

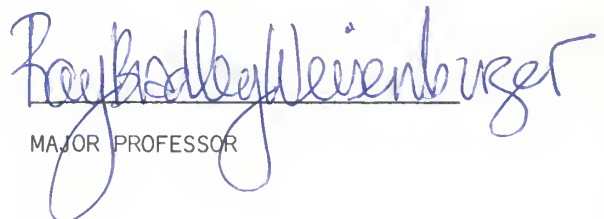
SYMAP: A POTENTIAL MULTI-COUNTY
REGIONAL PLANNING TOOL

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B.S., KANSAS STATE UNIVERSITY, 1971

A NON-THESIS PROJECT
SUBMITTED IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS FOR THE DEGREE
MASTER OF REGIONAL AND COMMUNITY PLANNING

DEPARTMENT OF REGIONAL AND COMMUNITY PLANNING
KANSAS STATE UNIVERSITY
MANHATTAN, KANSAS
1973

APPROVED BY:


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INTRODUCTION

In recent years there has developed a great deal of interest in regional planning and development in Kansas. Part of this interest has been generated by declining and disappearing small towns in rural areas as a result of loss of jobs and loss of people. Part of this interest has also been prompted by federal programs generally requiring local governments and the State to join in cooperative planning and development. This push for planning and development has resulted in the delineation of uniform regional areas by the State. These regions were created to facilitate cooperation in planning and development as well as coordination in policy and goals formulation.

To facilitate comprehensive planning and development, it is felt that utilizing the latest techniques and concepts offers the best process for maximizing both individual and community goals. One such technique, a form of system analysis known as Synagraphic Computer Mapping (SYMAP), could be effectuated in this process on the regional level. This technique could be very useful to the planner in the early stages of the planning process, that stage where the planner is trying to evaluate the current status of the region. This step very often involves collecting, processing, compiling and analyzing data. The planner is confronted with decisions and must utilize this data in his decision-making process. Very often these planning decisions are based on nothing more than the feelings or whims of the person at that particular moment. What is needed is a technique for looking at this data in another way. A way such that it will aid the planner in his decisions and give more credibility and usefulness to his plans. I propose that computer graphics, specifically SYMAP can be utilized in such a manner. It can be used to display both quantitative and qualitative data, over a geographical area for a variety of uses. Depending on the types of data used, the planner can determine trends in a region, examine migration, or locate growth areas,

all in a single run of the computer program. SYMAP could add another dimension in evaluating data.

In Kansas, with regional planning just beginning to make its presence felt, computer mapping could be a valuable tool to the decision-maker. To show its potential, an examination of the Big Lakes Region was undertaken. This newly organized planning region is composed of three counties: Geary, Pottawatomie and Riley. Its name originated from the immediate locations of Milford and Tuttle Creek Reservoirs. Two urban areas, Junction City and Manhattan, are located in this region. Ft. Riley and Kansas State University supply the major economic resources.

What follows is a look at this region with computer mapping as the medium. This project is intended to show the usefulness of computer mapping in a regional planning context. This usefulness is centered around the help it should add in easing the problems in the decision-making process.

To get a feeling for computer graphics, we start with a brief discussion of the different techniques available today. Section II looks at SYMAP in detail, going into its origin and its different packages. The methodology which was followed in this project is contained in Section III including possible applications of SYMAP and examples of the mapping. It is hoped that this project will lead to a better understanding of the capabilities of computer mapping.

SECTION I

Computer Graphics

Computer Graphics has been defined in many ways. The clearest definition, however, is still that it is an efficient (perhaps the most efficient technique) for exchanging useful information between computer and user, primarily through pictures.¹ One can trace the beginning of computer graphics to the Jacquard loom where for the first time a digitized representation of a graphical form in punch cards was used to control a loom. Modern computer graphics had its beginning at the M.I.T. Lincoln Laboratory where Dr. Ivan Sutherland developed the SKETCHPAD PROGRAM which allowed the user to sketch on a cathod ray tube. SKETCHPAD opened the horizons for industrial developments by illustrating the feasibility of having a designer construct rather complex diagrams with the aid of a computer. This work was first published in the Spring of 1963 at the Joint Computer Conference of the American Federation of Information Processing Societies.²

While there has been a rapid revolution in the ability to generate data, the planning professions ability to use computer-produced information is evolving more slowly. No matter how many computer runs or reports are available, they have no value unless they can be communicated to and used by a planner. Obviously, data must be presented to decision makers in some readily comprehensible form. It is this important step in communicating data to the user that truly creates information. The purpose of this section is to show some of the methods currently being used in computer graphics. Modern computers and their associated peripheral devices are capable of presenting a great variety of information in the form of graphs, pictures, maps, and models.

¹George A. Michael, "Computer Display Systems", Physics Today, July, 1970, Page 30.

²R.D. Parslow, R.W. Prowse and R.E. Green, Computer Graphics, Plenum Press, 1969, Page 23.

Printer Plotters

This type of graphic technique is concerned with the production of plots on standard line printers or teletypes. Printers can be used to produce good black-and-white pictures or maps with varying tones of gray achieved by overprinting. Most importantly, they can give almost any organization the ability to produce simple maps, charts, or graphs without incurring additional expense for hardware.

SYMAP is this type of graphical technique, and while it is somewhat limited in its graphical capabilities, its availability and cost makes up for this. (SYMAP will be discussed in more detail in the next section.)

Another example of a printer plotter technique is the Economic Development Administration's computer mapping system (CMS). This system is a computer program capable of mapping in quantitative mode any topics over a region or the entire country and combining such maps in a controlled, weighted combination. Which makes possible a variety of geographic searches and simulation models. The art of using CMS revolves around selecting and weighting factors. Location simulation requires a knowledge of the industries and location theory; or socio-economic index mapping requires a knowledge of the phenomena. CMS itself does not embody analytic models. The appropriate model for each case depends on the problem and the analyst's style.

CMS can display quickly and at low cost the patterns of any socio-economic statistics over large regions, from any taped census on population, agriculture, minerals, manufacturing, business or housing. Socio-economic condition mapping is possible, by compositing relevant maps. For example an index map of economic level may be composed from maps of unemployment, labor participation rate, population change, educational achievement, housing defects, infant mortality, etc.

Optimal location (OPLOC) of an industry or a major public facility can be simulated by compositing a set of locational factor maps. This simulation requires careful interpretation. An OPLOC map for a given industry signifies only within-region optimal location,

and only after industrial analysis has determined the between-region feasibility of the industry. An OPLOC map works only on the resources and the distribution and communications networks of this region. As an example: In Utah, economists first selected nine industries which would be feasible within the state, and then used CMS to seek optimal locations, first for each industry and then for possible clusters where infrastructure, services and industry linkages could be most efficient. One of the industries was Furniture Production, for which the location factors were : Lumber and Wood Products, Federal and State Highway Accessibility, Railroad Accessibility, Local Settlement Density, Regional Market Zones, Vocational Training Accessibility and Labor Availability Rating. The resulting Furniture OPLOC map showed that Salt Lake City was the most likely spot within the State.

Pen Plotters

One of the more common graphic devices is the pen and ink plotter. Most computer installations doing scientific data processing and many service bureaus have such a plotter available at very low cost. A typical pen plotter has a large flat drawing area. The pen is driven by a mechanical arm in much the same manner as a draftsman or artist would move his pencil. The pen widths and colors can be changed to produce color drawings and gradations in tone.

One of the most publicized uses of the pen plotter has been for architectural work. An example of such work that demonstrates the flexibility of this device is found in the experience of a major company which wished to place an office facility in an undeveloped area. One of its objectives was to blend the new office into the existing landscape. To study potential building designs, the company used a computerized perspective simulation program. The drawings that resulted displayed the major aspects of the landscape and the proposed building from a series of viewpoints.

CRT Terminals

The Cathode Ray Tube terminal uses a television screen to display computer output. There are two types of CRT terminals: (1) the Alphanumeric CRT, which as the name implies, displays only letters and numbers, and (2) the graphic or vector CRT, which displays lines and drawings. Since both types of CRT's provide a temporary picture, hard copy output must be obtained from other devices.

One CRT terminal system for pilots is nearing completion at the Massachusetts Institute of Technology. It uses a cockpit display system to give pilots information that is now available only to ground controllers. The M.I.T. system is designed to improve air safety and to enable traffic controllers to make more efficient use of air space.

COM Plotters

Computer Output to Microfilm (COM) is gaining acceptance because of its extremely fast output rate and versatility. COM plotters can produce one high-speed photograph per second of material displayed on a CRT. The equipment offers a choice of 16mm, 35mm, 70mm, or 105mm film in single exposures or movies. Many COM's can produce paper copies as well.

One company has developed a program for producing bar graph output on COM devices. The graphs can be used to show expense data by department and by function or product line with each department. Sales, inventory, and other financial data for a given period can also be presented in this easily comprehended fashion. In addition, the choice of formats for bar graphs is large.

Spatial Plotters

One of the newest and most unusual computer-driven graphic devices is a spatial plotter. This technique has been used for presenting data from geological surveys, air pollution studies, and landscape models.

The spatial plotter develops a three-dimensional graphic by placing wires on the plotting surface. The location of each wire corresponds to the location of each point samples in a survey or study. The wires are then cut at the appropriate heights to indicate the density per measured unit volume or unit area.

A totally new area opened up by this technique is that of model making. This type of plot could be used to produce models of golf courses, ski slopes, shore fronts, buildings. In most cases, all that would need to be done is to give a smooth top to the model.

Many of the advances in science are really no more than a new way of presenting existing information. Computer graphics is a medium that offers a new way of examining, handling, and communicating data. In short, it is a new way of looking at Information.³

³Kenneth Shostack and Charles Eddy, "Management by Computer Graphics", Harvard Business Review, November-December, 1971, Pages 52-62.

SECTION II

SYMAP

SYMAP is the best known, most comprehensive, and most widely used computer mapping program currently available. It uses a standard high-speed printer to print typewriter-like characters, on a standard 11 X 15 inch computer printout sheet. Lines can be roughly approximated with printer characters, and areas can be shaded with up to 10 progressively darker shades. The darkest shades are created by overprinting two or more printer characters.

The original SYMAP program was written in 1963 under the direction of Howard Fisher at Northwestern University. The program is currently being maintained by the Harvard Laboratory for Computer Graphics, where it is supported by a technical staff, ongoing research, and teaching materials such as correspondence courses and seminars.⁴

SYMAP graphically depicts spatially disposed quantitative and qualitative information. It is suitable for a broad range of applications in a variety of disciplines and is provided with numerous options to meet widely varying requirements.

The term synagraphic is used to designate the general type of computer mapping to be described. It is derived from a combination of the words synactic and graphic, the former an English word meaning acting together, cumulative in effect--from the Greek word synagein, to bring together. The first syllable of SYMAP is pronounced as in symbol.

The program permits raw data of many kinds (physical, social, economic, etc.) to be related, manipulated, weighted and aggregated in a variety of ways subject only to the user's needs or requirements. By assigning values to the coordinate locations of data points or data zones, one or more of three basic types of maps may then be produced, as specified by the user.

⁴Elliott Dudnik, SYMAP User's Reference Manual for Synagraphic Computer Mapping College of Architecture and Art, University of Illinois at Chicago, 1971, Page 2.

Generally, SYMAP has been programmed for the larger scale IBM systems, although modifications of SYMAP have been used on other large scale computers. SYMAP requires that the data and outline of the map to be produced must be in the same sort, or indexed, on a line by line basis.

Types of Maps

SYMAP enables three basic types of maps to be produced through its three primary options. The contour (or isoline or isopleth) map consists of closed curves known as contour lines which connect all points having the same numeric value or height. It is based on the use of these contour lines, each of which represents a uniform value throughout its length. Contour lines emerge from a datum plane at selected levels which are determined from the scale of the map and the range of the data. Between any two adjacent contour lines, a continuous variation or slope is assumed. Therefore, the use of contour lines should be restricted to the representation of spatially continuous information, such as most topography, rainfall and population density.

The conformant (or choropleth) map is based on conformance to the boundaries of a data zone. It is best suited for data, either qualitative or quantitative, whose areal limits are of significance, and whose representation as a continuous surface is inappropriate. Each data zone is enclosed by a boundary conformant to some predefined spatial unit. The entire spatial unit is given the same value, and symbolism is assigned according to its numeric class. Local variation of the data within the boundary will not be apparent, but on the average, will be correct.

The proximal map is based on proximity to a data point. It is very similar in appearance to the conformant map. However, the spatial units are defined by nearest neighbor methods from point information. Each character location on the output map is assigned the value of the data point nearest to it. Boundaries are assumed along the line where the values change and conformant mapping is applied.

Types of Packages

The titles of all available packages, with a brief explanation of their general purpose, are listed below in the sequence of their position in the deck. For more complete and definitive instructions in the preparation of these packages, see Appendix A.

A-OUTLINE

This package describes the outline of the study area if non-rectangular, by specifying the coordinate locations of the outline vertices. This package is used only for contour and proximal maps.

A-CONFORMOLINES

This package is used to give the positions of the data zones to which data is to be related, by specifying the coordinate locations of vertices on the zonal outlines. This package is required for a conformant map.

B-Data Points

This package is used to give the positions of the data points to which your data is to be related, by specifying their coordinate locations. Data points may be either the points for which data is available, or the centers of areas, called data zones, for which data is available. (When warranted by the nature of your study, and under exceptional circumstances, other centers may be used, such as centers of population.) This package is required for contour and proximal maps.

C-OTOLEGENDS

This package is used to specify the coordinate location and content of certain supplementary information called legends, appearing on the face of the map. The relative location of legends is adjusted automatically if the size and or scale of the map are altered.

D-BARRIERS

This package is used to give the coordinate location and strength of impediments to interpolation at specified vertices.

E-VALUES

This package is used to assign numerical data to the data points and or data zones, by specifying the values involved. All such data must, of course, be measured on a consistent uniform basis. (While normally required, this package may be omitted if you wish to procure a preliminary base map for checking locations before applying values.)

E1-VALUES INDEX

This package is used to adjust the reference order of data values in the E-VALUES package.

F-MAP

This package is used to specify below the map an appropriate title for the identification of each separate map you may wish to run. In addition, it instructs the computer to make each specific map pursuant to certain electives. These electives provide a variety of options for obtaining maps suited to your particular needs. (See Appendix A) An F-MAP package is required for each map desired.

