over clayey till or lake-laid clays (Association 9). There is a high degree of local variation in these areas in comparison with the more clayey parts of the lake plain.

2. Nature of the Glacial Moraines and Till Plains

Clay loam till left by the receding glacial lobe of Lake Erie occurs in parts of nine Michigan, Ohio and Indiana counties on the northwest flank of the lake plain and twelve Indiana and Ohio counties on the southwest and south. That part between St. Joseph River and the lake plain is perhaps the most rolling with best expressed morainic features and is mostly part of the Fort Wayne moraine. That southeast of Fort Wayne and east toward Findlay lies lower and is less rolling, being mostly ground moraine. Drainage of the southwest portion is through the St. Marys River which parallels the south flank of the Fort Wayne moraine. The eastern portion drains toward Auglaize River and its tributaries which flow north through the lake plain. The northern part drains through St. Joseph River, which parallels the north flank of the Fort Wayne moraine and through Tiffin River which flows south across the lake plain.

On the south flank where the rise to the till plain is very gradual, it is hard to determine the exact location of the lake plain boundary. Since there was apparently less eroded debris from the uplands on the south side, only a discontinuous apron of medium textured deltaic deposits formed on the southwestern flank. However, there are a number of local lake bed deposits and muck areas in the till plain which occupy broader depressions (Association 6). Also there are lake border ridges as that one followed by U.S. Highway 30 SE of Fort Wayne (Association 8) and broader deltaic strips fringe the lake plain in the area north of Lima and east toward Findlay.

At the extreme north end of the St. Joseph River drainage in Michigan the till is sandier and lies more elevated and more rolling (Associations 3 and 4). In this area there are many valley train deposits along courses of glacial meltwater streams which are often under-laid by sand and gravel.

E. Soils

The General Soils Map for the Maumee Basin, which follows this section, gives a visual reference to the variations of soils and associated geology. Each of the soil associations are described below. Associations 1 through 5 are soils dominantly formed in glacial till. Associations 6 through 10 are soils dominantly formed in water-deposited material, organic material, eolian material.

1. Blount-Pewamo association

Depressional to gently sloping, very poorly drained to somewhat poorly drained soils that have clayey subsoils.

The landscape in this association consists of a glacial ground moraine that is nearly level with many narrow depressions. The soils formed in glacial till.

This soil association occupies about 26 percent of the watershed.

Blount soils are nearly level and gently sloping and are somewhat poorly drained. They have a surface layer of very dark grayish-brown and dark grayish-brown loam or silt loam and a subsoil that is mostly dark-brown and dark grayish-brown, mottled silty clay and clay.

Pewamo soils are depressional and nearly level and are very poorly drained. They have a surface layer of very dark gray silty clay loam and a subsoil that is mostly dark gray or grayish-brown, mottled silty clay or silty clay loam.

2. Morley-Blount-Pewamo association

   Depressional to moderately steep, very poorly drained to moderately well drained soils that have clayey subsoils.

   The landscape in this association consists of a glacial moraine that is gently rolling with some depressional areas near drainageways. The soils formed in glacial till.

   This soil association occupies about 22 percent of the watershed.

   Morley soils are gently sloping to moderately steep and are moderately well drained. They have a surface layer of very dark grayish-brown and grayish-brown silt loam and a subsoil that is mostly dark yellowish-brown and brown clay and is mottled in the lower part.

   Blount soils are nearly level and gently sloping and are somewhat poorly drained. They have a surface layer of very dark grayish-brown and dark grayish-brown loam or silt loam and a subsoil that is mostly dark brown and dark grayish-brown, mottled silty clay and clay.

   Pewamo soils are depressional and nearly level and are very poorly drained. They have a surface layer of very dark gray silty clay loam and a subsoil that is mostly dark gray or grayish-brown, mottled silty clay or silty clay loam.

3. Miami-Conover association

   Nearly level to moderately steep, well drained and somewhat poorly drained soils that have loamy subsoils.

The landscape in this soil association consists of a glacial moraine that is gently rolling with some depressional areas near drainageways. The soils formed in glacial till.

This soil association occupies about 2 percent of the watershed.

Miami soils are gently sloping to moderately steep and are well drained. They have a surface layer of dark grayish-brown loam and a subsoil that is dark brown clay loam.

Conover soils are nearly level and are somewhat poorly drained. They have a surface layer of very dark grayish brown loam and a subsoil that is mostly yellowish-brown and dark yellowish-brown, mottled clay loam.

4. Hillsdale-Fox association

Gently sloping to moderately steep, well drained soils that have loamy subsoils.

The landscape in this soil association consists of glacial moraines, kames, kame moraines, and valley trains that are rolling with nearly level areas at the lower elevations. The soils formed in glacial till and outwash.

This association occupies about 1 percent of the watershed.

Hillsdale soils are gently sloping to moderately steep and are well drained. They have a surface layer of dark grayish-brown sandy loam and a subsoil that is dark brown and dark yellowish-brown sandy loam and sandy clay loam.

Fox soils are gently sloping to moderately steep and are well drained. They have a surface layer of dark grayish-brown loam and a subsoil that is dark brown clay loam and gravelly loam.

5. Hoytville-Toledo-Nappanee association

Depressional to gently sloping, very poorly drained and somewhat poorly drained soils that have clayey subsoils.

The landscape in this soil association consists of glacial lake plain and glacial till plain that is dominantly nearly level with occasional slight rises. The few sloping areas in the landscape are near deeply dissected streams. Hoytville and Nappanee soils formed in glacial till. Toledo soils formed in lacustrine sediments.

This soil association occupies about 17 percent of the watershed.

Hoytville soils are depressional and nearly level and are very poorly drained. They have a surface layer that is very dark gray silty clay and a subsoil of dark grayish-brown, mottled silty clay.

Toledo soils are depressional to level and are very poorly drained. They have a surface layer of very dark gray silty clay and a subsoil that is dark gray and gray, mottled silty clay.

Nappanee soils are nearly level to gently sloping and are somewhat poorly drained. They have a surface layer that is dark gray and grayish brown silt loam or silty clay loam and a subsoil that is mostly grayish brown, mottled clay.

6. Carlisle-Montgomery association

Depressional and nearly level, very poorly drained soils that have organic and clayey subsoils.

The landscape in this soil association consists of a local lake plain that is flat and is surrounded by a glacial ground moraine. Carlisle soils formed in organic materials. Montgomery soils formed in lacustrine sediments.

This soil association occupies about 1 percent of the watershed.

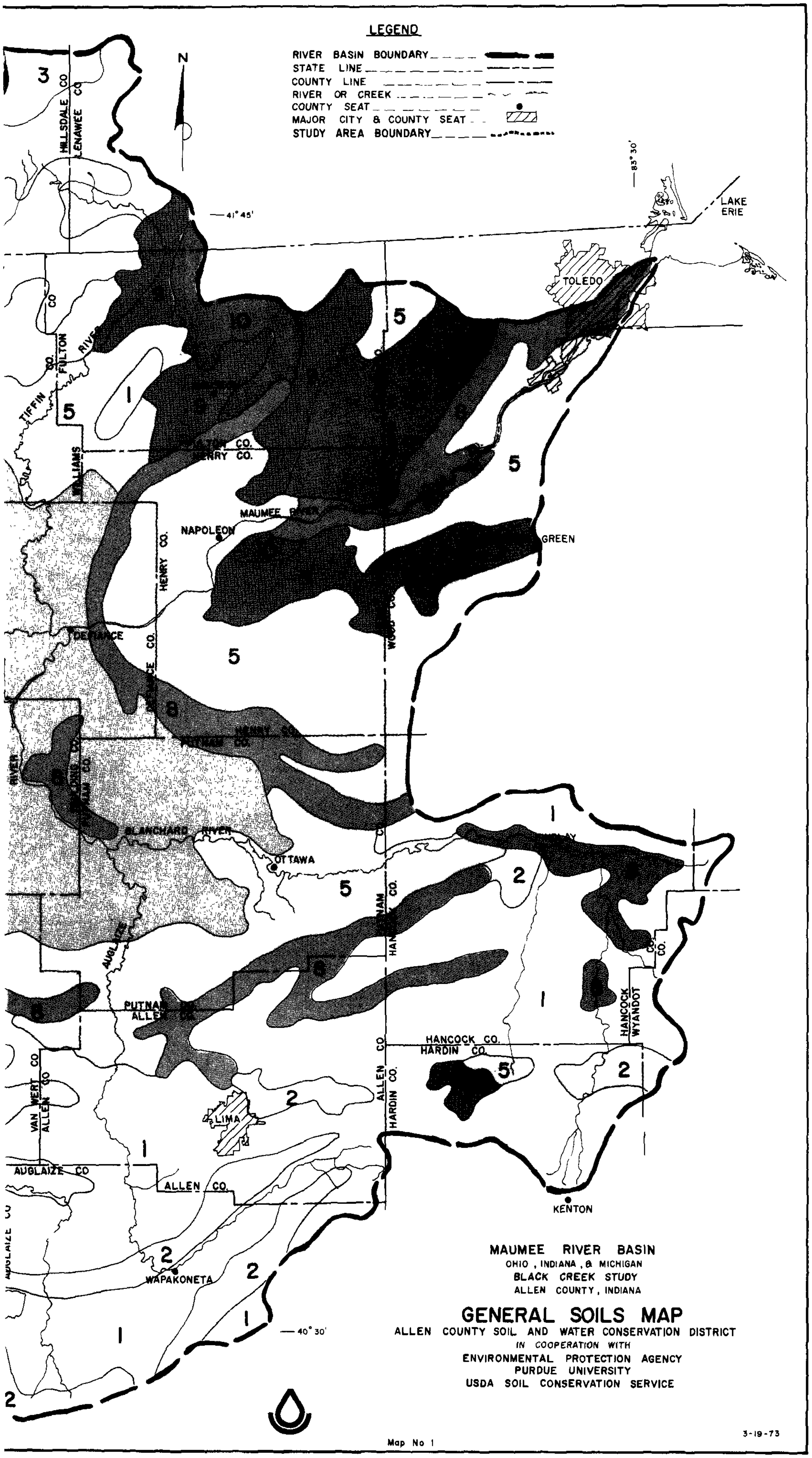
Carlisle soils are depressional to nearly level and are very poorly drained. They have a surface layer of black muck and underlying material that is black and dark-reddish brown muck.

Montgomery soils are depressional to nearly level and are very poorly drained. They have a surface layer of black silty clay loam and a subsoil that is dark gray, grayish-brown, and gray silty clay loam and silty clay.

7. Paulding-Latty-Roselms association

Depressional and nearly level, very poorly drained and somewhat poorly drained soils that have clayey subsoils.

The landscape in this soil association consists of a glacial lake plain that is dominantly nearly level with occasional slight rises. A few sloping areas in the landscape are near deeply dissected streams. The soils formed in lacustrine material.


LEGEND
RIVER BASIN BOUNDARY
STATE LINE
COUNTY LINE
RIVER OR CREEK
COUNTY SEAT
MAJOR CITY & COUNTY SEAT
STUDY AREA BOUNDARY
N
83° 30'
41° 45'
40° 30'
LAKE ERIE
TOLEDO
HILLSDALE CO
LENAWEE CO
FULTON CO
TIFFIN RIVER
WILLIAMS
HENRY CO.
MAUMEE RIVER
NAPOLEON
GREEN
DEFIANCE
WOOD CO
PUTNAM CO.
BLANCHARD RIVER
OTTAWA
HANCOCK CO.
HARDIN CO.
WYANDOT
AUGLAIZE
ALLEN CO
VAN WERT CO
AUGLAIZE CO
LIMA
KENTON
WAPAKONETA
1
2
3
5
8
MAUMEE RIVER BASIN
OHIO, INDIANA, & MICHIGAN
BLACK CREEK STUDY
ALLEN COUNTY, INDIANA
GENERAL SOILS MAP
ALLEN COUNTY SOIL AND WATER CONSERVATION DISTRICT
IN COOPERATION WITH
ENVIRONMENTAL PROTECTION AGENCY
PURDUE UNIVERSITY
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Map No 1
3-19-73

This soil association occupies about 15 percent of the watershed.

Paulding soils are nearly level and are very poorly drained. They have a surface layer that is dark gray clay and subsoil that is gray, mottled heavy clay.

Latty soils are depressional and nearly level and are very poorly drained. They have a surface layer of dark gray clay and a subsoil that is gray and olive gray, mottled clay.

Roselms soils are nearly level and are somewhat poorly drained. They have a surface layer of dark gray silty clay loam and a subsoil that is light gray, brown, and grayish brown, mottled heavy clay.

8. Haney-Bellmore-Millgrove association

Depressional to strongly sloping, very poorly drained, moderately well drained, and well drained soils that have loamy subsoils.

The landscape in this soil association consists of long narrow sloping beach ridges rising above the terrane and nearly level glacial deltas and lake plain. The soils formed in glacial and beach ridge deltaic deposits and lacustrine sediments.

This soil association occupies about 10 percent of the watershed. Any soil named in this association is more extensive than the many soils of small extent not named. Although collectively, the Haney, Bellmore, and Millgrove soils do not make up the majority of the association.

Haney soils are gently sloping and sloping and are moderately well drained. They have a surface layer of dark grayish-brown loam and a subsoil that is dark brown clay loam and sandy clay loam.

Bellmore soils are gently sloping to strongly sloping and are well drained. They have a surface layer of dark yellowish-brown loam and a subsoil that is dark brown sandy clay loam and gravelly sandy clay loam.

Millgrove soils are depressional to nearly level and are very poorly drained. They have a surface layer of very dark-grayish-brown loam and a subsoil that is dark grayish brown and grayish-brown, mottled sandy loam and sandy clay loam.

9. Mermill-Haskins-Wauseon association

Depressional and nearly level, very poorly drained and somewhat poorly drained soils that have loamy and clayey subsoils.

The landscape in this soil association consists of a glacial lake plain and glacial ground moraine that are nearly level with depressional areas and some gently undulating rises. The soils formed in outwash on glacial till or lacustrine sediments.

This soil association occupies about 3 percent of the watershed.

Mermill soils are depressional and nearly level and are very poorly drained. They have a surface layer of very dark gray sandy clay loam. The subsoil is mottled and is dark gray, gray, and grayish-brown. It is a sandy clay loam in the upper part and a clay in the lower part.

Haskins soils are nearly level and are somewhat poorly drained. They have a surface layer of dark grayish-brown loam. The subsoil is mottled and is yellowish-brown and light yellowish-brown. It is sandy clay loam, sandy loam, and loam in the upper part and light clay in the lower part.

Wauseon soils are depressional and nearly level and are very poorly drained. They have a surface layer of very dark gray fine sandy loam. The subsoil is mottled and is dark gray, grayish-brown, and gray. It is fine sandy loam in the upper part and clay in the lower part.

10. Ottokee-Granby association

Depressional to sloping, very poorly drained, poorly drained, and moderately well drained soils that have sandy subsoils.

The landscape in this soil association consists of beach ridges that are nearly level with gently undulating rises. The soils formed in water-laid and eolian sediments.

This association occupies about 3 percent of the watershed.

Ottokee soils are gently sloping and sloping and are moderately well drained. They have a surface layer of very dark grayish-brown loamy fine sand and a subsoil that is light yellowish-brown and yellowish-brown, mottled loamy fine sand.

Granby soils are depressional and nearly level and are very poorly drained and poorly drained. They have a surface layer of black loamy sand and a subsoil that is dark gray and light brownish gray, mottled sand.

IV. BLACK CREEK STUDY AREA

A. General Description

The Black Creek Study Area comprises a drainage area of approximately 18.8 square miles (12,038 acres) in northeastern Allen County, Indiana. The watershed is about 13 miles northeast of Ft. Wayne, Indiana. Black Creek originates about 2 miles north of the community of Harlan and flows in a south-southeasterly direction for about 4 miles where it turns to an easterly direction for about 2 miles, thence after a number of abrupt changes in direction the creek flows southward for about 1-1/2 miles to the Maumee River. Black Creek is an entrenched stream throughout most of its course, particularly in the lowermost 2 miles when it flows about 25 to 30 feet below the general level of the lucustrine plain. Principal tributaries are Smith-Fry Drain, Wertz Drain, Reichelderfer Drain and Upper Gorrell Drain.

The mean annual rainfall at Fort Wayne is 35.31 inches. The rainfall is well distributed throughout the year with the month of December having the least (2.09") and the month of June having the most (4.17"). The mean annual temperature is 50.3 degrees Fahrenheit with a mean July temperature of 74.2 degrees and a mean January temperature of 27 degrees.

The altitude of the watershed ranges from about 710 to 850 feet above mean sea level, a maximum relief on the order of 140 feet. Local relief ranges from a fraction of a foot on portions of the lacustrine plain to as much as 40 to 50 feet in the northernmost part of the watershed and in the entrenched portion of Black Creek near the Maumee River.

The Black Creek study area is largely within the Maumee lacustrine plain. Surficial deposits consist largely of wave-scoured lake-bottom till. A narrow (about 1,000 foot) band of beach and shoreline deposits parallels Indiana Route 37 through the watershed. These shoreline deposits are bordered on the northwest by glacial till end-moraine deposits and to the southeast by a rather narrow (approximately 1 mile wide) band of lacustrine sands which grade into the wave-scoured lake-bottom tills. Bedrock consists of Dovonian limestone and dolomite generally less than 100 feet deep.

The Indiana Department of Natural Resources, Division of Fish and Game census information shows populations of cottontail rabbit poor to good; bob-white quail as poor to good; ringneck pheasant fair to good; squirrel as good; and deer as light over most of the watershed. Waterfowl usage and populations of other aquatic species are very light due to the general lack of permanent surface water throughout this watershed. Rabbit and squirrel hunting is most important and together accounts for about 59 percent of all hunting efforts in the area. Quail and pheasant hunting together rank next at about 25 percent and night hunting ranks 12 percent of all hunting efforts. The fishery of the watershed is restricted primarily to farm ponds and the lower end of Black Creek. There are over 100 species of songbirds and other nongame species in this study area.

The Black Creek Watershed area is entirely rural except for the small unincorporated community of Harlan which is located along Indiana Route 37 in the west central portion of the watershed. Land ownership is characterized by numerous small holdings. There are 176 individual ownership tracts, of which 127 or 72% are less than 100 acres, 45 or 26% are from 100-249 acres, and only 4 (2%) are 250 acres or larger. The average value of land and buildings is approximately $600 per acre.

The proximity of the watershed to Ft. Wayne provides excellent opportunities for employment in needy industry and results in high off farm employment. It is estimated that nearly 2/3 of the farm operators work off the farm. Of those operators who have off-farm employment, approximately 20% work less than 100 days off the farm, and 80% work more than 100 days off the farm.

The average market value of agricultural products sold is approximately $11,300 per farm. This is about equally divided between the two categories of cash crops and livestock, poultry and livestock and poultry products.

B. Soils

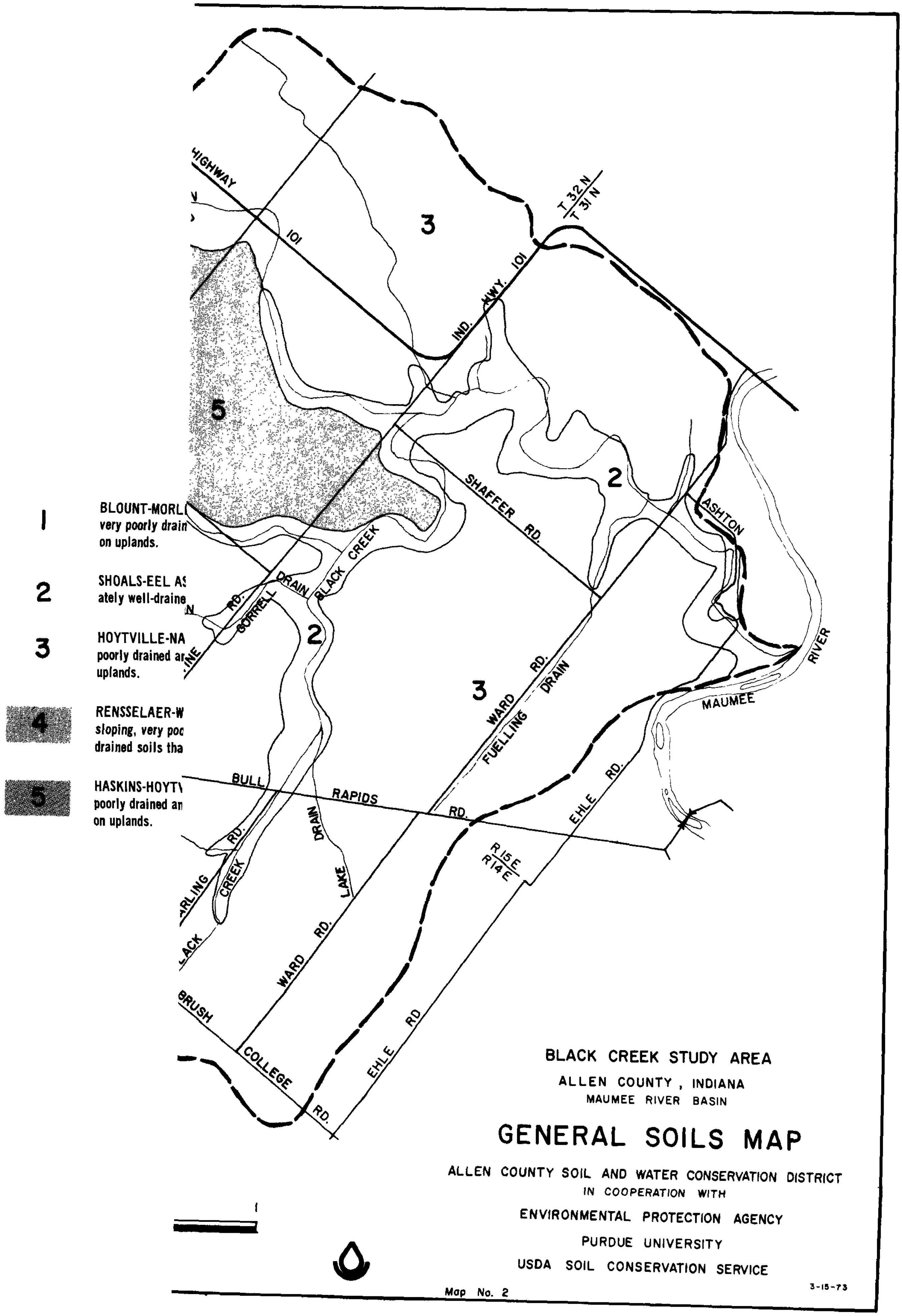
The General Soils Map of the Black Creek Study Area, which follows this section, gives a visual reference to the variations of soils within the area. Each of the soil associations are described below, with number references corresponding to Map Number 3.

