REPORT FOR CONSULTATION ON THE METROPOLITAN CINCINNATI INTERSTATE AIR QUALITY CONTROL REGION

U.S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
Public Health Service
Consumer Protection and Environmental Health Service
National Air Pollution Control Administration

January 1969

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PREFACE

The Secretary, Department of Health, Education, and Welfare, is directed by the Air Quality Act of 1967 to designate "air quality control regions" to provide a basis for the establishment of air quality standards and the implementation of air quality control programs. In addition to listing the major factors to be considered in the development of region boundaries, the Act stipulates that the designation of a region shall be preceded by consultation with appropriate State and local authorities.

The National Air Pollution Control Administration, DHEW, has conducted a study of the Metropolitan Cincinnati Area, the results of which are presented in this report. The Region* boundaries proposed in this report reflect consideration of all available and pertinent data; however, the boundaries remain subject to revisions suggested during consultation with State and local authorities. Formal designation of a Region will follow the consultation meeting. This report is intended to serve as background material for the consultation.

The Administration appreciates assistance received either directly during the course of this study or indirectly during previous activities in the Cincinnati Metropolitan Area from official air pollution agencies at the State and local level, and the OKI Regional Planning Authority.

*For the purposes of this report, the word region, when capitalized, will refer to the Metropolitan Cincinnati Interstate Air Quality Control Region. When not capitalized, unless otherwise noted, it will refer to air quality control regions in general.

INTRODUCTION

> "For the purpose of establishing ambient air quality standards pursuant to section 108, and for administrative and other purposes, the Secretary, after consultation with appropriate State and local authorities shall, to the extent feasible, within 18 months after the date of enactment of the Air Quality Act of 1967 designate air quality control regions based on jurisdictional boundaries, urban-industrial concentrations, and other factors including atmospheric areas necessary to provide adequate implementation of air quality standards. The Secretary may from time to time thereafter, as he determines necessary to protect the public health and welfare and after consultation with appropriate State and local authorities, revise the designation of such regions and designate additional air quality control regions. The Secretary shall immediately notify the Governor or Governors of the affected State or States of such designation."
>
> Section 107(a)(2), Air Quality Act of 1967

THE AIR QUALITY ACT

Air Pollution in most of the Nation's urban areas is a regional problem. This regional problem demands a regional solution, consisting of coordinated planning, data gathering, standard setting, and enforcement. Yet, with few exceptions, such coordinated efforts are notably absent among the Nation's urban complexes.

Beginning with the Section quoted above, in which the Secretary is required to designate air quality control regions, the Air Quality Act presents an approach to air pollution control involving coordinated efforts by Federal, State, and local governments, as shown in Figure 1. After the Secretary has (1) designated regions, (2) published air quality criteria, and (3) published corresponding documents on control technology and associated costs, the Governor(s) of the State(s) must file with the Secretary within 90 days a letter of intent, indicating that the State(s) will adopt within 180 days ambient air quality standards for the pollutants

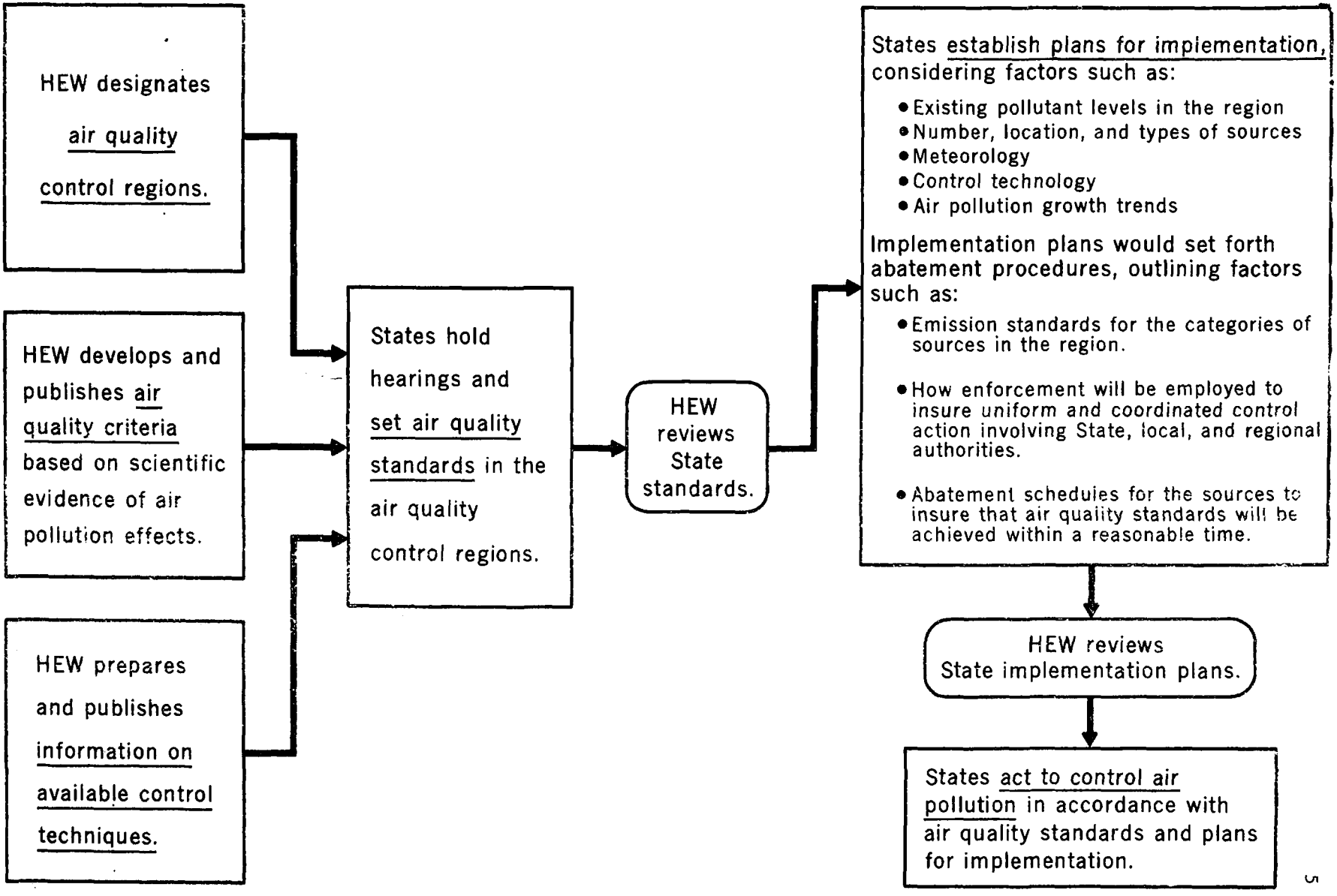


Figure 1 Flow diagram for State action to control air pollution on a regional basis.

covered by the published criteria and control technology documents and adopt within an additional 180 days plans for the implementation, maintenance, and enforcement of those standards in the designated air quality control regions.

The new Federal legislation provides for a regional attack on air pollution and, at the same time, allows latitude in the form which regional efforts may take. While the Secretary retains approval authority, the State(s) involved in a designated region assumes the responsibility for developing standards and an implementation plan which includes administrative procedures for abatement and control. Informal cooperative arrangements with proper safeguards may be adequate in some regions, whereas in others, more formal arrangements, such as interstate compacts, may be selected. The objective in each instance will be to provide effective mechanisms for control on a regional basis.

THE SIZE OF A REGION

Several objectives are important in determining how large an air quality control region should be. Basically, these objectives can be divided into three separate categories. First a region should be self-contained with respect to air pollution sources and receptors. In other words, a region should include most of the important sources in the area as well as most of the people and property affected by those sources. In this way, all the major elements of the regional problem will lie within one unified administrative jurisdiction. Unfortunately, since air pollutants can travel long distances, it is impractical if not impossible to delineate regions which are completely self-contained. The air over a region will

usually have at least trace amounts of pollutants from external sources. During episodic conditions, such contributions from external sources may even reach significant levels. Conversely, air pollution generated within a region and transported out of it can affect external receptors to some degree. It would be impractical and inefficient to make all air quality control regions large enough to encompass these low-level trace effects. The geographic extent of trace effects overestimates the true problem area which should be the focus of air pollution control efforts. Thus, the first objective, that a region be self-contained, becomes a question of relative magnitude and frequency. The dividing line between "important influence" and "trace effect" will be a matter of judgment. The judgment should be based on estimates of the impact a source has upon a region, and the level of pollution to which receptors are subjected. In this respect, annual and seasonal data on pollutant emissions and ambient air concentrations are a better measure of relative influence than short term data on episodic conditions.

The second general objective requires that region boundaries be designed to meet not only present conditions but also future conditions. In other words, the region should include areas where industrial and residential expansion are likely to create air pollution problems in the foreseeable future. This objective requires careful consideration of existing metropolitan development plans, expected population growth, and projected industrial expansion. Such considerations should result in the designation of regions which will contain the sources and receptors of regional air pollution for a number of years to come. Of course, region boundaries need not be permanently fixed, once designated. Boundaries

should be reviewed periodically and altered when changing conditions warrent readjustment.

The third objective is that region boundaries should be compatible with and even foster unified and cooperative governmental administration of the air resource throughout the region. Air pollution is a regional problem which often extends across several municipal, county, and even state boundaries. Clearly, the collaboration of several governmental jurisdictions is prerequisite to the solution of the problem. Therefore, the region should be delineated in a way which encourages regional cooperation among the various governmental bodies involved in air pollution control. In this regard, the existing pattern of governmental cooperation on the whole range of urban problems may become an important consideration. Certainly the pattern of cooperation among existing air pollution control programs is a relevant factor. In general, administrative considerations dictate that governmental jurisdictions should not be divided. Although it would be impractical to preserve State jurisdictions undivided, usually it is possible to preserve the unity of county governments by including or excluding them in their entirety. Occasionally, even this would be impractical due to a county's large size, wide variation in level of development, or striking topographical features.

To the extent that any two of the above three objectives lead to incompatible conclusions concerning region boundaries, the region must represent a reasonable compromise. A region should represent the best way of satisfying the three objectives simultaneously.

PROCEDURE FOR DESIGNATION OF REGIONS

Figure 2 illustrates the procedures used by the National Air Pollution Control Administration for designating air quality control regions.

A preliminary delineation of the region is developed by bringing together two essentially separate studies--the "Evaluation of Engineering Factors," and the "Evaluation of Urban Factors."

The study of "Engineering Factors" indicates the location of pollution sources and the geographic extent of serious pollutant concentrations in the ambient air. Pollution sources are located by taking an inventory of emissions from automobiles, industrial activities, space heating, waste disposal, and other pollution generators. Pollution concentrations in the ambient air are estimated from both air quality sampling data and a theoretical diffusion model. When it exists, air quality sampling data is more reliable than the theoretical diffusion model results since the data is directly recorded by pollution measuring instruments. Unfortunately, in many cases air quality sampling data is available for only one or two pollutants measured at an insufficient number of locations. The theoretical model is used to supplement inadequate air quality sampling data. As a whole, the engineering study indicates how large the air quality control region must be in order to encompass most pollution sources and most people and property affected by those sources.

The study of "Urban Factors" encompasses non-engineering considerations. It reviews existing governmental jurisdictions, current air pollution control programs, present concentrations of population and industry,

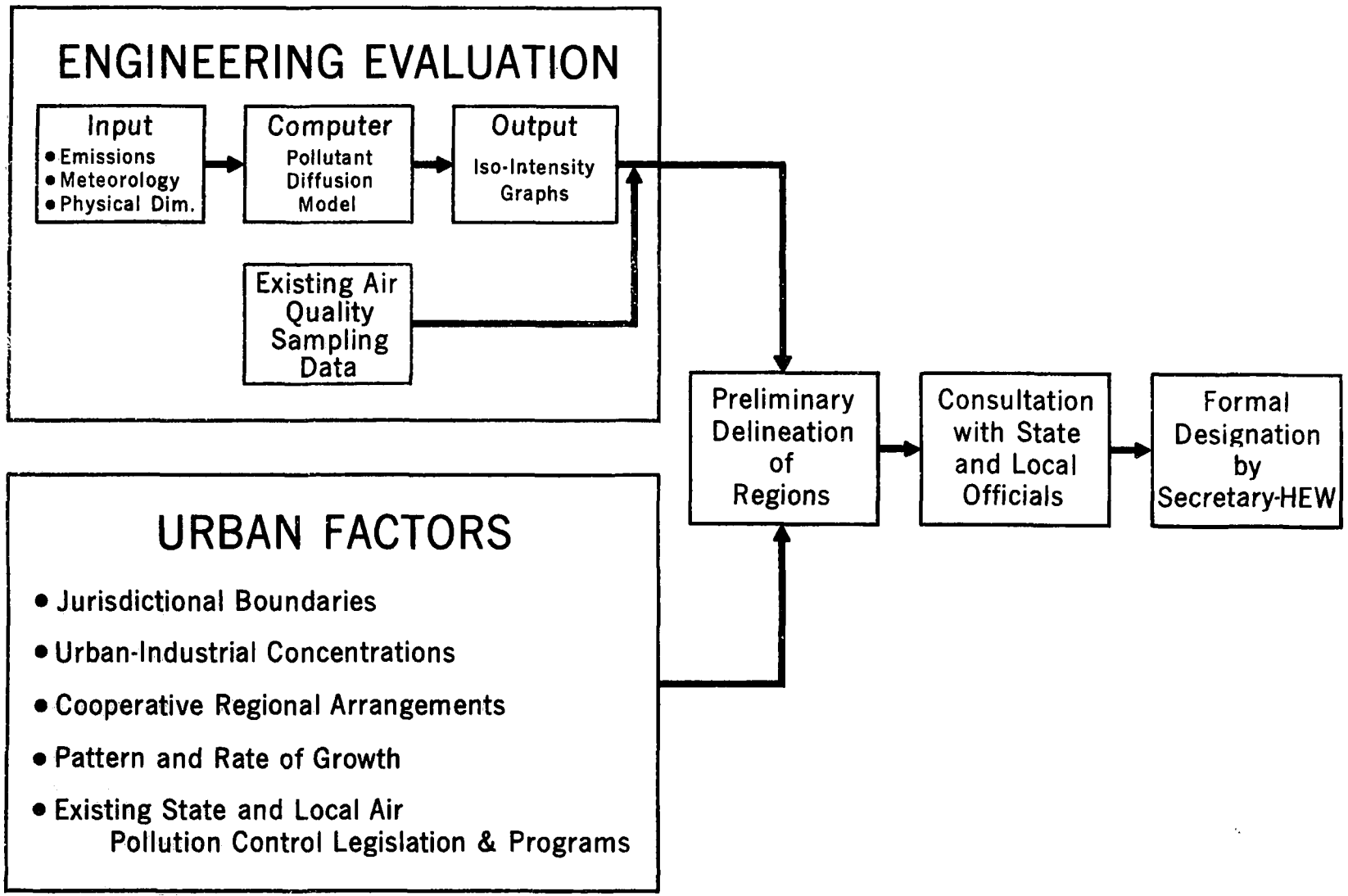


Figure 2. Flow diagram for the designation of air quality control regions.

and expected patterns of urban growth. Other non-engineering factors are discussed when they are relevant. As a whole, the study of urban factors indicates how large an air quality control region must be in order to encompass expected growth of the pollution problem in the future. It also considers which group of governmental jurisdictions will most effectively administer a strong regional air quality control program.