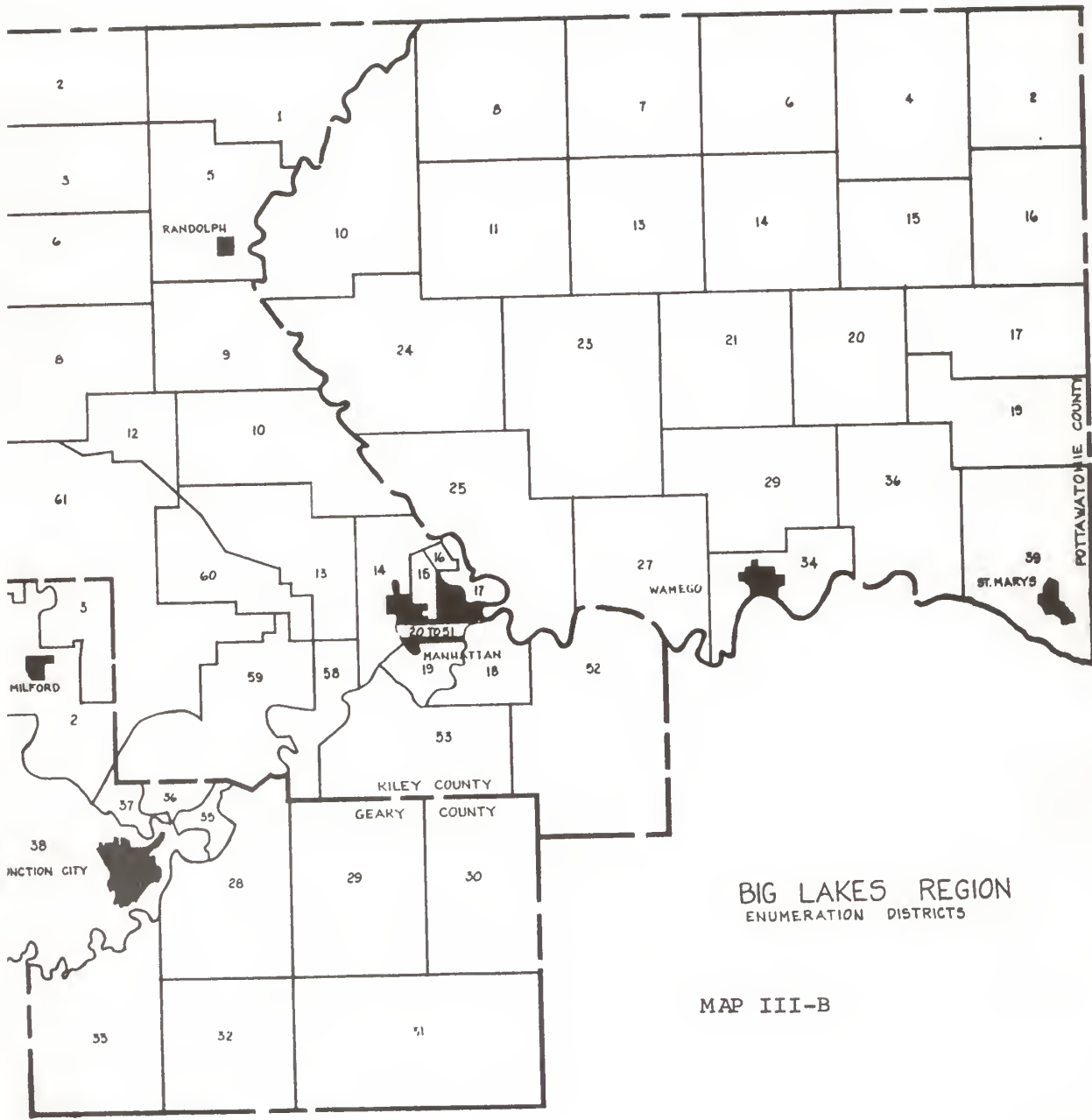
The possible applications of the SYMAP program in a Planning context is many and varied. The above information is a brief discussion of what goes into the program. With this we can begin to see the possibilities that such a mapping technique might have.

SECTION III Methodology

In developing the necessary input for the SYMAP program the first requirement is the data to be mapped. Because of the convenience of Census information, this was decided upon to be the best approach. The Population Research Laboratory at Kansas State University has on hand the Census Summary Tape developed from the 1970 first count Census. This tape is divided into two files. File A contains census information broken down by block groups and enumeration districts. These tallies are for small areas for which there exists no other printed reports. The tape also contains more data items for each area than are available from the printed reports. File B contains tallies for state, counties, minor civil divisions or Census county divisions. These first count data files are considered final at the time they are created; they will not be updated as a result of subsequent processing. Since File A contained information by enumeration districts, this provided convenient data zones for the computer mapping. The wide range of data items which are contained on the tape provided an ideal source for selecting data for mapping purposes. This data ranges from all types of population tallies to tallies concerned with housing. (See Appendix B.)

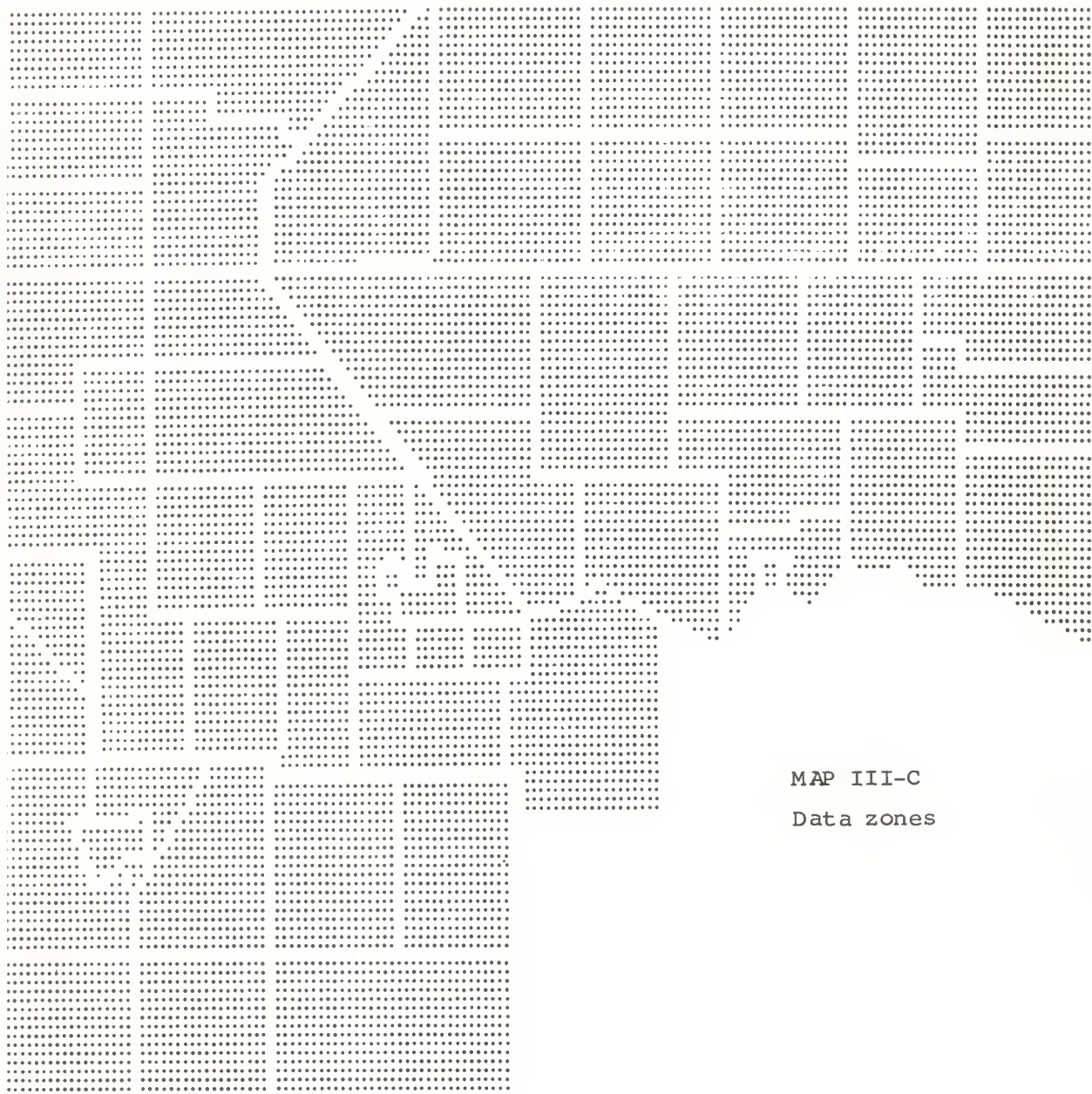
The Population Research Laboratory did not have a program available to retrieve this data off the tape, so it was necessary to write one. (See Appendix D.) Once this was completed and after many problems in getting the tape to run on the computer, success was finally achieved in getting some output. The output was in the form of groups of numbers divided into sections (see Figure III-A). Each section represented an enumeration district. The problem was delineating these groups of numbers to determine what each number represented. This was done through the aid of the Census User's Guide (see Appendix C), which explained in detail what each number represented and where it was located in the section.

With a source of data now in useable form, the next step is developing the source map for the computer mapping. The source map is the geographic area to be mapped. From this map one may establish the relative positions of controlling points to which the data will relate. Through conversations with Mr. Ken Mai from the Institute of Social and Environmental Studies at the University of Kansas, maps were received of the three county area. These maps showed the boundaries of the enumeration districts used for Census collection purposes. (See Map III-B). By developing a map with these boundaries and using a grid, the points necessary for describing the study area (See Map III-A), could be plotted. It was necessary to plot the points for the outline of the area, (needed for a contour map), but also the outlines of the data zones which is required for a Conformant map. With these points plotted and the necessary control cards for the program, it can now be run through the computer without data to produce a map showing the delineation of the data zones. (See Map III-C). These data zones represent the enumeration districts, but in the case of Junction City, Manhattan, and Wamego where several apply, each area is taken as one enumeration district. The total value of the data applying to that particular area is then taken to represent it.



BIG LAKES REGION
ENUMERATION DISTRICTS

MAP III-B



MAP III-C
Data zones

To prepare the input for production of maps with data, one simply has to put this data in the E-VALUES package of the SYMAP program. After setting the F-MAP package appropriate to the data, the program is ready to run through the computer. What is important to remember is that once the initial outline for the study area is set up, it is simply a matter of applying the data to the area to be mapped.

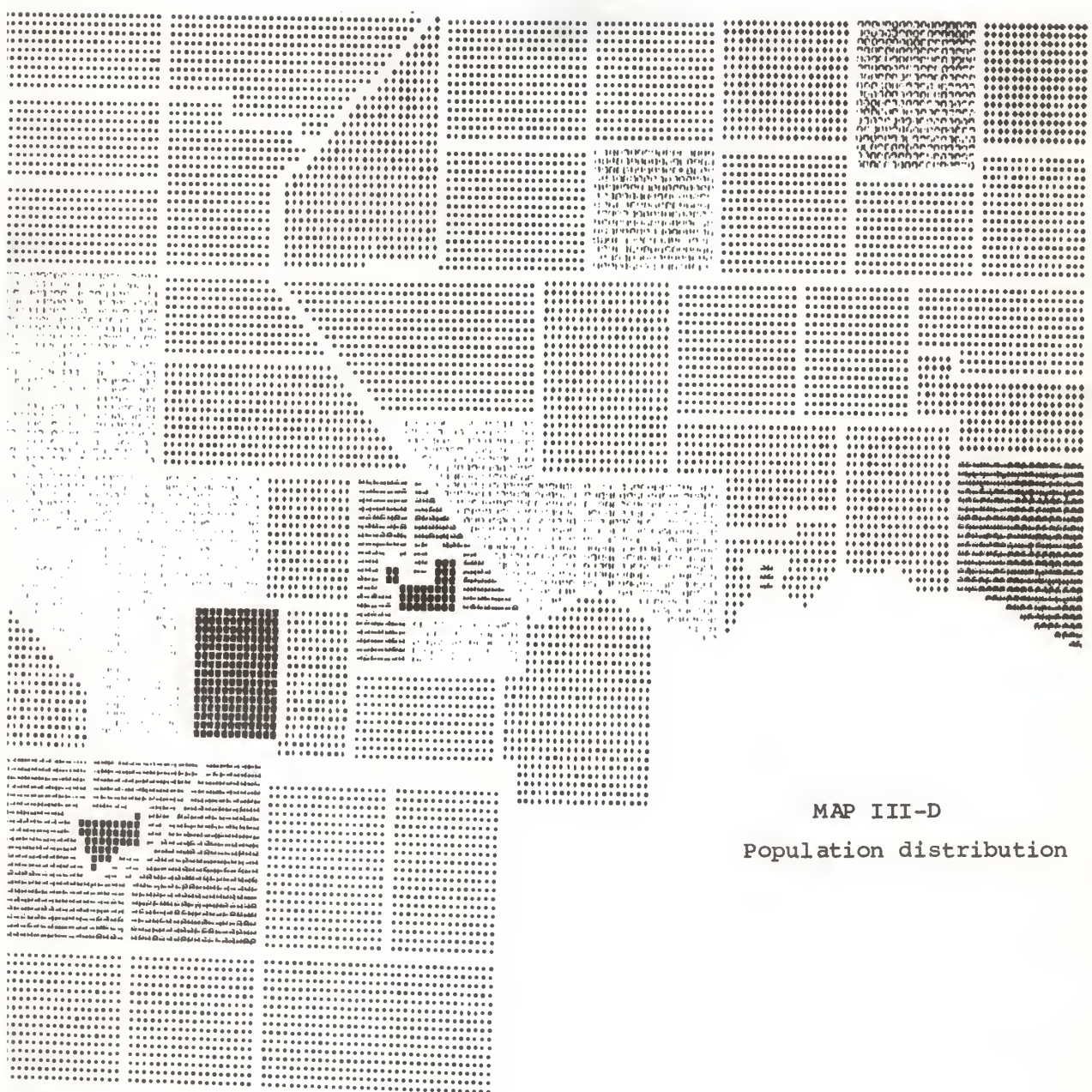
The Maps

An examination of each of the maps developed through computer mapping is done in the following pages. The data selected for each of these maps were done in such a manner as to give good examples of the program's capability.

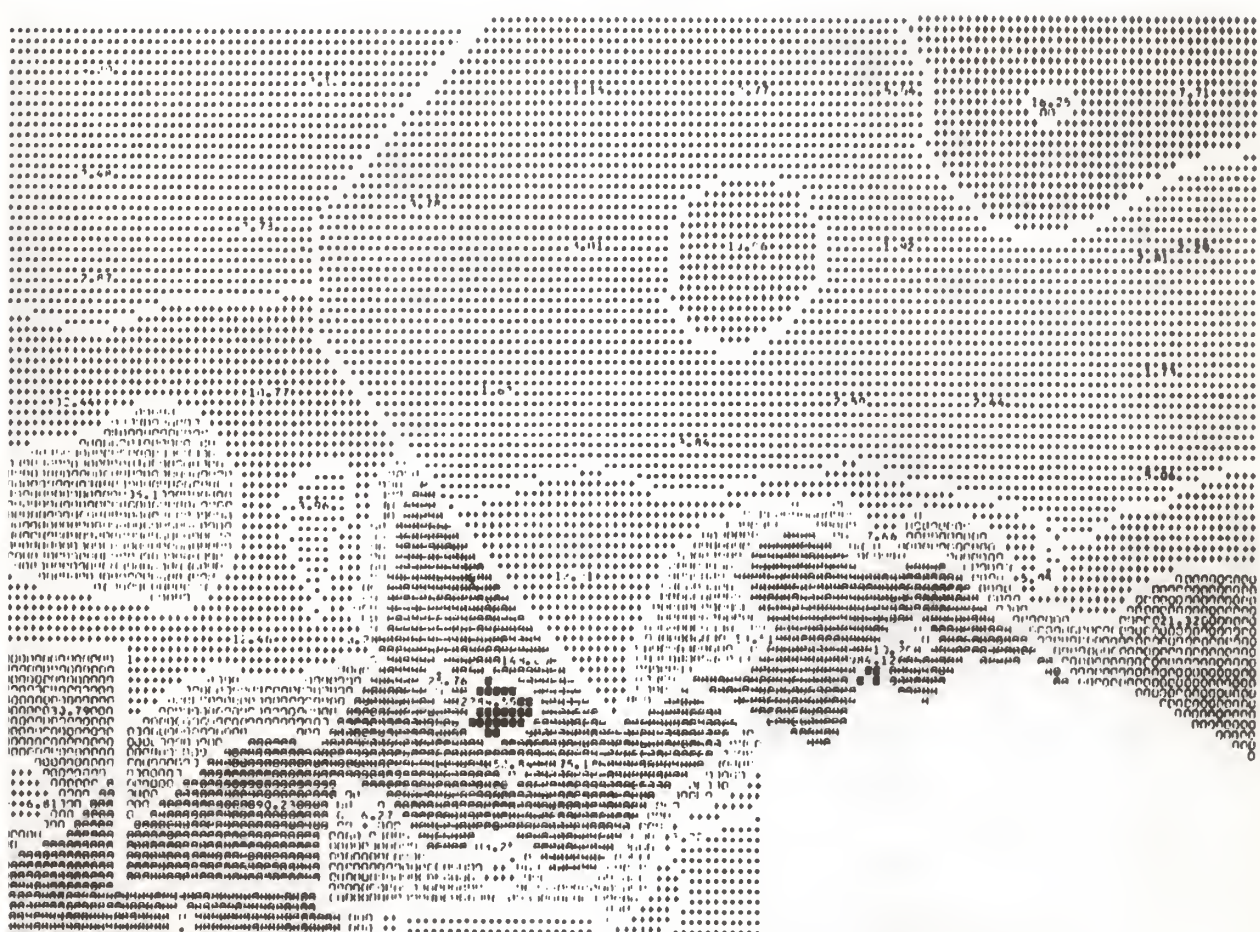
Map III-D

The first map to be discussed is a conformant map of population distribution in the region. Since this map is a conformant, the distribution of population is based on differences between data zones, or more specifically, enumeration districts. When one first looks at the map, his eyes immediately travel to the concentration of dark printing in the Manhattan and Junction City areas. These dark areas represent the higher concentrations of population, the lower population concentrations show up as a lighter type of print. The data for this map ranged from a minimum of 57.0 to a maximum value of 26897.0. An examination of the histogram indicates the frequency of the occurrence of data in each of the five different levels. In the lowest population level, the highest occurrence of data is shown, from there it gets progressively smaller. These levels are automatically set up by the computer or can be set up to the user's specifications. If one wanted to rank the enumeration districts in this region by population from lowest to highest, this map would be ideal in indicating differences in population.