1. Blount-Morley-Pewamo association

Depressional to moderately steep, very poorly to moderately well drained soils that have clayey subsoils; on uplands.

The landscape in this association consists of glacial ground moraine and moraine that is nearly level with many narrow depressions and is gently rolling with some depressional areas near drainageways. The soils formed in glacial till.

This soil association occupies about 36 percent of the watershed. About 39 percent is made up of Blount soils, 38 percent of Morley soils, 16 percent of Pewamo soils, and 7 percent of minor soils.



1
BLOUNT-MORL
very poorly drain
on uplands.
2
SHOALS-EEL AS
ately well-draine
3
HOYTVILLE-NA
poorly drained a
uplands.
4
RENSSELAER-W
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drained soils tha
5
HASKINS-HOYT
poorly drained an
on uplands.
HIGHWAY
101
IND. HWY. 101
T 32 N
T 31 N
3
5
2
SHAFFER RD.
ASHTON
BLACK CREEK
DRAIN
CORRELL
RD.
2
3
WARD RD.
FUELLING DRAIN
MAUMEE
RIVER
BULL RAPIDS RD.
EHLE RD.
R 15 E
R 14 E
DRAIN
LAKE
CREEK
RD.
WARD RD.
BRUSH
COLLEGE RD.
EHLE RD
BLACK CREEK STUDY AREA
ALLEN COUNTY, INDIANA
MAUMEE RIVER BASIN
GENERAL SOILS MAP
ALLEN COUNTY SOIL AND WATER CONSERVATION DISTRICT
IN COOPERATION WITH
ENVIRONMENTAL PROTECTION AGENCY
PURDUE UNIVERSITY
USDA SOIL CONSERVATION SERVICE
Map No. 2
3-15-73

Blount soils are nearly level and gently sloping and are somewhat poorly drained. They have a surface layer of very dark grayish brown and dark grayish brown loam or silt loam and subsoil that is mostly dark brown and dark grayish brown, mottled silty clay and clay.

Morley soils are gently sloping to moderately steep and are moderately well drained. They have a surface layer of very dark grayish-brown and grayish brown silt loam and a subsoil that is mostly dark yellowish-brown and brown clay and is mottled in the lower part.

Pewamo soils are depressional and nearly level and are very poorly drained. They have a surface layer of very dark gray silty clay loam and a subsoil that is mostly dark gray or grayish-brown, mottled silty clay or silty clay loam.

2. Shoals-Eel association

Nearly level, somewhat poorly and moderately well drained soils that have loamy subsoils; on bottom lands.

The landscape in this association is nearly level flood plains that are adjacent to streams. The soils formed in alluvium.

This soil association occupies about 5 percent of the watershed. About 44 percent is made up of the Shoals soils, 29 percent of Eel soils, and 27 percent of minor soils.

Shoals soils are nearly level and are somewhat poorly drained. They have a surface layer of dark gray and dark grayish-brown silty clay loam and a subsoil that is gray silty clay loam.

Eel soils are nearly level and are moderately well drained. They have a surface layer of dark grayish-brown and dark brown silt loam and loam and a subsoil that is brown and dark yellowish-brown, mottled light silty clay loam.

3. Hoytville-Nappanee association

Depressional and nearly level, very poorly and somewhat poorly drained soils that have clayey subsoils; on uplands.

The landscape in this soil association consists of glacial till plain that is dominantly nearly level with occasional slight rises. The soils formed in glacial till.

This soil association occupies about 29 percent of the watershed. About 48 percent is made up of Hoytville soils, 23 percent of Nappanee soils, and 21 percent of minor soils.

The Hoytville soils are depressional and nearly level and are very poorly drained. They have a surface layer that is very dark gray silty clay and a subsoil of dark grayish-brown, mottled silty clay.

Nappanee soils are nearly level and are somewhat poorly drained. They have a surface layer that is dark gray and grayish-brown silt loam or silty clay loam and a subsoil that is mostly grayish brown, mottled clay.

4. Rensselaer-Whitaker-Oshtemo association

Nearly level to moderately sloping, very poorly, somewhat poorly, and somewhat excessively drained soils that have loamy subsoils; on uplands.

The landscape in this soil association consists of long narrow sloping beach ridges above the terrane and nearly level glacial deltas and lake plain. The soils formed in glacial deltaic and beach ridge deposits and lacustrine sediments.

This soil association occupies about 25 percent of the watershed. About 28 percent is made up of Rensselaer soils, 21 percent of Whitaker soils, 6 percent of Oshtemo soils, and 45 percent of minor soils.

Rensselaer soils are nearly level and are very poorly drained. They have a surface layer of very dark brown loam, loam to silty clay loam, or mucky silty clay loam that is mottled in the lower part. The subsoil is mostly gray or strong-brown, mottled sandy loam or sandy clay loam.

Whitaker soils are nearly level and are somewhat poorly drained. They have a surface layer of fine sandy loam, loam, or silt loam that is dark grayish-brown in the upper part and pale brown in the lower part. The subsoil is yellowish-brown and gray, mottled clay loam or silty clay loam.

Oshtemo soils are nearly level to moderately sloping and are somewhat excessively drained. They have a surface layer that is dark-brown sandy loam or fine sandy loam. The subsoil is dark-brown to yellowish-brown sandy loam or gravelly sandy loam.

5. Haskins, Hoytville Association

Depressional to gently sloping, somewhat poorly and very poorly drained soils that have loamy and clayey subsoils; on uplands.

The landscape in this soil association consists of glacial ground moraine that are nearly level with depressional areas and some gently undulating rises. Haskins soils formed in outwash on glacial till. Hoytville soils formed in glacial till.

This soil association occupies about 5 percent of the watershed. About 34 percent is made up of Haskins soils, 31 percent of Hoytville soils, and 35 percent of minor soils.

Haskins soils are nearly level or gently sloping and are somewhat poorly drained. They have a surface layer of dark grayish-brown loam. The subsoil is mottled and is yellowish-brown and light yellowish brown. It is loam or sandy loam in the upper part and light clay in the lower part.

Hoytville soils are depressional and nearly level and are very poorly drained. They have a surface layer that is very dark gray silty clay and a subsoil of dark grayish-brown, mottled silty clay.

C. Land Capability Units

The land capability unit represents a grouping of soils which share common limitations for agricultural uses and which respond to like treatment under similar conditions of use. There are 58 different kinds of soil in the Black Creek study area. These soils make up a total of 21 Land Capability Units which are used in determining land treatment needs. The major soils are listed in Table A-3 and depicted in Map 4.

Capability Unit I-1 (48 Acres)

This unit consists of deep, nearly level, well-drained, medium-textured soils of the Martinsville and Rawson series. These soils have moderate infiltration and permeability and a high available moisture capacity.

These soils are productive and easy to manage and can be cropped intensively. The proper use of crop residue maintains the content of organic matter and helps to keep good tilth.

TABLE A-3 - BLACK CREEK STUDY

Maumee River Basin

Soils Data By Land Capability - Black Creek Study Area

Land Capability Unit	Acres	Major Soils Series	Major Hazard
I-1	48	Martinsville, Rawson	None
I-2	239	Eel, Genesee	Flooding
IIe-1	206	Martinsville, Miami, Rawson	Erosion
IIe-6	1299	Morley	Erosion
IIe-9	10	Belmore	Erosion
IIs-1	3	Belmore	Droughtiness
IIw-1	4435	Pewamo, Hoytville, Brookston	Wetness
IIw-2	3698	Blount, Crosby, Haskins	Wetness
IIw-7	384	Shoals	Wetness
IIIe-1	3	Martinsville, Rawson	Erosion
IIIe-6	127	Morley	Erosion
IIIe-9	5	Fox	Erosion
IIIe-11	50	St. Clair	Erosion
IIIe-13	171	Belmore, Oshtemo	Erosion, Droughtiness
IIIs-2	102	Oshtemo	Droughtiness
IIIw-2	3	Montgomery	Wetness
IIIw-6	1074	Nappanee	Wetness
IVe-6	137	Morley	Erosion
IVe-11	24	St. Clair	Erosion
IVs-1	5	Plainfield	Droughtiness
VIe-1	15	Morley	Erosion
TOTAL	12038		

Capability Unit I-2 (239 Acres)

This unit consists of deep, nearly level, well drained and moderately well drained, medium textured soils of the Eel and Genesee series. These soils are flooded occasionally in the winter and spring. They have moderate infiltration and permeability and high available moisture capacity.

Capability Unit IIe-1 (206 Acres)

This unit consists of deep, gently sloping, well-drained, medium-textured soils. These soils are of the Martinsville, Miami, and Rawson series. They have moderate infiltration and permeability and high available moisture capacity.

Erosion control is the main management need. Contour farming, diversion terraces, sod waterways, and proper crop rotation and minimum tillage are among the measures that can be used to control erosion.

Capability Unit IIe-6 (1,299 Acres)

This unit consists of deep, gently sloping, moderately well-drained, medium-textured soils of the Morley series. These soils have moderate infiltration, slow permeability, and high available moisture capacity. Their natural fertility is moderate. Their content of organic matter is generally moderate or low.

Erosion is a hazard, particularly in intensively cropped fields. Diversion ditches, contour tillage, stripcropping, and sod waterways are among the measures needed for control of erosion. Crop residue and intercrops help to maintain and increase the organic-matter content. Minimum tillage helps to maintain good tilth and control erosion. Wet spots created by springs or by seepage can be drained with random tile lines.

Capability Unit IIe-9 (10 Acres)

This unit consists of gently sloping, well-drained soils of the Belmore series. These soils are moderately deep and deep to gravel and sand. They have moderately rapid infiltration, moderate permeability, and moderate available moisture capacity.

Erosion is a hazard. Contour farming and sod waterways are among the measures needed for control of erosion. Proper management of crop residue is important in maintaining the organic-matter content.

Capability Unit IIs-1 (3 Acres)

This unit consists of nearly level, well-drained, medium-textured soils of the Belmore series. These soils are moderately deep to gravel and sand. They have moderately rapid infiltration, moderate permeability, and moderate available moisture capacity.

Droughtiness is a major limitation and crop residues should be left on the soil to maintain and increase the content of organic matter.

Capability Unit IIw-1 (4,435 Acres)

This unit consists of deep, level and depressional, very poorly drained, dark-colored, medium-textured to fine-textured soils. These soils are of the Brookston, Hoytsville, Lenawee, Mermill, Pewamo, Rensselaer, Washtenaw, and Westland series. They are waterlogged in periods of wet weather. They have moderate infiltration, slow permeability, and high available water capacity.

Wetness is the main limitation. An adequate drainage system is needed if the common crops are to be grown. Diversion terraces that intercept runoff from adjacent uplands are beneficial. Sod outlets or structural outlets for the diversion terraces are needed. Spring tillage should be delayed until the plow layer is dry. Minimum tillage and crop residue management help to maintain good tilth.

Capability Unit IIw-2 (3,698 Acres)

This unit consists of deep, nearly level and gently sloping somewhat poorly drained, medium-textured or moderately coarse textured soils of the Blount, Crosby, Del Rey, Haskins, and Whitaker series. These soils have moderately slow or slow permeability and high available moisture capacity. The gently sloping areas are erodible.

Wetness is the main limitation. An adequate drainage system is needed if the common crops are to be grown.

Diversion terraces that intercept runoff from higher areas are beneficial. Grass waterways are needed. Other practices needed include minimum and properly timed tillage and management of crop residues.

Capability Unit IIw-7 (384 Acres)

This unit consists of nearly level, somewhat poorly drained and very poorly drained soils of the Shoals series. These soils are flooded occasionally, and they have a fluctuating water table. They have moderate infiltration and permeability and high available moisture capacity.

Wetness is the main limitation. Adequate drainage is important. Other needed practices include conservation cropping systems, crop residue management and minimum tillage.

Capability Unit IIIe-1 (3 Acres)

This unit consists of deep, moderately sloping, well-drained, medium-textured soils of the Martinsville and Rawson series. These soils have moderate infiltration, moderate permeability, and high available moisture capacity.

Erosion is the main hazard. Contouring is the erosion control practice most applicable on the short slopes. On the few longer and more uniform slopes, stripcropping can be used. Sod waterways are needed to control erosion in drainageways.

Capability Unit IIIe-6 (127 Acres)

This unit consists of deep, gently sloping and moderately sloping, moderately well-drained, medium-textured soils of the Morley series. These soils range from uneroded to severely eroded. They have moderate infiltration, slow permeability, and high available moisture capacity.

Erosion is a hazard, particularly in intensively cropped fields. Diversion ditches, contour tillage, stripcropping, sod waterways, crop residue management and minimum tillage are among the measures needed for control of erosion.

Capability Unit IIIe-9 (5 Acres)

This unit consists of Fox loam, 6 to 12 percent slopes, moderately eroded, a well-drained soil. This soil is moderately deep to sand and gravel. It has moderate permeability and moderate available moisture capacity. This soil occurs as small areas, many of which are managed along with less sloping soils that can be used more intensively. As a result, considerable erosion has taken place. Erosion is the main hazard. Contour tillage, minimum tillage, mulch tillage, and a suitable cropping system help to control erosion.

Capability Unit IIIe-11 (50 Acres)

This unit consists of deep, gently sloping, well-drained soils of the St. Clair series. These soils range from uneroded to moderately eroded. They have moderate infiltration, slow permeability, and high available moisture capacity.

Erosion is the main hazard. Maintaining good tilth and increasing the content of organic matter are problems. Diversion terraces and contour tillage help to control runoff and erosion. Permanent grassed waterways are needed to prevent gullying of natural drainageways. Minimum tillage, a suitable cropping system, and proper use of crop residue help to improve tilth and to increase the content of organic matter.

Capability Unit IIIe-13 (171 Acres)

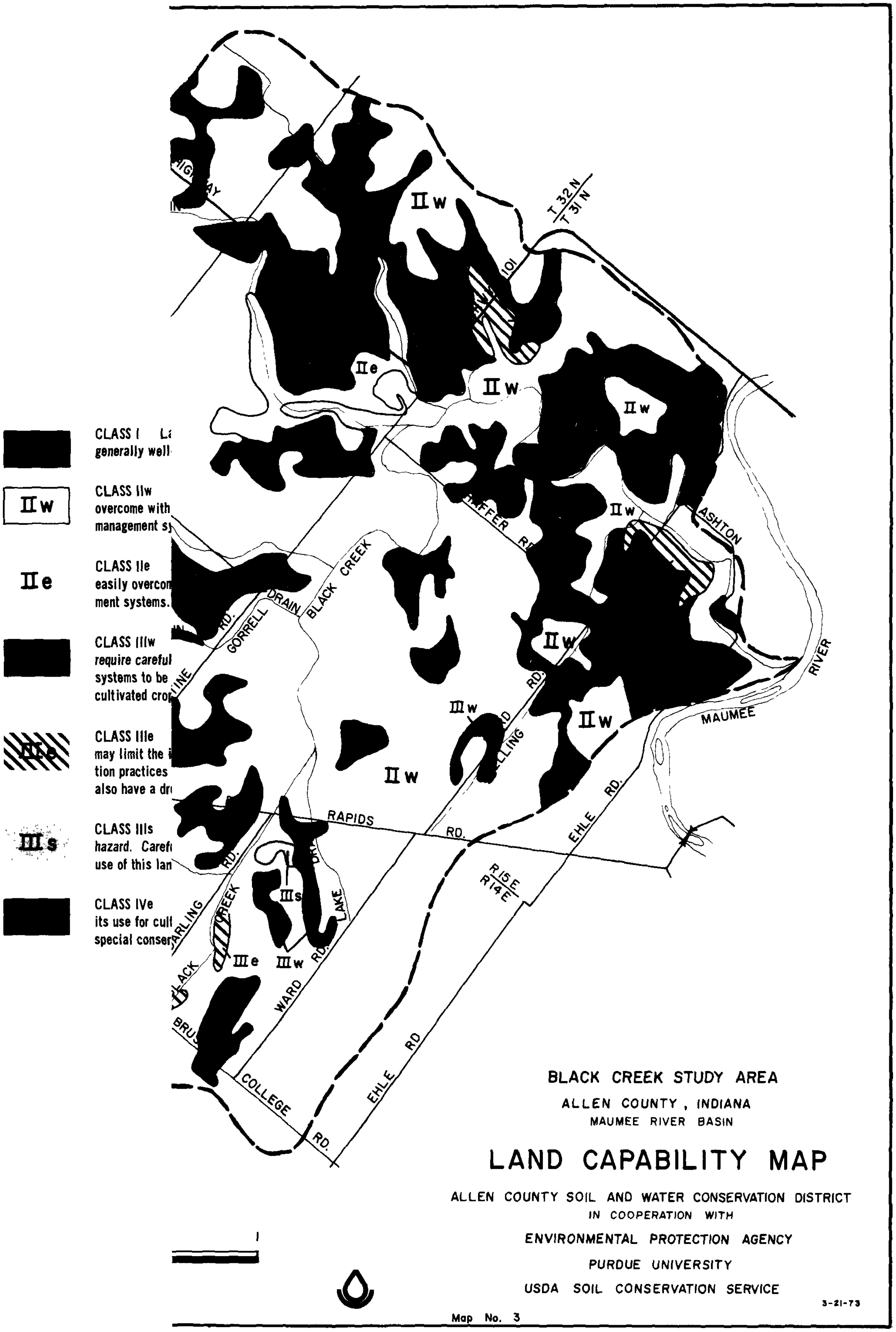
This unit consists of deep, gently sloping and moderately sloping, well-drained and somewhat excessively drained, moderately coarse textured soils of the Belmore and Oshtemo series. These soils have moderately rapid infiltration, moderate and moderately rapid permeability, and low available moisture capacity.

Erosion is the main hazard, and droughtiness is a serious limitation. Contour tillage, crop residue management, and minimum tillage help to control erosion.

Capability Unit IIIs-2 (102 Acres)

This unit consists of deep, nearly level, somewhat excessively drained moderately coarse textured soils of the Oshtemo series. These soils have moderately rapid infiltration and permeability and low available moisture capacity.

Droughtiness is the main limitation to use.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MAUMEE
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BLACK CREEK
GORRELL
DRAIN
RAPIDS
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EHLE
RD.
R 15 E
R 14 E
WARD
COLLEGE
LAKE
BLACK CREEK STUDY AREA
ALLEN COUNTY, INDIANA
MAUMEE RIVER BASIN
LAND CAPABILITY MAP
ALLEN COUNTY SOIL AND WATER CONSERVATION DISTRICT
IN COOPERATION WITH
ENVIRONMENTAL PROTECTION AGENCY
PURDUE UNIVERSITY
USDA SOIL CONSERVATION SERVICE
3-21-73
Map No. 3

Capability Unit IIIw-2 (3 Acres)

This unit consists of deep, nearly level, very poorly drained, dark-colored, moderately fine textured or fine textured soils of the Montgomery series. These soils become waterlogged in periods of wet weather and are slow to dry out in spring. They have very slow infiltration and permeability and high available water capacity.

Wetness is the major limitation. Maintaining good tilth is a serious problem. A drainage system is needed. Crop residue management, fall, and minimum tillage are important practices for these soils.

Capability Unit IIIw-6 (1,074 Acres)

This unit consists of deep, nearly level, somewhat poorly drained, medium-textured or moderately fine textured soils of the Nappanee series. These soils have moderate infiltration, slow permeability, and high available moisture capacity.

Wetness is the main limitation. Maintaining good tilth is a problem. An adequate drainage system is needed. It is necessary to keep tillage to a minimum. Crop residue management in the cropping system is needed.

Capability Unit IVe-6 (137 Acres)

This unit consists of deep, moderately sloping and strongly sloping, moderately well-drained, medium-textured and moderately fine textured soils of the Morley series. These soils have been eroded so severely that the present surface layer consists almost entirely of material from the subsoil. They have slow to moderate infiltration, slow permeability, and high available moisture capacity.

Erosion is the main hazard. Contour cultivation, diversion terraces, and sod waterways help to control runoff and erosion. Crop residue management and minimum tillage also improve tilth and reduce runoff.

Capability Unit IVe-11 (24 Acres)

This unit consists of St. Clair silty clay loam, 6 to 12 percent slopes, moderately eroded, a deep, well-drained or moderately well-drained soil. This soil has moderate infiltration, slow permeability, and high available moisture capacity.

Erosion is the main hazard. Permanent sod in natural drainageways helps to control gully erosion. Contour cultivation, crop residue management, and minimum tillage are effective in the control of runoff and erosion.

Capability Unit IVs-1 (5 Acres)

This unit consists of deep, nearly level and gently sloping well-drained, coarse-textured soils of the Plainfield series. These soils have rapid permeability and low available moisture holding capacity.

Droughtiness is the main limitation. Crop residue management, minimum tillage and cover crops, help to control wind erosion.

Capability Unit VIe-1 (15 Acres)

This unit consists of deep, strongly sloping, severely eroded, moderately well-drained, medium-textured soils of the Morley series. These soils have slow to moderate infiltration, slow permeability, and high available moisture capacity.

The soils are too steep and too erodible to be suitable for cultivation, except what is necessary for the establishment of permanent pasture.

Erosion is the main hazard. A vegetative cover and protection from overgrazing help to control erosion.

Major land uses in the Black Creek Study Area include cropland, 80.7%; grassland, 4.3%; woodland, 7.1%; wildlife and recreation, 2.7%; urban and built-up, 3.6% and farmstead, 1.6%. Lands categorized as urban and built-up include the acreages occupied by the town of Harlan as well as county roads, highways, schools, and cemeteries. Table A-3 shows present acreage for each capability unit in the Black Creek Study Area.

The pattern of land use is expected to remain relatively stable over the next five years. However, some minor changes in land use can be anticipated as indicated by recent trends and in response to planned land use. It is estimated that urban and built-up acreage will increase by 118 acres as some of the better drained woodland and cropland along county roads and highways are converted to residential use. A net decrease of 143 acres of cropland and 70 acres of woodland is projected. The acreage used for wildlife and recreation should increase by 118 acres.

D. Socio-economic Conditions

The socio-economic profile is based on data obtained from the 1970 census of the population, the 1969 agricultural census and local records. Most of the data available are for established political boundaries as specified by the selected basin. Therefore, Springfield Township will be the central focus for most of the profile since the communities in Maumee and Milan townships are outside of the basin (Black Creek) and would distort the socio-economic profile if all three townships were utilized. Future planned sociological studies will enable full discussion of characteristics of the entire basin since primary data collection will supplement the secondary sources.

By utilizing the minor civil division codes in the 1970 census, we are able to obtain various social and economic characteristics of the population residing within the Black Creek area (Springfield Township). The main purpose of the following discussion is to highlight some of these personal and demographic characteristics as obtained from the 1970 census deemed useful in describing the selected basin.