The conclusions of the engineering study are combined with the results of the urban factors study to form the basis of an initial proposal for an air quality control region. As shown in figure 2, the proposal is then submitted for consultation with State and local officials. After reviewing the suggestions raised during the consultation, the Secretary formally designates the region with a notice in the Federal Register and notifies the governors of the States affected by the designation.

The body of this report contains a proposal for the boundaries of the Metropolitan Cincinnati Air Quality Control Region and supporting studies on engineering and urban factors. The report itself is intended to serve as the background document for the formal consultation with appropriate State and local authorities.

EVALUATION OF URBAN FACTORS

INTRODUCTION

A number of urban factors are relevant to the problem of defining air quality control region boundaries. First, the location of population is an important consideration, since human activity is the ultimate cause of air pollution, and humans are the ultimate victims. The population growth pattern is another important consideration, since an air quality control region should be designed not only for the present but also for the future. The location of industrial activity and the industrial growth pattern are relevant considerations for similar reasons. Political and jurisdictional considerations are important also, since the 1967 Air Quality Act envisions regional air pollution programs based on cooperative efforts among many political jurisdictions. An air quality control region should take note of existing region cooperation among governmental untis and should avoid a combination of jurisdictions which would ignore local political relationships. For example, it should consider the strength of regional cooperation among existing local air pollution programs. The following discussion of urban factors will present these considerations as they apply to the Cincinnati area.

Population

Figure 3 displays present population densities in the metropolitan Cincinnati area. About 500,000 people reside within the City of Cincinnati, and represent about one third of the population in an eight county area

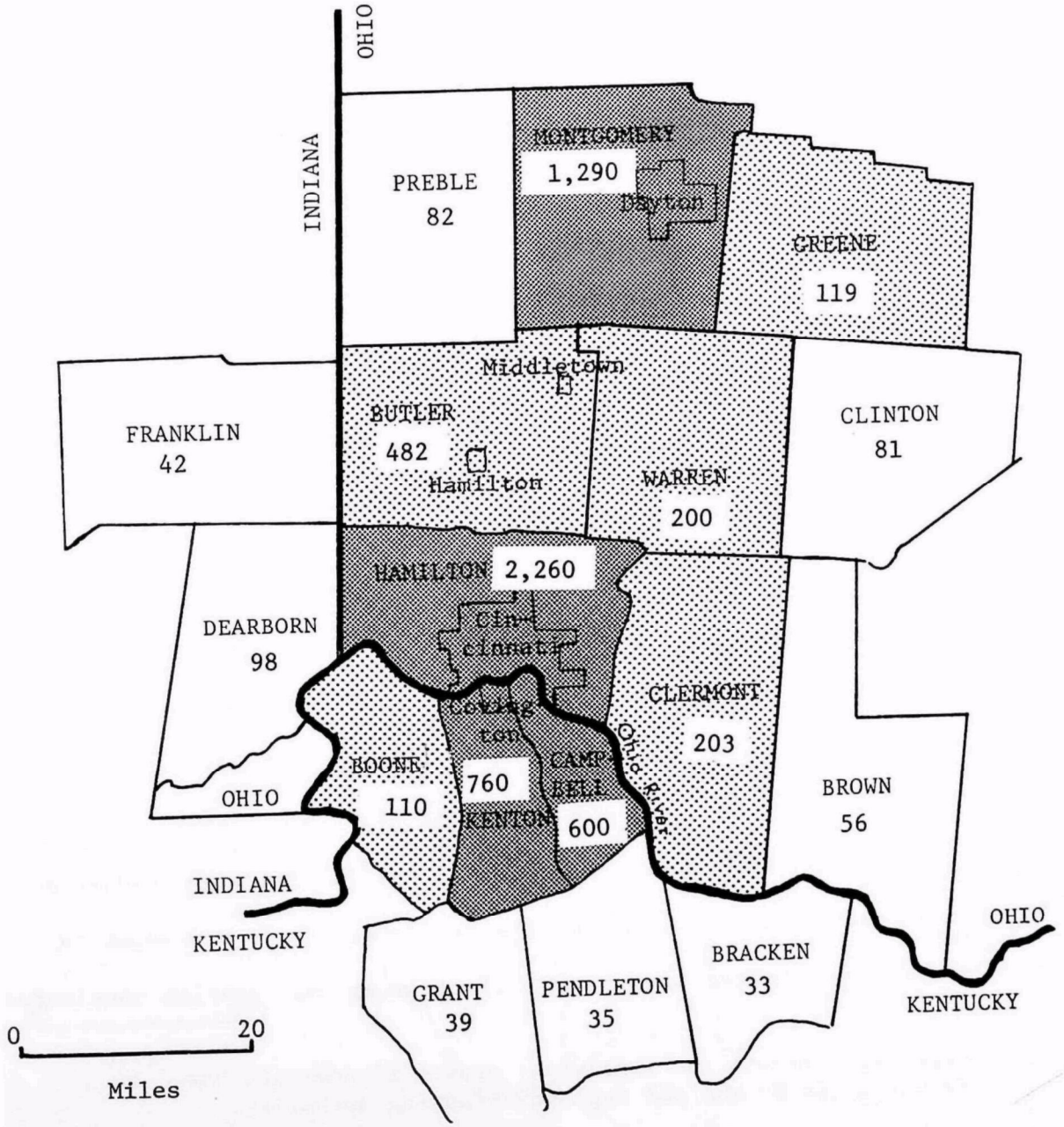
Figure 3: 1968 POPULATION DENSITY

Residents Per Square Mile

more than 500;

100 to 500;

less than 100;



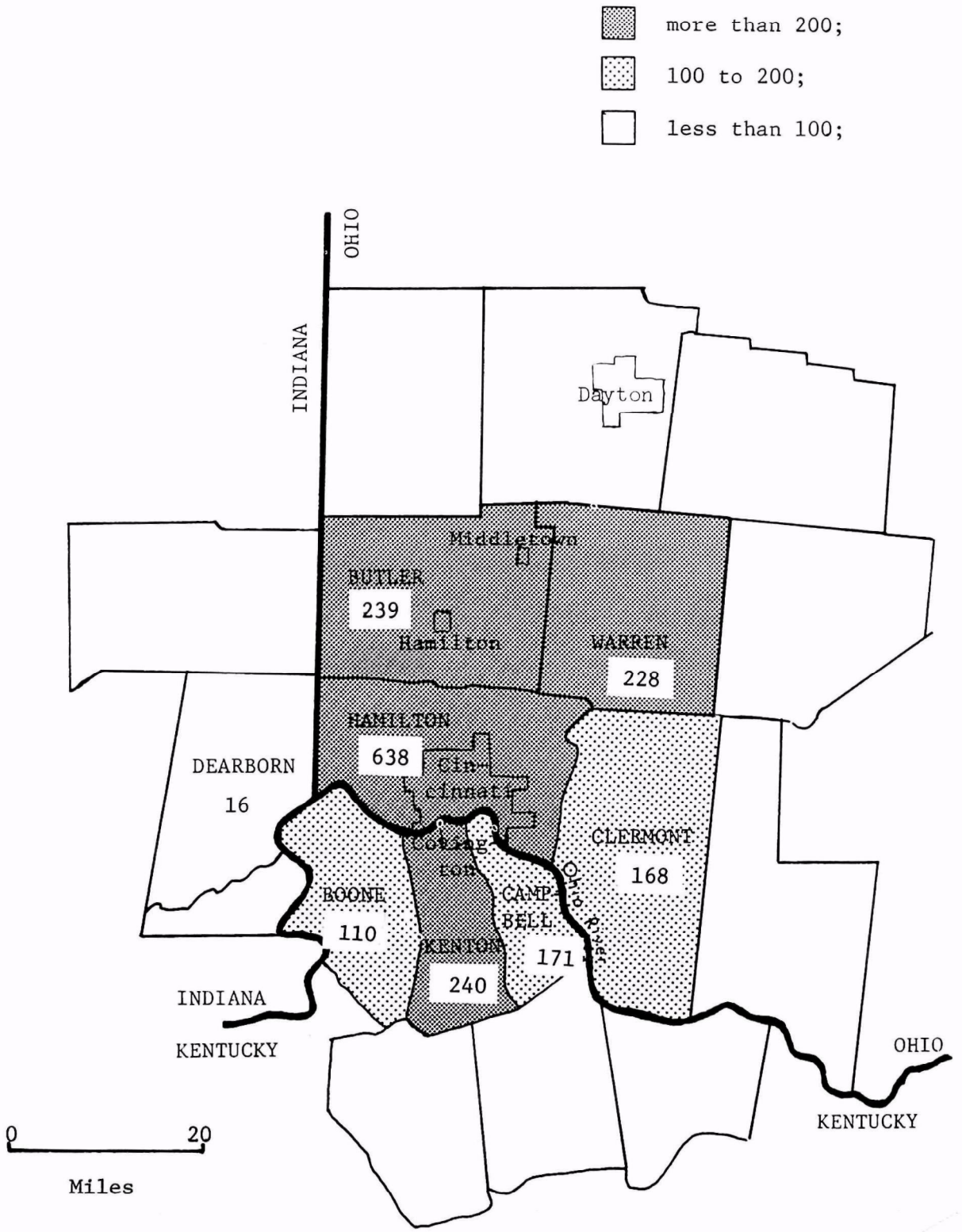
including Hamilton, Butler, Warren, Clermont, Campbell, Kenton, Boone, and Dearborn counties. Nearly an equal number of people reside in suburban areas outside of the city limits but still within Hamilton County. In other words, almost two thirds of the total eight-county population resides within the whole of Hamilton County. As a result, Hamilton County has by far the heaviest population density of any county in the area, with approximately 2,260 residents per square mile. The remaining portion of the eight-county population consists of somewhat more than 600,000 people. Of these, more than 200,000 live in Kenton and Campbell counties and account for the next highest population densities, 760 and 600 residents per square mile. Butler County, with the cities of Hamilton and Middletown, also contains somewhat more than 200,000 residents. However, since the land area of Butler is about 50 percent larger than Kenton and Campbell combined, the population density is only 480 residents per square mile. Warren and Clermont each have about 85,000 residents, with population densities of about 200 residents per square mile. Boone and Dearborn have about 30,000 residents each, with population densities of about 100 residents per square mile.

Population growth* during the next two decades is represented in Figure 4. The largest amount of absolute growth will probably take place in Hamilton County, with about 640 additional residents per square mile. Kenton, Butler and Warren are also likely to experience significant population growth, approximately 235 additional residents per square mile. It is interesting to note that when population growth is expressed in percentage terms, Warren County ranks first among the counties considered

*Population growth and employment growth figures are based on a recent study by the OKI Regional Planning Authority.

Figure 4: POPULATION GROWTH, 1968 TO 1990

Additional Residents Per Square Mile



with more than 50% increase in population expected during the next decade. Clermont, and Campbell are expected to grow only about two thirds as rapidly as Kenton, and Boone less than one half as rapidly. Thus, by 1990, Hamilton, Kenton, Campbell, and Butler are all expected to have population densities over 700 residents per square mile. Warren and Clermont will probably have around 400 residents per square mile while Boone and Dearborn remain around 200 or less.

Industry

Two methods can be used to determine the location of manufacturing activity. First, the land use map,* Figure 5, displays industrial areas. It demonstrates a concentration of industrial activity in Hamilton County. It also reveals major industrial locations in Butler County. Boone, Campbell and Kenton, in comparison, do not contain large industrialized areas, if the airport is ignored. A second method for determining the location of manufactoring activity can be based on the density of people employed in manufacturing firms. Figure 6 shows that Hamilton County has by far the highest density of manufacturing employees with 340 per square mile in 1963. Butler County ranks second, with 55 per square mile, and Kenton and Campbell follow with 24 and 22.

Expected growth of total employment is shown in Figure 7. By far the heaviest growth is expected in Hamilton County. Butler, Kenton and Campbell will experience a large amount of growth. However, Warren, Clermont, Boone and Dearborn will probably retain a non-industrialized status.

When broken down into industrial categories, the employment projections show that almost all heavy industry will be located in Hamilton and Butler

* Based on the 1965 OKI Regional Planning Authority survey.