Application of this map, for planning purposes could be very interesting. If one were to take population counts from an early Census and compare that map with this one, trends in certain areas could be developed as to the population changes. This might lead to



MAP III-D
Population distribution



MAP III-E1

Housing unit density per acre

graphical representation of migration in the region. Such a map also shows the less populated area or rural area of the region, which is an indication of probable agriculture or farming areas.

MAP III-E1

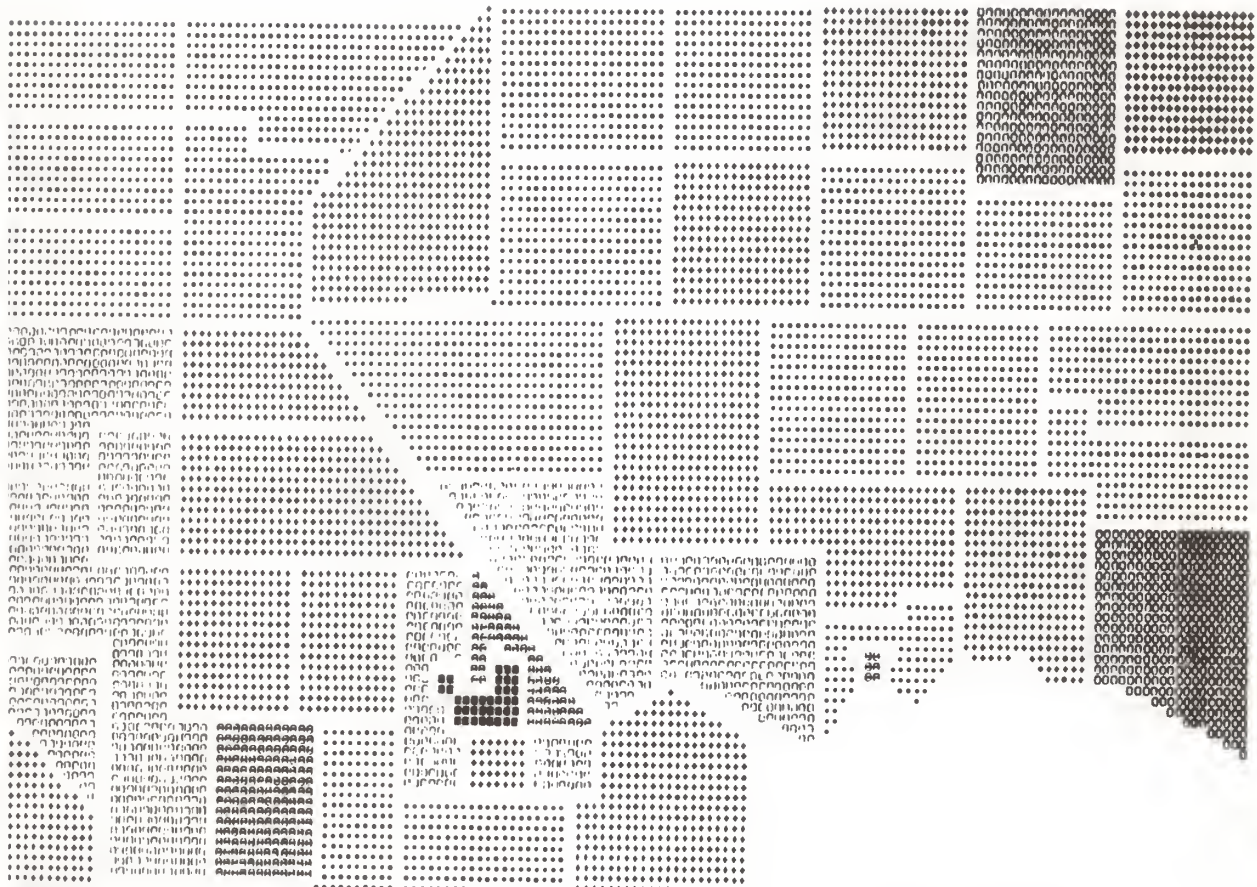
This map is a contour map indicating housing unit density in the region. Contour maps are best suited for representation of spacially continuous information, which makes a housing density map ideal. Each square inch of the map represents approximately 6300 acres.

The highest level of density (indicated by dark print) is located in the three largest urban areas in the region, Junction City, Manhattan and Wamego. The next level of density is concentrated around the Wamego area and also the Junction City-Ft. Riley-Manhattan area. A look at the histogram indicates that the lowest level of density contains the most occurrences of data values, almost twice as many occurrences as the next lowest level. This is an indication of the lack of high housing density through out the region. In fact, 49 of the 56 data points show a housing density figure of less than 49.73 housing units per 1000 acres.

In a planning decision-making process, more time should be taken to substantiate or refute a particular aspect of a decision. A map such as this one indicating density of one type or another in a graphical area, could be very useful. All that would be necessary is a willingness to do such a thing.

MAP III-E2

This map is a contrast to the last map in that it indicates housing unit distribution also. The data used for this map is taken for each data zone rather than per acre. It is a conformant map of course and housing unit figures are based on the total per enumeration district. The Manhattan area taken as one data zone is indicated as having the most units. Ft. Riley, Junction City and Wamego fell into the next highest level. This map is useful when considering total housing unit comparison between data zones. It could be useful in conducting housing studies, or used as a method showing possible projections for utilities in the region. A graphical representation of housing units by data zones



MAP III-E2

Housing unit distribution

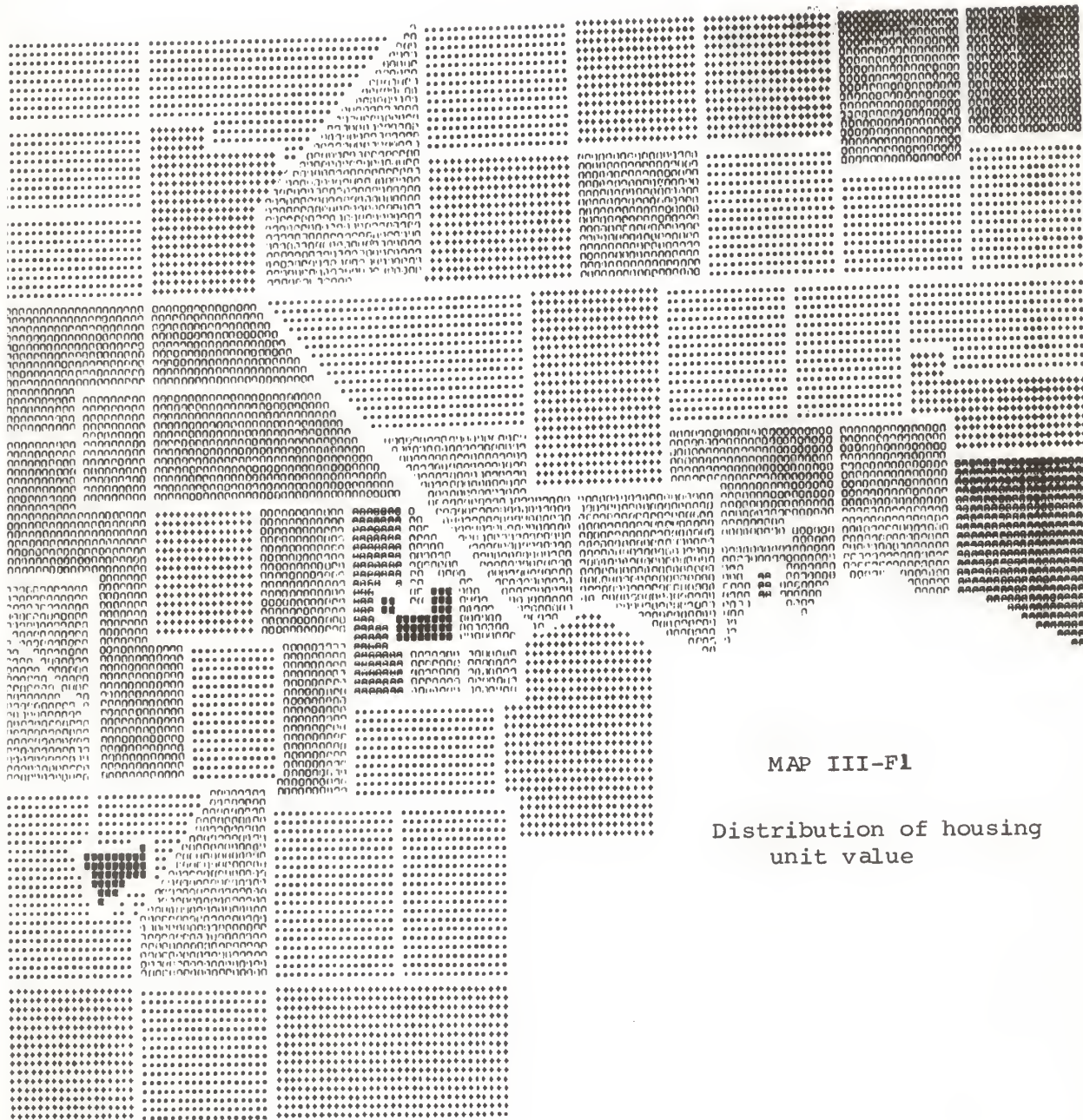


is far more useful to the planner than just raw data. For one thing, in analyzing this map, he utilizes his sense of sight in the process which is not the case in looking at just raw data. It also helps in the explanation stage where he is trying to show or prove a point with housing information. A map is a far better visual aid than just plain numerical figures.

MAP III-F1

This is a conformant map showing total dollar value for housing units in the region. The data for this map was tabulated for owner-occupied and vacant-for-sale-only one-family-houses which are on a place of less than 10 acres and have no business or medical office on the property. This figure does not include mobile homes, trailers, cooperatives or condominiums. What also needs to be pointed out about this total is that the tabulated value was scaled by a factor of 250 for tally purposes. Multiply the aggregate value by 250 to obtain the true value.

Junction City and Manhattan are indicated as being those areas of the highest aggregate dollar value for units. This stands to reason because they are the most populated areas in the region. The range of values for this map is from a minimum of 0 to a maximum of 278,670 in Manhattan. Those data zones which have an aggregate value of 0 probably in most cases contain all farms of a size no larger than 10 acres. This map along with the population distribution map may be helpful in locating those areas of the region which are primarily agricultural. The histogram indicates that 39 per cent of the data zones have an aggregate dollar value between 1114.68 and 9289.00. An additional 34 per cent of the data zones have an aggregate dollar value between 0 and 239.66. These figures could lead to an indication of the relative tax base in each data zone. Such a map could be useful in a housing study of the region.



MAP III-F1

Distribution of housing unit value

MAPS III-F2 and III-F4

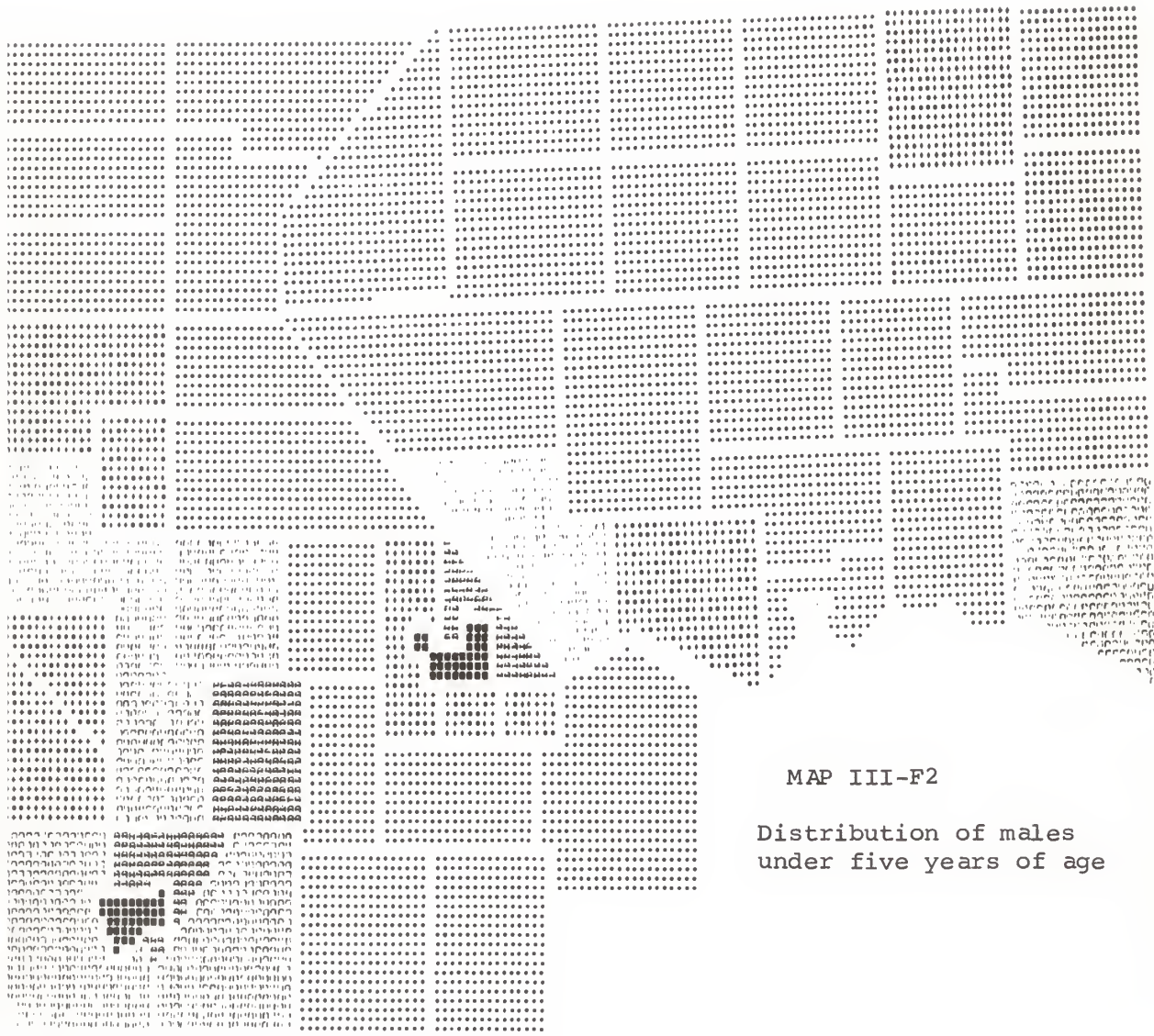
In determining the possible necessity for the location of day care centers a map of males and females under five years of age would be of particular usefulness. These two maps, both of which are conformant, might help in projections for the need of day care centers as well as new elementary schools. They give a visual idea of the geographical location of the numbers of children under the age of five.

A look at the histogram indicates the largest occurrence of data falls in the lowest level. This level indicates totals of from 1 to 23 children in a data zone. This is indicative of the type of region we are dealing with, in that it is mostly rural. The two most populated urban areas in the region again are indicated as having the highest total for children under five. Wamego falls in the third level which might be surprising. Generally, in the data items that have been mapped, so far, Wamego has fallen either in the fourth level or fifth. This might be an indication of a change in Wamego's population growth. Ft. Riley shows up as having counts which fall in the fourth level, as well as the data zone just to the immediate northeast of Manhattan. The primary worth of these two maps lie in their potential ability to project the areal location of future elementary school needs and day care centers in the more populated areas.