1. Income

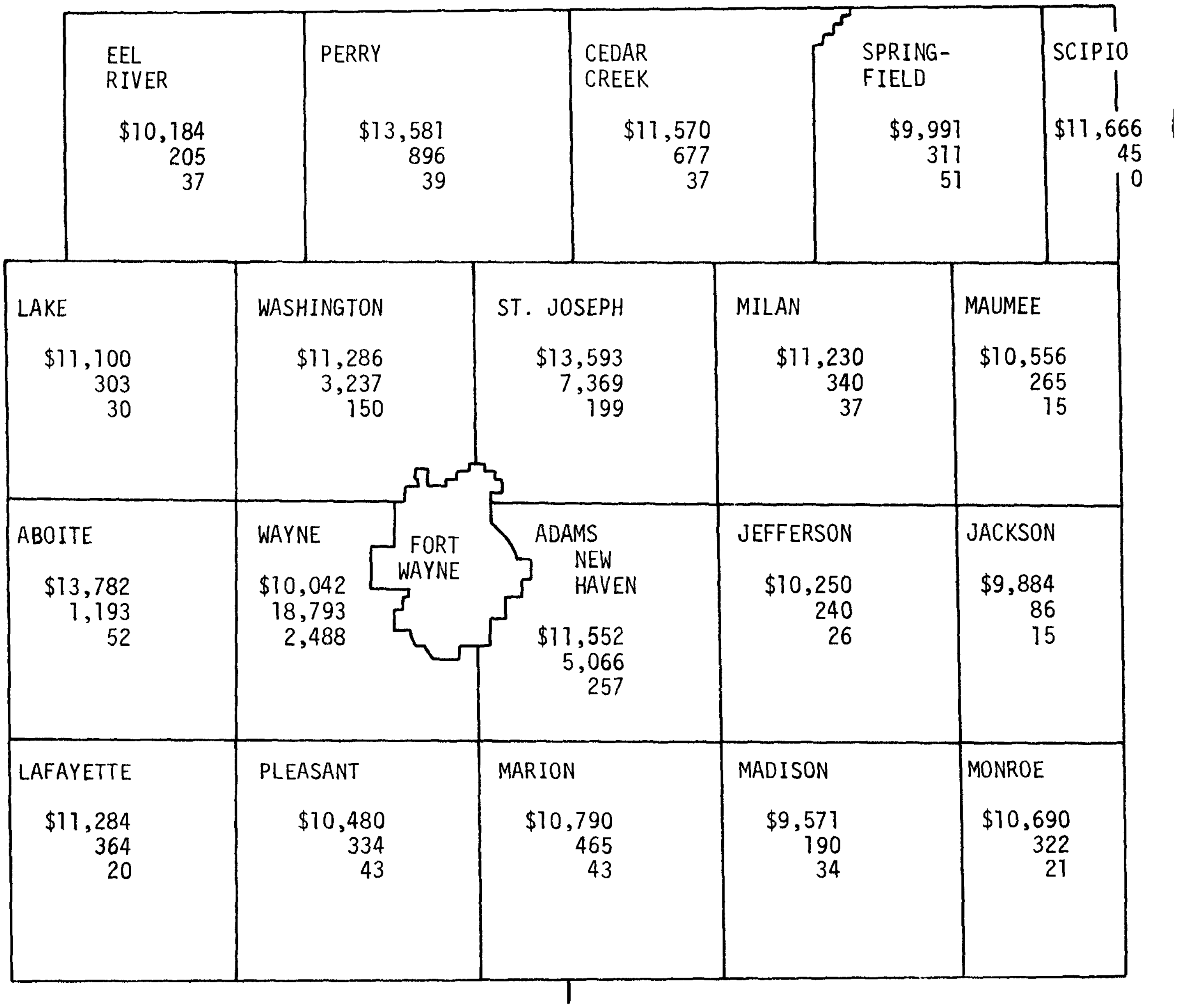
Springfield Township is reported to have a median family income of $9,991 in 1970 (See Figure A-1). Of the twenty townships in Allen County, only two others had lower median incomes. The $9,991 figure for Springfield is well below the Allen County median income figure of $11,010. Allen County ranks 5th in the state median income. The middle figure reported in Springfield Township (see Figure A-1) suggests there are 311 families with incomes over $10,000 and 51 families with incomes below $3,000.

Wages and salary plus non-farm self employment are the two largest categories of aggregate income (see Table A-4) in Springfield Township. The category of farm self employment, although not unusually large, accounts for only nine percent of the total male aggregate income.

Table A-4. Aggregate Income by Sex and Type in Springfield Township

TYPE	Females AMOUNT	Males AMOUNT	NUMBER
Wage and Salary	$109,360	$425,725	537
Non-Farm Self Employment	0	89,160	109
Farm Self Employment	1,865	51,165	109
Social Security/ Railroad Pension	6,755	12,110	92
Welfare	460	630	10
Other Income	6,530	15,295	214

Figure A-1. Median Family Income and Number of Families with Incomes over $10,000 and under $3,000, 1970



Top = Median Family Income
Middle = Number of families with incomes over $10,000
Bottom = Number of families with incomes under $3,000

Figure A-2. Allen County Population Pyramid

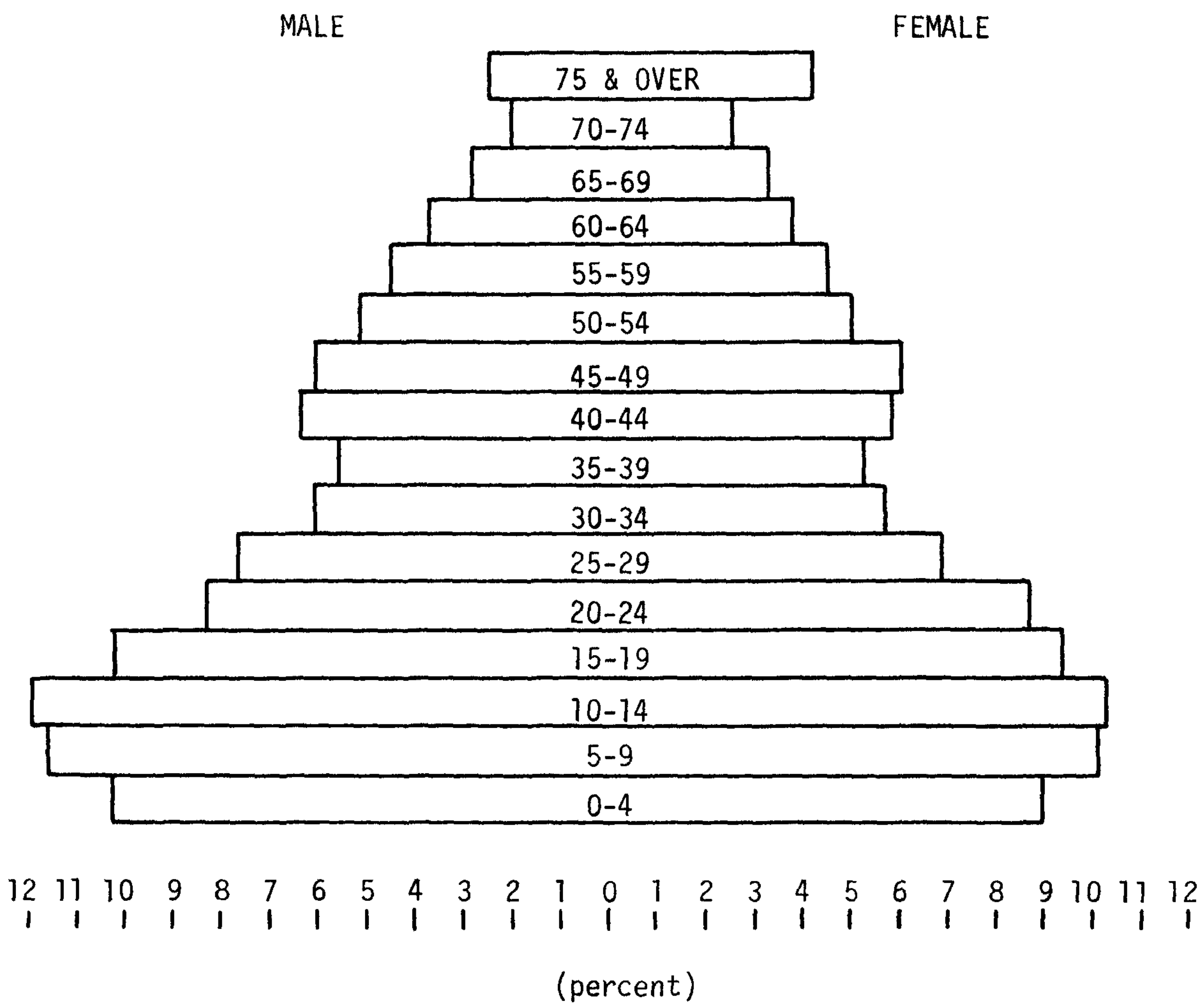
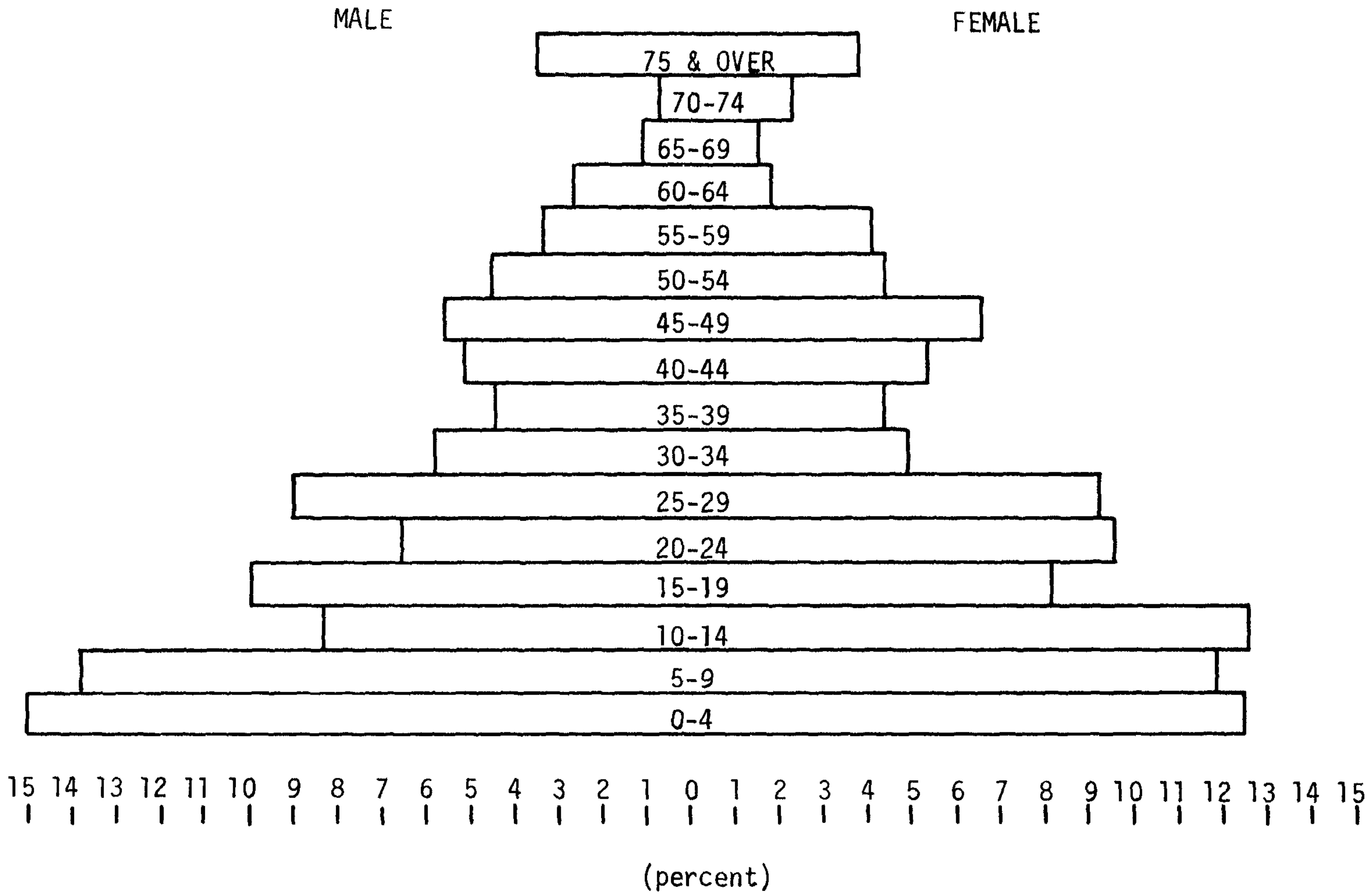


Figure A-3. Springfield Township Population Pyrmid, 1970



2. Population

Figure A-2 is a population pyramid for Allen County. The pyramid is presented to provide a brief overview of the population structure in the county. The three groups of interest are those 18 years and younger (dependent youth), 19 to 64 (the active working population) and 65 and older (dependent aged population). Allen County has 36.8 percent of its population in the 18 and under category. This is compared to 35.4 percent for the state. In the 19-64 age group, Allen County has 54.7 percent of its population compared to 55.1 percent for the state. The 65 and over group comprises 8.5 percent of the county population with 9.5 percent of the state in this category.

Springfield Township's population is presented in Figure A-3. The erratic indentations and projections of the various age groupings may be due to migration. A much larger percentage of the population in Springfield Township is between the ages of 0 and 10 years than the same age group in Allen County. Indeed, the comparisons for the township and Allen County age groups of "under 18", "19 to 64" and "65 and over" are 43.7% to 36.8%, 50.5% to 54.7% and 6.3% to 8.5%, respectively. Using these indicators would suggest that the basin is a young dynamic population. The population pyramid can be a basis for comparing the structure of the Black Creek population with the population of the entire Ohio, Michigan and Indiana basin. This will be included in future analyses.

3. Occupation and Commuters

The three largest occupation groups in Springfield Township are presented in Table A-5. At the top, in terms of percent of workers, is craftsmen, foremen and kindred workers accounting for 24% of the males 14 years and older. Operatives are second with 19% and the third and fourth places are tied at 15% each for managers, administrators and farmers (except managers).

Most of the work force is employed within Allen County (see Table A-6). Almost 95% of the working population in Springfield Township was at work somewhere in the county during the week of the census. Only 5% of the employed Springfield residents have employment outside of the county. Also, Table A-7 suggests that 83% of the residents in Springfield Township were born in the state of Indiana. The next largest group is comprised of those born in the north central states region. Many of these states are contiguous to Indiana and account for 14% of its population.

Table A-5. Occupation of Males 14 Years and Older in Springfield Township

OCCUPATION	NUMBER	%
Managers, Administrators (Not Farm)	104	15
Sales Workers	28	4
Clerical and Kindred	29	4
Craftsmen, Foremen and Kindred	160	24
Operatives, except Transportation	129	19
Transportation Equipment Operatives	55	8
Laborers, except Farm	27	4
Farmers, except Managers	101	15
Farm Laborer and Foremen	4	.6
Service Workers	30	4
Private Household Workers	0	0
Occupation Not Reported	7	1
Total Males 14 and over in Labor Force	674	

Table A-6. Summary of Springfield Township's Population at Work During Census Week

PLACE OF WORK	NUMBER	%
Inside of County	912	94
Outside of County	46	5
Not Reported	5	0.5
Number of Workers	963	99.5

Table A-7. Migration of Springfield Township Residents by State of Birth

WHERE BORN	NUMBER	%
In State of Residence (Ind.)	2197	83
Northeast	11	0.4
Northcentral	382	14
South	60	2
West	0	0
Abroad	0	0
Not Reported	10	0.3
Township Population Total	2660	

Table A-8. Education in Springfield Township by Sex for Residents 25 Years and Older

LEVEL OF EDUCATION	MALE	%	FEMALE	%
None Completed	15	2	5	1
1-4 years	7	1	0	0
5-6 years	24	4	15	2
7 years	22	4	36	6
8 years	136	22	112	18
High School: 1-3 years	108	18	157	25
High School: 4 years	251	41	257	42
College: 1-3 years	33	5	30	5
College: 4 years	16	3	3	1
College: 5 years or more	1		2	
Total	613		617	

Table A-9. Poverty Status for Springfield Township Residents 65 and Over

POVERTY STATUS	NUMBER	%
Above Poverty Level	139	82.7
Below Poverty Level	29	17.3
Total 65 and Over	168	100.0

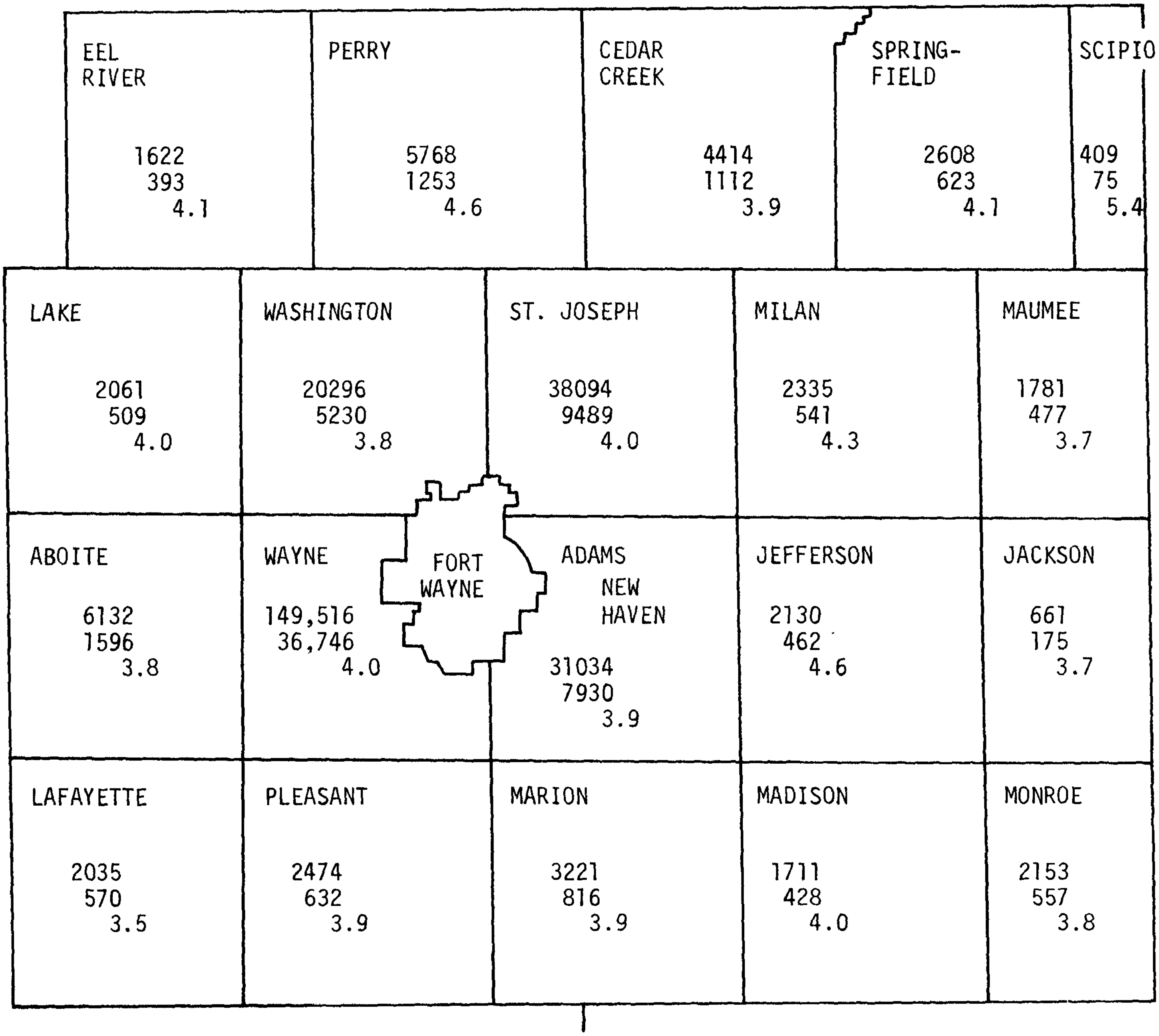
4. Education and Poverty Status

In 1970, 49% of the Black Creek Basin's male residents, 25 years and older (see Table A-8) had completed four years of high school or beyond. Almost the same percentage applies for the females. These levels of education attained in the township are very near to the state averages for individuals 25 years and older.

With a relatively high level of education we might expect to find a low level of poverty within the basin. Nearly 83% of the 65 and older residents have incomes above the government poverty level (see Table A-9). Only 17% were below the established government level.

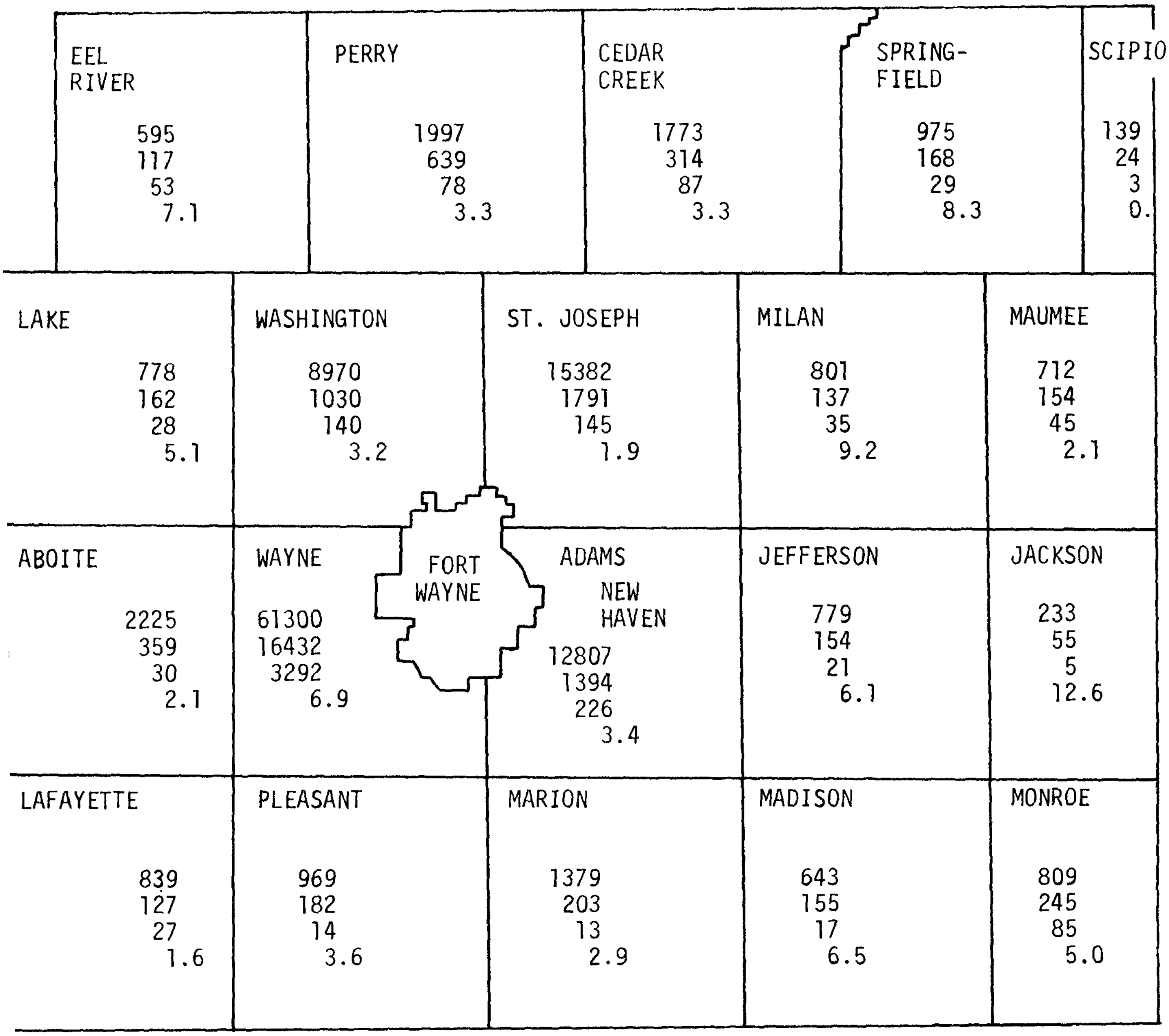
Figures A-4 and A-5 are included to present additional data on population, family size and poverty. Figure A-4 shows Springfield with 2608 total population and 623 families with 4.1 as the average size per family.