Figure 5: INDUSTRIAL AND COMMERCIAL

LAND USE

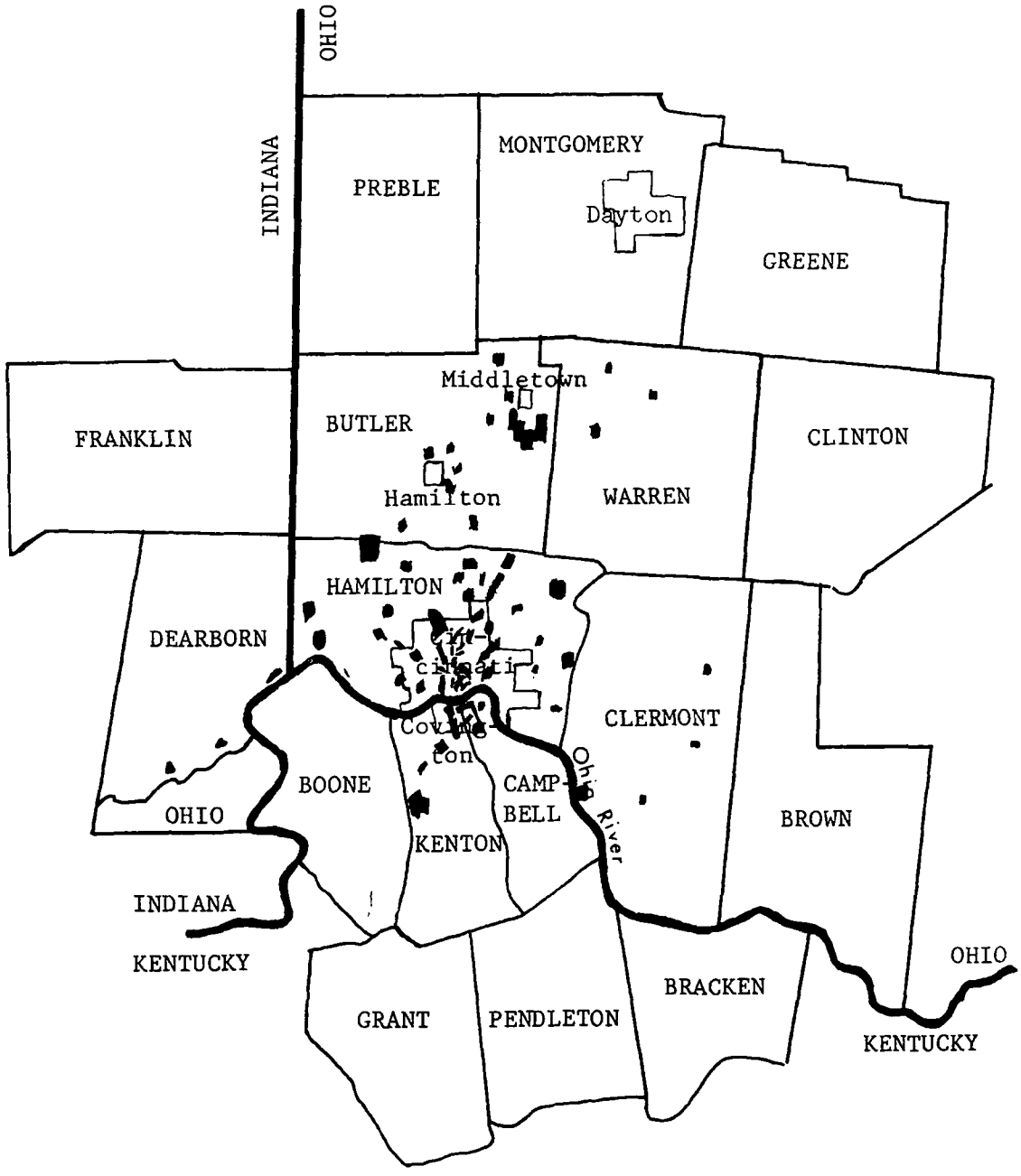


Figure 6: MANUFACTURING EMPLOYMENT DENSITY, 1963

Manufacturing Employees Per Square Mile

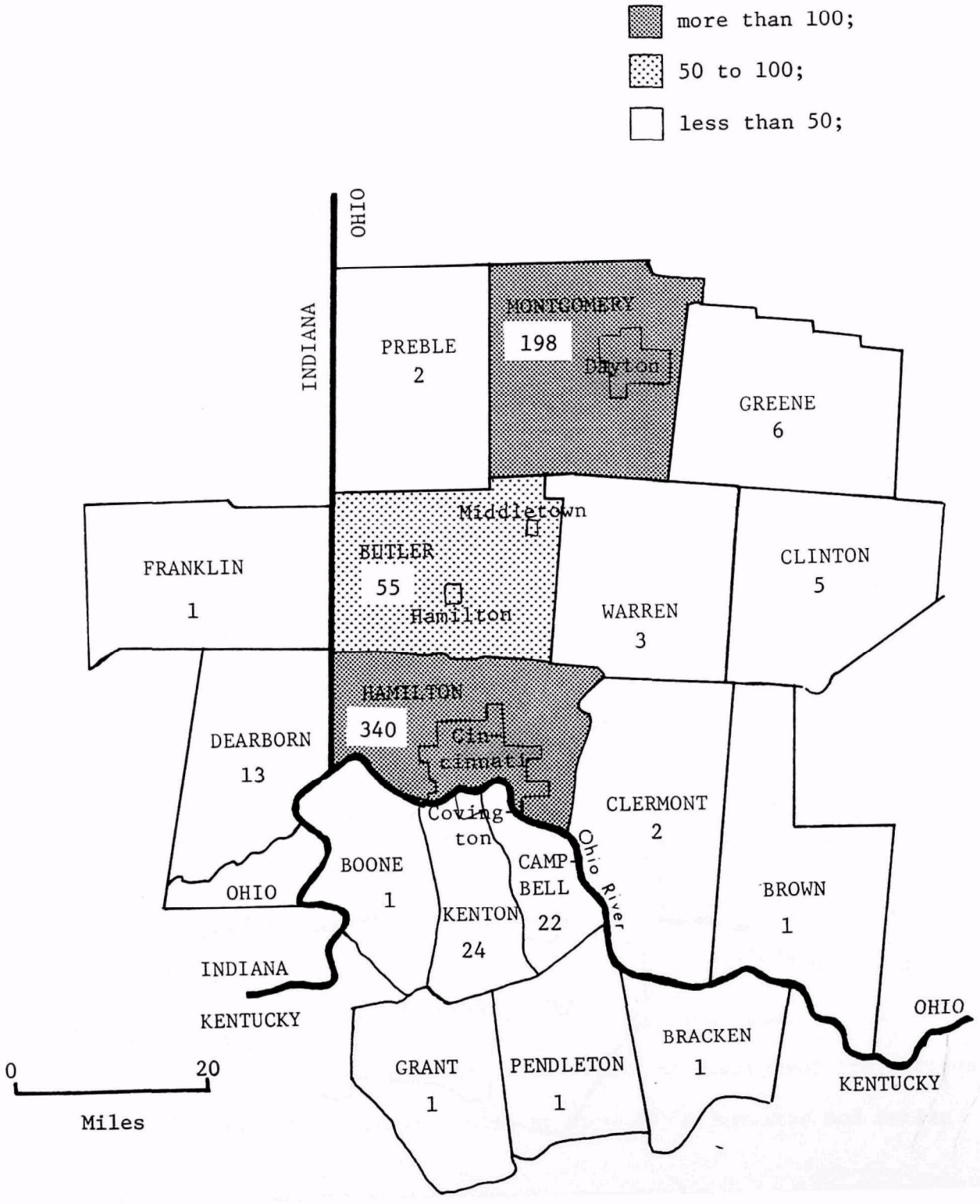
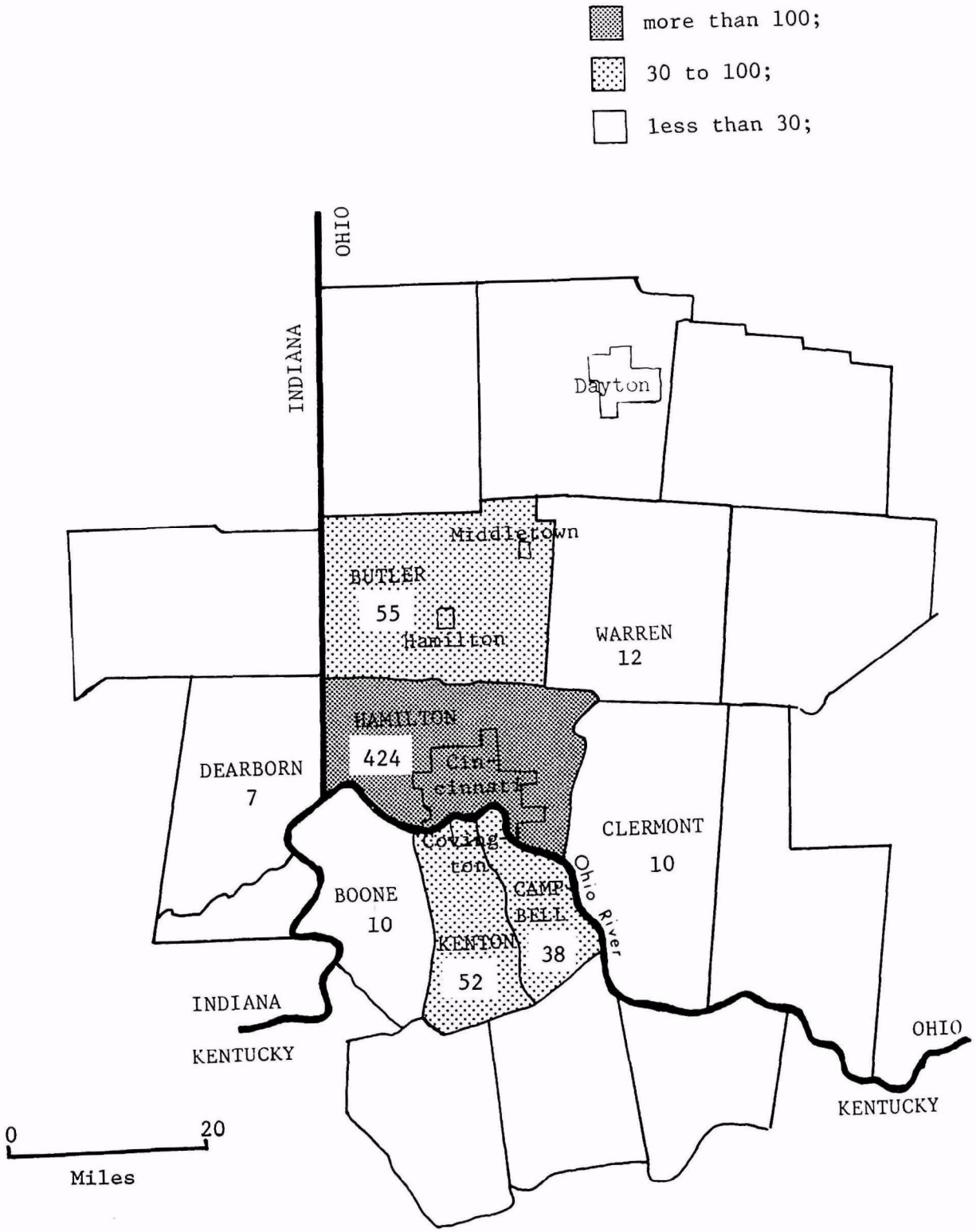


Figure 7: EXPECTED GROWTH OF EMPLOYMENT, 1965 to 1990

Additional Employees Per Square Mile



Counties, even two decades from now. The manufacture of primary metals will be centered in Butler, with smaller contributions from Hamilton and Campbell. Manufacture of fabricated metals and machinery will be centered in Hamilton, with a contribution from Butler and Kenton. The manufacture of chemicals, petroleum products, rubber and plastics will all be located principally in Hamilton, and to a lesser extent Butler.

The projected growth pattern for employment, combined with that for residential population, reflects the expectation that present suburban trends will continue to shape the regional area. People are expected to continue moving to outlying suburban areas for residence, while using transportation arteries to commute to centrally-located work sites.

In sum, residential population is presently concentrated in Hamilton, Kenton, Campbell, and Butler Counties. Manufacturing employment and industry are concentrated in the same four counties. Residential population is expected to grow most rapidly in Hamilton, Butler, and Kenton, and Warren. But growth of employment will probably be most rapid in Hamilton and Butler, and to a lesser degree in Kenton and Campbell.

Existing Air Pollution Programs:

In the State of Ohio, responsibility for air pollution control rests upon an Air Pollution Control Board located within the State Department of Health. In order to meet its responsibility, the Board is authorized to prescribe ambient air quality standards for various sections of the State, to enforce emission standards designed to meet the air quality standards in those sections, and to issue variance permits for exceptional circumstances. The State program has an annual budget of approximately $250,000.

Under existing law in Ohio, county governments can develop air pollution control programs only as part of their health program. County regulations concerning air pollution control do not apply within municipal boundaries if a city or incorporated area has its own regulations. Due to this limitation on county jurisdiction, municipal government has become the most usual unit in Ohio for administration of local air pollution control programs. For example, in the Cincinnati Metropolitan Area the City of Cincinnati conducts the largest air pollution control program, with an annual budget of about $105,000. County governments in the area have only a modest involvement in air pollution control. Hamilton County health officials are limited to operating on a complaint basis only. Clermont County health officials are even less involved in air pollution control activities. Similarly, in Butler County the cities of Hamilton and Middletown conduct more extensive air pollution control activities, limited as they are, than the county government. A few suburban communities have joined Cincinnati in an agreement for the sharing of technical services. This program is the Intercommunity Air Pollution Control Program.

In Kentucky, responsibility for air pollution control rests with the Air Pollution Control Commission. The Commission has authority to set statewide ambient air quality standards and emission standards. The Commission also has authority to prescribe local standards more stringent than the statewide standards in various areas of the state when conditions warrant such control. Kentucky statutes specifically allow the Commission to cede its jurisdiction to a county air pollution control program if, after review, the Commission finds the county program to be satisfactory. The Commission may recover its jurisdiction at any time it believes the county

program is failing to meet the State standards. At the present time, the State program has a budget of approximately $320,000. So far, none of the Kentucky counties in the Cincinnati area have established extensive air pollution control programs.

In areas of Indiana which are not covered by local air pollution control regulation, the Air Pollution Control Board of the State has responsibility to investigate complaints and to initiate abatement action against air contaminant sources. The budget of the State program was approximately $90,000 during 1968. Plans for 1969 call for a budget increase of 50 to 100 percent.

In sum, at the present time there is no regional program in the Cincinnati area for the management of the regional air resource. The only local air pollution control program of substantial strength is the one run by the city of Cincinnati. The Intercommunity Air Pollution Control Program, linking Cincinnati with several suburban communities, does not presently fill the need for regional planning of air pollution control, regional collection of air quality data, regional setting of ambient air quality standards or emission standards, and regional enforcement.

From 1965 to 1967 the United States Public Health Service cooperated with several local governmental units in the Cincinnati metropolitan area in a study of the regional air pollution control program. The resulting report, "Air Resource Management for Southwestern Ohio and Northern Kentucky", advocated a regional approach towards air pollution control and proposed a number of actions to implement that approach. So far, those action proposals have not been carried out.

Regional Planning in the Cincinnati Metropolitan Area

Although no institution presently conducts regional planning of air pollution control in the Cincinnati area, other regional planning functions are being carried out by two agencies. The first, the OKI Regional Planning Authority, contains nine counties in its planning jurisdiction (Hamilton, Butler, Warren, Clermont, Campbell, Kenton, Boone, Ohio, and Dearborn). Originally, it was established in order to satisfy the planning requirements of the Bureau of Public Roads program. Now OKI has an annual budget of approximately $500,000 and has planning activities in the areas of transportation, water supply and sewage, solid waste disposal, and review of HUD grant proposals. OKI is exploring opportunities to extend its regional planning activities into additional problem areas.