MAPS III-F3 and III-F5

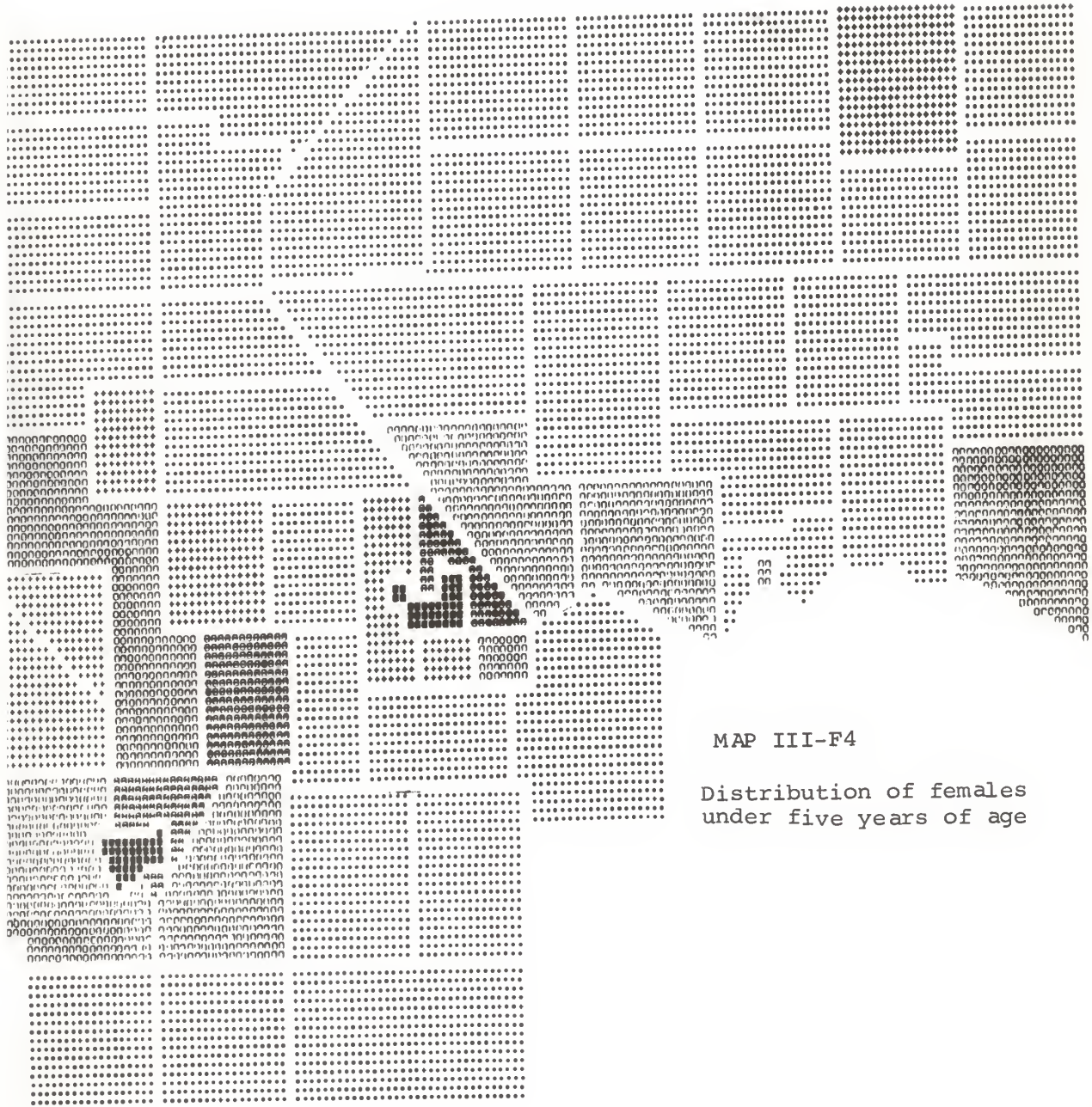
These two maps are conformant maps showing the distribution of elderly (75 years of age and older) in the region. What may be of some significance is that in Geary County all data zones show that the number of females 75 years old and over is less than 23. The only change is in Junction City with a female 75 years and over population falling in the highest level. The male elderly population in Geary County is similar to the females except that one data zone shows up as having a population in the second level (23 to 46).

The usefulness of maps showing distribution of the elderly can be seen in their potential for showing the possibilities of future locations for nursing homes, public housing for the elderly, and special hospitals for the elderly.