Figure A-4. Population, Total Number of Families and Family Size, 1970



Top = Total Township Population
Middle = Number of Families
Bottom = *Average Number of Persons per Family*

Figure A-5. Number of People Employed, Residents 65 Years and Older and in Poverty, and Families Below Poverty Level, 1970



Top = Total Number of people employed
Next = Residents Over 65 Years of Age
Next = Residents Over 65 and in Poverty
Bottom = Percent of Families Below Poverty Level

V. INVESTIGATIONS OF THE STUDY AREA

As proposed to the Environmental Protection Agency, an analysis of the study area was made to identify by volume the types of land treatment it is believed will reduce soil erosion significantly in the area.

This study was completed by Soil Conservation Service personnel based on established procedures of the service and long field experience. No attempt was made during the study period to plan systems of treatment for individual landowners.

A significant result of the project will be an analysis of the success of known techniques of soil conservation as a mechanism for reducing the degradation of water quality by sedimentation.

A. Needed Conservation Practices

The following lists, by volume, the various practices it is believed should be applied in the study area to achieve adequate land treatment along with a statement of estimated costs and a schedule for installing these practices. Refer to Table A-10. It should be pointed out that success of this program of installation will depend on planning of areas for individual landowners which will be an ongoing process during the study period. It is anticipated that treatment of the area will allow an accurate assessment of the effect of the program on water quality.

1. Cropland

With cropland comprising more than 80 percent of the study area the need for conservation treatment to minimize soil erosion and sediment movement from croplands is recognized. Conservation cropping systems, crop residue management, minimum tillage, contour farming, terracing, stripcropping, and grassed waterways are practices which can minimize soil erosion when applied in varying combinations to match on-site problems.

Drainage measures, grade stabilization structures, field borders and streambank protection along the many miles of drainageways serving the cropland fields are needed for erosion control, sediment reduction, and protection and maintenance of cropland resources.

2. Pasture and Hayland

Lands used for pasture and hay occupy a relatively low percentage of the total land area. However, significant soil erosion occurs from grasslands when the stands of grasses and legumes are allowed to deteriorate through lack of fertility and overgrazing. Pasture and hayland planting and management are needed to maintain vigorous plant cover and prevent erosion losses. Where streams flow through pastures, protection of streambanks from grazing and trampling by livestock is needed. Ponds and additional livestock watering facilities help to solve this problem.

3. Woodland

Of the mixed hardwood forests which originally covered a large part of the study area only 853 acres now remain in woodland use. Much of the woodland is on sloping soils adjacent to streams, while several small wooded areas are located on wet soils and depressional sites. Management of the timber resource to improve and maintain existing stands is an important factor in controlling erosion and reducing sediment.

Livestock exclusion, improved harvest cutting, and pruning are practices which contribute to maintaining amount and quality of woodland cover. Tree planting, including the planting of windbreaks, is needed in limited amounts.

Natural black walnut reproduction has been observed along streams. Encouraging the growth of these and other desirable species through plantings on selected sites along streams will aid in erosion control, wildlife area improvement, and provide environmental benefits.

4. Wildlife and Recreation Land

Practices needed for wildlife include ponds constructed, stocked with game fish, fenced, and developed for wildlife nesting and winter cover; livestock exclusion from wooded areas to develop dense edges for good wildlife cover; wildlife habitat development to provide travel lanes and winter cover; field border plantings for erosion control that are managed for wildlife habitat; critical area planting; and livestock exclusion from stream and ditch banks.

Secondary wildlife benefits are realized from other conservation practices such as grassed waterways and diversions which are mown only as needed, and then after August 1 for the protection of ground nesting species; ditch bank seeding and management for ground nesting habitat; pasture planting and pasture management which provides clumps of herbaceous vegetation that can be utilized by quail and rabbit; minimum tillage and crop residue management; and windbreak planting.

Since a high percentage of this area is in cropland, the wildlife populations of this watershed will be substantially influenced by the agricultural land use and management practices. Wildlife habitat development and other vegetative erosion control practices are very important.

5. Urban and Built-up Lands

Roadside erosion control, critical area planting, recreation area improvement, and the protection of land during development are practices and measures which can do much to reduce erosion and sediment losses from lands in this use. Minimum disturbance of existing vegetation in developing areas will be emphasized as land use changes are made.

6. Farmsteads

Protection of farmsteads and feedlots from erosion and surface runoff is important throughout the area. Livestock waste disposal systems are needed along with farmstead and feedlot windbreaks to abate pollution, improve the environment, and add beauty to the countryside.

The inter-relationship of land use and land treatment needs is such that when the needed practices and measures are applied and properly maintained for the selected land use, adequate treatment of the land is achieved. Based upon Conservation Needs Inventory data and field information it is estimated that 12 percent of lands in the study area are presently adequately treated. The balance of the land will need additional treatment involving the application of various combinations of conservation practices and measures.

Table A-10 summarizes the goals and costs for land treatment and the schedule for achieving adequate treatment over a five year period. Both total and annual goals are listed for conservation planning, land use conversions, and practice installation.

The following practices and measures are briefly described and listed in the amounts needed to achieve adequate land treatment. The amounts listed are in addition to practices currently applied in the study area.

1. Conservation Cropping Systems - 7,418 Acres

Growing crops in combination with needed cultural and management measures. Cropping systems include rotations that contain grasses and legumes as well as rotations in which the desired benefits are achieved without the use of such crops.

2. Contour Farming - 769 Acres

   Farming sloping cultivated land in such a way that plowing preparing and planting, and cultivating are done on the contour. (This includes following established grades of terraces, diversions, or contour strips.)

3. Critical Area Planting - 10 Acres

   Stabilizing silt-producing and severely eroded areas by establishing vegetative cover. This includes woody plants, such as trees, shrubs or vines, and adapted grasses or legumes established by seeding or sodding to provide long-term ground cover. (Does not include tree planting mainly for the production of wood products.)

4. Crop Residue Management - 7,491 Acres

   Using plant residues to protect cultivated fields during critical erosion periods.

5. Diversions - 39,200 Lineal Feet

   A channel with a supporting ridge on the lower side constructed across the slope.

6. Farmstead and Feedlot Windbreaks - 78 Acres

   A belt of trees or shrubs established next to a farmstead or feedlot.

7. Field Border Planting - 288,320 Lineal Feet

   A border or strip of perennial vegetation established at the edge of a field by planting or by converting from trees to herbaceous vegetation or shrubs.

8. Field Windbreaks - 12,000 Lineal Feet

   A strip or belt of trees or shrubs established to reduce wind erosion.

9. Grade Stabilization Structure - 368

   A structure to stabilize the grade or to control head cutting in natural or artificial channels. (Does not include stream channel improvement, streambank protection, diversion, or structure for water control.)

10. Grassed Waterways - 68 Acres

A natural or constructed waterway or outlet shaped or graded and established in vegetation suitable to safely dispose of runoff from a field, diversion, terrace or other structure.

11. Holding Ponds and Tanks - 11

A fabricated structure or one made by constructing a pit dam or embankment for temporary storage of animal or agricultural wastes, associated runoff and waste water.

12. Land Smoothing - 300 Acres

Removing irregularities on the land surface by use of special equipment.

13. Livestock Exclusion - 215 Acres

Excluding livestock from an area where grazing is not wanted.

14. Livestock Watering Facility - 28

A trough or tank with needed devices for water control to provide drinking water for livestock.

15. Minimum Tillage - 7,656 Acres

Limiting the number of cultural operations to only those that are properly timed and essential to produce a crop and prevent soil damage.

16. Pasture and Hayland Management - 402 Acres

Proper treatment and use of pastureland or hayland.

17. Pasture and Hayland Planting - 501 Acres

Establishing and re-establishing long-term stands of adapted species of perennial, biennial, or reseeding forage plants. (Includes pasture and hayland renovation, does not include grassed waterway or outlet on cropland.)

18. Ponds - 39

A water impoundment made by constructing a dam across a watercourse or a natural basin, or by excavating a pit or "dugout". (Such ponds do not include spring development or irrigation reservoirs.)

19. Protection During Development - 118 Acres

Treatment based on a plan to control erosion and sediment during development for residential, commercial-industrial, community services, transportation routes or utility uses.

20. Recreation Area Improvement - 12 Acres

Establishing grasses, legumes, vines, shrubs, trees or other plants or managing woody plants to improve an area for recreation.

21. Sediment Control Basins - 6

A barrier or dam constructed across a waterway or at other suitable locations to form a silt or sediment basin.

22. Stream Channel Stabilization - 96,000 Lineal Feet

Stabilizing the channel of a stream with suitable structures. (Includes 90,000 feet, fencing; 6,000 feet structural stabilization.)

23. Streambank Protection - 122,000 Lineal Feet

Stabilizing and protecting banks of streams or excavated channels against scour and erosion by the use of vegetative or structural means.

24. Stripcropping - 300 Acres

Growing crops in a systematic arrangement of strips or bands on the contour to reduce erosion.

25. Surface Drains - 90,500 Lineal Feet

A graded channel for collecting excess water within a field. This does not include grassed waterway or outlet.

26. Terrace, Gradient - 11,000 Lineal Feet

An earth embankment or a ridge and channel constructed across the slope at a suitable opening and an acceptable grade to reduce erosion damage and pollution by intercepting surface runoff and conducting it to a stable outlet.

27. Terrace, Parallel - 11,000 Lineal Feet

An earth embankment or a ridge and channel constructed in parallel across the slope at a suitable spacing and acceptable

TABLE A-11 - BLACK CREEK STUDY

Maumee River Basin

Land Treatment Goals & Estimated Installation Costs

ITEM	UNIT	GOAL	UNIT PRICE $	TOTAL COST	YEARLY GOALS AND PROJECT INSTALLATION COSTS (DOLLARS) Oct.72-Oct.73 GOAL	Oct.72-Oct.73 COST	Oct.73-Oct.74 GOAL	Oct.73-Oct.74 COST	Oct.74-Oct.75 GOAL	Oct.74-Oct.75 COST	Oct.75-Oct.76 GOAL	Oct.75-Oct.76 COST	Oct.76-Oct.77 GOAL	Oct.76-Oct.77 COST
Land Adequately Treated	Ac.	10,573			671		2,612		3,533		3,757			
Cropland to Grassland	Ac.	4					4							
Cropland to Woodland	Ac.	10							10					
Cropland to Wildlife & Rec.	Ac.	94					20		29		45			
Cropland to Other	Ac.	35					8		11		16			
District Cooperators	No.	148			40		60		29		19			
District Cooperators	Ac.	7,747			2,094		3,141		1,538		977			
Conservation Plans	No.	170			16		53		57		44			
Conservation Plans	Ac.	10,641			1,002		3,317		3,589		2,733			
Conservation Plans Revised	No.	6			3		3							
Conservation Plans Revised	Ac.	1,040			520		520							
Conservation Cropping System	Ac.	7,418	1.50	11,127	600	900	1,978	2,967	2,637	3,955	2,203	3,305		
Contour Farming	Ac.	769	2.00	1,538	-	-	205	410	273	546	291	582		
Critical Area Planting	Ac.	10	400.00	4,000	1	400	2	800	4	1,600	3	1,200		
Crop Residue Management	Ac.	7,491	1.50	11,236	600	900	1,997	2,995	2,663	3,995	2,231	3,346		
Diversions	Ft.	39,200	0.50	19,600	2,600	1,300	10,000	5,000	13,500	6,750	13,100	6,550		
Farmstead & Feedlot Windbreaks	Ac.	75	80.00	6,000	-	-	21	1,680	28	2,240	26	2,080		
Field Border	Ft.	288,320	0.30	86,496	25,000	7,500	51,866	15,560	102,488	30,747	108,966	32,689		
Field Windbreak	Ft.	12,000	0.05	600	-	-	3,199	160	4,265	213	4,536	227		
Grade Stabilization Structures	No.	368	500.00	184,000	30	15,000	88	44,000	117	58,500	133	66,500		
Grassed Waterway or Outlet	Ac.	68	450.00	30,600	9	4,050	18	8,100	24	10,800	17	7,650		
Holding Ponds & Tanks	No.	11	5,600.00	61,600	1	5,600	2	11,200	4	22,400	4	22,400		
Land Smoothing	Ac.	300	75.00	22,500	-	-	80	6,000	107	8,025	113	8,475		
Livestock Exclusion	Ac.	215	20.00	4,300	20	400	47	940	66	1,320	82	1,640		
Livestock Watering Facility	No.	28	200.00	5,600	2	400	5	1,000	9	1,800	12	2,400		
Minimum Tillage	Ac.	7,656	6.50	49,764	300	1,950	2,041	13,266	2,722	17,694	2,593	16,854		
Pasture & Hayland Management	Ac	402	18.00	7,236	20	360	87	1,566	143	2,574	152	2,736		
Pasture & Hayland Planting	Ac.	501	70.00	35,070	50	3,500	124	8,680	165	11,550	162	11,340		
Pond	No.	39	2,500.00	97,500	2	5,000	8	20,000	14	35,000	15	37,500		
Protection During Development		118	100.00	11,800	3	300	28	2,800	42	4,200	45	4,500		
Recreation Area Improvement	Ac.	12	200.00	2,400	-	-	3	600	4	800	5	1,000		
Sediment Control Basin	No.	6	5,000.00	30,000	6	30,000					-	-		
1/ Stream Channel Stabilization	Ft.	90,000	0.50	45,000	3,000	1,500	23,594	11,797	31,458	15,729	31,948	15,974		
2/ Stream Channel Stabilization	Ft.	6,000	6.00	36,000	-	-	2,000	12,000	2,000	12,000	2,000	12,000		
Streambank Protection	Ft.	122,000	2.00	244,000	10,000	20,000	32,525	65,050	43,365	86,730	36,110	72,220		
Stripcropping	Ac.	300	5.00	1,500	-	-	80	400	105	525	115	575		
Surface Drains	Ft.	90,500	0.40	36,200	3,000	1,200	24,127	9,651	32,170	12,868	31,203	12,481		
Terraces, Gradient	Ft.	11,000	0.25	2,750	-	-	2,933	733	3,910	978	4,157	1,039		
Terraces, Parallel	Ft.	11,000	0.75	8,250	-	-	2,933	2,200	3,911	2,933	4,156	3,117		
3/ Tile Drains	Ft.	200,300	0.40	80,120	16,068	6,427	50,360	20,144	68,360	27,344	65,512	26,205		
Tree Planting	Ac.	10	80.00	800	-	-	3	240	4	320	3	240		
Wildlife Habitat Management	Ac.	222	70.00	15,540	-	-	59	4,130	79	5,530	84	5,880		
Woodland Improved Harvesting	Ac.	200	15.00	3,000	20	300	40	600	74	1,110	66	990		
Woodland Improvement	Ac.	610	20.00	12,200	20	400	143	2,860	217	4,340	230	4,600		
Woodland Pruning	Ac.	50	30.00	1,500	10	300	10	300	13	390	17	510		
SUBTOTAL				1,169,827		107,687		277,829		395,506		388,805		
TECHNICAL ASSISTANCE (SCS)				197,364		46,500 4/		36,843		55,291		45,705	-	13,025
TOTAL INSTALLATION COSTS				1,367,191		154,187		314,672		450,797		434,510	-	13,025

1/ Fence to exclude livestock; 2/ Structural protection; 3/ Quantity shown includes only tile under grassed waterways and surface drains; 4/ Includes cost associated with preparation of detailed work plan.

April 1973

grade to reduce erosion and pollution and provide a more farmable terrace system.

28. Tile Drains - 2,249,200 Lineal Feet

A conduit, such as tile, pipe or tubing, installed beneath ground surface and which collects and/or conveys drainage water. The project goal is approximately 200,300 lineal feet which is needed for erosion and sediment control of surface drains and grassed waterways.

29. Tree Planting - 10 Acres

Planting tree seedlings or cuttings.

30. Wildlife Habitat Management - 222 Acres

Retaining, creating, or managing wildlife habitat for both upland and wetland.

31. Woodland Improved Harvesting - 200 Acres

Systematically removing some of the merchantable trees from an immature stand to improve the conditions for forest growth.

32. Woodland Improvement - 610 Acres

Improving woodland by removing unmerchantable or unwanted trees, shrubs or vines.

33. Woodland Pruning - 50 Acres

Removing all or parts of selected branches from trees.

B. Monitoring Sites

Purdue University Scientists have identified proposed sites for monitoring of the project:

Killiam Drain at Notestine Road
Smith-Fry Drain at Noestine Road
Wertz Drain at Notestine Road
Gorrell Drain at Notestine Road
Richelderfer Drain at Notestine Road
Dreisbach Drain at Brush College Road
Lake Drain at Bull Rapids Road
Wertz Drain at Bull Rapids Road
Dreisbach Drain at Trammel Road
Dreisbach Drain at Highway 37
Fuelling Drain at Shaffer Road
Fuelling Drain below proposed detention reservoir
Gorrell, Wertz and Smith-Fry Drains at sites immediately below detention reservoirs which are still to be selected
Wann Drain (external reference watershed)
Maumee River at Highway 10 Bridge
St. Joseph River at USGS gaging station
St. Marys River at USGS gaging station
Tile drains (to be selected)
Feedlot outfalls (to be selected)
Rainulator plots (to be selected)

Based on the initial investigations of the basin and the study area, it has been concluded that numerous cultural practices as they relate to the land capability classes discovered by the Soil Conservation Service, need to be evaluated.

Some of the most important are:

1. Fall versus spring plowing of row cropland.

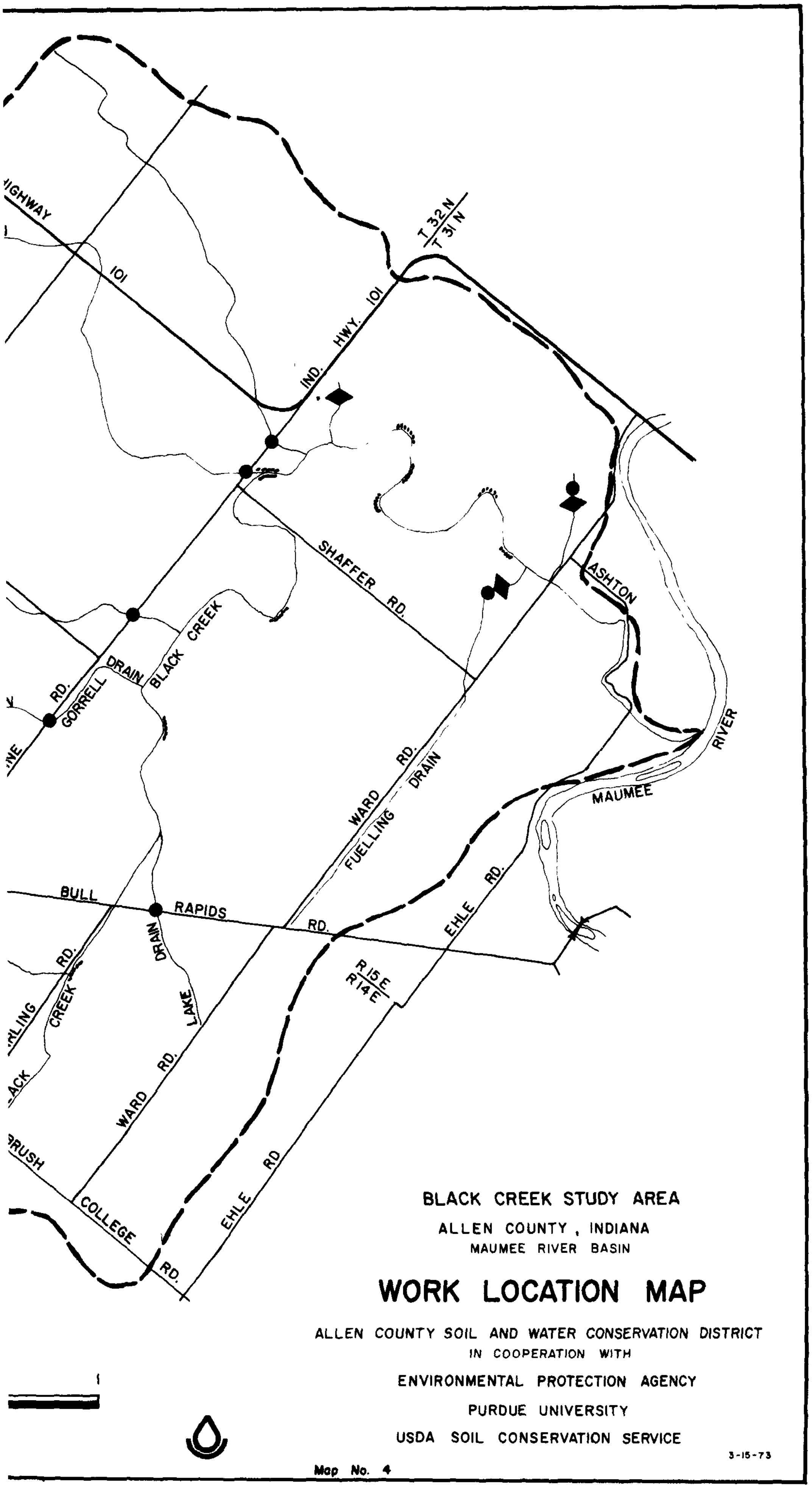
2. Effect of winter cover crops.