The second regional planning commission, The Northern Kentucky Area Planning Commission (NKAPC), has jurisdiction in two counties, Kenton and Campbell. The functions of NKAPC are similar to those of OKI. NKAPC is currently conducting a feasibility study for unified administration of schools, solid waste disposal and other urban services for the two-county area.

Recently a proposal was made for the establishment of the Health Planning Association of the Central Ohio River Valley. If funded, the association would perform various planning activities related to modernization of hospital and other medical facilities, identification and alleviation of medical manpower shortages, special health projects for center city poverty areas, and environmental health control. The jurisdiction of the Association would include eight counties: all of those in OKI except Ohio County in Indiana.

The increasing scope of regional planning activities in the Metropolitan Cincinnati area suggests that regional problems are more and more likely to receive regional planning attention. Nevertheless, planning attention is no substitute for regional operational authority, which is currently lacking in air pollution control efforts in the Cincinnati region.

EVALUATION OF ENGINEERING FACTOR

INTRODUCTION

The engineering evaluation for the Cincinnati area was based on a study of topography, pollutant emissions, estimated air quality levels and available ambient air quality data. The emission inventory indicated the location of point and area sources, the quantity of pollutants emitted from these sources, and the resulting emission densities. This information was combined with meteorological data and used in a diffusion model to estimate air quality levels in the Cincinnati area. The estimated air quality information was supplemented by measured air quality data whenever available.

TOPOGRAPHY

The Cincinnati area consists of an upland plain about 900 feet above sea level which is cut by the flood plain of the Ohio River, about 300 feet lower. Downtown Cincinnati is located in the basin formed by the flood plain of the Ohio River, the Mill Creek, and the Licking River. The basin area is surrounded by steep bluffs rising 200 to 400 feet to the general upland plain level. These bluffs are cut frequently by the valleys of small tributary streams which produce a setting of promontories and steep hills.

EMISSION INVENTORY

The National Air Pollution Control Administration* conducted an inventory of air pollutant emissions for the Cincinnati area. Three major pollutants--sulfur oxides, carbon monoxide, and particulates--were considered since they would provide a general measure of the extent of the air pollution problem around Cincinnati. Sulfur oxides are a reliable

measure of the impact of fossil fuel burning in power plants and space heating equipment. These sources contribute more than 90% of the sulfur oxide emissions in the area. Carbon monoxide pollutant levels provide the best indication of the impact of gasoline-powered motor vehicles, since these sources are responsible for more than 90% of the carbon monoxide emissions. Particulate emission data provide an indication of the combined effect of all source categories since emissions of this pollutant are more evenly distributed among the possible source categories (no single source category accounts for more than one third of the total). Results of the emission inventory are tabulated by source category in Table 1.

The Cincinnati emissions inventory encompasses the counties of Hamilton, Butler, Warren, Clermont, Campbell, Kenton, Boone, Dearborn, Ohio, and parts of surrounding counties. This area was divided into the grid coordinate system shown in Figure 8. The estimated emissions of each of the three pollutants by grid zone were expressed as average daily emissions for three different time periods--annual, winter, and summer.

Average annual emission densities for each of the three pollutants in tons per square mile per day were determined by relating the total quantity of pollutants emitted in each of the grid zones to the land area of each zone. Table 2 lists the resulting emission densities by grid zone, and figures 12, 13, and 14 show them graphically. Where identified point sources are responsible for more than 50% of the emissions in a grid zone, this fact is indicated in both the table and the figures. Point sources in the Cincinnati area are responsible for about 90% of sulfur oxide emissions, 65% of particulate emissions, and about 8% of carbon monoxide emissions.

Table 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN THE CINCINNATI-HAMILTON-MIDDLETOWN STUDY AREA, 1967 (Tons/Year)

Source	SO_x	Part.	CO
1. Transportation			
Auto	1,720	2,290	472,800
Trucks & Buses	1,240	3,400	1,860
Trains	440	1,220	670
Planes	Neg.	780	7,130
Total	3,400	7,690	482,460
2. Stationary Fuel Combustion			
Industry	34,500	35,300	3,500
Steam-Electric	332,000	18,500	1,500
Residential	6,950	6,780	7,710
Commercial & Institutional	19,000	21,800	23,000
Total	392,450	82,380	35,710
3. Solid Waste			
Incineration	470	1,790	240
Open Burning	Neg.	2,610	12,000
Total	470	4,400	12,240
4. Industrial Process	31,000	28,000	6,600
Total All Sources	427,520	122,470	537,000

Neg. = Negligible

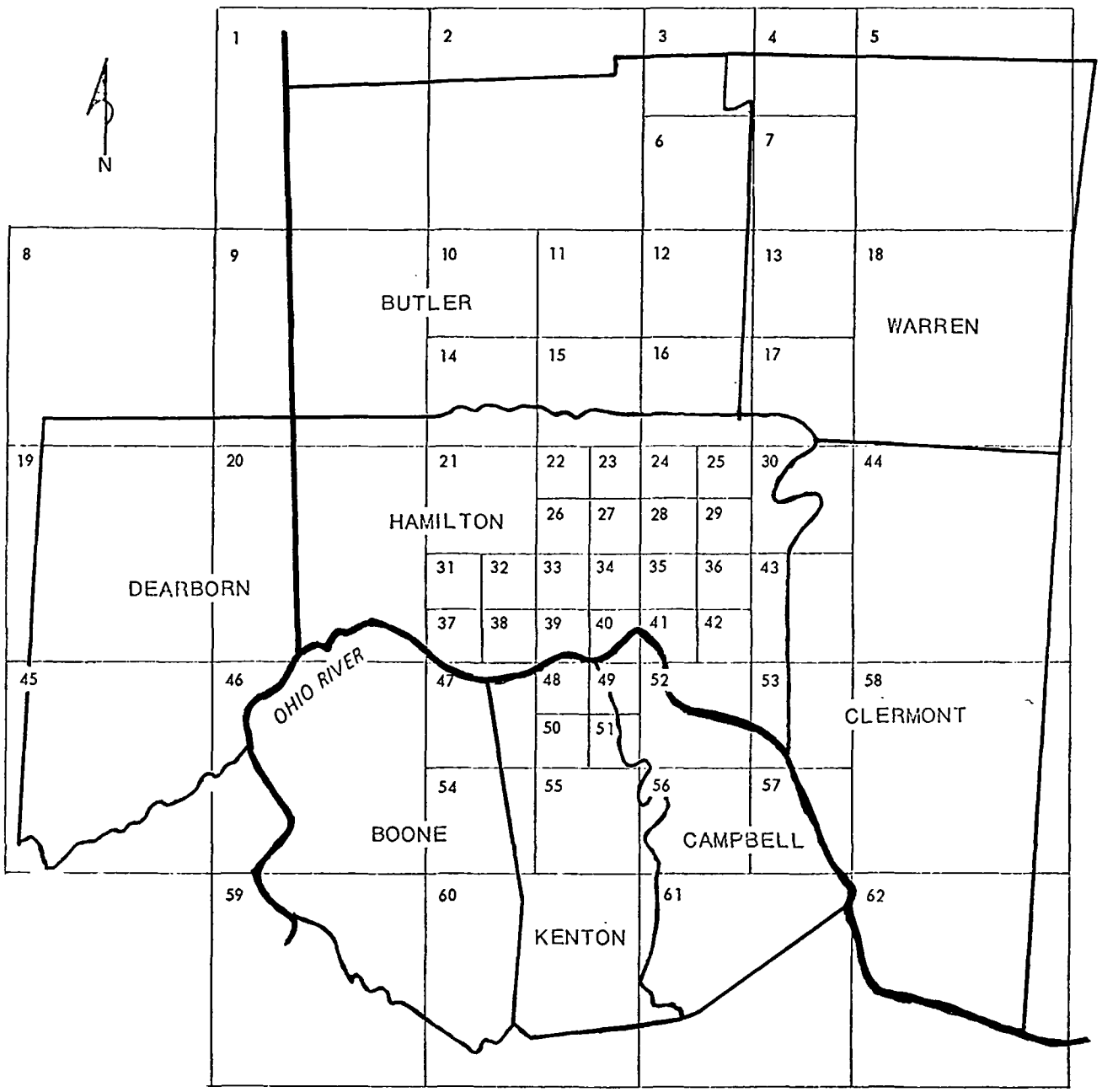
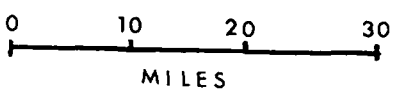


Figure 8: EMISSION INVENTORY GRID MAP



CINCINNATI AIR QUALITY CONTROL REGION REPORT

Errata Sheet

1. Table 1, Page 27, should be replaced by the attached Table (changes in figures are underlined).

2. Table 2, Page 30, Grid Number 46 should be changed from "2.85*" to "2.24*" for Density of Sulfur Oxide Emissions, and from "0.11*" to "0.44*" for Density of Particulate Emissions.

3. Page 34, Line 13, should read "a smaller influence in the case of particulates. They emit only about <u>25%</u>."

4. Page 52, Line 7, should read "for approximately <u>32%</u> of the sulfur oxide emissions in the whole."

Table 1 SUMMARY OF AIR POLLUTANT EMISSIONS IN THE CINCINNATI-HAMILTON-MIDDLETOWN STUDY AREA, 1967 (Tons/Year)

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Planes	Neg.	780	7,130
Total	3,400	7,690	482,460
2. Stationary Fuel Combustion			
Industry	34,500	35,300	3,500
Steam-Electric	298,000	36,000	1,500
Residential	6,950	6,780	7,710
Commercial & Institutional	19,000	21,800	23,000
Total	358,450	99,880	35,710
3. Solid Waste			
Incineration	470	1,790	240
Open Burning	Neg.	2,610	12,000
Total	470	4,400	12,240
4. Industrial Process	31,000	28,000	6,600
Total All Sources	393,320	139,970	537,010

Neg. = Negligible

Table 2: TOTAL EMISSION DENSITY BY GRID ZONE
(Tons Per Day Per Square Mile)

Grid Number	Density of Sulfur Oxide Emissions	Density of Particulate Emissions	Density of Carbon Monoxide Emissions
1	0.01	0.01	0.06
2	0.01	0.01	0.09
3	0.00	0.00	0.10
4	0.02	0.02	0.50
5	0.00	0.01	0.11
6	2.42*	2.38*	1.41
7	0.03	0.03	0.51
8	0.00	0.00	0.02
9	0.01	0.01	0.03
10	0.08	0.09	0.83
11	0.96*	0.46*	0.85
12	0.02	0.03	0.47
13	0.02	0.03	0.33
14	0.02	0.07*	0.33*
15	0.04	0.05	1.23
16	0.28*	0.25*	0.98
17	0.09	0.10	0.49
18	0.01	0.01	0.12
19	0.01	0.01	0.04
20	0.95*	0.14*	0.22
21	0.04	0.10	0.96
22	0.10	0.11	1.23
23	0.42*	0.46*	1.34
24	1.04*	0.76*	2.67
25	0.10	0.13	1.68
26	0.46	0.49	3.14
27	1.90*	2.24*	6.54
28	0.44*	0.29	2.34
29	0.10	0.10	1.92
30	0.40	0.05	1.49
31	0.10	0.08	1.20
32	0.12	0.23	3.30
33	0.41	0.60	6.26
34	1.77*	1.31*	6.91
35	0.89*	0.75	4.34

Grid Number	Density of Sulfur Oxide Emissions	Density of Particulate Emissions	Density of Carbon Monoxide Emissions
36	0.16	0.24	1.74
37	0.08	0.09	0.54
38	0.11	0.13	2.86
39	0.80	0.92	9.38
40	0.74	0.79	8.51
41	0.48*	0.54*	5.14
42	0.09	0.16	1.91
43	0.02	0.02	0.55
44	0.01	0.01	0.10
45	0.01	0.01	0.07
46	2.85*	0.11*	0.08
47	0.14	0.21	1.23
48	0.10	0.19	4.76
49	0.28	0.97*	3.10
50	0.06	0.08	0.58
51	0.08	0.13	0.60
52	0.09	0.10	0.56
53	0.02	0.03	0.27
54	0.04	0.05	0.38
55	0.01	0.01	0.22
56	0.03	0.04	0.14
57	8.03*	0.54*	0.16
58	0.02	0.02	0.10
59	0.00	0.00	0.01
60	0.00	0.00	0.07
61	0.00	0.00	0.03
62	0.01	0.01	0.05

* Indicates that more than 50% of the emissions are from point sources.

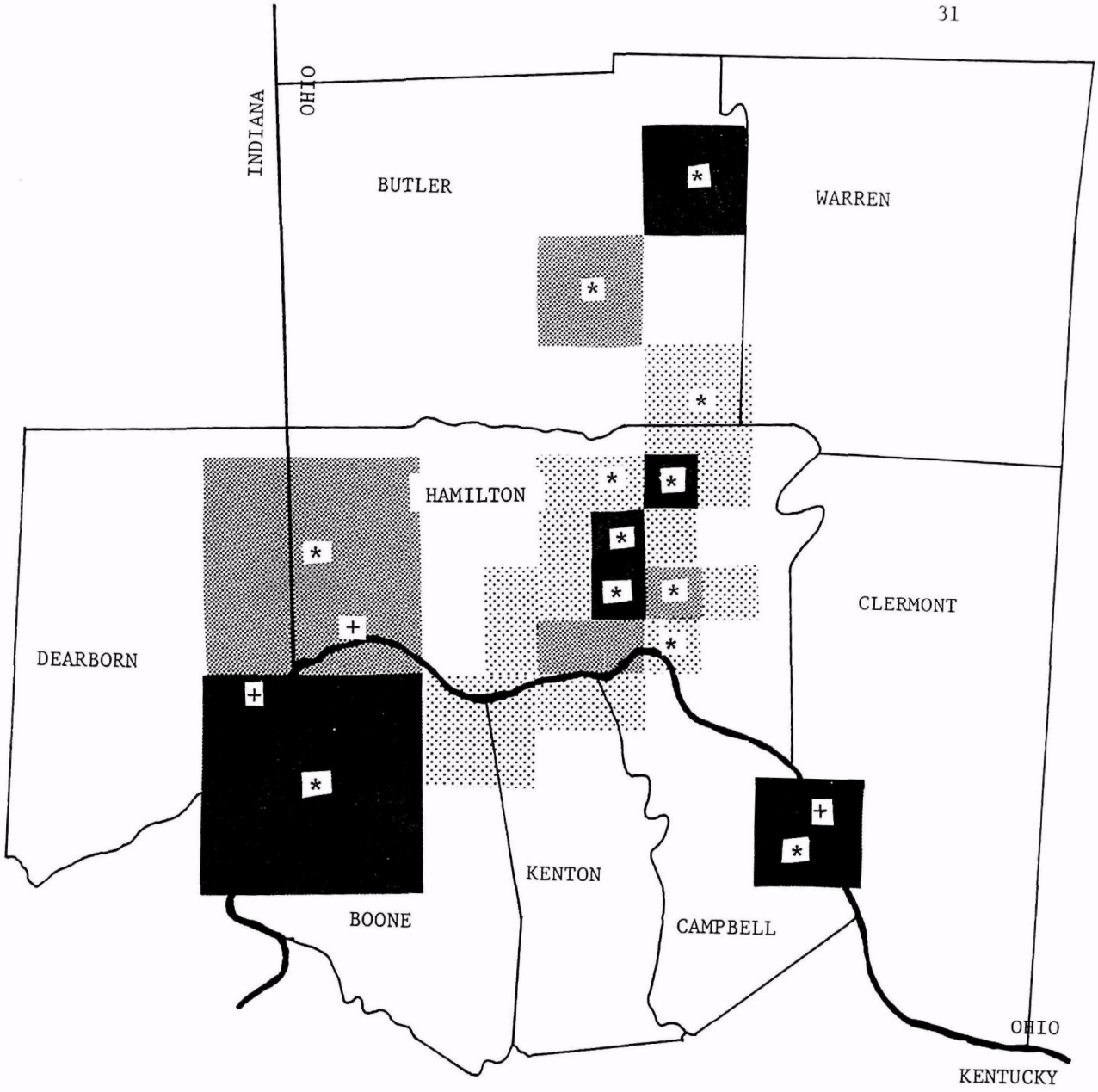


Figure 9: SULFUR OXIDES EMISSION DENSITY MAP

Tons Per Day
Per Square Mile:

- more than 1.0
- 0.5 to 1.0
- 0.1 to 0.5
- less than 0.1

\+ Indicates location of major coal-fired power plant.