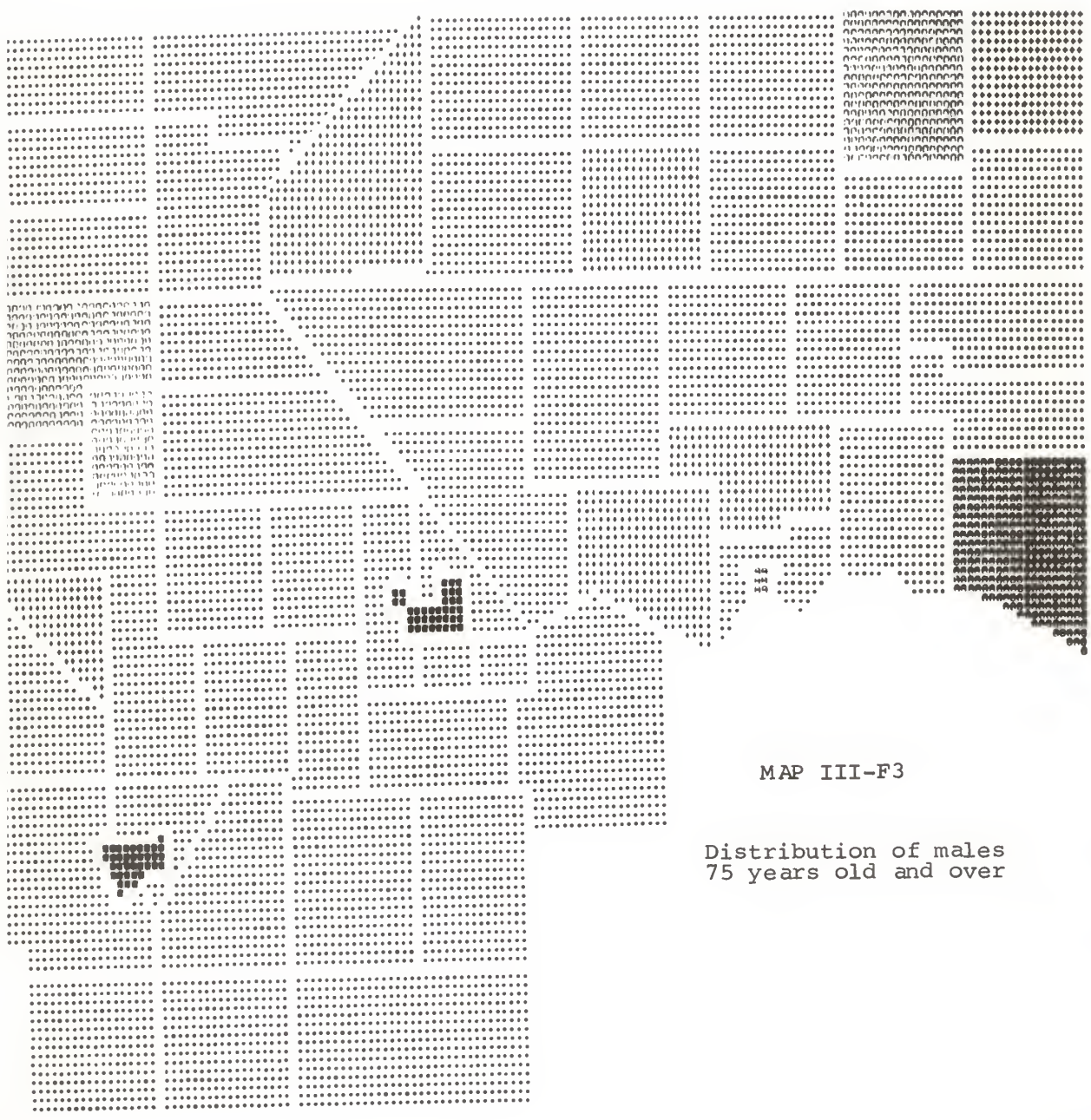
MAP III-F2

Distribution of males
under five years of age



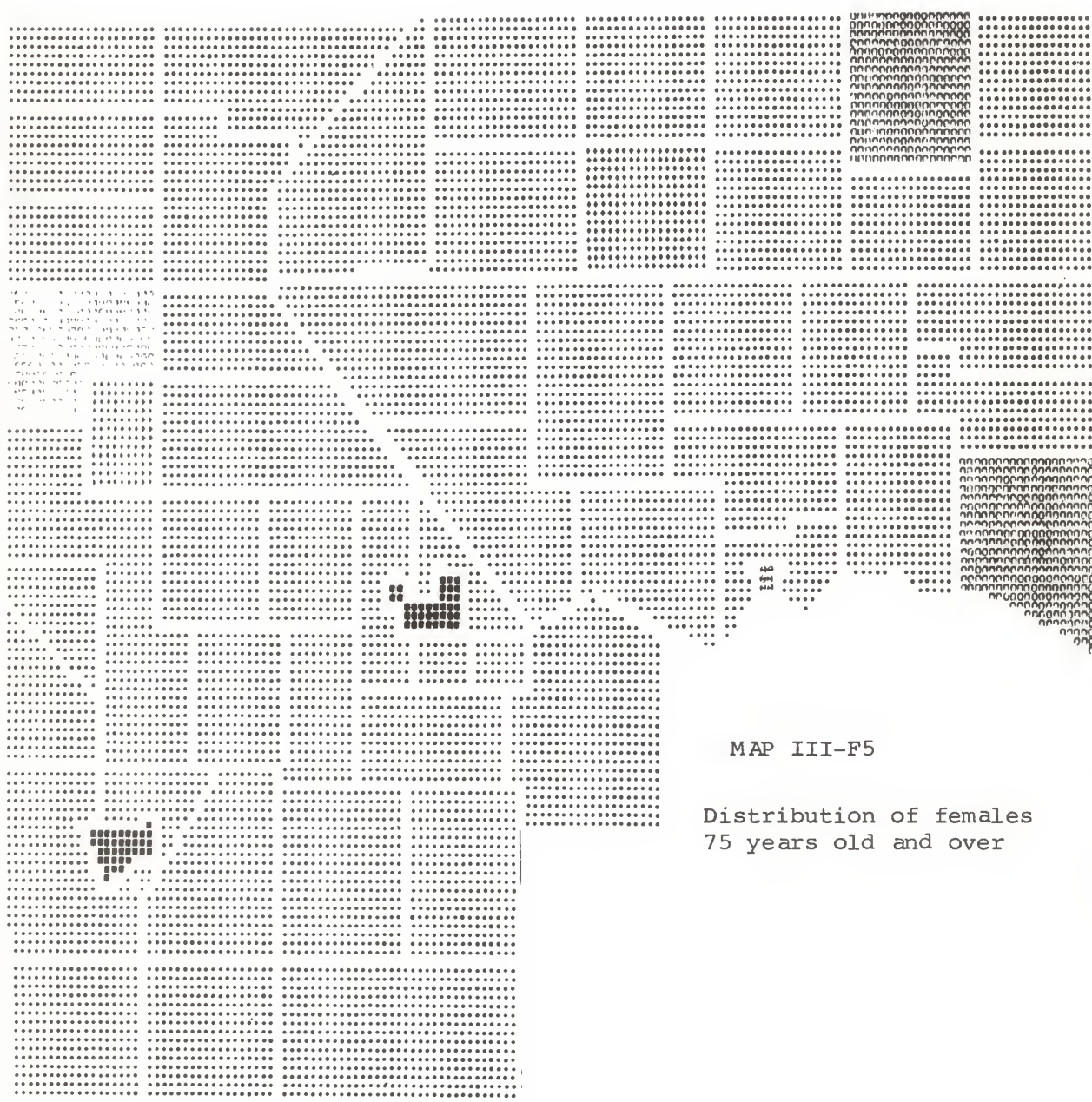
MAP III-F4

Distribution of females
under five years of age



MAP III-F3

Distribution of males
75 years old and over



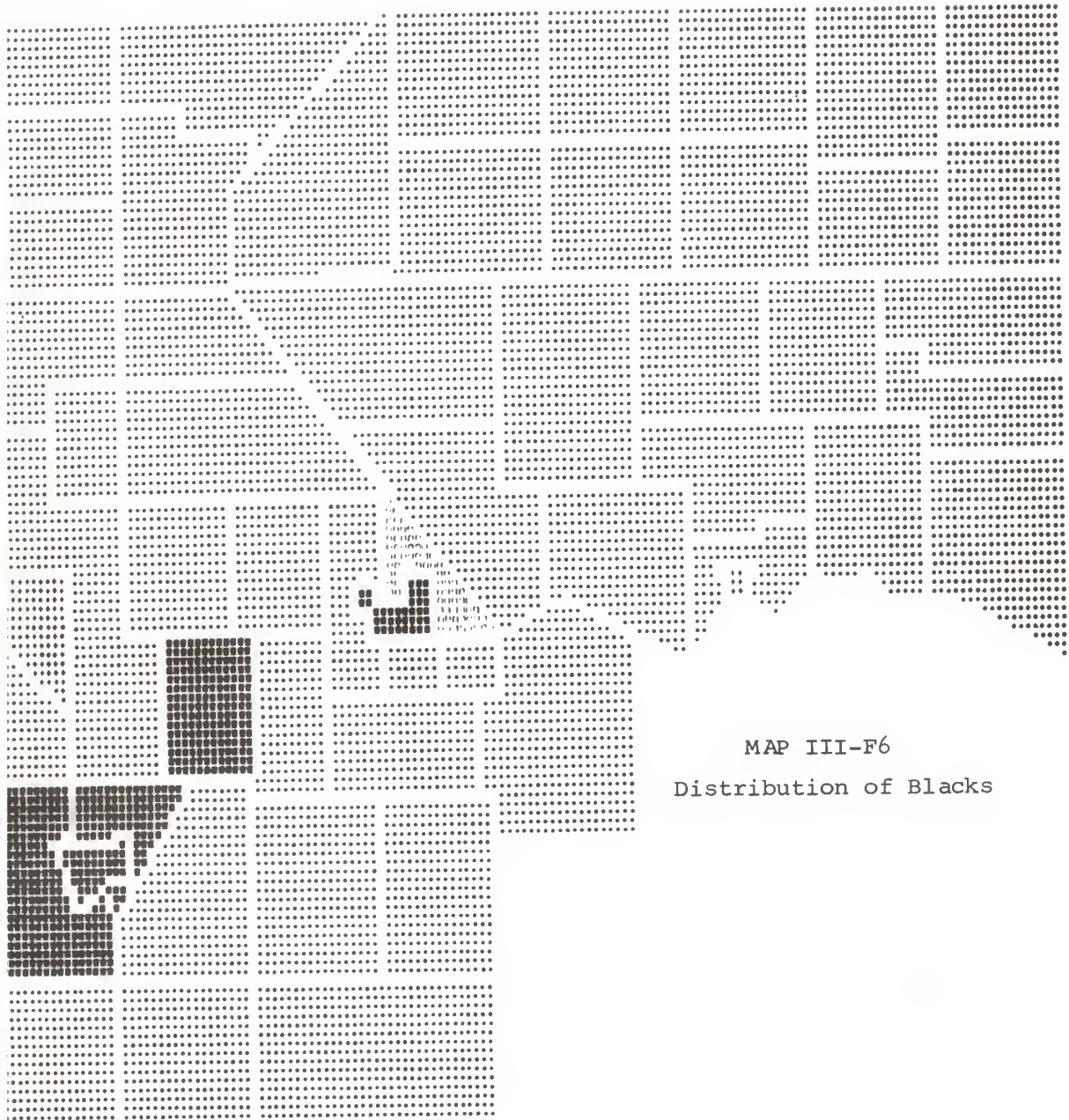
MAP III-F5

Distribution of females
75 years old and over

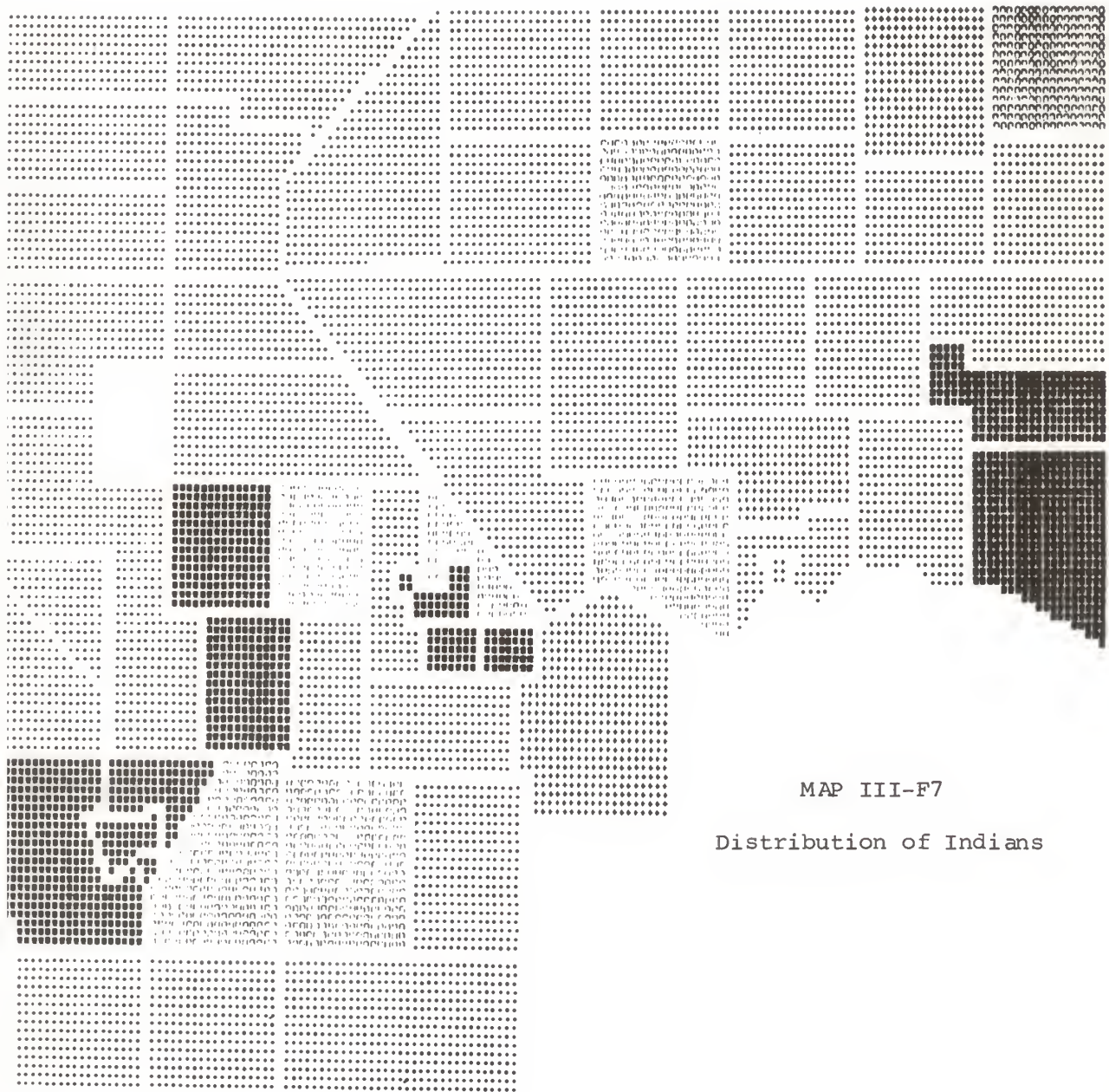
MAPS III-F6 and III-F7

The data for these two maps was taken from the tallies listed under race. Map III-F6 shows the distribution of Blacks throughout the region and Map III-F7 shows the Indian distribution. What is almost startlingly evident is the population of Blacks is distributed at the two extremes. The Junction City-Ft. Riley-Manhattan area at one extreme with the highest level of population and the rest of the region at the other extreme with the lowest level of population. The distribution of the Indian population is a little better than this. The histogram indicates that .33 per cent of the Black population is located in 48 data zones of the region while 95 per cent of the population is located in five of the data zones. For the Indians, .33 per cent of the population is located in 34 data zones and 95 per cent in 10 data zones. A contrast between the Black and Indian distributions exists in the fact that two data zones in Pottawatomie County are indicated as being located in the highest level of population for the Indians. These data zones are in the area of St. Marys. Three more data zones in Riley County are also shown in this highest level of population.

Application of such maps for planning purposes are somewhat limited. They do show graphically, however, very interesting contrasts in population distribution and would be an asset to a study of population in the region. These maps also show that Black population in the region is limited to the more populated areas. This is not quite the case for the Indians, although the high percentage in the St. Marys area is due to an Indian Reservation.



MAP III-F6
Distribution of Blacks



MAP III-F7

Distribution of Indians

MAP III-F8

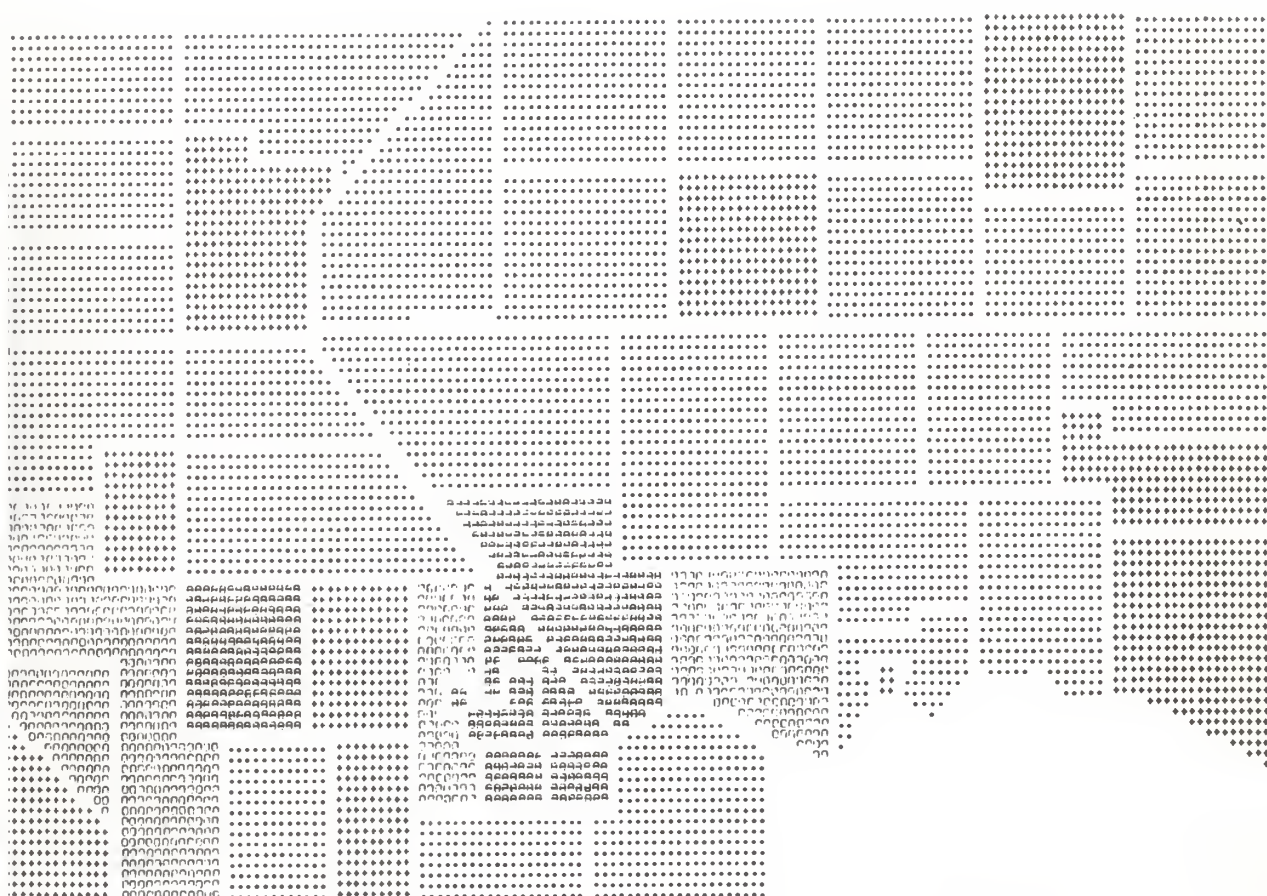
This is a conformant map showing the distribution of occupied mobile homes or trailers in the region. 33 per cent of the occupied mobile homes are located in Junction City. This 33 per cent is in the highest level on the histogram. The high percentage of mobile homes in Junction City as compared to the rest of the region is an indication of its immediate location to an Army installation, Ft. Riley. Most people in the Army are transient, therefore, this could lead to a high probability of the usage of mobile homes.

A map showing the location of occupied mobile homes in an area could have applications in projecting needs for utilities if taken with other maps at different periods of time. Such a map could be useful in developing an idea about the need for location of mobile home parks in a particular area.

MAP III-F9

The data for this map is for owner-occupied units of a value less than 5000. This value was tabulated as in the data for Map III-F1, for owner-occupied and vacant-for-sale-only one-family houses. These houses must be on a place of less than 10 acres and have no business or medical office on the property. This value was not tabulated for mobile homes, trailers, cooperatives or condominiums. Such a map could be useful in locating those areas which could have a need for low cost public housing.

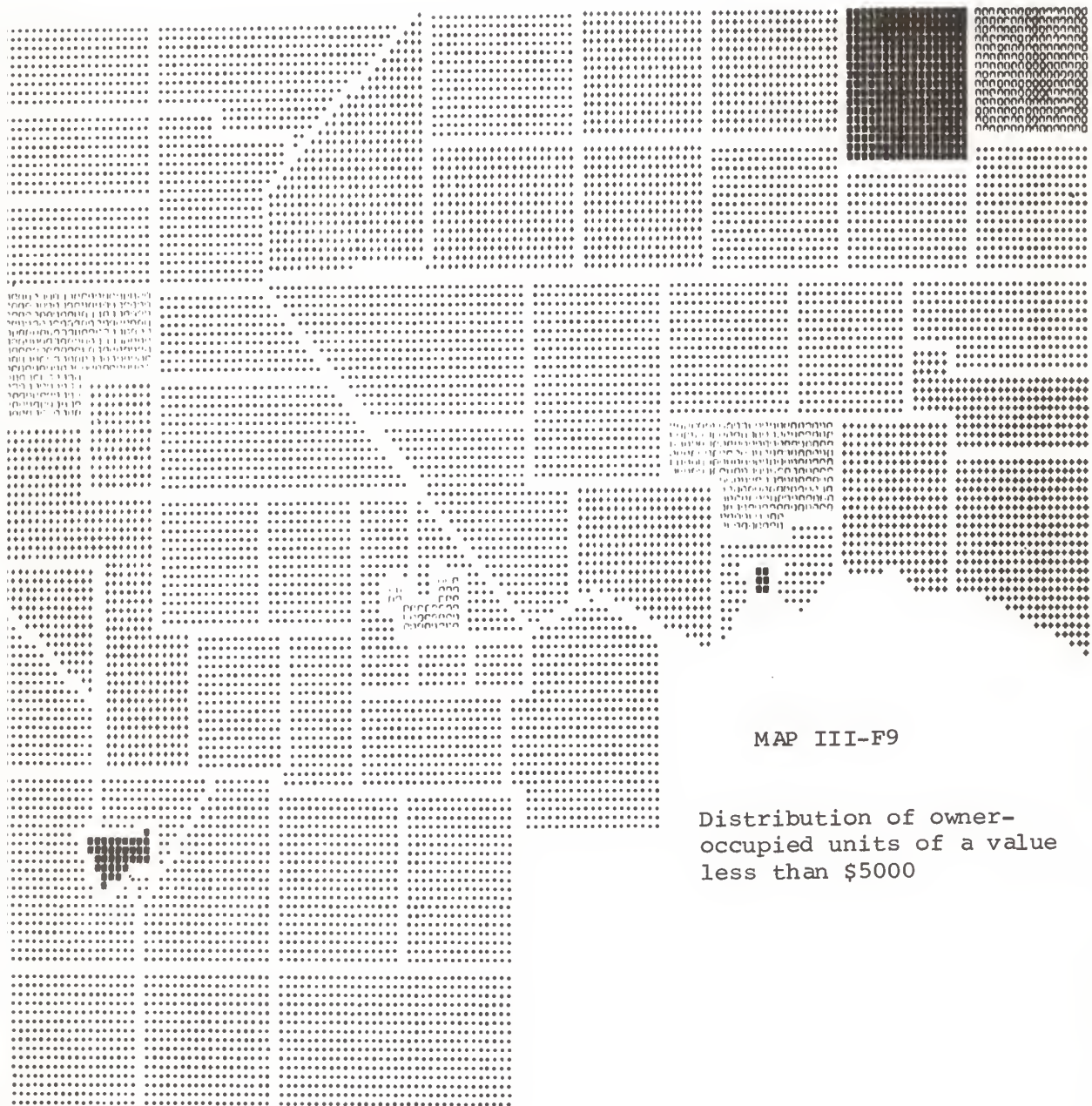
It is interesting to note that 40 per cent of this data fell in the highest level on the histogram for frequency distribution. This 40 per cent occurred in three data zones, Junction City, Wamego, and a data zone in the northeast corner of Pottawatomie County. The town of Onega is located in this data zone. An optimistic sign for the region is shown in that 10 per cent of the data values are contained in 37 data zones. These data zones have an occurrence of units of a value less than 5000 below nine. This is an indication that generally for the region the value of housing is better than 5000 dollars.



MAP III-F8

Distribution of mobile homes





MAP III-F9

Distribution of owner-occupied units of a value less than \$5000

CONCLUSION

"A picture is worth a thousand words", was once a very popular saying portraying the importance of visual aids in a discussion. The planner has learned this importance and shows it by his massive use of maps and diagrams. Computer mapping is another tool that can be added to his list of visual effects. This tool is effective in producing large volumes of a variety of maps quickly and accurately.

The usefulness of computer mapping, particularly SYMAP, is limited when talking of producing one or two maps for display purposes, because a draftsman can do this just as well, if not better. But when interested in several maps, displaying all types of data, then SYMAP's usefulness and efficiency becomes very apparent. A draftsman can very easily do the things that a conformant map does, but not as quickly. A person can figure out the contour intervals for a contour map, but not as quickly as the computer. In today's world, where time is becoming a bigger and bigger factor, tools that reduce the time required for decisions can be very valuable and economical.

An example of the savings in cost and time of computer mapping can be pointed to in this project. To produce the thirteen computer maps in this project took a total time of approximately one hour at a cost of \$120. It would have taken a draftsman approximately 24 hours at a somewhat lesser cost. But the time savings well outweighs the small difference in total cost.

Another point that should be emphasized about SYMAP is its flexibility. The SYMAP program has the ability which permits the user to build the packages to his own unique purposes. Not only can the program provide maps of one type, but it can also provide several different types of each of the three different types in one computer run. This multiplicity of mapping functions makes the SYMAP program an indeed valuable tool for display purposes.

The size of an area that could be considered for computer mapping is of no importance. It is the scale of the interested area that should

be closely examined when preparing the base map. The size of the print in the mapping process limits very small scale maps; the main consideration here is the size of the data zones to be produced. They should be large enough so that the boundaries of the zones can be readily distinguished visually. Problems often arise in obtaining data for very small zonal areas. Because of this reason areas of a size smaller than an enumeration district usually are not used for data zones in the preparation of the base map.

SYMAP has another limitation in the preparation of the data for input. The program does not perform mathematical calculations to manipulate the raw data into useable form. An example of this can be seen in the preparation of the data for MAP III-EI (Contour map of housing density). It was necessary to convert the data for this map from totals for each enumeration district to totals per acre, thus coming up with a density figure. A small computer program can be written to do these calculations. This same program could also punch the calculated answers on cards, which would be necessary input for E-VALUES package in the SYMAP program. These smaller programs would have to be written to the user's specifications. Each user will require different types of calculations and, therefore, different types of computer programs to perform these tasks.

Other versions of printer plotter mapping techniques can be very useful to the planner besides SYMAP. The OPLLOC program which was discussed in Section I is a little more sophisticated than SYMAP in that weights are assigned to each data value and calculations are performed on this basis. The OPLLOC program produces a composite SYMAP of weighted averages. It can also be very useful to the planner in developing optimal locations for industries or major facilities. Further information on OPLLOC can be obtained from the Office of Planning and Program Support of the Economic Development Administration.