3. Effect of conservation tillage systems. Of particular interest would be fall chisel plowing, fall disking, "no till" planting.

4. The effect of crop rotations, particularly those that include a grass-legume sod.

5. The influence of pasture management, particularly overgrazing.

6. The contribution of livestock waste disposal on crop and pasture land.



BLACK CREEK STUDY AREA
ALLEN COUNTY, INDIANA
MAUMEE RIVER BASIN

WORK LOCATION MAP

ALLEN COUNTY SOIL AND WATER CONSERVATION DISTRICT
IN COOPERATION WITH
ENVIRONMENTAL PROTECTION AGENCY
PURDUE UNIVERSITY
USDA SOIL CONSERVATION SERVICE

3-15-73

Map No. 4

SCS estimates show both the Maumee Basin and the Black Creek Study Area to be predominantly cropland. Almost 81 percent of the 12,038 acres in the Black Creek Study Area is cropland. Corn and soybeans are major crops in the study area accounting for 7,000 acres. Although numerous land use capability units are found in the Black Creek Study Area, four (4) units account for 87 percent of the watershed area. These are as follows: 11% - IIe-6; 37% - IIw-1; 30% - IIw-2; and 9% - IIw-6.

The predominant recommendations by SCS for cultural practices on cropland are: conservation cropping systems (containing grasses and legumes in rotations), crop residue management, and minimum tillage.

The above statistics indicate that experimental plot studies should concentrate on (1) determining the contribution from the four major soil capability units, (2) evaluating the effect of presently used practices for corn and soybean production, and (3) evaluating the conservation effectiveness of conservation cropping systems, crop residue management, and minimum tillage.

The detailed plan for monitoring and for conducting the proposed scientific study is Part B of this report.

PART B

PLAN OF WORK

For
Demonstration and Evaluation
in
Black Creek Study Area

May 1973

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FIGURES

TABLES

1. INTRODUCTION

Control of soil erosion has been a recognized goal of the United States Department of Agriculture for at least a half-century. Over many years, USDA agencies such as the Soil Conservation Service, the Forest Service and the Cooperative Extension Service, have developed a recognized competance in preventing the destruction of land resources through unchecked erosion.

Improved water quality has traditionally been a recognized benefit of erosion control. It has not, until very recent years, been identified as a primary goal of erosion control techniques.

The fundamental purpose of this project is to determine how successful erosion control techniques can be in improving water quality in the Maumee Basin and Lake Erie. To do this, it will be necessary to evaluate the effects of a concentrated program of land treatment for erosion control on a selected area within the Maumee Basin. Simultaneously it is necessary to study in detail and on a definitive basis the effects of combinations of treatment practices within that study area and on experimental plots to find out how a reduction of sediment is achieved.

From these studies, insight can be gained into the total problem even if the demonstration project does not achieve the desired reduction of sediment entering the Maumee River from Black Creek in Allen County, Indiana. If traditional treatment measures, based on the best current knowledge of erosion control, can not achieve a desired reduction in sedimentation, these definitive experiments can furnish insight into what other methods may be necessary. If a satisfactory reduction of sedimentation is achieved, the experiment will furnish insight into whether this reduction might have been duplicated with a less intensive and less costly program.

Results of the demonstration project and the experiments will be used to help develop a computer model of the Maumee Basin which will describe the current sedimentation problem and in combination with other results help to project the cost of achieving a desired reduction in sedimentation in the basin.

No attempt will be made in this project to force a diverse group of individual landowners to participate. Therefore, the results of an attendant sociological study which will identify the factors which insure participation in the program by the landowners will also be of significant value in helping formulate a course of action leading to sediment control in the basin.

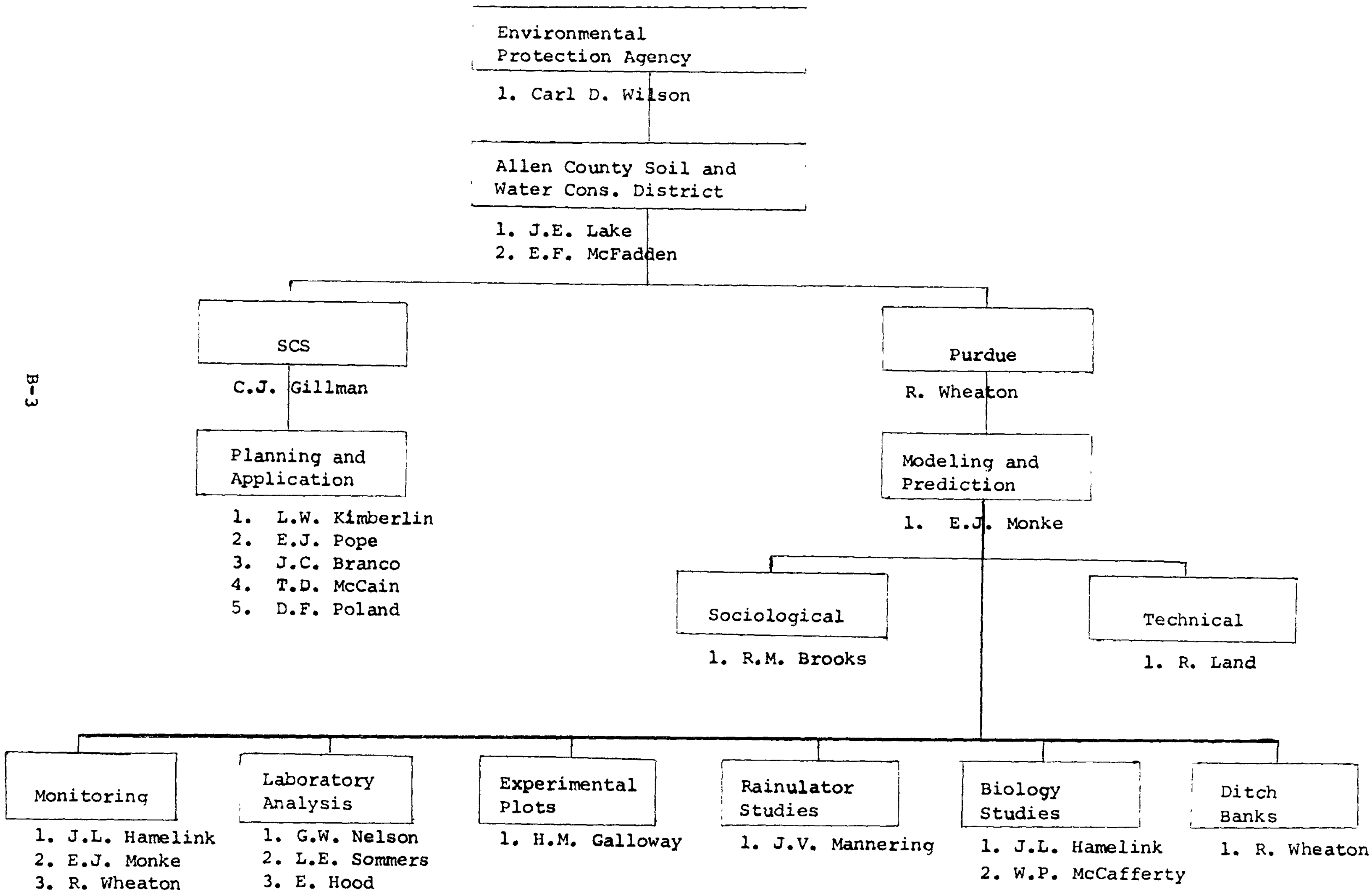
In addition to these primary project goals, studies of the effects of erosion control on the aquatic life in Black Creek and its tributaries will be conducted and measurement of nutrients entering the stream as a result of erosion will be made. These studies will concentrate on nitrogen and phosphorus to determine the significance of each as a pollutant not only in gross amount but in terms of the availability of each to plants in the river and the lake, particularly algae.

This work plan is a supplement to the final report on the six-month planning phase of the project described in a proposal "REDUCTION OF SEDIMENT AND RELATED NUTRIENTS IN THE MAUMEE RIVER AND LAKE ERIE." It describes the problem (Section II) identified by researchers from Purdue University during the study phase, the Demonstration Project (Section III), including the plan for work by the Soil Conservation Service and the Allen County Soil and Water Conservation District during the next four and one half years), the proposed research effort (Section IV), results to be expected (Section V) and the time frame for the balance of the project (Section VI).

A detailed breakdown of the projected budgets for the balance of the project is included as Appendix A to this work plan.

The primary grantee for this project is the Allen County Soil and Water Conservation District, a unit of state government funded by Allen County. The District, under its board of supervisors, retains responsibility for allocation of funds and for seeing that the work outlined is accomplished. The Soil Conservation Service, under contract to the District, will furnish the technical assistance for resource planning and application of planned practices. Purdue University, also under contract to the District, will furnish scientific support and conduct the research. Other state and local agencies and units of government will furnish assistance as required during the project period. The organization of the project is described in Figure B-1. Resumes of personnel listed in the figure are given in Appendix B.

Figure B-1. Project organization



II. APPROACH TO THE PROBLEM

The Maumee River Basin has been identified as a primary source of sediment and related pollutants in Lake Erie. The Basin is a roughly circular shaped area in northwestern Ohio, northeastern Indiana and southern Michigan measuring about 100 miles in diameter. Land use is primarily agriculture. It is essentially a level plain which represents a portion of the abandoned floor of glacial Lake Maumee which occupied the Lake Erie Basin in the late Pleistocene Age.

Despite the relatively level topography, erosion rates of the basin are among the highest in the Great Lakes region. The estimated annual gross erosion exceeds 4-1/2 tons per acre.

Gage data for the USGS station at Waterville, Ohio indicate that more than 1-1/2 million tons of sediment annually are carried by the Maumee River into Lake Erie. It has been postulated that this sediment carries with it many of the nutrients that contribute to algae "blooms" in the lake, with a resulting acceleration of the process of eutrophication.

The Ohio Environmental Protection Agency has set as a goal a reduction of the silt load in the Maumee by 50 percent. Other agencies and individuals have suggested higher reductions to be achieved.

It has been suggested that complete application of known techniques of erosion control can accomplish a 50 percent or greater reduction in the sediment load of the Maumee River.

It is therefore desirable to know if a concentrated application of existing methods of land treatment in the Maumee Basin can achieve a desired reduction in sediment, to make an estimate of how much such a program would cost on a basin-wide basis and, if possible, to correlate dollars spent for this goal with improvement in water quality, (i.e., an expenditure of X dollars in the basin would result in Y percent improvement in water quality).

It is also desirable to understand more fully the relationship between sedimentation and the nutrients that appear to be critical to an acceleration of the eutrophication process.

Concurrently, it is desirable to discover what kind of program might be carried out on a basin-wide basis which would convince individual landowners to apply conservation practices for the improvement of water quality in the Maumee Basin, whether this can be done adequately on an incentive basis, or whether some type of mandatory controls on pollution from non-point sources might be imposed with a reasonable chance of success.

The proposed project is a demonstration effort supported by research to allow meaningful projection of data to the basin and perhaps to other river basin systems and to understand more fully the mechanisms whereby sediment can be reduced through control of soil erosion.

A study area has been selected in Allen County, Indiana which is composed of the land draining into Black Creek, a tributary of the Maumee River. The area has been analyzed in terms of soil type, land use, and land capability and found to be very representative of the Maumee Basin (see the Final Report on the Planning Phase).

During the project, an accelerated program of land treatment will be carried out in this area. The treatment will be systematically applied beginning on the Dreisbach Drain in May of 1973 and continuing downstream on Black Creek in order on the Richelderfer Drain, the Gorrell Drain, the Wertz Drain, and the Smith-Fry Drain. This program will be completed by October of 1976.

Immediately, monitoring on these drains, and on a similar paralled drain outside the watershed will begin to furnish baseline data on the amount of sediment coming from the total watershed and to allow an evaluation of how successful the land treatment program is in accomplishing a reduction of the sediment load.

Because of the agricultural character of most of the land in the Maumee Basin, a major objective of the study is to identify the contribution of cropland agriculture to water quality in the Maumee River and in Lake Erie.

Both sediment and plant-nutrients associated with runoff and sediment require evaluation. The agricultural erosion problem in much of the basin is different with respect to soils and topography than what has been largely studied in the Midwest in the past. Earlier work indicates that sheet erosion from these nearly level areas may account for a significant portion of the material that is transported to Lake Erie. Also, those soils in the lake plain are high in total and colloidal clay and once this material is freed from the soil mass it will probably stay trapped in suspension and travel for long distances. It is important to know the relative sediment contribution of these nearly level-high clay lake plain soils to those sloping soils developed from glacial till.

In addition, the phosphorus composition of largely colloidal sediment would be expected to be much higher than sediment containing larger amounts of sand and silt. It is important to determine to what extent this is true. The contribution of erosion and sediment transport from various soils to NO_3^- concentrations of runoff waters is also an important consideration.

Another facet of the erosion-sedimentation problem on lake plain soils is the relative importance of rain drop energy to runoff energy in detaching soil material for transport. The relationship of quantity of surface flow to detachment and transport of sediment is still another consideration.

Evaluation of these factors will be made by use of the Agricultural Research Service Rainulator working on small plots within the study area. Also evaluated will be cultural practices such as fall vs. spring plowing of row crop land, effect of winter cover crops, and effects of conservation tillage systems (i.e., chisel plowing, fall disking, "no till planting").

The results of these experiments will greatly increase the understanding of the mechanisms within the demonstration watershed that lead to its success in improving water quality by reducing the sediment load. They will also furnish data to help verify projections of the results of the demonstration to the entire basin.

Water samples from the rainulator plots, demonstration plots, and the entire watershed will be analyzed to define the relationships and equilibra between various forms of phosphorus and nitrogen in runoff and stream waters. Laboratory studies will include fractionation of N and P components in water samples, incubation studies to determine if N and P are liberated from the sediment or if the sediment absorbs these nutrients over long periods of time, and studies to determine the availability of phosphorus and nitrogen in runoff and stream waters to algae.

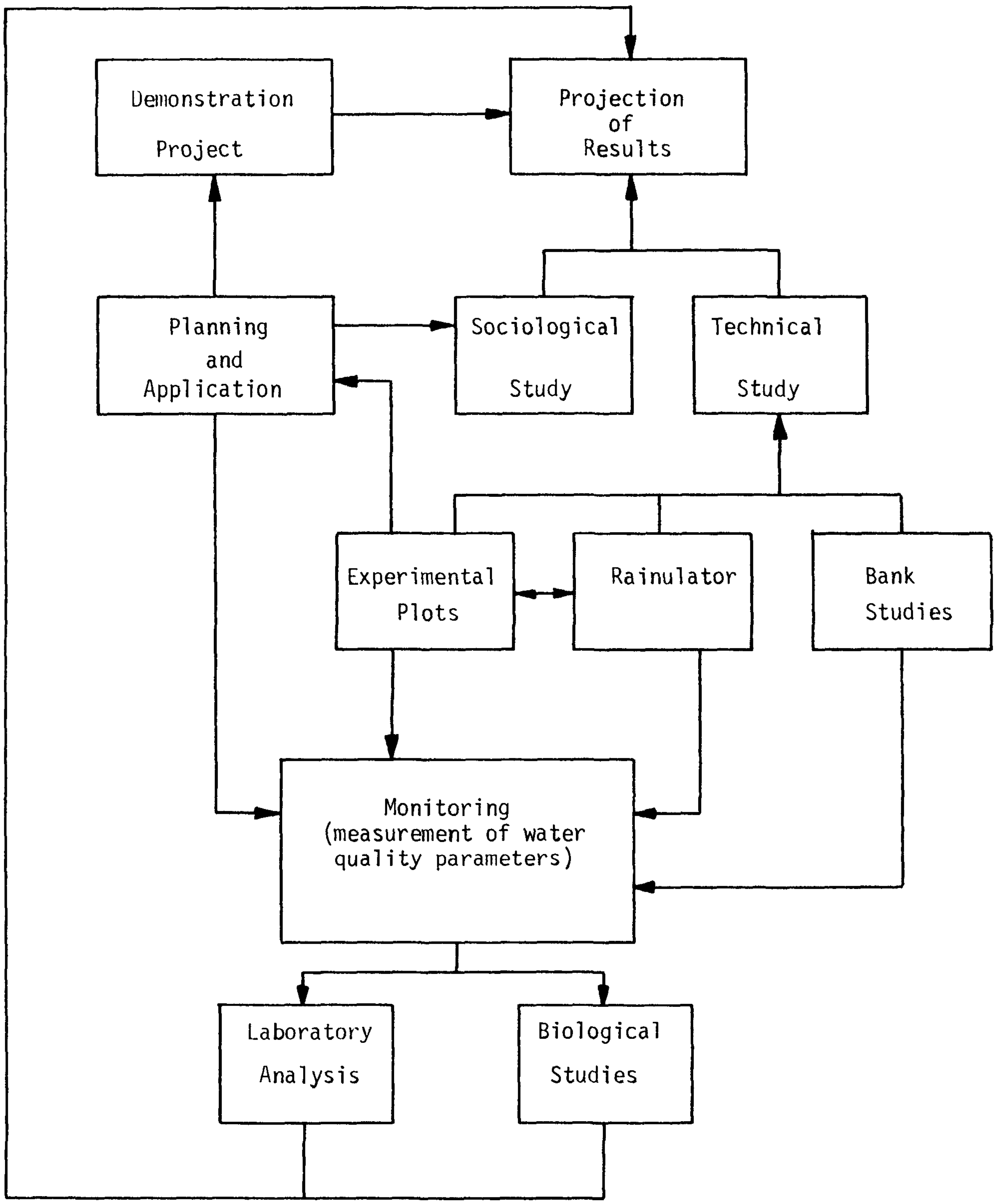
The results of these laboratory studies will be used in the computer model of the basin to refine estimates of water quality to be achieved by control of soil erosion.

A supporting section of the project will be the socio-economic analysis of the basin and the study area which is currently underway. This study will attempt to measure existing attitudes toward the environment and toward soil conservation in the study area and to compare these patterns with the basin in general. The program will continue through the life of the project so that it will be possible to determine factors which convinced individuals to participate in the program, where they received their information, and whether they can be expected to continue the program in future years.

The sociological study will furnish data that can lead to formulation of a program for control of sediment in the basin and perhaps in other river basins.

The interrelationships of the various activities are illustrated in Figure B-2.

Figure B-2. Interrelationship of Project Activities



III. DEMONSTRATION

Briefly stated, the goal of the demonstration project is to install what is, according to the best current estimates, adequate land treatment on the Black Creek Study Area and to monitor the results of this installation.

It will be necessary to conduct the demonstration program in such a way that it can support and be supported by the more laboratory-oriented research on small plots, the sociological study, and the anticipated projection of the results to the basin.

A. Resource Planning and Application

A continuing responsibility of the Project Director will be to coordinate the activities undertaken by the Soil and Water Conservation District and the Soil Conservation Service with the research needs of the Purdue Staff.

As a result, the first order of priority will be the selection of sites for and the installation of six sediment basins in the upland portion of the study area. These basins are necessary to the monitoring program and are also to be tested as means of reducing erosion.

Each basin will be installed on a tributary to one of the major drains within the study area and will collect water from a 200-to-400-acre drainage area. They will be essentially "overbuilt ponds" with a significant storage area and the capability to retain water so that most of the sediment settles out.

With this effort will come the geologic investigations and sampling of Black Creek and the Dreisbach Drain, also to furnish needed data to the scientific study group.

The study area contains one major drain, Black Creek, a tributary of the Maumee River which is joined by five major parallel drains. This arrangement allows comparison of the work being done on each drain with drains that have not yet received a concentrated application program.

In order to receive the maximum benefit from this controlled situation and also to allow for planning of the monitoring of water quality, a scheme has been developed to allow the installation of land treatment on an orderly basis throughout the watershed.

Concentrated effort in planning and practice application will be carried out in general from the west to the east of the study area and from the headwaters of each tributary drain to its intersection with Black Creek.

In keeping with this scheme, work will begin on the drainage areas of the Dreisbach Drain from its headwaters to the Notestine Road, and Black Creek, from its upper end to the junction of the Richelderfer Drain. Effort will progress to the Richelderfer Drain from its headwater to its intersection with Black Creek. Then planning effort will move to the Gorrell Drain from its headwater and Black Creek from its junction with the Richelderfer Drain to its junction with the Gorrell Drain.

Next, planning and application will be concentrated on the Wertz Drain, beginning at its headwaters, and finally effort will be concentrated on the Smith-Fry Drain and on the balance of Black Creek.

In the planning phase of this project, land treatment practices to be applied in the study area were identified, based on knowledge and procedures developed over many years by the Soil Conservation Service.

In the demonstration phase, each individual tract of land will be treated according to Soil Conservation Service technical criteria to achieve maximum reduction of erosion consistent with land use and land capability. Practices will be applied in combinations designed to achieve total treatment of each parcel.

The Allen County Soil Conservation District will concentrate its efforts in the areas designated above. It will probably be impossible to actually install practices in the regular order anticipated in this plan. However, by concentrating efforts in an orderly fashion, it is expected that a significant difference between the rates of application in the areas under consideration and the balance of the watershed will be achieved. This difference is expected to be great enough that data collected in the monitoring program will be meaningful. The installation and planning will begin in May of 1973 and be complete by October of 1976.

The planning process will be a joint effort in which the technical knowledge and experience of the Soil Conservationist are pooled with the knowledge and experience of the land user. Completed plans for individual farms or land units will reflect the voluntary decisions of the land owner or operator as to how he will use the land within its capability and how he will treat it according to its needs for protection and for improvement of water quality.

A complete conservation plan containing all major decisions to assure that the entire land unit will be used and treated to achieve conservation objectives will be the basis for cost share incentives on specific practices needed to implement the application of the plan.

Technical assistance furnished to landowners and operators will meet the technical guide standard and design criteria of the Soil Conservation Service.

Field demonstration tests conducted by Purdue University, will be used to assist landowners in the adoption of conservation practices. Certain selected practices will be chosen as particularly applicable to the dominant capability subclasses.

Small field size areas, still to be chosen, will be selected for farmer operator installation of adapted crop cultural-tillage practices.

Monitoring of these plots will supplement the Rainulator studies to be described in the next section of this plan.

B. Monitoring

Monitoring is important not only in terms of evaluating the success of the demonstration project in reducing the load of sediments and related nutrients entering the Maumee River, but also as a portion of the scientific research to be conducted with the demonstration project. Consequently, the monitoring program has been designed to both assess the effectiveness of the overall project and to answer specific questions or provide basic data for a variety of other studies.