* Indicates that more than 50% of the emissions within the associated grid are from point sources.

0 5 10 Miles

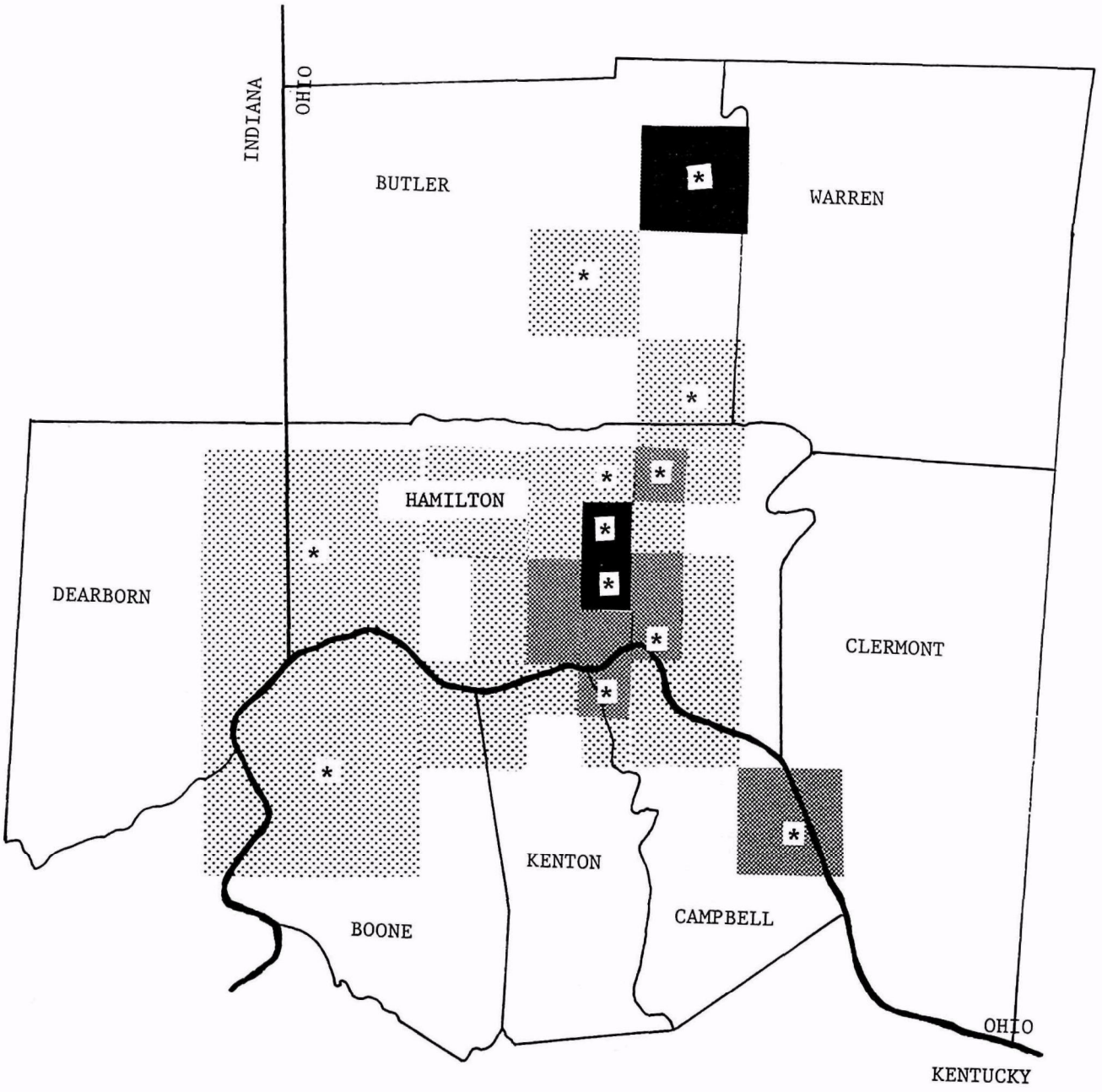


Figure 10: PARTICULATE EMISSIONS DENSITY MAP

Tons Per Day
Per Square Mile:

- more than 1.0
- 0.5 to 1.0
- 0.1 to 0.5
- less than 0.1

* Indicates that more than 50% of the emissions within the associated grid section are from point sources.

0 5 10 Miles

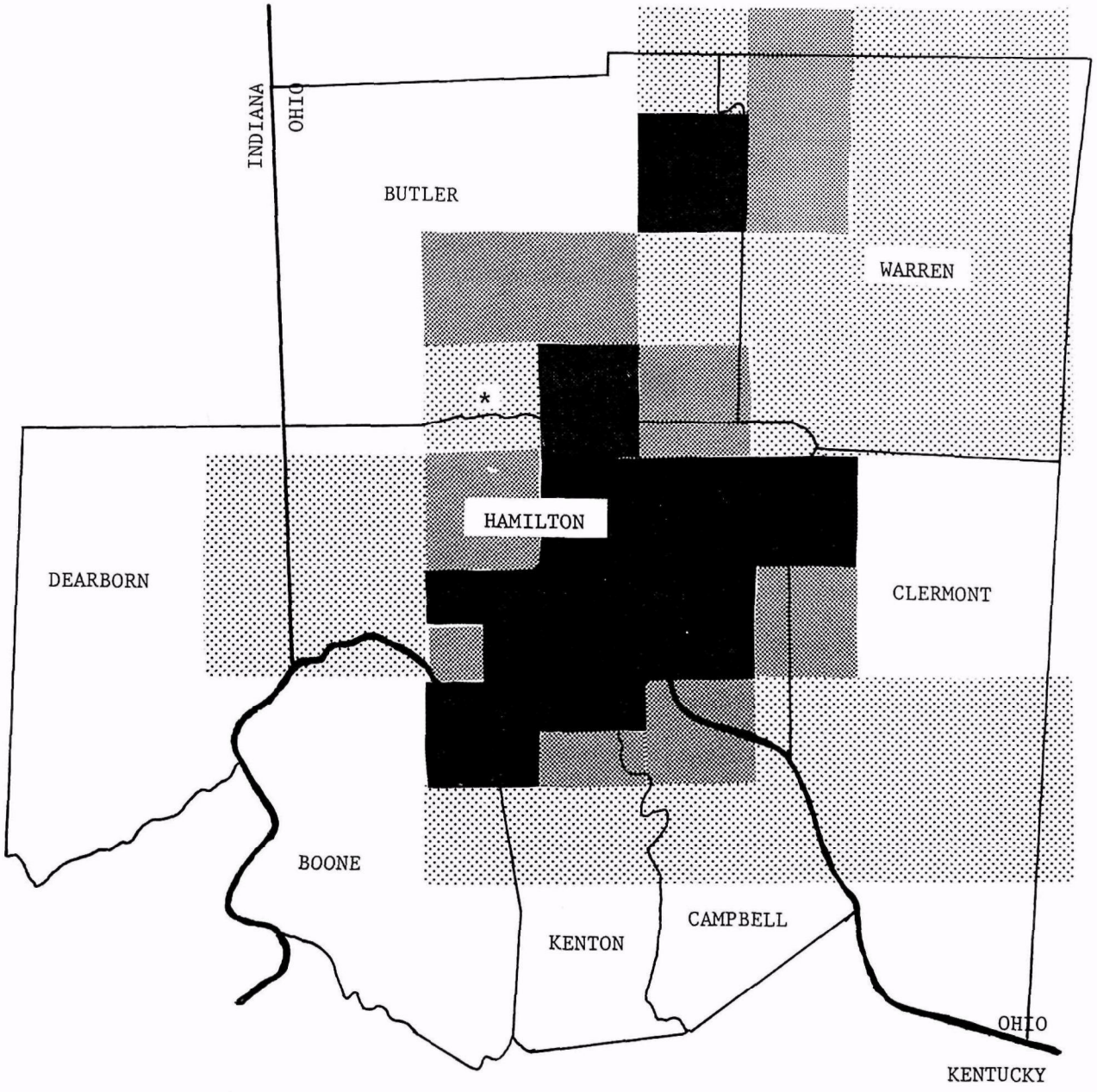


Figure 11: CARBON MONOXIDE EMISSION DENSITY MAP

Tons Per Day
Per Square Mile:

- more than 1.0
- 0.5 to 1.0
- 0.1 to 0.5
- less than 0.1

* Indicates that more than 50% of the emissions within the associated grid section are from point sources.

0 5 10 Miles

Figure 12 clearly demonstrates the tremendous impact which coal-fired steam electric power plants have upon sulfur oxides emissions in the Cincinnati area. The power plant located in Dearborn County is responsible alone for more than one third of the sulfur oxides emissions in the Cincinnati area. The power plant in Clermont County and the power plant in southwestern Hamilton County are responsible for more than another third of all sulfur oxides emissions. The Hamilton power plant and the industrial sources in Middletown account for a significant portion of the remaining sulfur oxides emissions. Thus, the bulk of sulfur oxides are emitted from point sources which circle the City of Cincinnati and which reflect the location of the major coal-fired power plants.

The power plants, which dominate the sulfur oxides emission map, exert a much smaller influence in the case of particulates. They emit only 15% of the total particulates, while industries are responsible for more than 50%. Industrial sources in Middletown and Hamilton alone account for about 30% of the particulate emissions. Industrial and commercial institutions located in the central Cincinnati area account for a large part of the remaining particulate emissions.

Automobiles are almost exclusively responsible for carbon monoxide emissions. Since automobile traffic density is closely correlated to urbanization, the greatest densities of carbon monoxide emissions are found in the central areas of Cincinnati, Middletown, Hamilton, Covington, and Newport. The expressway between Cincinnati and Columbus passes through Warren County and results in carbon monoxide emissions which would otherwise be unexpected in that rural county.

In summary, the emissions inventory shows that the most important point sources of sulfur oxides are located in Dearborn, Clermont, and Butler

Counties. The heaviest emissions of particulates are located in Middletown and Cincinnati. Carbon monoxide emissions are concentrated most densely in Cincinnati, Covington, Newport, Hamilton, and Middletown.

AIR QUALITY ANALYSIS

A study of air quality levels known or estimated to occur is useful in determining the area affected by the pollution sources and thus subject to inclusion in the air quality control region. Such analysis can be based directly on air quality sampling data in those instances where the sampling program covers a large enough area and has been in existence long enough to provide reliable patterns of air quality throughout the region under study. Since such air quality data rarely exists, it becomes necessary to develop estimates of prevailing air quality. Diffusion modeling is a technique by which such estimates can be made based on the location and quantity of pollutant emissions and on meteorological conditions. The influence of topography on ambient air quality levels is reflected in the results of the model, but only to the extent that it influences meteorological conditions.

MEASURED AIR QUALITY

Measured air quality data is available for the Cincinnati area from a considerable number of stations. Dustfall measurements have been reported from about 60 locations, suspended particulate measurements from about 25 locations, and lead peroxide candle measurements for sulfur oxides from about 25 locations. However, at many of those locations, measurements were taken for only three months or even shorter periods of time. These data for dustfall, suspended particulates, and sulfur oxides are of limited value in deciding upon region boundaries. First, much of

the data is not statistically reliable on a long term basis since it was collected over a relatively short period of time. Second, most of the stations were clustered in the urban centers of Cincinnati, Covington, Newport, Hamilton, and Middletown. While these stations provide a measure of the downtown air pollution problems, they do not indicate how far air pollution extends into rural areas. Despite these limitations, the measured air quality data has been presented in Figures 12, 13, and 14.