Further information on SYMAP can be obtained from the Laboratory for Computer Graphics and Spatial Analysis at Harvard University. The Laboratory has three other computer mapping programs which might prove useful to the planner:

1. SYMVU: generates three dimensional line drawings of continuous surfaces on a pen or CRT plotter. The program typically is used to prepare perspective views of "surfaces"

implicit in the various types of maps produced by the SYMAP program. Capabilities of the program include hidden line removal and user definition of image size, vertical and horizontal rotation.

2. GRID: uses a line printer to efficiently display data collected on the basis of a rectangular coordinate grid. GRID uses an array of values which are categorized, assigned graphic symbols and then displayed in the form of a map. The program is written to accept land use, census or any other data which has been aggregated to a grid.
3. CALFORM: produces shaded conformant maps on a line plotter by using symbolism (usually in the form of shading) to represent data values associated with geographic areas such as census tracts, municipalities or counties.

This project was intended to show some of the useful applications of SYMAP. The data chosen for mapping is not the only type of information useful in the decision-making process. A variety of types of information can be mapped; the situation dictates the data required for a map. Multi-county regional planning is a potential area where such a technique can be applied to its fullest capabilities. Its usefulness can be limited only by the limitations that the planner puts on it. Graphical display of data could be an important aid in the decision-making process.

APPENDIX A SYMAP

PREPARATION OF PACKAGES

A-OUTLINE

This package is optional and is used to specify the outline of the study area for a contour or a proximal map, when the study area does not fill the entire space within the rectangular map border.

On the first card of this package, punch "A-OUTLINE" in columns 1-9, and the letter "X" in column 23 if tabular printout of the input data is not desired.¹ (If coordinate measurements are by row and column, continue punching the first card with the number "8" in columns 31-32 and the number "10." in columns 41-43.)

On the last card, punch the number "99999" in columns 1--.

On other cards, to be inserted between the first and last, punch the coordinate locations of the study area outline vertices (namely, those points at which the outline changes its direction). Punch each vertex location on a separate card, starting with the uppermost vertex and proceeding clockwise back to and including once again the point of beginning. (This repetition tells the computer that the outline is complete.)

If there are two or more vertices equally high, start with the one furthest to the left. If the outline is curved, approximate the curve with short straight-line segments meeting at what will then be vertices. If the outline is overly complex, it may be simplified as desired. An approximate outline will usually prove adequate, especially if the source map is much larger than the anticipated output map.

Punch the vertical coordinate (measurement down from the top border) as a decimal number in columns 11-20. Punch the horizontal coordinate (measurement across from the left border) as a decimal number in columns 21-30. The FORTRAN format is (10X, 2F10.0).

If the study area is not contained within a single outline, two or more outlines may be employed--presented in any desired sequence. (There is no set limitation on the possible number of outlines.)

¹ For the first map using a newly-prepared package, it is recommended that column 23 be left blank to allow printing of the input data. This list will facilitate checking.

For example:

A map of Italy might employ three outlines--one for the Italian mainland, one for Sicily, and one for Sardinia.

No one outline in the package may have fewer than three nor more than 100 vertices. If a large or complex outline would require more than 100 vertices, subdivide it into two or more outlines which meet along a common edge, which edge may lie at any angle other than horizontal.

For example:

The map of Chicago shown in Appendix A employed two outlines with one contiguous border. The total number of vertices exceeds 100, but each of the two outlines has less than 100 vertices.

The outline of the study area, as it appears in the final printout, will conform to the outline specified, as follows: Symbolism will appear at all print locations whose centers are within the outline. Print locations whose centers are on the outline may, or may not appear. In the case of segments running obliquely, the outline will be "stepped", with the points of all steps falling approximately on or slightly within the outline specified.

A-CONFORMOLINES¹

This package is used to specify the outline of each of the data zones which make up the total study area and with which values from the E-VALUES package will be associated. Only one data value may be associated with any one data zone, and most commonly, only one outline is needed to delineate a data zone. In certain instances, however, more than one outline is needed; e.g., for the Hawaiian Islands, on a map of the U.S.A. with data by states. In such cases, each of the outlines, which together define the whole data zone, is associated with the same data value (i.e., identified by the same reference number).

The outline of a zonal area is determined on the source map and specified on cards by a procedure somewhat similar to that employed in the A-OUTLINE package (not used for conformant mapping). It is generally a good procedure to number each of the data zones on the source map, starting with the number "1" and continuing in numerical sequence without interruption. No special sequence of location is required, but if the locations or data to be used are already in some established order, it will usually be convenient to use that sequence.

Next, the outline of each data zone should be designated on the source map. If the outline is curved, approximate the curve with straight-line segments meeting at what will then be vertices (those points at which the

¹ Short for CONFORMANT OUTLINES.

outline changes direction). If the outline is overly complex, it may be simplified as desired. An approximate outline will usually prove adequate. The outline of a data zone will most commonly be designated by at least three points. However, a data zone may be so relatively small that it must be designated by a single point, or so narrow that it must be designated by two or more points as a line. (Only two points would be needed for a straight line.)

On the source map, starting with the uppermost vertex of the outline for data zone #1 and proceeding clockwise, number the vertices consecutively, using small-size numbers to distinguish them from zone numbers. (If two or more vertices are equally high, start with the one furthest to the left.) Proceeding by zone in the established reference order sequence, designate each of the remaining zonal outlines in a similar fashion. The numbering of vertices, which by reason of contiguity have already been numbered for a previous outline, should be passed over and should not be renumbered. Thus, each vertex of each zonal outline on the source map will have a unique numerical designation. (This is essential for any de-bugging which may subsequently prove necessary.)

On the first card of this package, punch "A-CONFORMOLINES" in columns 1-15, and the letter "X" in column 23 if tabular printout of the input data is not desired. Punch "PU" in columns 26-27 if the centers of conformant zones in the format of B-DATA points (section 2.3) on punched cards is desired. Punch "PR" in columns 29-30 if the center of each zone is to be printed out as data points on the output map. (If coordinate measurements are by row and column, continue punching the first card with the number "8" in columns 31-32 and the number "10." in columns 41-43.) Punch the letter "X" in column 63 if input is on tape (unit 11). In such cases, the entire package (including the 99999 card) following the package name card must be on tape. The tape format is the same as the standard coding form for this package. The tape is rewound after the 99999 is read.

On the last card, punch the number "99999" in columns 1-5.

On other cards, to be inserted between the first and last, punch the specifications for each of the zonal outlines, completing all of the cards for the first outline before going on to the second, etc.

Extreme care must be taken to ensure that each data zone is correctly associated with its corresponding data value, and on the first card for each conformant outline, columns 1-5 are available for punching the reference number of the associated data value. However, these columns may be left blank if zonal outlines are entered in precisely the order in which their associated data values are listed, and when only one outline is included for each zone. (Sequential reference to the values as listed in the E-VALUES package is automatic--the first outline refers to the first value, the second to the second, and so on.)

To establish a reference order other than the automatic association just described, use columns 1-5 in the manner described below:

On the first card for each conformant outline, punch (or leave blank) the reference number of the associated data value as an integer right justified in columns 1-5.¹ In column 10, punch the letter "A" or "L" or "P" to indicate whether the zonal outline is to be represented as an area, a line, or a point. Columns 11-20 and 21-30 are used to specify the coordinate location of the first vertex or point of the zonal outline. (For an "area" this will be the location of the first vertex on its circumference; for a "line", its starting point; for a "point", simply the location of that point. This first card is the only one required for a "point" representation.) Punch the vertical coordinate (measurement down from the top map border) as a decimal number in columns 11-20. Punch the horizontal coordinate (measurement across from the left map border) as a decimal number in columns 21-30. The FORTRAN format is (15, 4X, A1, 2F10.0).

On additional cards, the coordinate locations for the remaining vertices or points are specified in the order of their position on the outline, one location per card, punched as on the first card. For an "area" outline, the location of the first vertex should be repeated to "close" the outline. Nothing is punched in columns 1-10 on these cards. Thus, the FORTRAN format is (10X, 2F10.0).

B-DATA POINTS

This package is used to specify the coordinate locations for the points at which data is to be provided. Every data point must be numbered on the source map for reference, starting with the integer number "1" and continuing without interruption. Data points may be located outside the study area, and even beyond the rectangular map border. In the latter event, however, their location will not appear. No special sequence of location is required, but if the locations or data to be used are already

¹ Selective use of these columns may prove convenient when simple adjustments in the reference order can be made.

For example:

If "-1" (minus one) is punched in columns 4-5, the reference number will be assumed to be the same as for the previous outline; if "-2" (minus two) is punched, the reference number will be assumed to be the same as for the outline listed two before it, etc. If these columns are left blank for any outline, the reference number of the previous outline plus one is assumed.

The user may deduce from the last "if" that the computer reverts to the sequential reference order unless otherwise directed. He should also note that use of these "simple" adjustments will affect the absolute (but not the relative) positions of all succeeding outlines.

In some established order, it will usually be convenient to use that sequence. If a conformant map is produced from this source map, the reference number of each data point should be the same as that of the zonal outline in which it appears.

On the first card of this package, punch "B-DATA POINTS" in columns 1-13, and the letter "X" in column 23 if tabular printout of the input data is not desired. If coordinate measurements are by row and column, continue punching the first card with the number "8" in columns 31-32 and the number "10" in columns 41-43.

On the last card, punch the number "99999" in columns 1-5.

On other cards, to be inserted between the first and last, punch the coordinate locations of the data points, each data point on a separate card. There is a limit of 1000 data points for any one map. If more data points are needed, divide the work into two or more parts with some overlap. Proceed strictly according to the numerical order of the reference numbers as established on the source map. Be sure that the cards are kept in proper sequence. Punch the vertical coordinate (measurement down from the top border) as a decimal number in columns 11-20. Punch the horizontal coordinate (measurement across from the left border) as a decimal number in columns 21-30. The coordinate for a data point falling on the top (or left) border should be "0" (zero). Data points beyond these two borders would be located by means of negative numbers, (i.e., preceded by a minus sign). Again the FORTRAN format is (10X, 2F10.0).

C-OTOLEGENDS

This package is used to specify the relative position and content of any special wording, numbering or other symbolism desired on the face of the map or within the rectangular map border. Any supplementary information which will apply equally to all the maps in any one series may be provided, such as: the general title applicable to the study area, compass directions, major landmarks, rivers, and railroads. As maps may be run at different scales, it is recommended that the scale of the map be shown by a graphic scale, without reference to inches or other fixed dimensional units.

The map background--the area between the rectangular map border and the outline of the study area--may be used for legends to an extent deemed suitable by the user. Within the study area, however, legends should be used with restraint. This applies both to their number and size, as otherwise they may adversely affect map legibility and comprehension. There is no set limit on the number of legends.

The C-OTOLEGENDS package enables the user to specify legends as strings of characters, and symbols, to be placed on the output map in relation to the vertical and horizontal coordinates of the source map. The actual grid locations of these legends on the output map will depend on the use

made of electives 1,2,13, 14 and 15 of the F-MAP package in establishing the size and scale of the map. Coordinate locations are determined by either equal unit measurement or row and column measurement. All coordinate locations are specified by decimal numbers in the columns to which they are assigned.

On the first card of this package, punch "C-OTOLEGENDS" in columns 1-12, and the letter "X" in column 23 if printout of the input data is not desired. (If coordinate measurements are by row and column, continue punching the first card with the number "8" in columns 31-32 and the number "10" in columns 41-43.)

On the last card, punch the number "99999" in columns 1-5.

On other cards, to be inserted between the first and last, punch the specifications for the legends desired, as directed in Table 2.1. The cards required for each legend must, of course, be in correct sequence; however, OTOLEGENDS may be specified in any order without regard to type or their location on the map.

A character is any one of the following key punch designations: 123456789ABCDEFGHIJKLMN0PQRSTUVWXYZ+.)-\$*/,(=' and the blank.

A symbol (for the purposes of the program) is composed of four characters, printed one on top of the other in the same location, any or all of which may be blank. This process is called overprinting. Examples of such symbols are "Ø", "⊗", "■". The last symbol is composed of the characters "O", "X", "A", "V", and usually appears as solid black on most printers.

A string is an ordered set of one or more characters; e.g. "NEW YORK: or :*/*/*/".

There are three major types of legends which can be specified in the C-OTOLEGENDS package. Each type is associated with a distinct type of figure on the source map, as follows:

POINT LEGEND:

This type of legend is associated with a given point on the source map. The legends which can be associated with this point are of three types: i) a horizontal row of characters, ii) a vertical row of characters (a row of characters may not include overprints), or iii) a single symbol (composed of four characters overprinted, any or all of which may be blank).

Horizontal and vertical legends require two cards for each legend. On the first card, column 1 is blank if the character string is to proceed horizontally across, or contains a minus sign ("-") if the character string is to proceed vertically down the map. Columns 2 and 3 are blank, and the number of characters in the string is punched as an integer right justified in columns 4-5. This number may not exceed 50. Columns 6-9 are blank, and the letter "P" for "POINT" is punched in column 10 to indicate that the associated figure is a point. The

location of the point on the source map with which this character string is associated is specified by punching the vertical coordinate (measurement down from the top border) in columns 11-20, and the horizontal coordinate (measurement across from the left border) in columns 21-30, both as decimal numbers. If the first character of the string is not to appear at the row and column location of the associated source map point, punch as a decimal number in columns 31-40 the number of rows to be added or subtracted and/or punch the number of columns to be added or subtracted in columns 41-50. (See example below). On the second card the character string desired is punched, beginning in column 1. It may not extend beyond column 50, and should end in the column whose number appears in columns 4 and 5 of the preceding card.

Assume that we wish to indicate the location of Haifa, Israel on a map with the character string "HAIFA", and that the vertical and horizontal coordinates of Haifa on the source map are 7.43 and 2.31. If we leave card columns 31-50 blank, the letter "H" of "HAIFA" will be printed (on the output map) at the associated location of the point with coordinates 7.43 and 2.31. If we wish to center the name "HAIFA" so that the "F" would fall on the precise location of the city, the legend would be moved two columns to the left by specifying "-2.0" in columns 47-50. The two cards for the latter legend would be punched:

column 1-5	10	11-20	21-40	31-40	41-50
5	P	7.43	2.31		-2.0
HAIFA					

If, instead, we wished the name "HAIFA" to be centered and to appear on the line below the actual location of the city, "1.0" would be punched in columns 38-40 as the number of rows to be added. (We might wish to do this if a data point symbol is to appear on the actual location). The two cards for this legend would be punched:

5	P	7.43	2.31	1.0	-2.0
HAIFA					

A single symbol legend requires only one card and is specified as follows: leave the first five columns blank; punch the print and overprint characters for the desired symbol in columns 6-9 (any of which may be left blank); punch the letter "P" for POINT in column 10; and punch the coordinate location of the point, the vertical coordinate (measurement down from the top border) in columns 11-20, and the horizontal coordinate (measurement across from the left border) in columns 21-30.

If the user does not wish to have the symbol appear exactly on top of the associated point, but rather a number of rows or columns away from this point (in either direction), he may specify this, as indicated above, in columns 31-40 and 41-50, respectively.

LINE LEGEND:

Line legends resemble single symbol point legends, except that the symbol specified appears everywhere along the specified line rather than at a single point. Line legends require two or more cards and are specified as follows:

Columns 1-5 are left blank; punch the print and overprint characters for the desired symbol in column 6-9 (any or all of which may be left blank); and the letter "L" for LINE in column 10; then punch the coordinate location of the first point on the line, the vertical coordinate (measurement down) in columns 11-20, the horizontal coordinate (measurement across) in columns 21-30, again as decimal numbers. There is no capability for row or column displacement with LINE and AREA legends.

The succeeding vertices on the line (points at which the line changes direction) are punched, one location to a card, on succeeding cards, in columns 11-20 and 21-30 as for the first point.