Due to the size and complexity of the sampling and analytical load envisioned with this project, plans have been formulated to integrate the monitoring and water quality with the application phase of the program. The basic approach is a combination of intensive sampling and selective sample analysis. This is necessary to conserve space and personnel time during the annual cycles of discharge and changes in emphasis which are expected during the remaining four and one-half years of the project. Water quality monitoring program procedures can not be "finalized" at this time because the program is expected to undergo considerable change as the various procedures, problems, results, and methods of evaluation are encountered and resolved. The following sampling schedule and sets of procedures are based on the study is currently visualized.

The specific effects and benefits of various land treatment methods will be evaluated by establishment of monitoring stations in the upper areas of the watershed following the schedule set by the district and previously outlined in general form. This schedule is included in Table B-1:

Table B-1. Work Plan Implementation

Date	General Work Area
May 73 - May 74	Dreisbach Drain and Black Creek to Richelderfer Drain
May 74 - Oct. 74	Richelderfer Drain
Oct. 74 - May 75	Gorrell Drain and Black Creek to Mouth of Gorrell Drain
May 75 to Feb. 76	Wertz Drain
Feb. 76 to Oct. 76	Smith-Fry Drain and balance of Black Creek

Table B-2 describes the water quality sampling sites to be installed.

Table B-2. Water Quality Sampling Sites

Site Number	Description
1.	Killian Drain at Notestine Road
2.	Smith-Fry Drain at Notestine Road
3.	Wertz Drain at Notestine Road
4.	Gorrell Drain at Notestine Road
5.	Richelderfer Drain at Notestine Road
6.	Dreisbach Drain at Brush College Road
7.	Lake Drain at Bull Rapids Road
8.	Wertz Drain at Bull Rapids Road
9.	Dreisbach Drain at Trammel Road
10.	Dreisbach Drain at Highway 37
11.	Fuelling Drain at Shaffer Road
12.	Fuelling Drain below detention reservoir (sites to be selected)
13.	Gorrell Drain below detention reservoir (sites to be selected)
14.	Wertz Drain below detention reservoir (sites to be selected)
15.	Smith-Fry Drain below detention reservoir (sites to be selected)
16.	Wann Drain (external reference watershed)
17.	Maumee River at Highway 101 Bridge
18.	St. Joseph River at U.S.G.S. gaging station
19.	St. Marys River at U.S.G.S. gaging station
20.	Tile drain outfalls
21.	Feedlot outfalls
22.	Rainulator plots
23.	Biological survey sites
24.	Laboratory samples for nutrient availability studies

Figure B-3 outlines the general schedule for monitoring the sites listed in Table B-2. Periodic collections in each case may be made in subsequent years as dictated by conditions.

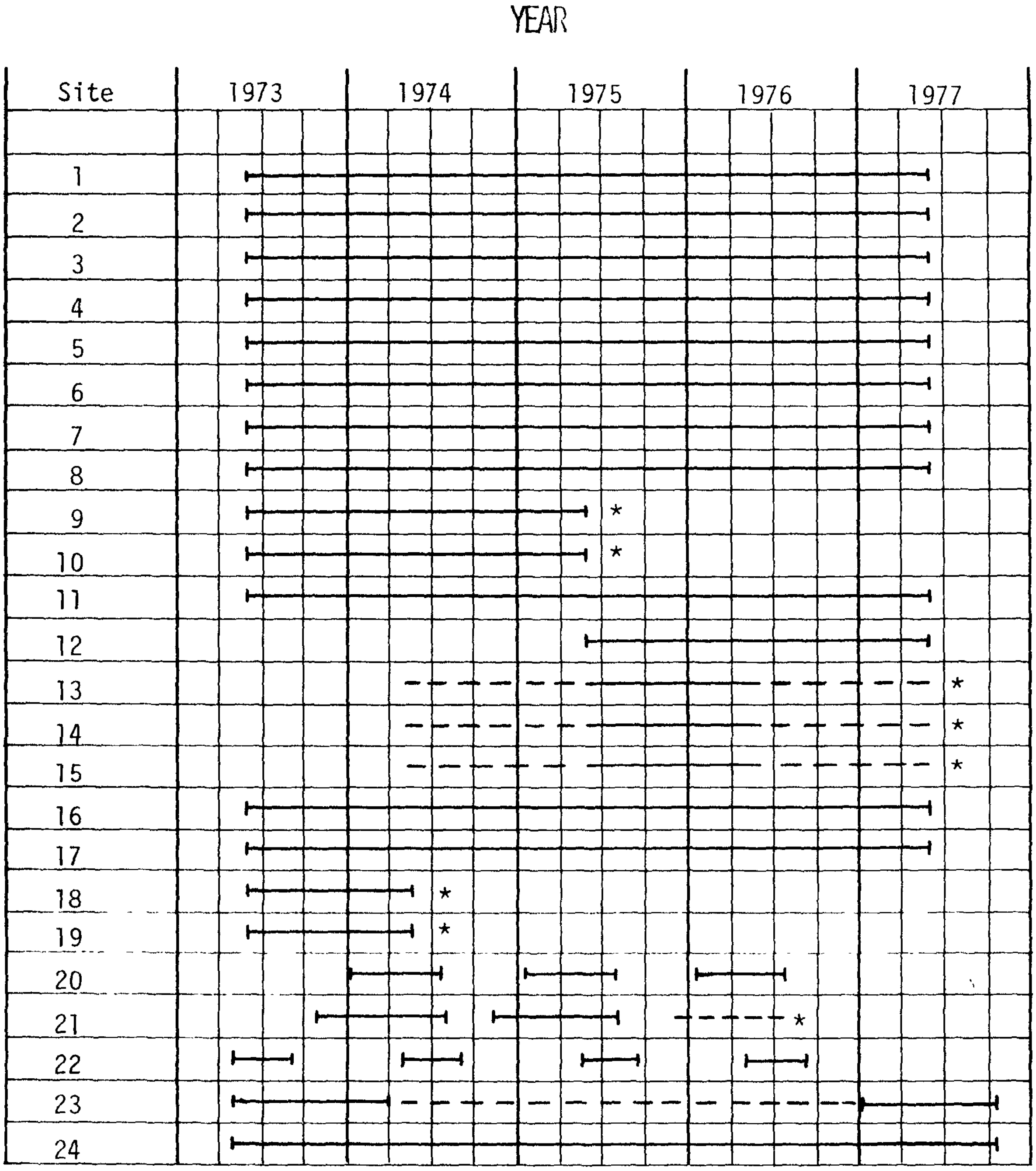
In general, sites 1 through 7 should provide adequate data to assess the effectiveness of the various treatments as they are applied in combination across the watershed as well as "pretreatment" and "internal control" data. Sites 8 through 12 should provide detailed data for both upland and lake bed areas which will receive specific treatments that may later be evaluated for their cost effectiveness in comparison to the results observed over the whole watershed. Sites 13 to 15 will serve to evaluate the effectiveness of detention structures in reducing both sediment and nutrient load. Site 16 is in an adjacent watershed for which no treatments are scheduled. It will be periodically sampled to provide additional data for the transport model being developed as a portion of the research.

Sites 20 to 22 consist of miscellaneous sites which will be used to allocate the nutrient input loads relative to the whole watershed. Site 24 is for laboratory studies which will be conducted to assess the availability of nutrients associated with the sediments collected both from the rainulator and the watershed.

Sites 1 through 11 will be routinely sampled once per week during periods of normal or low flow and intensively sampled during periods of high flows. It is anticipated normal flow periods would occur about 40 weeks per year and high flow about 12 weeks per year. Given a sampling intensity between 7 and 10 samples per week per site during periods of high flow, about 100 samples per site per year will be collected during high flow and about 40 samples per site per year will be conducted during normal flow. About 1500 samples will be collected annually from these stations. These samples will be primarily "grab" samples although an intensive effort will be made to obtain discharge-weighted composite samples whenever possible. Finally sites 12 through 19 will be sampled on a weekly basis but only about four of the sites will be sampled during a given year giving a total sample collection of about 200 samples.

Periodic collections of drainage tile effluents and rain water will occur. A major share of the nutrient budget may arise from tile outfalls due to both agricultural and septic tank drainage. The objective of these studies will be to allocate that portion of the total nutrient load from the watershed due to these "uncontrolled" sources. Thus, about 20 tile outfalls will be sampled on a biannual basis in each of the six major tributaries by a large team of researchers. Currently, there will be a period of intensive sampling at each of the respective gaging stations. Rain water samples will be obtained from the rain gages.

Figure B-3. Schedule for Monitoring Activities



——————— Primary monitoring period

– – – – – – Supplementary monitoring period

* Continuation depending on results

Depending on the time required to conduct the tile sampling, the discharge at the time of sampling, and the actual number of tiles sampled, around 300 or 400 samples will be collected annually.

Finally, an assortment of miscellaneous samples will be obtained from feed lot drainage, Amish farms, the rainfall simulator and the stream bank erosion study areas. It is expected that about 100 to 200 samples annually will be obtained for these sources.

About 2500 samples would be collected annually for analysis.

IV. RESEARCH

The purpose of the research conducted with this project is to (1) more fully understand the mechanisms whereby the demonstration project can reduce the sediment load entering the Maumee River and (2) utilize this understanding to project to the Maumee Basin an accurate estimate of methods that can be employed to achieve a desired reduction in sediment and the costs of doing so.

Small plot studies, rainulator studies, biological studies and laboratory studies described in this section have as their primary purpose collection of data that will aid in this understanding and help refine the projections to the basin level. However these studies will also provide useful data in themselves concerning such things as (1) the effect of cultural practices on erosion, (2) the importance of ditch banks as a source of erosion, (3) both the amount and availability of nitrogen and phosphorus to plant life that can be associated with soil erosion, and (4) the effect of a reduction in sediment resulting from erosion on aquatic life. Although the results of these separate experiments can be considered as subordinate to the general project, close attention will be paid to the possibility that the results may lead to conclusions which can be applied in a general way to the problems of erosion in the Maumee Basin and in other areas.

A. Modeling and Prediction

The mechanism whereby it is hoped that a prediction of sedimentation and related chemical pollution of the Maumee River and Lake Erie can be related to land use is a systems approach using computer simulation models of sedimentation and related-chemical pollution into the river and the lake.

During the six-month study phase, some preliminary work was done and Purdue University is currently looking at several models which may be adapted to this purpose. The work of actually selecting a model and testing it will begin April 15 and will continue throughout the project as data from the demonstration watershed and the various experiments being conducted within it become available.

To accomplish this task, all known information concerning the Maumee River Basin as related to this study will be cataloged. This information will include soil regions and land use patterns in the basin, existing discharge, sedimentation and related-chemical pollution measurements in the Maumee River and its tributaries, and sediment loading of Lake Erie. Cooperative relationships will be sought with sources of such information such as USGS (contact has already been established with the Indiana State Office), U.S. Corps of Engineers, Environmental Protection Agency, departments within Ohio State University known to be doing research in the basin, and other county and state agencies. In addition at least three sediment and chemical pollution sampling stations, one on the Maumee River below Black Creek, and one each above Ft. Wayne on the St. Joseph and St. Marys Rivers are planned.

A review of literature reveals basically six different approaches to the prediction of sediment yield from watersheds. As a beginning, this study will start by trying to apply these models to the Black Creek Watershed. Fundamentally, all of these models are of the lumped variety and no accounting is made of spacial differences and distributions within a watershed. The success of these models has been widely varied and depends to a large extent on a judicious evaluation of the model coefficients most of which have little physical significance. For this reason, a distributed model approach will be developed early in the study to see if indeed this approach has some validity in sediment prediction. Within small spacial units, erosion can be estimated fairly reliably using the statistically-based Universal Soil Loss Equation (USLE). The variables in this equation are physically related. The problem, even if USLE can be used, will still be to develop transport functions between homogeneous spacial units across land, into intermittent drainage networks, into major streams and finally into deposition sites such as bays or estuaries. Involved in this transport process is a continuous interchange all along a route between deposition and accretion of sediment apparently easily conceptualized but extremely difficult to quantatize. No known research at least on a river basin scale is being performed using this approach.

Results from the other studies are expected to define the erosion potential from land area transport characteristic of sediment and nutrient runoff.

An accompanying phase of this study is being planned for the laboratory using an existing erosion-bed apparatus with adjustable slope, variable inflow rate at the top of the bed, and simulated rainfall. The purpose of this phase of the study will be to determine the mechanics of erosion with cohesive soils on gentle slopes. This will amplify the work in the field.

B. Analysis of Samples

Analysis of the samples collected from the system outlined in the preceding section will help to:

1. determine the range, median, and mean values of certain water quality parameters,

2. establish the species diversity and population abundance of macro-invertebrates in designated areas of the watershed,

3. assess changes in the water quality, macro-invertebrate and fish population parameters with time as the treatment methods are implemented,

4. measure the quantities of pollutant compounds and materials discharged from the watershed to allow assessment of the impact of the various treatment practices on these loads,

5. help determine how much of the nutrient budget may arise from septic drainage and how much may come from agricultural drainage,

6. help define the relationships and equilibria between various forms of phosphorus and nitrogen in runoff slurries and river water.

The procedures to be involved include changes in water quality assessment by analyzing for selected water quality parameters in samples collected from the monitoring sites throughout the watershed. Some of the water quality parameters to be routinely assessed are total suspended solids (turbidity), total dissolved solids (conductance), total suspended organic matter, total dissolved organic matter, alkalinity, pH, total ammonia, total organic nitrogen, total nitrogen, total ortho-phosphate, total organic phosphate, and total phosphate. In addition, periodic measurements will be made of temperature and dissolved oxygen, BOD, chloride, potassium, sodium, calcium and magnesium content of the water as dictated by conditions observed or under study in the basin. An attempt will also be made to assess the extent of organo-chlorine pesticide and heavy metal contaminations in the area.

Information thus obtained will be compiled in a computerized format together with records of the discharge volume measured in other phases of the study. Computations will be made to obtain estimates of the loads received from the various areas of the watershed, as well as the total basin. Average concentrations and the variability of the concentrations of the various compounds of materials will be compiled. The expectation is that averages may provide a way for assessing the impact of the treatment methods employed, while the occurrance of extreme or critical conditions may be expected to have a greater impact on the biological components being monitored.

The water samples will be calculated and analyzed in the following manner:

Dissolved oxygen, temperature, turbidity, pH, alkalinity and conductance will be measured immediately either on site or following collection in a suitably outfitted truck. Then two 500 ml aliquots of water will be prepared for analysis in the laboratory on campus.

Since an attempt will be made to obtain a "standard" regression between total suspended solids and turbidity, and total dissolved solids and conductance for each sampling site, some additional manipulations will be required the first year which will be largely avoided in subsequent years. Thus, at the present time it is planned to collect 1500 ml samples of water in narrow mouth plastic bottles. About 500 ml will be used immediately to determine the pH alkalinity, conductance and turbidity. Another 500 ml will be transferred unfiltered into a storage bottle and frozen for later analysis. The final 500 ml will be precisely measured, vaccuum filtered through a tarred dry weight glass fiber or 5 μ membrane filter into a plastic storage bottle and frozen for later analysis. The filterable solids will be returned with the water samples, dried and weighed to obtain suspended solids for establishment of the turbidity standard regressions.

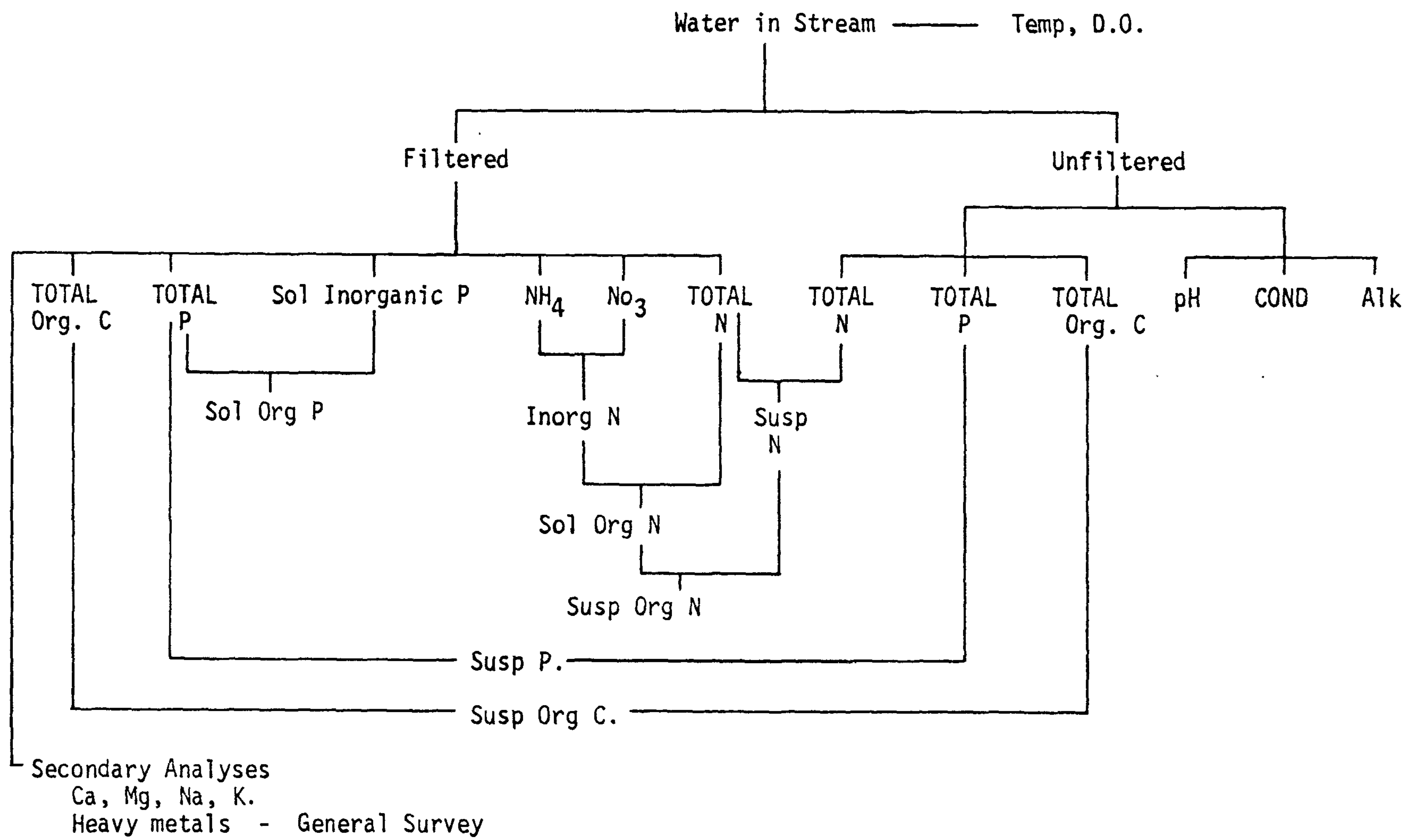
The water samples brought to the laboratory would be analyzed according to the flow chart given in Figure B-4. Under this plan, the filtered samples will be analyzed for total carbon, total phosphorus, soluble phosphorus, ammonium, nitrate nitrogen and total nitrogen, while the unfiltered samples would be analyzed for total nitrogen, total phosphorus, and total carbon.

By difference or summation, values will be obtained for soluable organic nitrogen, suspended organic nitrogen, suspended phosphorus, and suspended carbon. If time permits and the results are desired, analyses may also be conducted for calcium, magnesium, sodium and potassium by atomic adsorption and flame photometry.

C. Biological and Chemical studies

The biological components which will be intensively studied during the course of the project are fish and benthic macro-invertebrates, primarily insects. Periodic surveys of the fish populations will be conducted by seining and electro-fish shocking. These surveys will be used to assess changes in the spacial distribution and relative abundance of the species in the watershed. Fish biomass and species diversity within the watershed will be evaluated on an annual basis by collecting all the fish inhabiting designated areas with Rotenone. All the fish collected will be preserved in 10% formalin and returned to the laboratory at Purdue for indentification and enumeration.

Figure B-4. Water Sample Analysis Flow Chart



Benthic macro-invertebrate populations will be periodically surveyed throughout the watershed with a "kick-screen" to assess spacial distribution of the species present. This technique also provides a rapid method for assessing relative changes in population abundance over time. Absolute measures of population abundance and species diversity will be obtained by sampling selected sites four times annually with either a Surber sampler or a Ponar dredge, depending on stream conditions. The invertebrates will be preserved in alcohol and returned to the laboratory for identification and processing. Furthermore, although no intensive studies are planned, a general survey of the algae and higher aquatic plants will be conducted as time and resources permit. Finally, the presence of other forms of wildlife will be noted as observed during the course of these studies.

Chemical studies will be carried out in an attempt to define the relationships and equilibria between various forms of phosphorus nitrogen in runoff slurries and river water. Runoff slurries will be collected during rainfall simulator experiments.

Specific laboratory studies include:

1. Fractionation of N and P components in surface runoff and water samples. Elucidation of relationships between forms of these nutrients, i.e. the amount of one form of P such as dilute acid extractable P in the sediment may control the amount of soluble P in the water phase.

2. Incubation studies to determine if N and P are liberated from the sediment or if the sediment absorbs these nutrients over long periods of time. The influence of environmental parameters upon the liberation or sorption of nutrients by sediment will be investigated.

3. The availability of phosphorus and nitrogen in runoff water and river water to algae will be investigated. Of particular interest is the ability of algae to utilize sediment phosphorus. Tracer techniques will be used to elucidate the mechanisms involved.

D. Precipitation Measurements

To evaluate runoff from a watershed, the basic input rainfall must be known in amount, intensity, type and areal distribution. These measurements will be made with a series of rain gages. One recording rain gage is presently installed and in operation. Nine additional gages will be installed beginning April 15, 1973 with installation completed by July of 1973. Twenty-four hour clocks will be used on these gages which will allow storm rainfall to be analyzed in five-minute intervals when necessary.

The gages will be installed as uniformly as possible on the watershed consistent with securing sites which will provide good rainfall exposure and rainfall collection.

Two rainfall collectors will be installed in the watershed to determine rainfall water quality. Samples will be stabilized until analyzed in line with the previous description of sample analysis. These collectors will be installed before July 1973.

E. Rainfall Simulator Studies and Experimental Plots

As has been previously indicated, a primary requirement for a successful projection of results of the demonstration project to the entire will be a more precise understanding of how the application of cultural and conservation practices recommended by the Soil Conservation Service effect erosion rates and sediment load in the basin.

Much of this more precise information will be obtained from studies utilizing the ARS Rainulator and from field experimental plots. These experimental plots will help furnish base values needed to validate data collected in the simulated rainfall experiments.

Objectives of these studies are:

1. To determine base values for the sediment contributions of the major soil capability units in the study area.

2. To determine runoff and sediment compostion (physical and chemical) coming from the major soil capability units.

3. To determine the relative importance of rain drop impact and surface runoff in detaching soil material from nearly level lake plain soil.