ESTIMATED AIR QUALITY

In order to supplement the measured air quality data, the diffusion model was applied for carbon monoxide, sulfur oxides, and particulates for three different time periods; annual, winter, and summer. Due to the prevailing southwesterly wind (see Figure 15), it was clear that pollution sources in Hamilton County would have an impact upon the air quality of Butler County, whereas sources in Butler County would have an impact upon air quality in Dayton. It was necessary to estimate the relative importance of these two effects in order to decide whether Butler County should be included in the Cincinnati or Dayton region. Therefore, the diffusion model was applied to the Dayton emission inventory as well as the Cincinnati emission invenotry, and the two results were combined to generate an overall map of estimated air quality for the Cincinnati-Dayton area as a whole. Carbon monoxide emissions are greatest during the summer season, while sulfur oxides emissions are greatest during the winter, and particulate emissions remain fairly constant throughout the year. Therefore, the corresponding diffusion model results were

Figure 12: MEASURED SULFUR OXIDES CONCENTRATIONS

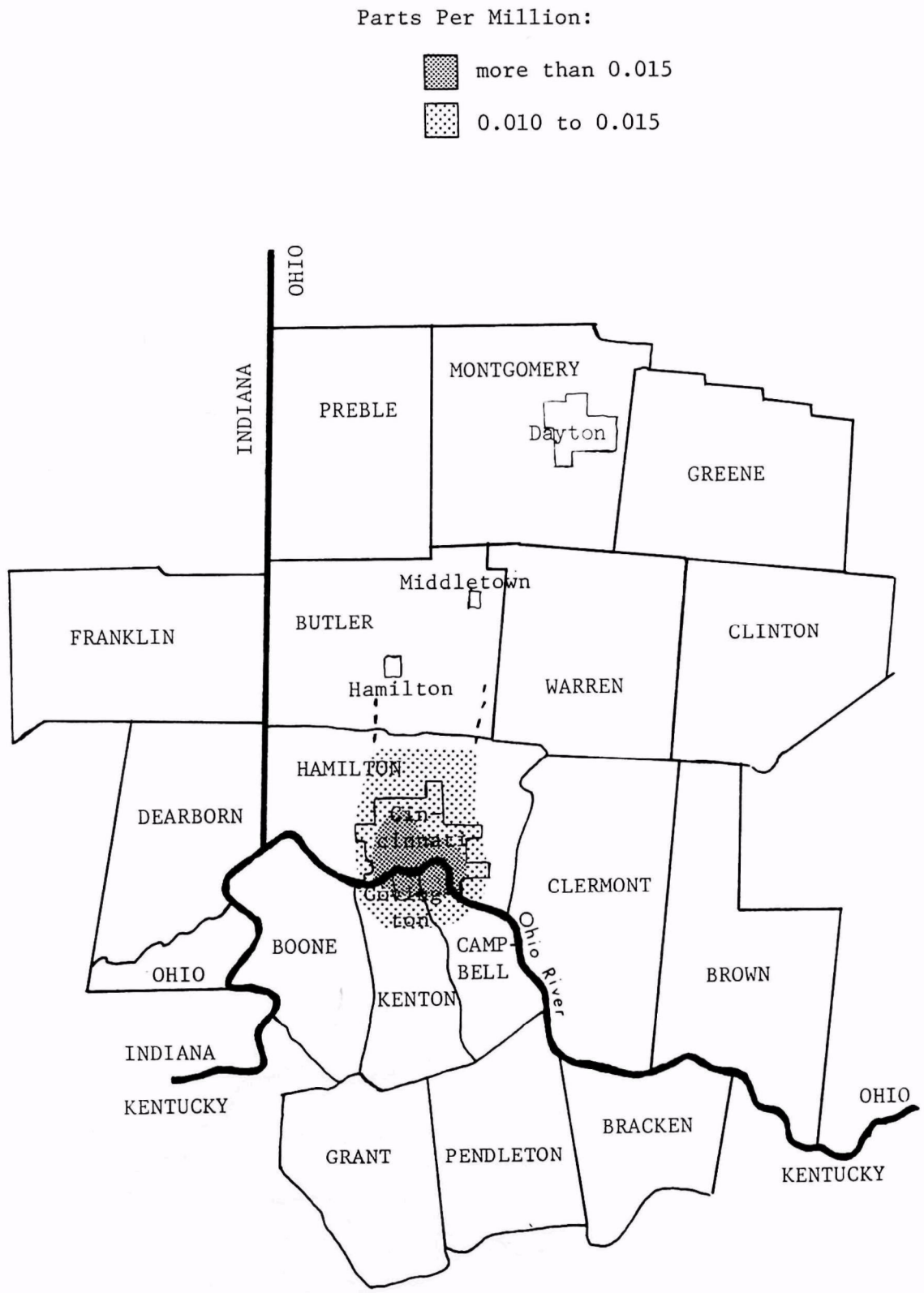


Figure 13: MEASURED SUSPENDED PARTICULATE CONCENTRATIONS

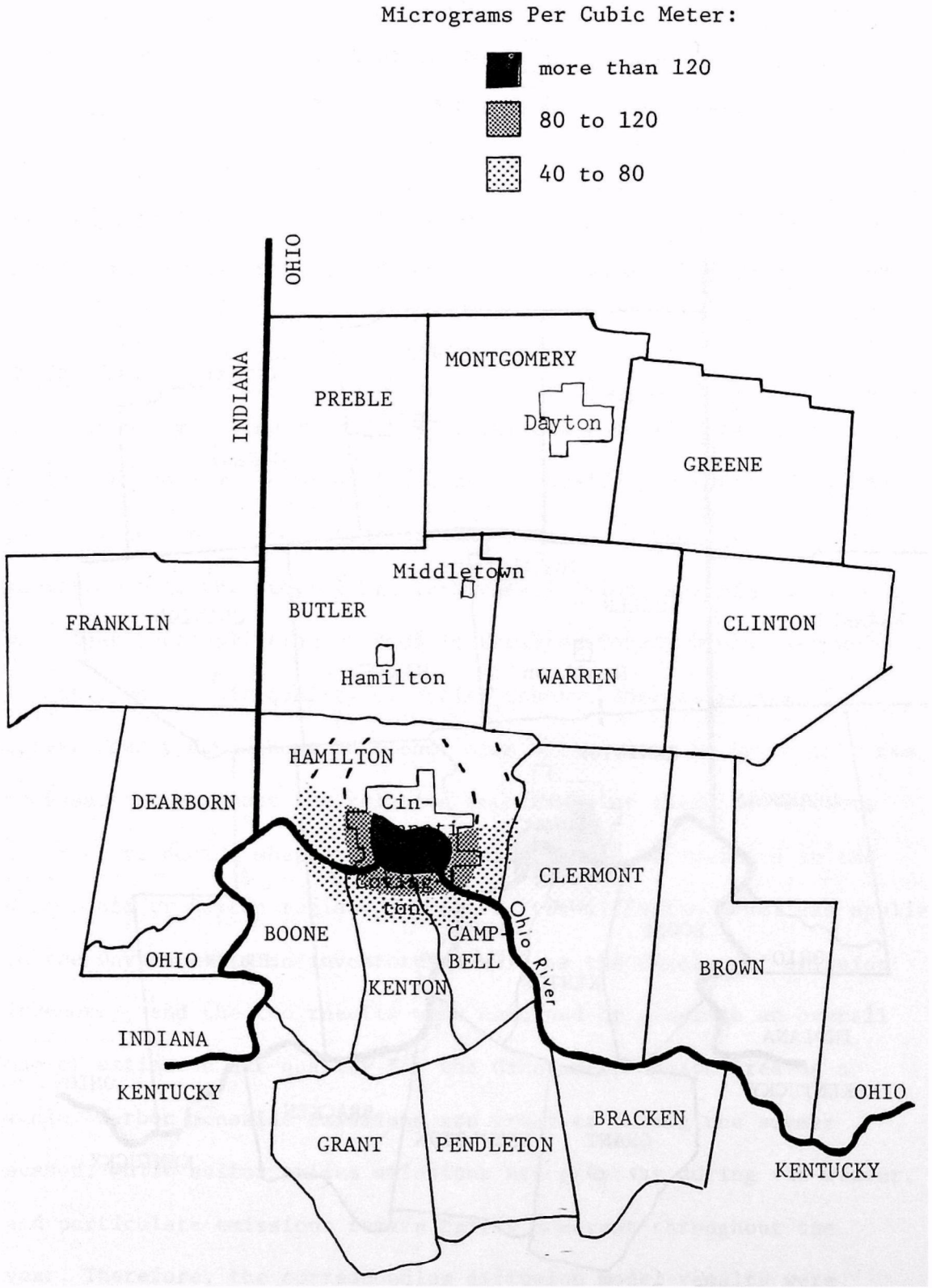


Figure 14: MEASURED DUSTFALL

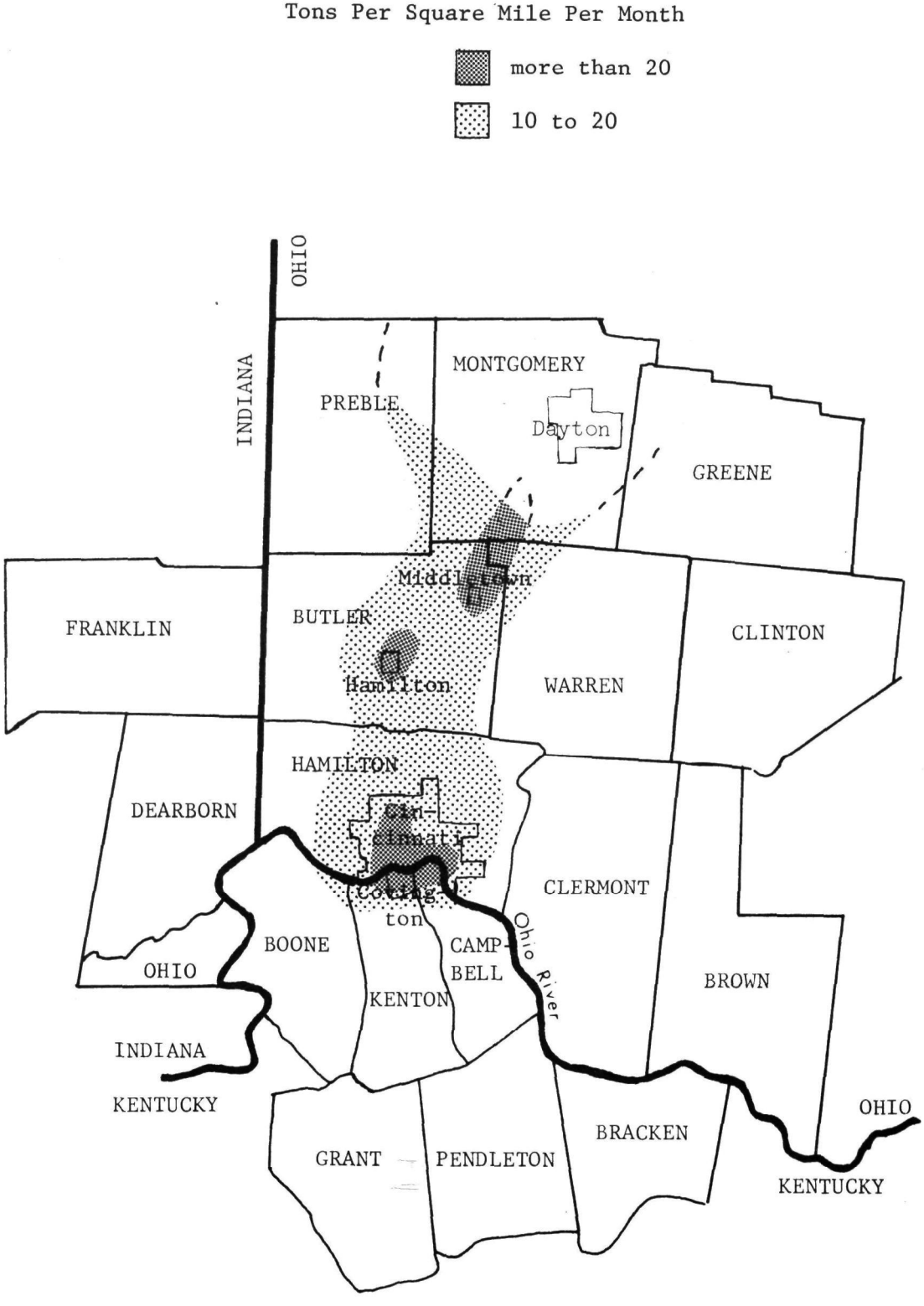
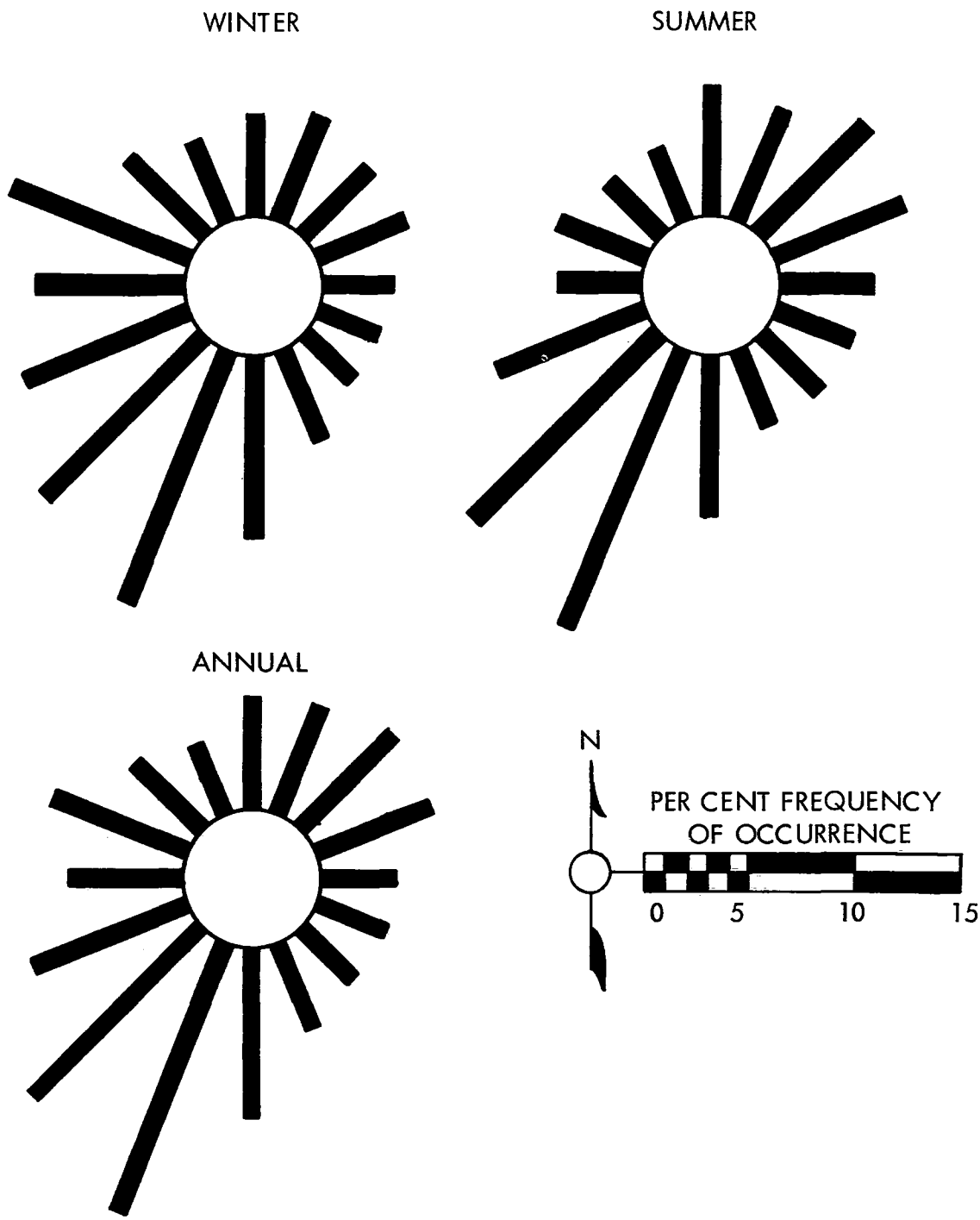


Figure 15: CINCINNATI WIND ROSE



chosen as most relevant for determining region boundaries. These results are presented in Figures 16, 17, and 18.*

Sulfur Oxides

Estimated sufur oxides concentrations from the diffusion model indicate the strong impact of the power plants noted above. The plant in Dearborn and the plant in Clermont cause two peaks of ambient sulfur oxides concentrations which straddle Cincinnati. Dearborn, Boone, Clermont, Campbell, Hamilton, and Kenton are all subjected to sulfur oxides levels substantially above the background level. However, pollution from these sources does not seem to affect Butler County to an important degree. On the other hand, sulfur oxides emission sources in Middletown seem to have a significant impact upon Montgomery County and the Dayton area. In those instances where a comparison can be made, the estimated sulfur oxides concentrations correspond roughly to the measured concentrations shown in Figure 12. The deviation appears to be about a factor of 2.