To indicate a railroad running from Buffalo to Albany to New York (and assuming that it runs relatively straight between Buffalo and Albany and between Albany and New York) we might use a line legend filled with the symbol "R". Three cards would be punched as follows:

column 6-9	10	11-20	21-30
R/	L	2.31	4.08
		2.35	7.92
		5.81	8.01

The location of Buffalo is on the first card, Albany on the second and New York on the third. Note that the "R" and "/" would not be printed side by side, but on top of one another.

AREA LEGEND:

An area legend causes the entire area within its specified outline to be filled with the specified symbol. The outline of an area legend is dealt with by the method used for outlines in previous packages. Area legends require three or more cards and are specified as follows:

Columns 1-5 are left blank; punch the print and overprint characters for the desired symbol in columns 6-9 (any or all of which may be left blank); and the letter "A" for AREA in column 10; then punch the coordinate location of the first vertex on the outline of the area, the vertical coordinate (measurement down) in columns 11-20, the horizontal coordinate (measurement across) in columns 21-30, both as decimal numbers.

SPECIFICATIONS FOR OTOLEGENDS

(i) POINT LEGEND, SINGLE SYMBOL--Overprinted,
if desired--1 card

Columns 6-9	The print and overprint characters (any of which may be blank) for the <u>single</u> symbol desired.
Column 10	The letter "P".
Columns 11-20	The vertical coordinate of associated source map point.
Columns 21-30	The horizontal coordinate of associated source map point.
Columns 31-40	The vertical displacement desired, namely, the number of rows up (precede by "-"), or number of rows down for the symbol to be adjusted, relative to its associated source map point.
Columns 41-50	The horizontal displacement, namely, the number of columns to the left (precede by "-"), or the number of columns to the right for the symbol to be adjusted, relative to its associated source map point.

(ii) POINT LEGEND, MULTIPLE CHARACTER (Vertical
or Horizontal)--No overprint--2 cards

First Card:

Column 1	Leave blank for horizontal legend, punch "-" (minus) for vertical legend.
Columns 4-5	The number of characters in legend (not to exceed 50).
Column 10	The letter "P".
Columns 11-20	The vertical coordinate of associated source map point.
Columns 21-30	The horizontal coordinate of associated source map point.

- Columns 31-40 The vertical displacement, namely, the number of rows down for the "start" of the legend, relative to its associated source map point.
- Columns 41-50 The horizontal displacement, namely, the number of columns to the left (precede by "-"), or the number of columns to the right for the "start" of the legend, relative to its associated source map point.

Second Card:

- Columns 1-50 Punch the desired legend starting in Column 1 and ending in the column whose number is punched in Columns 4-5 of the first card.

(iii) LINE LEGEND, SINGLE SYMBOL--Repeated--2 or more cards

First Card:

- Columns 6-9 The print and overprint characters (any of which may be blank) for the symbol desired.
- Column 10 The letter "L".
- Columns 11-20 The vertical coordinate of first point on line.
- Columns 21-30 The horizontal coordinate of first point on line.

Other Cards:

The coordinate locations of the succeeding vertices on the line, one location to a card, in columns 11-20 and 21-30 as for the first point. Columns 1-10 are left blank on these cards.

(iv) AREA LEGEND, SINGLE SYMBOL--Filled outline--
2 or more cards

First Card:

- Columns 6-9 The print and overprint characters (any of which may be blank).
- Column 10 The letter "A".

Columns 11-20 The vertical coordinate of the first vertex (the uppermost point on the outline, and if more than one, the left most of these).

Columns 21-30 The horizontal coordinate of the first vertex.

Other cards:

The coordinate locations of succeeding vertices on the outline, one location to a card, in columns 11-20 and 21-30 as for the first vertex. On the last card repeat the coordinate location of the first vertex to "close" the outline. Columns 1-10 are left blank on these cards.

The succeeding vertices (points at which the outline changes direction) are punched on succeeding cards, one coordinate location per card, in columns 11-20 and 21-30 as for the first vertex. Repeat the coordinate location of the first vertex to "close" the outline.

Using a modification of the above example, for illustration:

R/	A	2.31	4.08
		2.35	7.92
		5.81	8.01
		2.31	4.08

would cause the entire triangle formed by Buffalo, Albany and New York to be filled in with the symbol "R".

If a blank area is desired within the map outline, an area legend may be utilized. In this case, columns 6-9 would all be left blank. The rest of the procedure would be similar to that given above. While no printing would appear on the output map, interpolation would occur in this area. To prevent interpolation in the area, one would require the D-BARRIERS package discussed below.

D-BARRIERS

This package is used to specify the location and characteristics of any desired barrier to interpolation between data points. A barrier may be used to modify the computer's distance-oriented interpolation in order to reflect the probable effect of an obstacle, such as a body of water, a boundary of government control, or an expressway. For example, on a population density map of the Chicago area, the value computed at a point near the Chicago River would normally depend on (and reflect) the data from surrounding tracts on both sides of the river. But the river probably forms a physical, psychological and political barrier to the distribution of population, the effect of which the user may want included. Therefore one imposes a restriction upon the interpolation across the river through the use of a barrier--which may be either permeable or impermeable. Another example might arise in mapping the distribution of property values on Chicago's Near North Side. Unless a barrier is introduced, the abrupt change between the Gold Coast and the areas to the west would not appear. Impermeable barriers allow no interpolation to occur across the barrier; permeable barriers restrict interpolation across the barrier, but do not stop it.

IMPERMEABLE BARRIERS:

To be used correctly, an impermeable barrier must divide the study area into completely separate regions. Two types of impermeable barriers are thus possible:

1. Dividing Line. A dividing line barrier begins at the map border,

may have changes in direction, and terminates at the map border. (It may terminate at the same or a different border.) It completely divides the study area. For example, in a map of greater New York City with the Hudson River extending up the center, the river separates New York and New Jersey so that interpolation, for many phenomena, should not occur from one state to the other. To convey this separation to the computer, a barrier would be placed from a point on the top border to a point on the bottom border of the map, passing down the center of the river.

2. Closed Loop. If one region is to be separated from another which completely surrounds it, then a closed loop barrier should be placed around the interior region. A region such as an island, or an isolated city, which is not thought to have any relation to the surrounding area for the data under consideration, should be encircled by a closed loop barrier. For example, a closed loop barrier may be used to advantage in making a map of population density over the continental United States, based on data for forty-eight states and the District of Columbia. Because the District is a small, very densely populated region, data from it are not comparable with data from the states.

PERMEABLE BARRIERS:

Permeable barriers might be used to represent the inhibiting influence of bays, harbors, lakes, or other obstacles. Points across a lake or at opposite ends of a bay may still be thought to bear a relation to each other, but the relation would depend more on the overland distance between them, than the actual distance. Permeable barriers provide an adequate approximation to calculating overland distance, or in general, distance on a surface whose uniformity is impaired with obstacles. Several important cases follow:

1. Protruding Barrier. A bay, harbor, or river mouth may be thought of as protruding into the study area, as Boston Harbor "protrudes" between Winthrop and South Boston, or as Cape Cod Bay "protrudes" between Provincetown and Plymouth. An impermeable barrier is not appropriate, because there are areas which provide a link between the tip of the Cape and the rest of Massachusetts, or South Boston and Winthrop. The best solution in such cases is a protruding permeable barrier, which begins at the shoreline, continues into the bay or harbor and ends at the map border. Each vertex of this barrier will have a different strength, assigned as follows: the vertex at the shoreline will have a strength of 0. Following the barrier out towards the map border, the strengths will increase by twice the length of the previous segment, measured in inches to the nearest half-inch. Thus the strength at the second vertex is twice the length of the first segment, the strength at the third vertex is twice the length of the second segment. Plus the strength at the second vertex, etc. The strength at the vertex on the map border will be roughly twice the total length of the barrier, in inches. The strength of zero at one end of the barrier means it has no effect at that point. The other strengths approximate the effect of doubling

around the barrier to avoid transversing it. It should be noted that the strength at each vertex of a protruding vertex is twice its distance from the first vertex, measured in inches.

2. Other Configurations. Other configurations of permeable barriers are possible. In general, the strength at any terminal vertex within the study area should be zero. A long lake might need a barrier extending along its major axis, with zeroes at both ends and strengths increasing towards the center, where an additional vertex must be inserted. The strength at this vertex would be the length of the lake.

On the first card of this package, punch "D-BARRIERS" in columns 1-10, and the letter "X" in column 23 if tabular printout of the input data is not desired. (If coordinate measurements are by row and column, continue punching the first card with the number "8." in columns 31-32, and the number "10." in columns 41-43.)

On the last card punch the number "99999" in columns 1-5.

On other cards, to be inserted between the first and last, punch the coordinate locations of the barrier vertices--points at which the barrier may begin, change direction, and end--followed by the strength desired.

If a barrier has one end within the map and the other at the border, make the first vertex the interior end and work towards the border. For other types of barriers, begin with the uppermost terminal vertex. If both terminal vertices are equally high, start with the one furthest to the left. Punch vertices in the order in which they occur along the barrier, one vertex per card; proceed clockwise if the barrier is closed. Always repeat the last vertex of a barrier. This repetition tells the computer that the barrier is complete. Position barriers so that they would intercept all imaginary lines connecting character locations and data points between which interpolation is to be impeded by the barrier.

Punch the vertical coordinate (measurement down from the top border) of the vertex as a decimal number in columns 11-20. Punch the horizontal coordinate (measurement across from the left border) of the vertex as a decimal number in columns 21-30. Punch the strength as a decimal number in columns 31-40. FORTRAN format (10X,3F10.0). Permeable barriers may assume different strength at succeeding vertices, but they cannot become impermeable. If the barrier is impermeable (that is, no interpolation whatever is to occur across it), punch a strength of "-1." in columns 38-40.

If desired, two or more barriers may be employed--entered in any desired sequence. Each barrier acts independently. Thus, if necessary, barriers may cross at vertices or elsewhere. Two barriers may coincide for any portion of their length. There is no limitation on the possible number of barriers, provided only that the total number of vertices, excluding repetitions of terminal vertices, does not exceed 50.

E-VALUES

This package is used to specify the values of quantitative information applicable to each data point (for a contour or proximal map) or to each data zone (for a conformant map).

On the first card of this package, punch "E-VALUES" in columns 1-8; and the letter "X" in column 23 if tabular printout is not desired.

On the last card punch the number "99999" in columns 1-5.

On other cards, to be inserted between the first and last, punch the values to be applied at the data points given in the B-DATA POINTS package or to the zonal outlines specified in the A-CONFORMOLINES package. Each value is punched on a separate card. If a value is negative, punch a minus sign before it. Proceed strictly according to the numerical order of the reference numbers as established on the source map, and in conformance with the order of the data points input in the B-DATA POINTS package. A card must be provided corresponding to every data point or to every data zone. Be sure that cards are kept in proper sequence. Punch each value as a decimal number in columns 11-20.

If the same E-VALUES package is to be used for both a contour and a conformant map, the reference order established for points, zones and their associated values must be entirely consistent, and, only one data point from each zone may be included in the B-DATA POINTS package. Otherwise, (when and if both types of maps are desired), separate E-VALUES packages must be prepared; one to be associated with the A-CONFORMOLINES package (for the conformant map), and the other to be associated with the B-DATA POINTS package (for the contour map).

E-VALUES PREPARATION WITH DATA BANK:¹

If a data bank is to be used, the E-VALUES package is prepared in the following way for each map desired:

On the first card of this package, punch "E-VALUES" in columns 1-8; the letter "X" in column 18 (this tells the computer that a continuation card follows with additional instructions); and the letter "X" in column 23 if tabular printout of the input data is not desired.

On the second card (the continuation card), punch the Subroutine FLEXIN² identifying number (from 1-25) as an integer number right justified in columns 1-5; the total number of data points being used as an integer number right justified in columns 6-10; and the letter "X" in column 13 if the values are on tape (this tells the computer to rewind the tape, known as tape 12).

¹ The term "data bank" signifies a particular form of grouped statistics, so organized and arranged (on punch cards or on tape) that the computer, upon instruction, can select and use any portion of the data.

² For use of this subroutine, see Appendix C of this manual.

On the third card, if the data bank is on tape, punch the number "99999" in columns 1-5 (end of package). If the data bank is on cards, it is inserted here; thus the third card of this package is the first card of the data bank, containing the first value(s) to be used. A card with the number "99999" punched in columns 1-5 must follow the data bank cards (end of package).

When the data bank is very large, it is generally easier to put the data values on tape as then only 3 cards are needed for each E-VALUES package. If cards are to be used, the entire set of cards for the data bank must be duplicated for each map.

E1-VALUES INDEX

The E1-VALUES INDEX package is used to change the reference order of data values in the E-VALUES package. Normally the conformant outlines as specified in the A-CONFORMOLINES package and the data points as specified in the B-DATA POINTS package are assigned data values from the E-VALUES package in the order in which they are listed, i.e., the first zone or point is assigned the first value, the second, the second value, and so on. Every reasonable effort should be made to list zones, points, and their associated values in the same order. The E1-VALUES INDEX package is used only to avoid some considerable difficulty in reordering a non-standard B-DATA POINTS, A-CONFORMOLINES or E-VALUES package.

The A-CONFORMOLINES package provides for specification, by punching or by coded implication, of the reference order number of the data value with which each outline is to be associated. (See directions for A-CONFORMOLINES.) This data value reference number may be altered by using the E1-VALUES INDEX package.

The B-DATA POINTS package contains no provision for indicating reference order other than by the sequence in which the locations of data points are specified. If the data values are not listed in precisely the same order as the data points with which they are to be associated, the reference order of the data values must be altered. This may be done by using the E1-VALUES INDEX package.

On the first card of this package, punch "E1-VALUES INDEX" in columns 1-15.

On the last card, punch "99999" in columns 1-5.

On other cards, to be inserted between the first and last, punch the current reference order number of the data value as an integer right justified in columns 1-5; then punch the replacement reference order number for that value as an integer right justified in columns 6-10.

To have reference to the first value refer to the second value, only one

card is needed (in addition to the first and last). Punch the number "1" in column 5 and the number "2" in column 10. If columns 6-10 are left blank, the number following that assigned to the previous card is assumed.

To have reference to the fifth value replaced by reference to the fourth value, provide four cards with the reference numbers "1" through "4" successively punched in column 5, followed by one card with the number "5" punched in column 5 and the number "4" punched in column 10. If another card with the number "6" punched in column 5 (and columns 6-10 left blank) were to follow, reference to the sixth value would be replaced by reference to the fifth value, since the preceding card had specified reference to the fourth value.

If a card is included on which columns 1-5 are left blank, this referenced value (i.e., the reference number of the previous value plus one) will be treated as missing data for the map.

F-MAP

This package instructs the computer to make a map--based on the information supplied in the prior packages--and is used to specify the precise form of that map in terms of certain available optional treatments--henceforth to be termed "electives".

On the first card of this package, punch "F-MAP" in columns 1-5, and the letter "X" in column 23 if printout of the input data is not desired.

On the last card, punch the number "99999" in columns 1-5.

On the second, third, and fourth cards, punch the title you wish to have appear below the map. Be sure your title is clearly descriptive to differentiate the particular map being requested from all other maps, of a similar nature, which have been run previously or which may be run in the future. One or more of these three cards may be left blank if desired, but all three cards must be provided.

On other cards, to be inserted between the fourth and last cards, punch any "electives" that may be desired. As stated earlier, these electives control various options such as content, scale, size, and tone. These electives control the format of the output map. They are most essential and will be discussed in great detail in the following chapter.

END OF SUBMISSION

The last card of any submission--following the "99999" card of the F-MAP package--should be a card with "999999" (6 nines) in columns 1-6. This card enables the program to terminate normally without generating an "end of file" input diagnostic message. When running multiple maps at one submission (sec. 3.4) this card is required only after the last F-MAP package.