4. To compare the runoff and soil erosion effects of presently used cultural practices to the conservation cultural practices recommended by SCS.

The research conducted in 1973 will be confined to the first three objectives. In the spring of 1973 test sites will be selected that represent soil and topographic conditions of the four major soil capability units in the study area. Agreements will be secured from the land owner to allow research to be conducted over the next five years. Water storage areas will be constructed adjacent to the study areas to permit the use of simulated rainfall as a test procedure. On these four sites test plots will be turn-plowed to create a fallow condition for testing during the summer of 1973. Additional cultural practices will be included as needed to control weeds prior to testing.

The ARS-Purdue Rainfall Simulator will be set up over the test sites during the period of the 1973 summer. Reproducible simulated test storms will be applied to the four sites to secure the base values mentioned in objective 1. Runoff samples will be processed so that the following information can be obtained: (1) runoff rate and volume, (2) sediment concentration of runoff, and (3) sediment composition of runoff (physical and chemical including the P and N forms associated with the liquid and solid phase of the sediment).

Using the same plots, runoff water will be introduced at the top of the plot to simulate increased slope length and to study the effect of runoff volume on sediment transport. Measurements will be made of sediment transport by runoff with and without simulated rainfall to determine the relative contributions of both energy forms in soil detachment and transport.

The first year results will provide the base sedimentation values occurring from the four principal soil capability groups. The relative conservation effectiveness of various cropping and cultural practices to be tested in 1974, 1975, 1976, and 1977 will be compared to these base values.

After the initial year of study plots will be established on the same general soils area to permit simulated rainfall testing of the influence of cropping and cultural practices on runoff and erosion from cropland. These comparisons will evaluate such practices as:

1. fall plowing
2. winter cover
3. several forms of conservation tillage
4. crop rotations
5. residue management
6. overgrazing of pasture
7. animal waste disposal on crop and pasture land.

Simulated rainfall research will be carried out by personnel of the Agronomy and Agricultural Engineering Departments of Purdue University and the Agricultural Research Service, USDA. Site selection and arrangements as well as other assistance will also be obtained from the Allen County Soil and Water Conservation District and the Soil Conservation Service.

Field demonstration test plots will be chosen to represent the dominant capability subclasses to test effects on the soil as well as the equipment needs and procedures of operators. So as to sample the textural or other management differences among those wetness subclasses, capability units IIw-1, IIw-2 and IIw-6 will be studied in the field for suitable locations for field demonstration test locations. Similar locations will be sought on areas of IIe-6, the dominant gently sloping moderately erodible soil unit in the watershed.

Small field size areas (strips, blocks, etc.) will be chosen for farmer operation of equipment to install adapted crop cultural-tillage practices which can have several values, including:

1. Acquainting farmers with practices they have not formerly used.

2. Allowing comparison between the new practices and customary practices performed nearby.

3. Furnishing a place where persons can observe comparative results either through individual visits or during field days.

4. Furnishing controlled management which can later be tested for effectiveness with the ARS-Purdue Rainfall Simulator.

Examples of practices useful in field demonstrations are comparison of moldboard and chisel plowing in fall land preparation, double cropland preparation in spring, no-till planting in a mulch without plowing on appropriate soils, and winter cover crops with various forms of land preparation in spring.

In the spring of 1973, double disking will be compared with fall and spring moldboard plowing. In the fall of 1973, comparison of chisel plowing and moldboard plowing will be established to afford comparisons with spring moldboard plowing for 1974 growing season. In 1974, no-till corn culture will be installed for later comparison with plowed systems.

These practices will be monitored in accordance with procedures outlined in the previous sections.

F. Stream Channel and Bank Studies

There are indications that a major source of erosion and sediment in the Maumee River Basin is from stream banks and channels, including the areas which are immediately adjacent to the streams. To determine the contribution of sediment from the stream channel area, a detailed study will be conducted.

Starting in April 1973, the Soil Conservation Service will conduct a geologic and soil mechanics study along the Black Creek Channel. This study will include an evaluation of different channel grades, bank slopes, vegetative cover, soil properties, and surface water runoff. This soil and cover data will be used to select channel study sites. Soil types to be studied include the non-cohesive sands and silts and the cohesive clays. Seepage problems in layered soils will also be observed. Principal types of cover to be evaluated are trees, grass, and areas from which trees have been recently removed. Some of the tests to be made are dispersion, sheer parameters, bulk density, and Atterberg limits. Tractive force and slope stability measurements will also be made.

Starting in the spring of 1973 and continuing through 1976, an evaluation of stream bank stability under tree cover will begin. There is considerable area along Black Creek where trees have recently been cut. Cross sections will be measured to determine what change, if any, takes place in the channel.

The stability of grass-covered banks will be determined by selecting sites with different soil properties and locating or establishing bank slopes ranging from 1 to 1 to 3 to 1, or flatter. Effectiveness of a grass strip along the edge of the bank will also be studied.

Badly eroding sections of stream banks will be armor plated by the use of riprap or other materials for analysis of effectiveness. Some grade stabilizing (grade reducing) structures and other structural means of erosion control in or adjacent to the channel may be available for analysis as the land treatment measures progress.

Channel stability evaluations will consist of cross-sectional measurements using standard surveying procedures. Each cross-section measurement will be replicated for a given set of conditions so that an accurate statistical answer can be obtained.

The stream bank studies will provide information to refine the projections to the Maumee Basin and should also furnish some useful insight into the ways in which ditchbank treatment effects erosion generally.

G. Socio-Economic Evaluation

The present socio-economic status and level of understanding of and bias to soil conservation practices of the Black Creek Watershed residents must be determined to provide baseline data from which the impact of the program on the behavior of the residents can be measured. A study will be conducted to measure these factors in detail. Basic objectives will be:

1. To assess present knowledge, attitudes, and behavior toward the environment and probable future involvement in conservation practices.

2. To determine the present level of involvement in land use programs.

3. To assess individual land owner's present understanding the role of public and private organizations and agencies in environmental activities and his use of these organizations and agencies.

During this study, the following questions will be considered:

a. Who now participates in various pollution abatement programs?

b. What are the characteristics of participants and non-participants?

c. Where do they get their information?

d. Why are they (or are they not) participating?

e. What are their attitudes concerning the environment?

f. What are their future plans for land use and soil conservation?

Immediate plans for the socio-economic study of the Black Creek area, and their approximate sequence for the first year are:

<u>Six Month Period: April - October, 1973</u>

April - June	Review of literature emphasizing participation in incentive programs, soil conservatin as practiced by the general public and sociological studies in the area of conservation.

July - August	Study design.
September - October	Development of research instrument. Personal interviews with land owners in the basin, mail questionnaires and telephone interviewing are being considered since the population is already identified.

Next Six Month Period: November - April, 1974

November	Pretest and revise the research instrument.
December - January	Collect data (This will vary depending on the type of interviewing procedure).
February - March	Code data and prepare for first draft of report.
April	Analyze data and prepare for first draft of report.

From this study, baseline data will be provided from which comparisons can be made after the incentive program has been functioning for over a year. Collection and analysis of data will continue throughout the balance of the project. Development of a framework for this activity will be dependent on the results of the preassessment and study design described above.

V. PROGRAM SCHEDULE

The program of work to be accomplished in this project is summarized in Figure B-5 which represents a progress chart for the proposed project.

The work to be accomplished depends to a great extent on the schedule of application of land treatment set forth by the Allen County Soil and Water Conservation District. This planning and application phase will begin almost immediately with the first time period (scheduled to end in May of 1974, being concentrated on the Dreisbach Drain from its headwaters to the Notestine Road and on Black Creek from its upper end to the junction of the Richelderfer Drain.

In May of 1974, planning and application will begin on the Richelderfer Drain from its headwater to its intersection with Black Creek. This phase will end in October of 1974.

Beginning in October of 1974 and continuing until May of 1965, concentration of effort will be on the Gorrell Drain from its headwaters to its intersection with Black Creek and on Black Creek from its junction with the Richelderfer Drain to its junction with the Gorrell Drain.

Beginning in May of 1974, the work will move to the Wertz Drain with concentrated planning and application there to be finished by February of 1976.

The final phase of the planning and application process will include the Smith-Fry Drain and Black Creek from its junction with Gorrell Drain to its entrance into the Maumee River. This work is scheduled to last from February of 1976 through October of 1976.

Monitoring will begin immediately in order to record values which will represent the watershed before work has started in any concentrated fashion. The monitoring will continue until well after the application of land treatment has been completed. The monitoring schedule is set out in brief form in Figure B-5 and in more precise form in Figure B-3.

For monitoring percipitation, one gage has already been installed. All are to be in place by July of 1973. Also by July, instruments to collect rainfall for analysis of water quality parameter are to be installed.

Ditch bank studies will begin with the selection of appropriate tree covered and denuded bank sites for evaluation and baseline measurements. These sites will be selected in May of 1973 and measurements will be made over the next three years.

During June and July, two other stream channel sites will be selected, based on a Soil Conservation Service geologic and soil mechanics investigation which is to be completed by July of 1973. Cross-section measurements will be begun during July of 1973 and will continue until 1976.

Laboratory analysis to fractionate N and P components in surface runoff and water samples will begin immediately. These studies will continue throughout the life of the project as runoff samples become available.

From June of 1974 through June of 1976, incubation studies to determine if N and P are liberated from the sediment or if the sediment adsorbs these nutrients over long periods of time will be conducted.

From October 1975 through October 1977, studies to determine the availability to algae of phosphorus and nitrogen in runoff water and river water will be conducted.

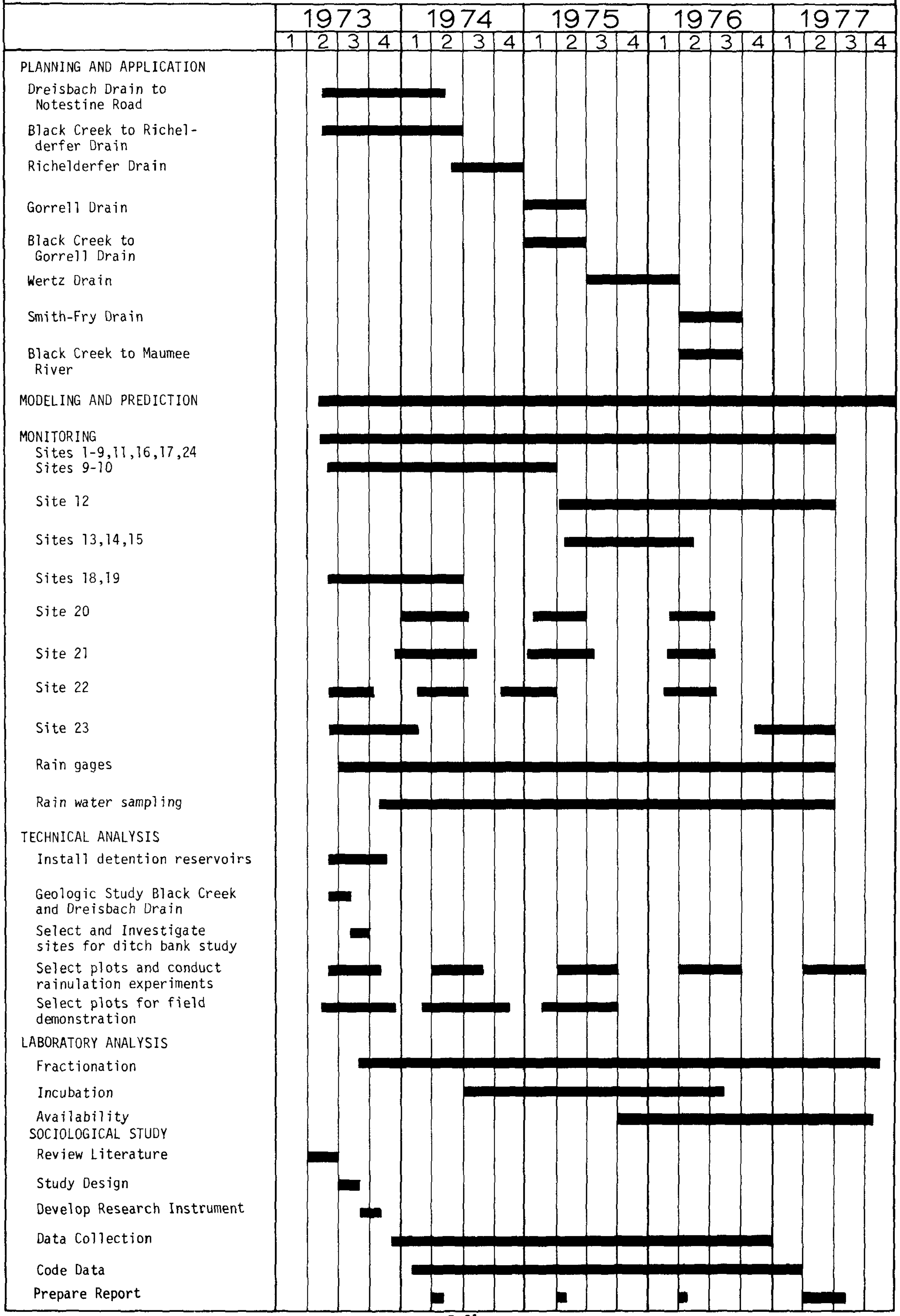
Plots will be selected for the rainfall simulator studies during April of 1973 for testing during the summer of 1973. The rainfall simulator will be set up over the test sites during the summer of 1973 to gain base sedimentation values from the four principal soil types. Testing of the various cultural practices will be made during the summers of 1974, 1975, 1976, and 1977 with the order of study determined to a large extent by the needs of the project to prepare a computer model of erosion and sedimentation in the basin.

For the experimental plots, the spring of 1973 furnishes an opportunity to consider runoff where there was no fall plowing. (An extremely wet fall led to very little fall plowing in the Maumee Basin last year.) During this spring, double disking will be compared with fall and spring plowing. In the fall of 1973, comparison of chisel plowing and moldboard plowing will be made. In 1974, no-till corn culture will be installed for later comparison with plowed systems.

The computer model of the Maumee Basin will be an ongoing project, beginning in April of 1973 and continuing through the life of the project.

Sociological studies, beginning in April of 1973, will concentrate on the selection of a research instrument, data collection and preliminary analysis with tentative format for the balance of the study determined by mid-1974.

FIG. B-5 PROGRAM SCHEDULE



I. RESULTS AND BENEFITS EXPECTED

The program outlined in this work plan will provide data in the form of technical and scientific information and sociological-economic projections.

The Black Creek Study Area, containing 12,038 acres, was selected because it is representative of the Maumee Basin in terms of soils, land use, conservation needs and socio-economic conditions.

The Black Creek Study Area will provide a demonstration of improved environmental quality through better use of the land, proper management of the land and water resources, and a resultant effect on the quality of the water leaving the study area and entering the Maumee River and ultimately Lake Erie.

As a result, data collected from the study area will be suitable for projection to the entire Maumee Basin. To help insure that the data is accurate when projected to the basin, a computer model will be developed. Results from monitoring of the total study area and results of controlled experiments on small plots will be fed into the computer model to update and validate it.

The project will provide an assessment of the practices listed in Section IV, not only independently but also in conjunction with other practices, to determine their effect on water quality.

As a result, it will be possible to state, at a reasonable level of confidence, that the application of certain levels of practices within the total basin, will result in a reduction of sediment and related pollutants by a corresponding fixed amount. By applying cost figures to these data, it will be possible to state that the spending of a given sum of money, on specified measures, will result in a corresponding decrease in the amount of pollution.

Results will primarily be concerned with the measurement of sediment reaching the Maumee River. However, the sediment will be related to other pollutants including nitrogen, phosphates, heavy metals, pesticide residue and coliforms.

These measurements will provide information on how reduction in soil erosion tends to effect these other elements of water quality.

The Black Creek Study Area contains 176 operating units averaging 68 acres in size. Many complex relationships will be involved which will require group co-operation. The Allen County Soil and Water Conservation District does not have the legal authority to force landowners to co-operate with the project.

It is expected that most landowners will co-operate when offered adequate explanation of the project and when offered financial incentives.

Socio-economic studies will shed light on the factors which lead some landowners to co-operate and other land owners to refuse to take part. Projections based on these data will allow an evaluation of how great a reduction in sediment and related pollutants might reasonably be expected from adequately financed and properly conducted voluntary programs throughout the Maumee Basin.

Although the primary value of this study will be realized by the technical, scientific, and socio-economic data and projections previously outlined, the study area will have great value as a demonstration area.

Results of the land treatment applications should be visible early in the program and their effect will be cumulative as the program progresses. The value of the site as a demonstration area will continue for some time after the termination of the program since the effects of the land treatment practices to be applied can be expected to be evident for many years beyond the program period.

VII. PROJECT COSTS

Costs for the Maumee Study can be grouped into two major categories: (1) application of land treatment measures and associated technical assistance, and (2) personnel, equipment, and related costs for administering and conducting the five year study.

Total costs for the project is estimated to be $2,597,250. Costs for land treatment measures are summarized in Table A-10 Part A, and amount to approximately $1,169,827.

Total costs for personnel, equipment, construction and related expenses are estimated to be $1,427,423, and are summarized in Table B-3, Project Cost Summary. Costs are divided to show input by the three principal participants, Allen County Soil and Water Conservation District, Purdue University, and the Soil Conservation Service. Also shown are costs related to land treatment measures. A detailed budget is attached in Appendix A.

TABLE B-3 - BLACK CREEK STUDY

Maumee River Basin

Project Cost Summary

Time Period	Allen SWCD Project Costs	Allen SWCD Grant Request	Purdue Univ. Project Costs	Purdue Univ. Grant Request	Soil Cons. Service Project Costs	Soil Cons. Service Grant Request	Project Costs Land Treatment Measures	Grant Request Land Treatment Measures	Total Project Cost	Total Grant Request
Oct.1972-May 1973	8,899	2,301	24,230	11,044	20,000	20,000	-	-	53,129	33,345
May 1973-Oct.1973	9,290	2,100	153,854	129,315	26,500	26,500	107,687	70,000	297,331	227,915
Oct.1973-Oct.1974	17,512	4,200	241,681	190,152	36,843	36,843	277,829	180,500	573,865	411,695
Oct.1974-Oct.1975	18,398	4,400	233,533	179,435	55,291	55,291	395,506	256,400	702,728	495,526
Oct.1975-Oct.1976	19,184	4,600	242,926	186,131	45,705	45,705	388,805	253,100	696,620	489,536
Oct.1976-Oct.1977	20,074	4,800	240,478	180,847	13,025	13,025	-	-	273,577	198,672
TOTALS	93,357	22,401	1,136,702	876,924	197,364	197,364	1,169,827	760,000	2,597,250	1,856,689

April 1973

APPENDIX A

Budget for

Black Creek Study

Maumee River Basin

1. Allen County Soil & Water Conservation District
2. Purdue University
3. U.S. Soil Conservation Service

ALLEN COUNTY SOIL & WATER CONSERVATION DISTRICT
BUDGET - BLACK CREEK STUDY MAUMEE RIVER BASIN
October 20, 1972 - October 19, 1977

COST CATAGORY	PROJECT PERIOD		BUDGET PERIOD	
	TOTAL	REQUESTED	TOTAL	REQUESTED
Personnel salary & wages	47,556.00	11,150.00	47,556.00	11,150.00
Fringe Benefits	4,056.00	180.00	4,056.00	180.00
Travel	2,140.00	1,155.00	2,140.00	1,155.00
Equipment	5,255.00	3,566.00	5,255.00	3,566.00
Supplies	1,900.00	975.00	1,900.00	975.00
Other publication cost	1,100.00	575.00	1,100.00	575.00
local gov. units	31,350.00	computer serv. 4,800.00	31,350.00	4,800.00
TOTAL PROJECT	93,357.00	22,401.00	93,357.00	22,401.00
TOTAL INDIRECT	-	-	-	-
TOTAL	93,357.00	22,401.00	93,357.00	22,401.00