Particulates

Particulate emissions in the Cincinnati area do not appear to present a serious problem outside of the downtown urban center. The results of the diffusion model, Figure 17, indicate that Hamilton,

* The wind speed and direction data used in the diffusion model were assumed to be representative of the previaling wind patterns throughout the general Cincinnati and Dayton areas. Since the Martin-Tikvart diffusion model used in the study attempts to show long-term rather than episodic air quality conditions, only average emissions and long-term average meteorology are considered. The pollutant concentrations estimated by the diffusion model process are in addition to "background" levels since the model was not supplied with information on sources located outside the emissions inventory grid area for Dayton and Cincinnati.

Figure 16: ESTIMATED SULFUR OXIDES CONCENTRATIONS

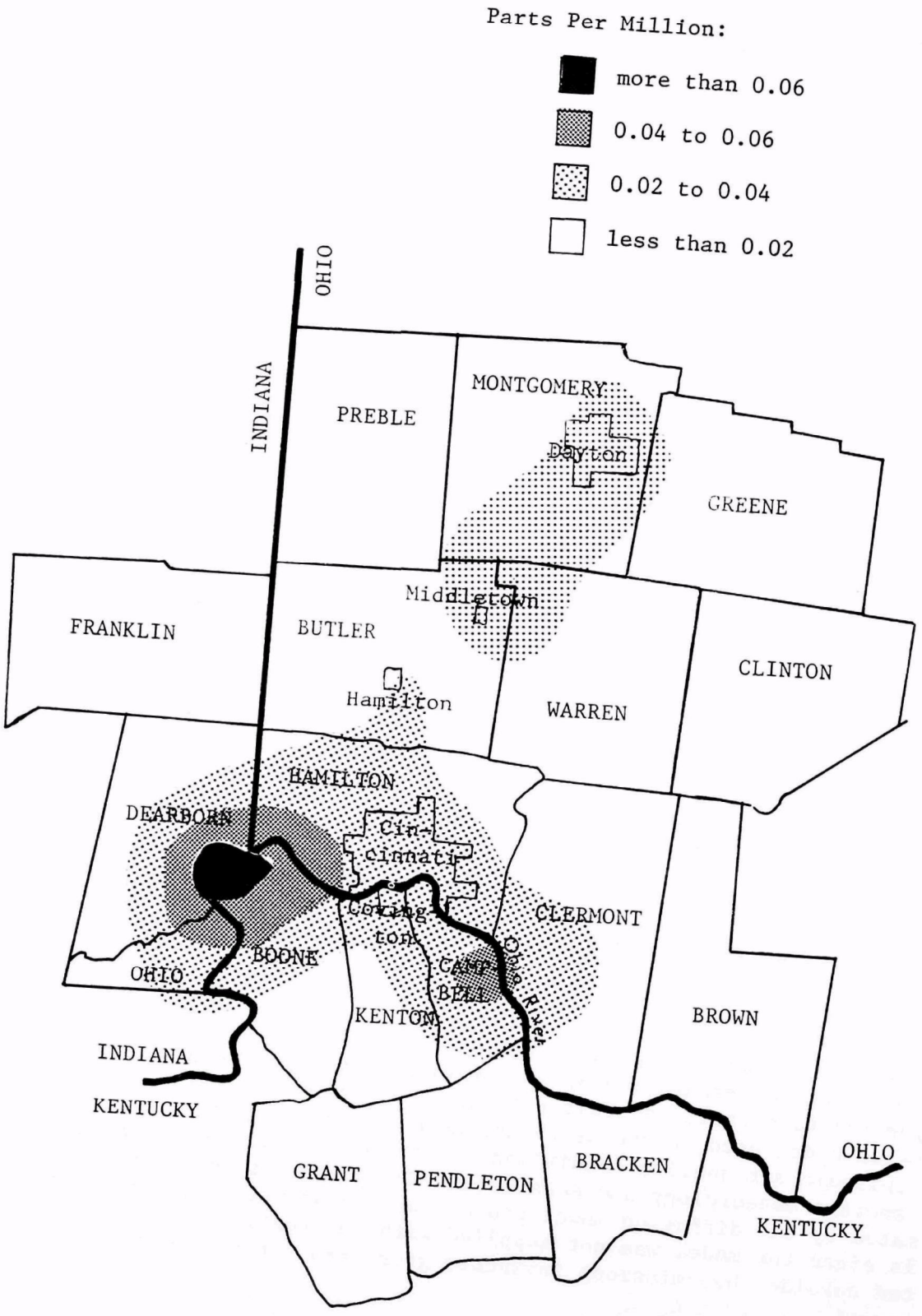


Figure 17: ESTIMATED SUSPENDED PARTICULATE CONCENTRATIONS

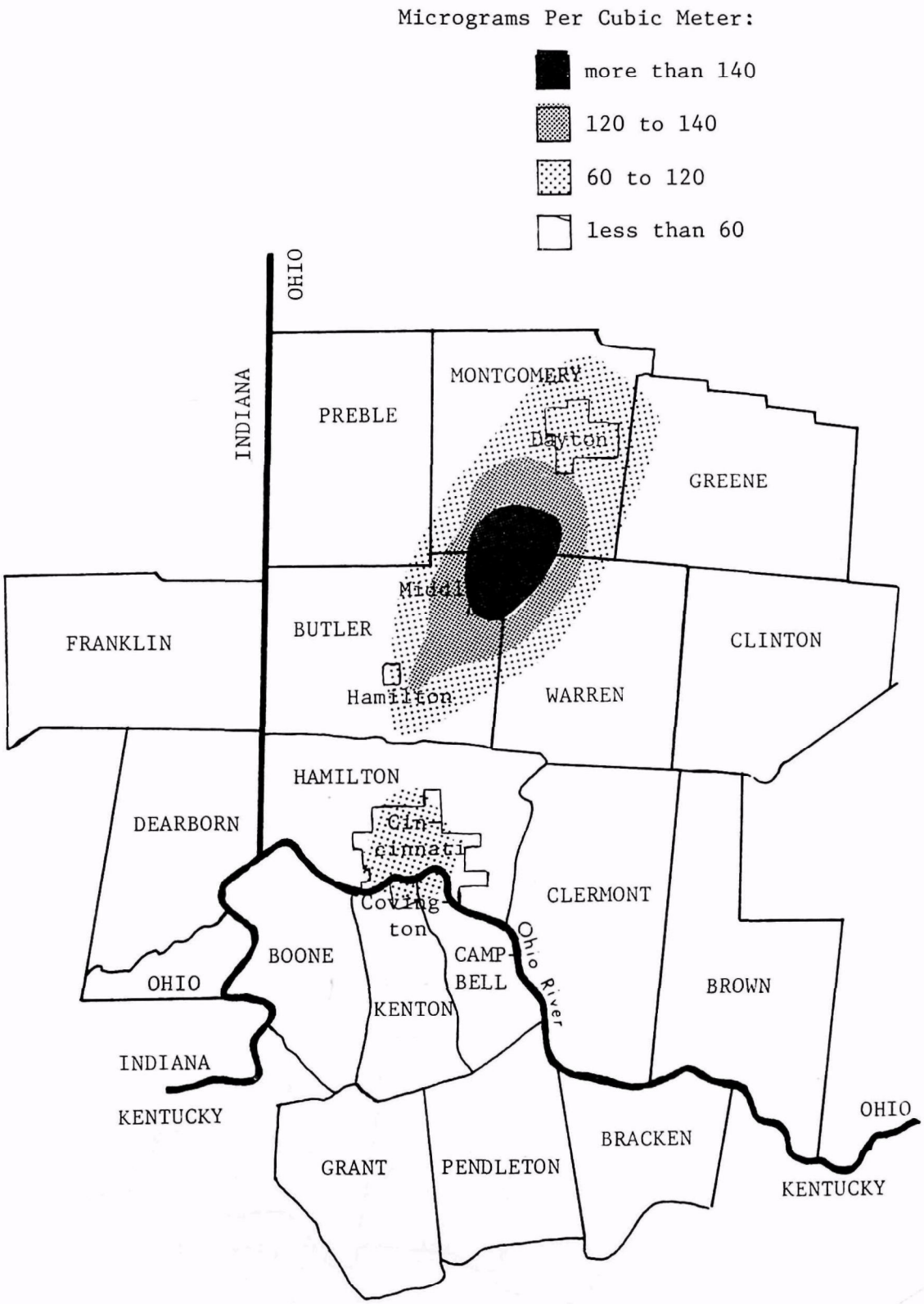
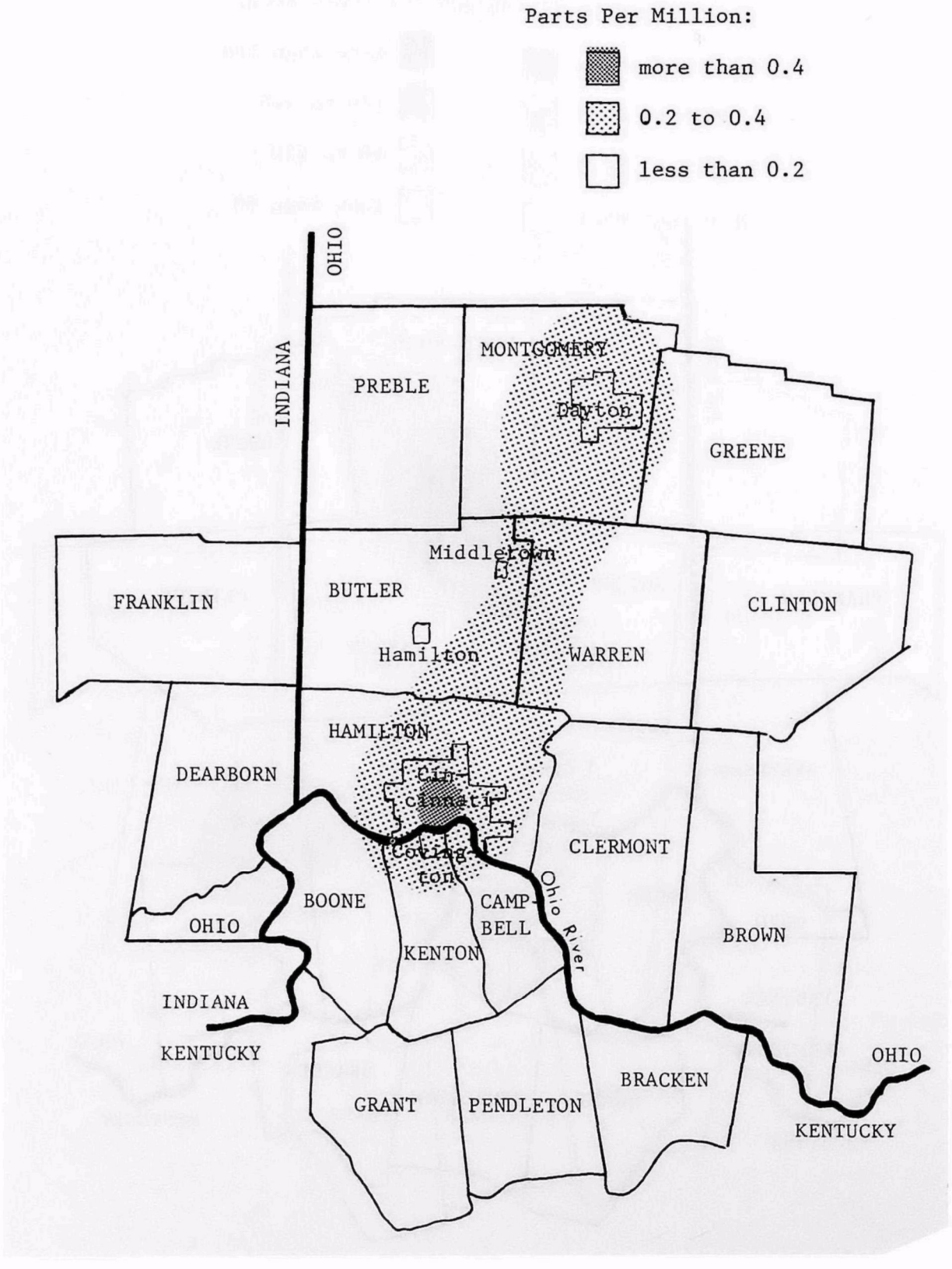


Figure 18: ESTIMATED CARBON MONOXIDE CONCENTRATIONS



Kenton, and Campbell Counties are affected by concentrations somewhat above background levels. Butler County appears unaffected by particulate emission sources in Cincinnati. However, sources of particulates in Butler County combine with sources in Montgomery County to produce a corridor of high particulate concentrations between Hamilton, Middletown, and Dayton. In this case, as with sulfur oxides, Butler County appears to be linked to the Dayton problem. Where comparison is possible, estimated concentrations of particulates correspond roughly (within a factor of 2) to the measured concentrations shown in Figure 13.

Carbon Monoxide

Concentrations of carbon monoxide which are significantly greater than background levels appear to form an elongated pattern along the Cincinnati-Dayton corridor. The highest values of carbon monoxide concentrations are found in Cincinnati, Covington, and Newport. But Butler and Warren Counties also experience levels which are somewhat above the background. The pattern of carbon monoxide pollution extends through Butler County into Montgomery.