	Purdue	[illegible] (Allen Co) EPA	Total	Purdue	[illegible] (Allen Co) EPA	Total	Purdue	2nd Yr (Allen Co) EPA	Total	Purdue	3rd Yr (Allen Co) EPA	Total	Purdue	4th Yr (Allen Co) EPA	Total	Purdue	5th Yr (Allen Co) EPA	Total	Purdue	Total Project (Allen Co) EPA	Total
I. Salaries																					
A. Senior Personnel FTE																					
1) R. Z. Wheaton 20% 15%	2030	1523	3553	2030	1522	3552	4263	3197	7460	4476	3356	7832	4699	3523	8222	4933	3699	8632	22431	16820	39251
2) E. J. Monke 15%	1673		1673	1672		1672	3512		3512	3687		3687	3871		3871	4064		4064	18479		18479
3) J. V. Mannering 15% 1st 5 mon. 18% 2nd 5 mon. and after	1290		1290	1548		1548	3250		3250	3412		3412	3582		3582	3761		3761	16843		16843
4) H. M. Galloway 15% 1st 6 mon. 18% 2nd 6 mon. and after	1395		1395	1674		[illegible]574	3515		3515	3690		3690	3874		3874	4067		4067	18215		18215
5) R. M. Brooks 15%	1125		1125	1125		1125	2362		2362	2480		2480	2604		2604	2734		2734	12430		12430
6) E. L. Hood 25%				1650		1650	3465		3465	3638		3638	3819		3819	4009		4009	16581		16581
7) L. E. Sommers 15%				1080		1080	2268		2268	2381		2381	2500		2500	2625		2625	10854		10854
8) D. W. Nelson 15%				1252		1252	2629		2629	2760		2760	2898		2898	3042		3042	12581		12581
9) W. P. McCafferty 10%				740		740	1554		1554	1631		1631	1712		1712	1797		1797	7434		7434
10) J. L. Hamelick 15%				1057		1057	2219		2219	2330		2330	2447		2447	2572		2572	10625		10625
B. Project Coordinator 1 @ 100%					6500	6500		14000	14000		15000	15000		16000	16000		17000	17000		68500	68500
C. 1) Graduate Instr. 2 @ 100%					8300	8300		16800	16800		17000	17000		17200	17200		17400	17400		76700	76700
2) Professional Ast. 1 @ 100%					5000	5000		10250	10250		10763	10763		11301	11301		11866	11866		49180	49180
D Research Assist. 2 @ 50%		750	750		3000	3000		6000	6000		6000	6000		6000	6000		6000	6000		27750	27750
E. Technicians 2 @ 100% {3 @ 2 month for 1st 4 years					10000	10000		17350	17350		18068	18068		18821	18821		16612	16612		80851	80851
F. Clerical Support 1.5 @ 100%		2800	2800		3500	3500		8700	8700		9000	9000		9300	9300		9600	9600		42900	42900
G. Wages					2500	2500		5000	5000		5000	5000		5000	5000		5000	5000		22500	22500
TOTAL SALARIES AND WAGES	7513	5073	12586	13828	40322	54150	29037	81297	110334	30485	84187	114672	32006	87145	119151	33604	87177	120781	146473	385201	531674
II. Fringe Benefits																					
A) TIAA/SS	724	229	953	1591	228	1819	3341	480	3821	3508	503	4011	3683	2224	5907	3867	2335	6202	16714	5999	22713
B) Gen. Insurance	90	61	151	166	484	650	349	976	1325	366	1010	1376	384	1046	1430	404	1046	1450	1759	4623	6382
C) Unemployment Insurance	24	14	38	53	110	163	111	131	242	116	131	247	120	131	251	125	131	256	549	648	1197
D) Workmens Comp.	4	5	9	10	118	128	20	214	234	21	222	243	22	231	253	24	213	237	101	1003	1104
TOTAL FRINGE BENEFITS	842	309	1151	1820	940	2760	3821	1801	5622	4011	1866	5877	4209	3632	7841	4420	3725	8145	19123	12273	31396
III. Equipment																					
A) Site Instrumentation					8000	8000		5000	5000											13000	13000
B) Individual Studies $1000/Res.Asst./Grad.Inst.		400	400		3600	3600		4000	4000		4000	4000		4000	4000		4000	4000		20000	20000
C) Laboratory *Attachment A					4175	4175														4175	4175
TOTAL EQUIPMENT		400	400		15775	15775		9000	9000											37175	37175
IV. Supplies and Expenses																					
A) Office Supplies		75	75		75	75		150	150		150	150		150	150		150	150		750	750
B) Duplicating, Photo		25	25		525	525		1050			1050	1050		1050	1050		1050	1050		4750	4750
C) Individual Studies $750/Res.Asst./Grad.Inst		250	250		2750	2750		3000	3000		3000	3000		3000	3000		3000	3000		15000	15000
TOTAL SUPPLIES AND EXPENSES		350	350		3350	3350		4200	4200		4200	4200		4200	4200		4200	4200		20500	20500
V. Travel and Per Diem																					
A) Senior Personnel		900	900		900	900		1500	1500		1500	1500		1800	1800		1900	1900		8500	8500
B) Project Coordinator					1200	1200		1200	1200		1200	1200		1200	1200		1200	1200		6000	6000
C) Individual Studies $750/Res.Asst./Grad. Inst.		250	250		2750	2750		3000	3000		3000	3000		3000	3000		3000	3000		15000	15000
D) Technician (Rainulator 3 Tech.x $500 Mo. x 2 Mo.					3000	3000		3000	3000		3000	3000		3000	3000					12000	12000
E) Water Sampling Group					3000	3000		6000	6000		6000	6000		6000	6000		6000	6000		27000	27000
TOTAL TRAVEL AND PER DIEM		1150	1150		10850	10850		14700	14700		14700	14700		15000	15000		12100	12100		68500	68500
VI. Construction																					
A) Small Detention Reservoirs 6 to 10 @ $3000 to $5000					20000	20000		10000	10000											30000	30000
TOTAL CONSTRUCTION					20000	20000		10000	10000											30000	30000
VII. Operational Cost																					
A) Supplies, Expenses, Repair (for Sampling and Rainulator)					1870	1870		2100	2100		1800	1800		1800	1800		1000	1000		8570	8570
B) Laboratory		500	500		4500	4500		10000	10000		10000	10000		10000	10000		8000	8000		43000	43000
C) Sample Storage Facility					1000	1000		500	500		500	500		500	500		500	500		3000	3000
TOTAL OPERATIONAL COST (Included with Supplies in Major Grouping)		500	500		7370	7370		12600	12600		12300	12300		12300	12300		9500	9500		54570	54570
VIII. Other Research Expenses																					
A) Publication Expenses (for landowners and to publish results)					500	500		500	500		500	500		500	500		1000	1000		3000	3000
B) Computer					1875	1875		3750	3750		3750	3750		3750	3750		3750	3750		16875	16875
C) Communication					250	250		250	250		250	250		250	250		250	250		1250	1250
B) Lease Payment **Attachment B					3650	3650		3000	3000		3000	3000		3000	3000		3000	3000		15650	15650
TOTAL OTHER RESEARCH EXPENSES					6275	6275		7500	7500		7500	7500		7500	7500		8000	8000		36775	36775
TOTAL DIRECT COST	8355	7782	16137	15648	104882	120530	32858	141098	173956	34496	128753	163249	36215	133777	169992	38024	128702	166726	165596	644944	810590
IX. Indirect Cost																					
A) 64.3% of S&W On Campus Research	4831	3262	8093	8891	21748	30639	18671	43272	61943	19602	44487	64089	20580	45746	66326	21607	45124	66731	94182	203639	29782[illegible]
B) 41.3% of S&W Off Campus Research					2685	2685		5782	5782		6195	6195		6608	6608		7021	7021		28291	28291
TOTAL INDIRECT COST	4831	3262	8093	8891	24433	33324	18671	49054	67725	19602	50682	70284	20580	52354	72934	21607	52145	73752	94182	231930	326112
X. TOTAL PROJECT COST	13186	11044	24230	24539	129315	153854	51529	190152	241681	54098	179435	2335[illegible]	56795	186131	242926	59631	180847	241478	259778	876924	1136702

*ATTACHMENT A

2 Hot Plate	$ 330.00
1 Muffle Furnace	350.00
1 Conductivity Meter	400.00
1 Terbidimeter	475.00
1 Power Dredge	200.00
1 Refrigerator	500.00
1 Freezer	500.00
1 PH Meter	500.00
1 D.O. Temp.	600.00
1 Vacuum Pump	120.00
1 Portable Gas Gen.	200.00
	$4,175.00

**ATTACHMENT B

The following equipment will be leased from outside University vendors for 4½ years of this Grant:

1 Org. Carbon Analyzer

1 Spectrophotometer

APPENDIX A - BLACK CREEK STUDY

Maumee River Basin

Estimated Technical Assistance Costs - USDA Soil Conservation Service

From To	Oct.1972 May 1973	May 1973 Oct.1973	Oct. 1973 Oct. 1974	Oct. 1974 Oct. 1975	Oct. 1975 Oct. 1976	Oct. 1976 Oct. 1977
Soil Conservationist GS-9 or Above Man-Years (Professional)	1.0	0.8	1.3	1.8	0.7	0.5
Cost	$20,000 1/	$17,000 2/	$29,075	$36,650	$16,500	$13,025
Soil Conservation Technician GS-6 or Above Man-Years (Sub-Professional)	0.0	0.6	1.0	1.1	1.2	-
Cost	0	$ 9,500	$ 15,536	$18,641	$ 21,437	-
Total	$20,000	$ 26,500	$ 44,611	$55,291	$ 37,937	$13,025

1/ Includes $ cartographic costs for plan of work preparation.

2/ Includes $2300 Soil Mechanics Testing Cost

April 1973

Approved by: Carl Wilson 6/28/73

APPENDIX B - BLACK CREEK STUDY
Maumee River Basin

The following biographical sketches are included to acquaint those interested in the study with those people who will have direct responsibilities for the implementation of the proposed program.

Joseph C. Branco

Joseph C. Branco is Area Conservationist with the USDA Soil Conservation Service, assigned to northeastern Indiana. He holds a B.S. Degree in Agriculture, majoring in Agricultural Engineering, from Ohio State University.

He began his career with the Soil Conservation Service in 1956, and has served in various positions and locations, more recently as RC&D Project Coordinator and District Conservationist. He is a member of the Soil Conservation Society of America.

Mr. Branco's involvement in this study will be administrative responsibility for all SCS area and field office personnel assigned.

Ralph M. Brooks

Ralph M. Brooks is Assistant Professor in the Department of Agricultural Economics at Purdue University since 1972. He holds a B.S. in Business Management and a M.S. in Sociology from Brigham Young University. In 1971, he was awarded a Ph.D. in Sociology from Iowa State University. Dr. Brooks is in charge of the socio-economic studies to be conducted under demonstration grant.

Dr. Brook's interests include organization for multicounty development areas, effects of intangible goals on resoucre development programs, the training of local coordinators and the assessment and evaluation of social indicators for community planning and development.

Dr. Brooks is a member of the American Sociological Society, Rural Sociological Society, the Pacific Sociological Society and the American Academy of Political and Social Scientists.

Harry M. Galloway

Harry M. Galloway is Associate Professor and Extension Agronomist at Purdue University. He holds a B.S. Degree in Forestry from Pennsylvania State University and an M.S. in Soils awarded by the University of Wisconsin. He completed additional graduate studies at Michigan State University and Oklahoma State University.

As an Extension Agronomist at Purdue, Mr. Galloway developed a new program in soil survey uses in soils management and land use planning. He served on a task force studying reorganization of the Indiana Cooperative Extension Service.

From May, 1968 through May, 1970 he was visiting professor in soils at Federal University of Vicosa in Minas Gorais, Brasil where he helped inspire development of a rainfall simulator to use in soil management studies.

He is a member of the American Society of Agronomy, Soil Science Society of America, the Soil Conservation Society of America, the Indiana Academy of Science, the Resources Chapter of the Isaak Walton League and the Purdue University Cooperative Extension Specialists Association.

His principal areas of research have been in soil drainage and tillage management systems in cooperation with agricultural engineers, weed scientists and others.

Cletus J. Gillman

Cletus J. Gillman, State Conservationist for Indiana with the USDA Soil Conservation Service, is a native of Brookville, Indiana. He received his bachelors degree in Agricultural Engineering from Purdue in 1949 and a masters degree in Public Administration from Harvard in 1968.

Mr. Gillman began his Soil Conservation Service career as an Agricultural Engineer and Soil Conservationist at Jeffersonville. He also served as the District Conservationist at Angola, Decatur and Rensselaer. Later he became the Area Conservationist at Muncie. After attending Harvard University, he became assistant state conservationist in Pennsylvania and deputy state conservationist in Ohio. He accepted the State Conservationist's position here in Indiana in October of 1972.

Mr. Gillman's involvement in this study will be administrative responsibility for all Soil Conservation Service operations in Indiana, and specifically the SCS contribution to planning and application of conservation practices in the study area.

Jerry L. Hamelink

Jerry L. Hamelink is Assistant Professor in charge of fisheries biology at Purdue University since 1969. He holds a B.S. and Ph.D. Degrees from Michigan State University majoring in fisheries, wildlife and limnology.

Dr. Hamelink is a member of the American Fisheries Society, Sigma Xi, and the Institute of Advanced Sanitation Research. He was certified as a fisheries scientist in 1972.

Dr. Hamelink developed the aquatic ecology program in teaching and research at Purdue University, none of which existed before his arrival in 1969. His research interests include the uptake and degradation of DDT in farm ponds, exchange equilibria for controlling biological magnification of chlorinated hydrocarbons in lentic environments, trace contaminants in Indiana fish, the dynamics of mercury in model lakes, and the utilization of heated waste water from power plants.

Leon W. Kimberlin

Leon W. Kimberlin is State Resource Conservationist for the Soil Conservation Service in Indiana. He holds a B.S. in Agriculture from Purdue University and an M.S. in Public Administration for Harvard University awarded in 1971.

Prior to being named Indiana Resource Conservationist in 1971, Mr. Kimberlin was State Agronomist with the Soil Conservation Service at Phoenix, Arizona. He began his career with the SCS in 1948 as Conservation Technician.

In 1966, Mr. Kimberlin was detailed to USAID as Soil Conservation Advisor to the Government of Paraguay. In 1969 he served as a civilian detailed to the U.S. Navy Research and Development Unit in South Vietnam, working on Soil Stabilization and Erosion Control.

He is a member of the Soil Conservation Society of America, the American Society of Agronomy, and the Society for Range Management.

James E. Lake

James E. Lake will assume the duties of project director for the proposed study. He will assume direct responsibility for the conduct of the proposed study. He will be responsible for the direct communication between the grantor (U.S. Environmental Protection Agency) and the grantee (Allen County Soil & Water Conservation District.) He is an employee of the Allen County Soil and Water Conservation District.

He holds a B.S. Degree from Purdue University, awarded in 1970.

While at Purdue, he was a member of the Purdue University soil judging team which won the National Contest in 1968. He was employed in the Soil Conservation Service office in Adams County, Indiana before being appointed County Conservationist by the Allen County District.

He is a member of the Soil Conservation Society of America, the American Vocational Association, Purdue Agricultural Alumi Assoication and the Agricultural Education Association.

Richard E. Land

Richard E. Land is Project Coordinator located in the Fort Wayne vicinity. In this capacity he will have primary responsibility for routine monitoring activities including the design and installation of special sites for measuring stream discharge and precipitation and for sampling stream and tile line waters. He will also act to coordinate the application, monitoring and research phases of the project on Black Creek Watershed.

Prior to his present position as Project Coordinator, Mr. Land was employed by the Soil Conservation Service as an agricultural engineer from 1955 to 1958, and from 1958 to 1973, he worked with several pipe manufacturing companies.

Mr. Land received a B.S. in Agricultural Engineering from Purdue University in 1955. During his undergraduate training, he worked part-time for the Soil Conservation Service.

Mr. Land is a member of the Indiana Society of Professional Engineers, American Society of Agricultural Engineers, American Waterworks Association, and the American Concrete Pipe Association.

Jerry Mannering

Jerry Mannering is Professor of Agronomy at Purdue University. He holds a B.S. from Oklahoma State University, and an M.S. and Ph.D. from Purdue University. He served as a research soil scientist with the Agricultural Research Service and as a researcher at the Agricultural Experiment Station at Purdue.

He is a member of the Agronomy Society of America, Soil Science Society of America, Soil Conservation Society of America, and the Indiana Academy of Sciences.

At the Purdue Agricultural Experiement Station, Dr. Mannering has been involved in research in the area of soil management, tillage practices, soil and water conservation, and land management. He has primary responsibility for runoff and erosion studies plus those which relate to water use and conservation.

Previously, he was involved in research with a principal goal of refining factors presently used in universal soil loss prediction equation including study of the physical properties of soils as they relate to runoff and erosion.

Thomas Daniel McCain

Dan McCain is District Conservationist for the Fort Wayne Field Office assigned by the U.S.Soil Conservation Service. He holds a B.S. Degree in Agronomy from Purdue University awarded in June of 1962. He is a Council Member for the Hoosier Chapter Soil Conservation Society of America.

McCain has been employed by the Soil Conservation Service since 1961 and has served in five separate Indiana counties---White, Jay, Tippecanoe, Warren, and Allen. From 1963 to 1964 he was assigned as a production PL-566 Watershed Conservation Planner in Little Wea Creek Watershed. As District Conservationist in Warren County, he was responsible for the operation of Kickapoo Creek Watershed. Since 1969, he has been responsible for Soil Conservation Service operations in Allen County.

Field Office operations will be supervised by McCain including the SCS staff assigned to the Black Creek Study area. As District Conservationist he meets regularly with the Allen County Soil & Water Conservation District and assists with planning and implementing conservation programs under the guidance of the Board of Supervisors.

Ellis McFadden

Ellis McFadden is chairman of the Allen County Soil and Water Conservation District and as such will be responsible for administration of the proposed federal grant. He has been a member of the District Board of Supervisors since 1969.

Mr. McFadden operates more than one thousand acres of agriculture land in south-central Allen County. In his second year as chairman of the Allen County District, he has pioneered local efforts in land use planning, up-dating of District long-range goals, and the establishment of positive objectives in environmental control through cooperation with the Allen County Council of Governments (Three Rivers Coordinating Council).

Edwin J. Monke

Edwin J. Monke is Professor of Agriculture Engineering at Purdue University in charge of research and teaching the soil and water resources area of the department. He holds a B.S. in Agricultural Engineering from the University of Illinois, was awarded an M.S. in that discipline by the University of Illinois in 1953 and a Ph.D. in Civil Engineering in 1959. He was appointed Professor of Agricultural Engineering at Purdue in 1967.

Dr. Monke's research has concerned the mechanics of erosion, the hydraulics of sediment-laden flow on circular drains, the treatment of water from small reservoirs, the movement of water and chemicals in soils.

Findings to date have lead to formulas which better describe the erosion process and sediment-carrying ability of circular drains, to recommendations of improved practices for treating water from small reservoirs, to a better understanding of water movement in soils and needed drainage requirements, to a discovery that electrical properties of bacteria may play an important role in turbidity removal from raw water supplies, and to an assessment of the degree of contamination of small reservoirs by runoff from watersheds treated with organo-toxicants.

Dr. Monke is a member of the Indiana Society of Professional Engineers, American Society of Agricultural Engineers, Soil Conservation Society of America, American Geophysical Union, Sigma Xi, and Tau Beta Pi.

Darrell W. Nelson

Darrell W. Nelson is Associate Professor of Agronomy at Purdue University since 1973. He received a B.S. from the University of Illinois in 1961 and a Ph.D. from Iowa State University in 1967.

Dr. Nelson's training has been in the areas of soil chemistry, biochemistry, and microbiology. His special interests have focused on chemical and biological transformations of nitrogen in soils with particular reference to processes which lead to gaseous loss of nitrogen.

Dr. Nelson has extensive experience in the use of N^{15} - labelled compounds in research on the nitrogen cycle in soils and is proficient in the use of mass spectrometer techniques for the estimation of N^{15} - isotope abundance in biological materials. He has developed methods for estimating hydroxylamine in soil extracts and nitric oxide and nitrogen dioxide in atmospheric samples which are rapid, precise, and accurate and permit N^{15} - isotope abundance determinations on the ammonium formed during the reduction of these compounds in the analysis procedures.

Dr. Nelson is currently working on the transport of phosphorus by surface runoff from fertilized and unfertilized soil, accumulation and movement of nitrate in soils under very high nitrogen fertilization rates, chemistry of soil organic nitrogen, and denitrification as a pathway for nitrate removal in rivers and ponds.

Claudius F. Poland

Claudius F. Poland is Area Engineer with the USDA Soil Conservation Service, assigned to northeastern Indiana. He holds a B.S. Degree in Agricultural Engineering from Virginia Polytechnic Institute. He previously served as agricultural engineer with SCS in Kentucky, coming to Indiana in 1965.

He is a Registered Professional Engineer in Kentucky, and member of the Soil Conservation Society of America and National Association of Conservation Districts.

As Area Engineer, Mr. Poland will have responsibility for design and installation of all engineering practices in the Black Creek Study area. He will also be involved with establishing and maintaining good working relationships with landowners involved.

Eugene J. Pope

Eugene J. Pope is the Soil Conservation Service State Conservation Engineer for Indiana. He is a registered professional engineer and land surveyor. Immediately prior to his assignment in Indiana, Mr. Pope spent four years as a Soil Conservation Service irrigation and drainage engineer in India on loan to the Agency for International Development. He holds a B.S. Degree in Civil Engineering from the University of North Dakota.

With the Soil Conservation Service, Mr. Pope has served as an Area Engineer in Minot, North Dakota, a District Conservationist in Fariview, Montana, a Watershed Engineer in Cavalier, North Dakota and a Design Engineer in Bismark, North Dakota.

Mr. Pope is a member of the Soil Conservation Society of America and the American Society of Civil Engineers.

Lee E. Sommers

Lee E. Sommers is Assistant Professor of Agronomy at Purdue University since 1970. He holds a B.S. and Ph.D. Degrees, the latter awarded by the University of Wisconsin in 1970.

Dr. Sommers' training has been in the areas of soil microbiology and biochemistry and water chemistry. His special interests include the effect of substrate water potential on the growth of microorganisms and the forms, amounts, and transformations of organic phosphorus in lake sediment with special emphasis on the role of organic phosphorus in eutrophication.

A program has been initiated recently to study the fate of mercury added to aquatic environments.

Research interests include: development of rapid and simple procedures for determining total P, N, and C in soil, sediment and sewage sludge samples; eludication of the factors controlling Hg concentrations in soils and sediments and affecting methylation of Hg in soils and sediments; evaluation of N and P transformations occuring during erosion and deposition of soil materials in reservoirs.

Rolland Z. Wheaton

Rolland Z. Wheaton is Associate Professor of Agricultural Engineering at Purdue University. He holds B.S. and M.S. Degrees from Michigan State University and a Doctor of Engineering Degree, awarded in 1967 by the University of California.

Dr. Wheaton has been an Associate Professor at Purdue since 1969. Prior to that he was an Associate Professor of Agricultural Engineering at Texas Tech University from 1966 through 1969, an Instructor, Research and Extension Teaching at Michigan State University and a Research Fellow of the University of California from September 1959 through August, 1963.

He is a member of the American Society of Agrigultural Engineers, a technical member of the Sprinkler Irrigation Association and a member of the Indiana Planning Association.

His principal areas for research have been in waste water management, development of systems for ground water recharge into the Ogallala formation (Texas), hydrology and waste management of feedlots and the durability and stability of underdrains in organic soils.

William P. McCafferty

William P. McCafferty is Assistant Professor in charge of aquatic entomology and director of the Purdue Laboratory of Insect Diversity since 1971. He holds B.S. and M.A. degrees from the University of Utah in environmental biology, and a Ph.D. in entomolgy from the University of Georgia awarded in 1971.

Dr. McCafferty is a member of the Entomological Society of America, the Society of Systematic Zoology, Indiana Academy of Science, Sigma XI and several other professional and honorary societies.

Dr. McCafferty is primarily involved with teaching and research of aquatic entomology. He has been especially interested in mayflies (Ephemeroptera) and systematics of aquatic insects. As director of the Insect Diversity Laboratory he has greatly expanded the facility and begun an ecological classification scheme while improving the traditional systematics information retreival systems. He is presently involved in a number of research projects dealing with the ecology and distribution of aquatic insects in Indiana streams.

Eldon L. Hood

Eldon L. Hood is an Assistant Professor of Agronomy. He holds a B.S. and M.S. degree from Oklahoma State University, and a Ph.D. from Purdue University.

Dr. Hood has been on the Purdue staff since 1957. Prior to that, he was employed by Panhandle A&M College, Boodwell, Oklahoma. He is a member of the American Society of Agronomy, the Soil Science Society of America, Sigma Xi, and Alpha Zeta.

His principle area of responsibility is the Purdue Soil Testing Laboratory, which receives, processes, and interprets some 3,000 soil samples a year. He also provides plant tissue and other related tests and interpretations on request.

Darrell E. Brown

Darrell E. Brown is soil conservationist with the Soil Conservation Service. He is a 1970 graduate of Purdue University with a B.S. degree in Agriculture.

Mr. Brown has worked in the south, east central and north east areas of Indiana. He was District Conservationist in Adams County, Indiana before coming to the Black Creek Project.

Mr. Brown's responsibilities will include working with individuals and groups in the study area and assist them in developing conservation plans for their land.