SUMMARY

The emissions inventory and the estimated air quality information are important measures of how large a region must be in order to contain all of the major technical elements of the air pollution problem. Based on the analysis of sulfur oxides, it appears that Dearborn, Boone, and Clermont are linked to Cincinnati's air pollution problem. Butler, however, appears linked to the Dayton area. Based

on the analysis of particulates, the pollution of Cincinnati appears to have little impact on Dearborn, Boone, and Clermont Counties. Butler still appears linked to the Dayton area. However, carbon monoxide concentrations seem to have an impact along the whole Cincinnati-Dayton corridor, with the heaviest concentrations occurring at the Cincinnati end.

THE PROPOSED REGION

PROPOSAL

Subject to the scheduled consultation, the Secretary, Department of Health, Education, and Welfare, proposes to designate an air quality control region for the metropolitan Cincinnati area, consisting of the area encompassed by the following jurisdictions:

In the State of Ohio

Clermont County

Hamilton County

In the Commonwealth of Kentucky

Boone County

Campbell County

Kenton County

In the State of Indiana

Dearborn County

The boundaries of the proposed Region are illustrated in Figure 19. Figure 20 locates the Region in relation to the rest of Ohio, Kentucky, and Indiana.

DISCUSSION OF PROPOSAL

Introduction

To be successful, an air quality control region should meet three

Figure 19: PROPOSED METROPOLITAN CINCINNATI INTERSTATE AIR QUALITY CONTROL REGION

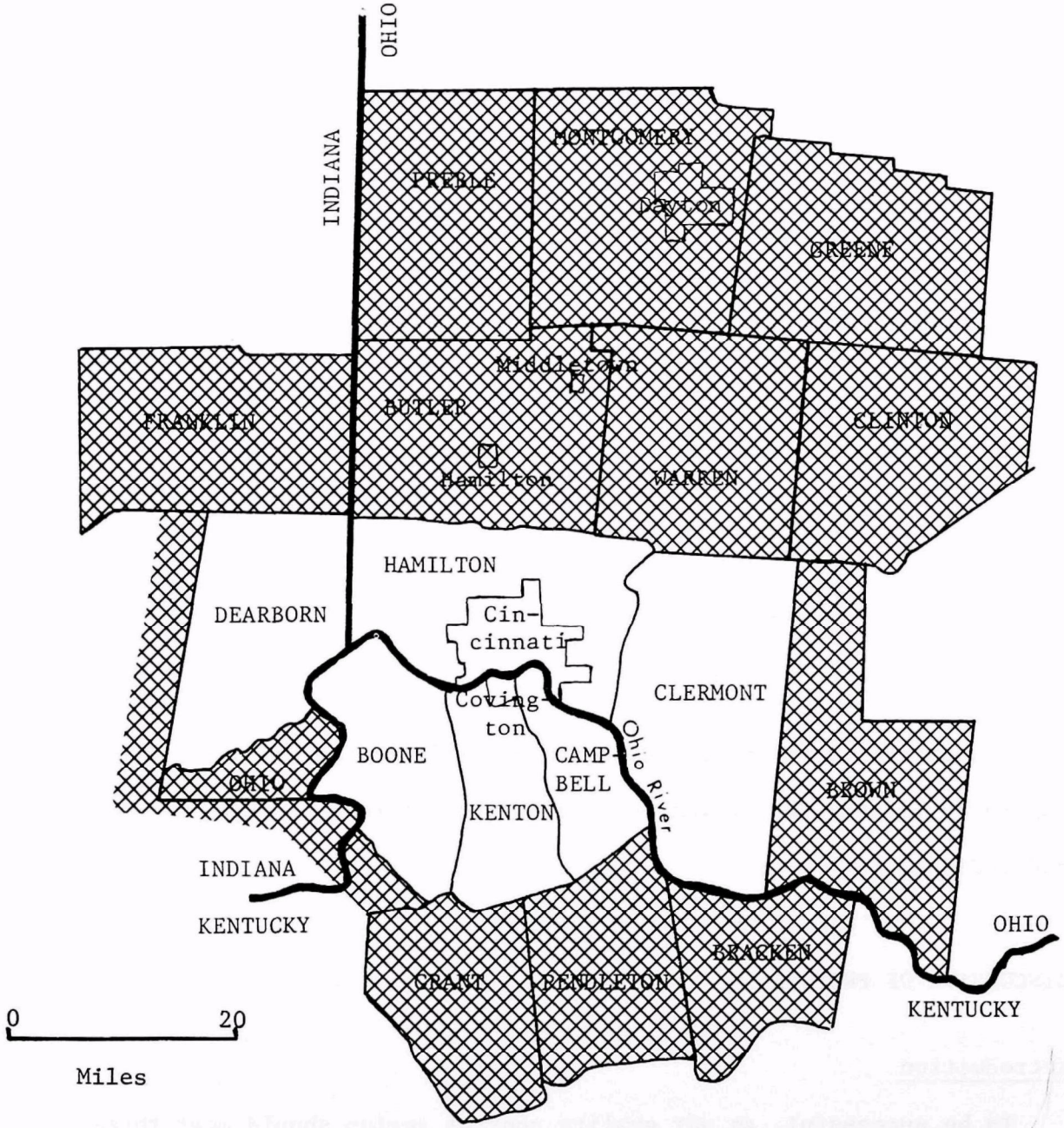
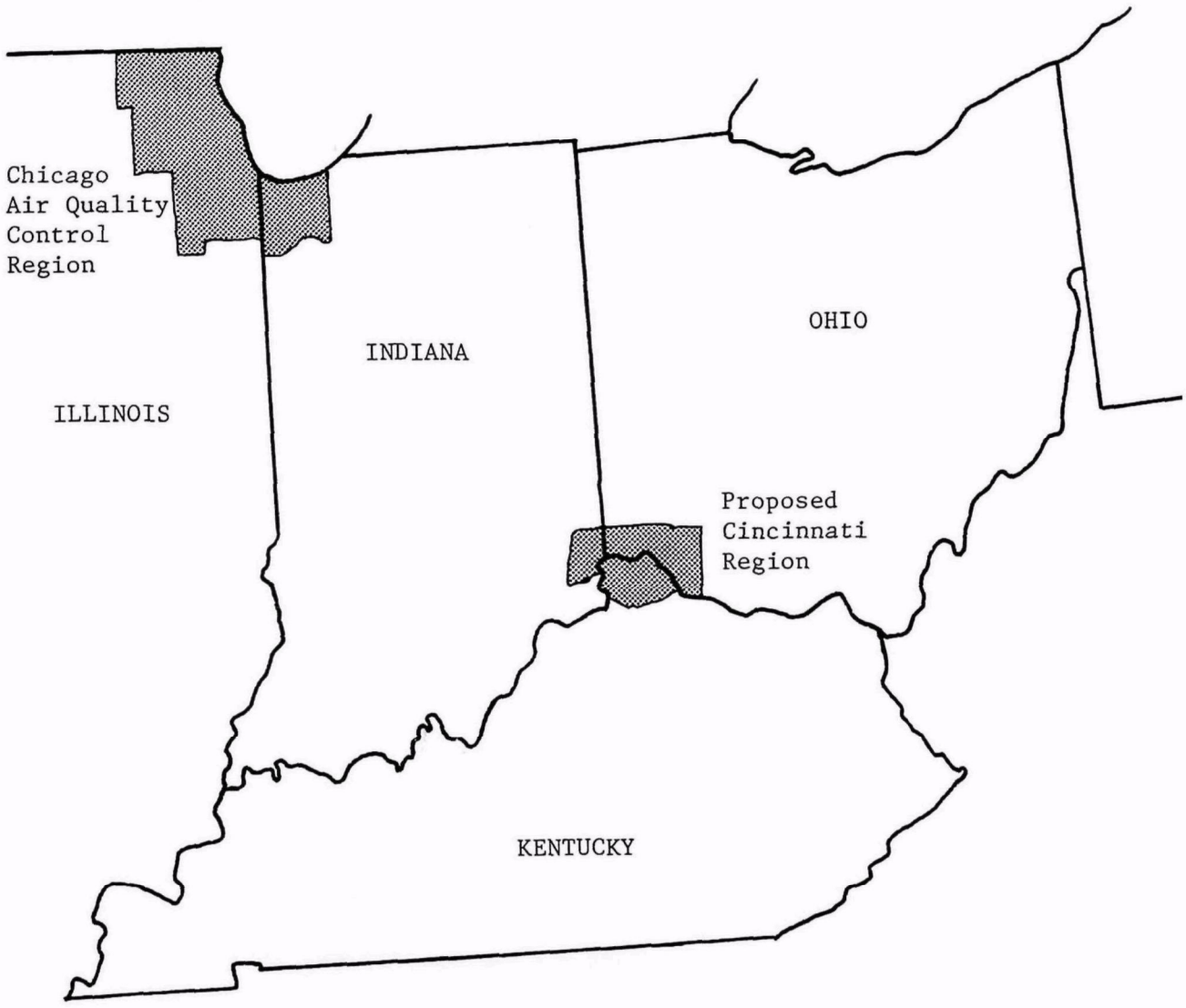


Figure 20:

PROPOSED METROPOLITAN CINCINNATI

INTERSTATE AIR QUALITY CONTROL REGION



basic objectives, as discussed in the section entitled "The Size of a Region," page 6. First, a region should be self-contained with respect to air pollution sources and receptors. Second, a region should be designed to meet not only present conditions but also future conditions. Third, region boundaries should be compatible with and even foster unified and cooperative governmental administration of the air resource throughout the region. The proposed boundaries of the Metropolitan Cincinnati Interstate Air Quality Control Region were designed to satisfy these three objectives.

The first objective, that a region be self-contained with respect to pollution sources and receptors, opened the possibility that the Cincinnati area should be combined with the Dayton area to form one air quality control region. This question was resolved by recognizing the lack of urban, governmental, and technical factors which could link these two cities. Dayton and Cincinnati are not closely linked in terms of population. Hamilton County (containing Cincinnati) has more than 900,000 residents, and Montgomery (containing Dayton) about 600,000. Yet Butler County, which separates the two cities, has only about 200,000 residents. The distance between downtown Cincinnati and downtown Dayton is more than 45 miles. There are no strong governmental links between Dayton and Cincinnati, nor any joint programs for the control of air pollution. Regional planning is handled separately for the two

urban areas. Finally, the analysis of air quality, presented earlier, indicates that the Dayton air pollution problem is essentially separate from the Cincinnati problem, except perhaps for pollution caused by automobiles. This last exception would be a weak reason for combining Dayton and Cincinnati into one region, since control of automobile emissions is more feasible on the state or Federal level than on the local level. Therefore, it appears reasonable to designate separate air quality control regions for Cincinnati and Dayton.

The Core Area

The core area of the Cincinnati region consists of the cities of Cincinnati, Covington, and Newport. Within these three cities resides about 45% of the population of an eight-county area composed of Hamilton, Butler, Warren, Clermont, Campbell, Kenton, Boone, and Dearborn Counties. The heaviest concentrations of carbon monoxide and particulate emissions are located in these three cities. Suburban communities circling the urban center are also part of the core area. These communities contain another 30% of the population of the area, add to the volume of traffic flowing into and out of Cincinnati each day, and experience ambient pollutant concentrations substantially above background levels. Since the core area extends into Hamilton, Kenton, and Campbell Counties, these three counties should be included in the Metropolitan Cincinnati Interstate Air Quality Control Region.

Areas on the Periphery

In terms of population, employment, and location, the counties of Dearborn (Indiana), and Clermont (Ohio), are on the periphery of the Cincinnati urban area. However, Dearborn and Clermont Counties both contain large coal-fired power plants located on the Ohio River. The power plant in Dearborn alone is responsible for approximately 37% of the sulfur oxide emissions in the whole Cincinnati area, and the one in Clermont County is responsible for about 25% more. Clearly, no program for the control of sulfur oxides pollution in the Cincinnati area could be successful if it ignored these two emission sources. For this reason, the proposed Region includes both Dearborn and Clermont Counties.

In contrast to Dearborn and Clermont, Boone County does not contain important emission sources. It is less densely developed than the core areas in Hamilton, Kenton, and Campbell Counties. Nevertheless, it seems reasonable to include Boone in the proposed Region for a number of reasons. Boone County lies less than 10 miles from downtown Cincinnati, and is bound to develop closer and closer links to the urban center as time passes. As an indication of this liklihood, Boone is expected to experience as much as 50% population growth during the next decade due to an influx of surburban residents. Boone County is a member of the OKI Regional Planning Authority, which is responsible for planning activities in a nine county area surrounding Cincinnati.* This is another indication of growing links

*Hamilton, Butler, Warren, Clermont, Campbell, Kenton, Boone, Ohio, and Dearborn.

between Boone and the urban center. Boone County also participated in the 1965-1967 regional study of air pollution in the Cincinnati area**. Finally, the power plant in Dearborn County is located directly across the Ohio River from Boone County, less than one mile away. The resulting high concentrations of sulfur oxides which Boone experiences are a strong argument for including Boone County in the proposed Region.

Butler County

Butler County contains important air pollution emission sources, experiences high concentrations of some air pollutants, has a moderate population density, and is expected to grow rapidly during the next decade. These factors definitely indicate that Butler should be included in an air quality control region. But the results of this study seem to demonstrate that Butler is more closely connected to the air pollution problem of Dayton than that of Cincinnati. The prevailing wind for the Southwestern Ohio area is southwest. Thus, although pollutants emitted in Cincinnati can be transported into Butler County and create a link between the two areas, an even more important link is created by transport of pollution from Butler County into the Dayton area. The emission sources in Butler County are most likely to be controlled in the future if they are included in the same air quality control region which contains the

**"Air Resource Management for Southwestern Ohio and North Kentucky", a report by the Study's Technical Committee.

people they affect. Since it appears desirable to place Butler County in an air quality control region for the Dayton area, it is not included in the proposed Region for Cincinnati.

Warren County

Warren County is located just to the east of Butler County, and is expected to grow at a faster percentage rate during the next decade than any other county considered in this study. However, at the present time, Warren is not densely populated, and contains few emission sources of any consequence. If Warren is to be included in any air quality control region at all, it appears reasonable to keep it joined with Butler County. For this reason, Warren County has not been included in the proposed Region for Cincinnati.

This proposal represents a starting point for discussion in the consultation with appropriate state and local officials, which will be held before the Cincinnati Region is finally designated.

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