APPENDIX B

1970 First-Count Summary Tape

<u>Tabulation Number</u>	<u>Title</u>
1	COUNT OF ALL PERSONS
2	COUNT OF ALL HOUSING UNITS
3	COUNT OF PERSONS IN RURAL AREAS
4	COUNT OF PERSONS IN ANNEXED TERRITORIES
5	COUNT OF RURAL HOUSING UNITS
6	COUNT OF PERSONS IN SMSA'S
7	COUNT OF PERSONS IN URBAN PORTION OF CENTRAL CITIES OF SMSA'S
8	COUNT OF PERSONS IN RURAL PLACES OF 1,000-2,499
9	COUNT OF PERSONS IN RURAL PLACES OF LESS THAN 1,000
10	COUNT OF PERSONS IN URBAN PORTION OF CENTRAL CITIES OF URBANIZED AREAS
11	COUNT OF PERSONS IN URBANIZED AREAS IN URBAN PORTION OF PLACES OF 25,000+ OUTSIDE CENTRAL CITIES
12	COUNT OF PERSONS IN URBANIZED AREAS IN URBAN PORTION OF PLACES OF 2,500-24,999 OUTSIDE CENTRAL CITIES
13	COUNT OF PERSONS IN URBANIZED AREAS
14	AGGREGATE \$ VALUE
15	AGGREGATE \$ MONTHLY CONTRACT RENT
16	AGGREGATE \$ VALUE FOR UNITS WITH ALL PLUMBING FACILITIES
17	AGGREGATE \$ MONTHLY CONTRACT RENT FOR UNITS WITH ALL PLUMBING FACILITIES
18	AGE AND SEX
19	NEGRO AND OTHER RACES (EXCEPT WHITE) BY AGE AND SEX
20	RACE
21	POPULATION 14 YEARS OLD AND OVER BY MARITAL STATUS, RACE AND SEX
22	RELATIONSHIP AND RACE
23	POPULATION UNDER 18 YEARS OLD BY RELATIONSHIP AND FAMILY TYPE
24	POPULATION 65 YEARS AND OVER BY RELATIONSHIP
25	FAMILIES BY PRESENCE OF FAMILY MEMBERS UNDER 18 AND 65 AND OVER AND FAMILY TYPE
26	OCCUPANCY/VACANCY STATUS
27	TYPE OF STRUCTURE
28a	ROOMS IN UNIT
28b	AGGREGATE NUMBER OF ROOMS
29a	PERSONS IN UNIT
29b	AGGREGATE NUMBER OF PERSONS BY TENURE AND RACE OF HEAD
30	PERSONS PER ROOM, TENURE AND RACE OF HEAD
31	NUMBER OF UNITS AT ADDRESS
32	UNITS WITH A BASEMENT
33	ACCESS AND COMPLETE KITCHEN FACILITIES
34	TELEPHONE AVAILABLE

Tabulation
Number

Title

35	VALUE
36	MONTHLY CONTRACT RENT
37	UNITS FOR RENT THAT HAVE BEEN VACANT LESS THAN 2 MONTHS
38	UNITS FOR SALE ONLY THAT HAVE BEEN VACANT LESS THAN 6 MONTHS
39	VACANT YEAR-ROUND UNITS THAT HAVE BEEN VACANT 6 MONTHS OR MORE
40	UNITS WITH ROOMERS, BOARDERS OR LODGERS
41	PLUMBING FACILITIES
42	UNITS WITH ALL PLUMBING FACILITIES AND 1.01 OR MORE PERSONS PER ROOM BY TENURE AND RACE OF HEAD
43	VALUE FOR UNITS WITH ALL PLUMBING FACILITIES
44	MONTHLY CONTRACT RENT FOR UNITS WITH ALL PLUMBING FACILITIES
45	TOILET FACILITIES
46	UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY HOUSEHOLD TYPE
47	UNITS WITH 1.51 OR MORE PERSONS PER ROOM BY HOUSEHOLD TYPE
48	POPULATION IN UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY AGE
49	POPULATION IN UNITS WITH 1.51 OR MORE PERSONS PER ROOM BY AGE
50	POPULATION IN UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY TENURE AND RACE OF HEAD
51	POPULATION IN UNITS BY PLUMBING FACILITIES
52	POPULATION IN UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY PLUMBING FACILITIES
53	FAMILIES BY PLUMBING FACILITIES
54	HOUSING ALLOCATIONS
55	POPULATION SUBSTITUTIONS AND ALLOCATIONS

APPENDIX C
POPULATION AND HOUSING
FIRST COUNT

1. COUNT OF ALL PERSONS CHOSEN FOR MAPPING
2. COUNT OF ALL HOUSING UNITS CHOSEN FOR MAPPING

NOTE: (Counts 3-13 are counts introduced for Census processing and are useful only above the ED level.)

3. COUNT OF PERSONS IN RURAL AREAS*
4. COUNT OF PERSONS IN ANNEXED TERRITORIES
5. COUNT OF RURAL HOUSING UNITS
6. COUNT OF PERSONS IN SMSA's
7. COUNT OF PERSONS IN URBAN PORTION OF CENTRAL CITIES OF SMSA's
8. COUNT OF PERSONS IN RURAL PLACES OF 1,000-2,499
9. COUNT OF PERSONS IN RURAL PLACES OF LESS THAN 1,000
10. COUNT OF PERSONS IN URBAN PORTION OF CENTRAL CITIES OF URBANIZED AREAS
11. COUNT OF PERSONS IN URBANIZED AREAS IN URBAN PORTION OF PLACES OF 25,000+ OUTSIDE CENTRAL CITIES
12. COUNT OF PERSONS IN URBANIZED AREAS IN URBAN PORTION OF PLACES OF 2,500-24,999 OUTSIDE CENTRAL CITIES
13. COUNT OF PERSONS IN URBANIZED AREAS**
14. AGGREGATE \$ VALUE ^{1/} (See Item 35)

Aggregate \$ Value ^{2/} for Units for Which Value is Tabulated ^{3/}

By: Occupancy Status and Race of Head (3)

Total owner occupied-chosen for mapping
Negro owner occupied
Vacant for sale only

* In addition to the sum of data items in 8 and 9, this count includes persons in other rural territory (rural outside places).

** In addition to the sum of data items in 10, 11 and 12, this count includes persons outside central cities who are in places of less than 2,500, plus persons who are in other urban territory (outside places).

15. AGGREGATE \$ MONTHLY CONTRACT RENT $\frac{1}{-}$ (See Item 36)
Aggregate \$ Monthly Contract Rent for Units for Which Rent
 is Tabulated $\frac{4}{-}$
 By: Occupancy Status and Race of Head (3)
 Total renter occupied
 Negro renter occupied
 Vacant for rent

16. AGGREGATE \$ VALUE FOR UNITS WITH ALL PLUMBING FACILITIES $\frac{1}{-}$ $\frac{5}{-}$
 (See Item 43)***
Aggregate \$ Value $\frac{2}{-}$ for Units with All Plumbing
 Facilities for Which Value is Tabulated $\frac{3}{-}$
 By: Occupancy Status and Race of Head (3)
 Total owner occupied
 Negro owner occupied

Padding

Vacant for sale only

17. AGGREGATE \$ MONTHLY CONTRACT RENT FOR UNITS WITH ALL PLUMBING
 FACILITIES $\frac{1}{-}$ $\frac{5}{-}$ (See Item 44)
Aggregate \$ Monthly Contract Rent for Units With All
 Plumbing Facilities for Which Rent Is Tabulated $\frac{4}{-}$
 By: Occupancy Status and Race of Head (3)
 Total renter occupied
 Negro renter occupied
 Vacant for rent

Population

18. AGE AND SEX

Count of Persons

By: Sex (2) and Age (22)

Male:

 Under 5 years - chosen for mapping (male and female)
 5
 6
 7-9

*** Tabulation is comprised of 3 tallies split by padding.

10-13
14
15
16
17
18
19
20
21
22-24
25-34
35-44
45-54
55-59
60-61
62-64
65-74
75 and over - chosen for mapping (male and female)

Female:
Repeat Age (22)

19. NEGRO AND OTHER RACES (EXCEPT WHITE) BY AGE AND SEX

Count of Negro and Other Race Persons (except white)

By: Race (2) By: Sex (2) By: Age (8)

Negro:

Male:

Under 5 years

5-14

15-24

25-34

35-44

45-54

55-64

65 and over

Female:

Repeat Age (8)

Other races:

Same as Negro (16)

20. RACE

Count of Persons

By: Race (5)

White

Negro - chosen for mapping

Indian - chosen for mapping

Other specified races****
Reported "Other race"

21. POPULATION 14 YEARS OLD AND OVER BY MARITAL STATUS,
RACE AND SEX

Count of Persons 14 Years Old and Over

By: Race (2) By: Sex (2) By: Marital Status (5)

Total:

Male:

Now married (excludes separated)

Widowed

Divorced

Separated

Never married

Female:

Repeat Marital Status (5)

Negro:

Same as Total (10)

22. RELATIONSHIP AND RACE

Count of Persons

By: Race (2) By: Household Relationship (10)
(includes persons in group quarters)

Total:

Family head of husband-wife household

Family head of household with other male head

Family head of household with female head

Wife of head

Other relative of head

Male primary individual

Female primary individual

Nonrelative (includes roomer, boarder or lodger)
of head of household

Inmate of institution

Other in group quarters

Negro:

Repeat Household Relationship (10)

Includes Japanese, Chinese, Filipino, Hawaiian and Korean. In Alaska, Hawaiian and Korean will be Aleut and Eskimo, respectively.

23. POPULATION UNDER 18 YEARS OLD BY RELATIONSHIP AND FAMILY TYPE

Count of Persons Under 18 Years Old

By: Household Relationship and Family Type (10)
(includes persons in group quarters)

Head or wife of head of household
Own (never married) child of head:
 In husband-wife family
 In other family with male head
 In family with female head
Other relative of head:
 In husband-wife family
 In other family with male head
 In family with female head
Nonrelative (includes roomer, boarder or lodger)
 of head of household
Inmate of institution
Other in group quarters

24. POPULATION 65 YEARS AND OVER BY RELATIONSHIP

Count of Persons 65 Years Old and Over

By: Household Relationship (8)
(includes persons in group quarters)

Head of family
Wife of head
Other family member
Male primary individual
Female primary individual
Nonrelative (includes roomer, boarder or lodger)
 of head of household
Inmate of institution
Other in group quarters

25. FAMILIES BY PRESENCE OF FAMILY MEMBERS UNDER 18 AND 65 AND OVER AND FAMILY TYPE

Count of Families

By: Family Type (3) By: Presence of Family Members (other than head and wife) Under 18 and 65 and Over (4)

Husband-wife family:
 No members under 18 or 65 and over
 Members under 18, none 65 and over
 Members 65 and over, none under 18
 Members under 18 and 65 and over
Other family with male head:
 Repeat Family Members (4)
Family with female head:
 Repeat Family Members (4)

Housing

26. OCCUPANCY/VACANCY STATUS

a. Count of Housing Units

By: Occupancy/Vacancy Status and Race of Head (9)

Owner occupied:

Total (includes white, Negro and Other races in
this and all following tabulations where
race is shown)

White head of household

Negro head of household

Renter occupied:

Total

White head of household

Negro head of household

Vacant:

For rent

For sale only

Other vacant year round

b. Count of Vacant Seasonal and Vacant Migratory Units

NOTE: (All tabulations beginning with item 27 exclude vacant seasonal
and vacant migratory units.)

27. TYPE OF STRUCTURE

Count of Occupied and Vacant Year-round Housing Units

By: Type of Structure (3)

1-unit structure

2-or-more unit structures

Mobile homes or trailers (occupied only) - chosen for
mapping

28a. ROOMS IN UNIT

Count of Occupied and Vacant Year-round Housing Units

By: Number of Rooms in Unit (8)

1 room

2 rooms

3 rooms

4 rooms

5 rooms

6 rooms

7 rooms

8 rooms or more

28b. AGGREGATE NUMBER OF ROOMS ^{1/} (See Item 26)

Count of Rooms in Occupied and Vacant Year-round Housing Units

By: Tenure and Race of Head (9)

Total occupied and vacant year-round units

Total occupied

Owner occupied

Renter occupied

Total Negro occupied

Negro owner occupied

Negro renter occupied

Vacant for rent

Vacant for sale only

29a. PERSONS IN UNIT

Count of Occupied Units

By: Number of Persons in Unit (8)

1 person

2 persons

3 persons

4 persons

5 persons

6 persons

7 persons

8 persons or more

29b. AGGREGATE NUMBER OF PERSONS ^{1/} BY TENURE AND RACE OF HEAD
(See Item 26)

Count of Persons in Occupied Units

By: Tenure and Race of Head (6)

Total occupied

Owner occupied

Renter occupied

Total Negro occupied

Negro owner occupied

Negro renter occupied

30. PERSONS PER ROOM, TENURE AND RACE OF HEAD

Count of Occupied Units

By: Tenure and Race of Head (6) By: Number of Persons Per Room (3)

Total occupied:

1.00 or less

1.01 - 1.50

1.51 or more

Owner occupied:
Repeat Persons Per Room (3)
Renter occupied:
Repeat Persons Per Room (3)
Total Negro occupied:
Repeat Persons Per Room (3)
Negro owner occupied:
Repeat Persons Per Room (3)
Negro renter occupied:
Repeat Persons Per Room (3)

31. NUMBER OF UNITS AT ADDRESS

Count of Occupied and Vacant Year-round Housing Units
in Multi-unit Structures

By: Number of Units at Address (3)

2-4 units
5-9 units
10 units or more

32. UNITS WITH A BASEMENT

Count of Occupied and Vacant Year-round Housing Units

By: Basement (2)

Total with basement
Units with basement at addresses with 1,2 or 3 units

33. ACCESS AND COMPLETE KITCHEN FACILITIES

Count of Occupied and Vacant Year-round Housing Units

By: Access ^{6/} and Complete Kitchen Facilities ^{7/} (4)

With direct access and complete kitchen facilities
for this household only
With direct access, lacking complete kitchen facilities
for this household only
Lacking direct access, with complete kitchen facilities
for this household only
Lacking both direct access and complete kitchen facilities
for this household only

34. TELEPHONE AVAILABLE

Count of Occupied Units with Telephone Available

35. VALUE (See Item 14)

a. Count of Owner-Occupied Units for Which Value is Tabulated ^{3/}

By: Value (8)

Less than \$ 5,000 - chosen for mapping
\$ 5,000 - \$ 9,999
\$10,000 - \$14,999
\$15,000 - \$19,999
\$20,000 - \$24,999
\$25,000 - \$34,999
\$35,000 - \$49,999
\$50,000 or more

b. Count of Units for Which Value is Tabulated ^{3/}

By: Occupancy Status and Race of Head (3)

Total owner occupied
Negro owner occupied
Vacant for sale only

36. MONTHLY CONTRACT RENT (See Item 15)

a. Count of Renter-occupied units for Which Rent is Tabulated ^{4/}

By: Monthly Contract Rent (10)

With cash rent:
Less than \$40
\$ 40 - \$ 59
\$ 60 - \$ 79
\$ 80 - \$ 99
\$100 - \$119
\$120 - \$149
\$150 - \$199
\$200 - \$299
\$300 or more

Without payment of cash rent

b. Count of Units for Which Rent is Tabulated ^{4/}
(does not include "without payment of cash rent")

By: Occupancy Status and Race of Head (3)

Total renter occupied
Negro renter occupied
Vacant for rent

37. UNITS FOR RENT THAT HAVE BEEN VACANT LESS THAN 2 MONTHS

Count of Year-round Vacant-for-Rent Units Vacant
Less than 2 Months

38. UNITS FOR SALE ONLY THAT HAVE BEEN VACANT LESS THAN 6 MONTHS

Count of Year-round Vacant-for-Sale-Only Units
Vacant Less Than 6 Months

39. VACANT YEAR-ROUND UNITS THAT HAVE BEEN VACANT 6 MONTHS OR MORE

Count of Vacant Year-round Units Vacant
6 Months or More

40. UNITS WITH ROOMERS, BOARDERS OR LODGERS

Count of Occupied Units With Roomers,
Boarders or Lodgers

41. PLUMBING FACILITIES

Count of Occupied and Vacant Year-round Housing Units

By: Tenure and Race of Head (9) By: Plumbing Facilities (2)

Total occupied and vacant year-round:
With all plumbing facilities $\frac{2}{}$
Lacking one or more plumbing facilities $\frac{8}{}$

Total occupied:
Repeat Plumbing Facilities (2)

Owner occupied:
Repeat Plumbing Facilities (2)

Renter occupied:
Repeat Plumbing Facilities (2)

Total Negro occupied:
Repeat Plumbing Facilities (2)

Negro owner occupied:
Repeat Plumbing Facilities (2)

Negro renter occupied:
Repeat Plumbing Facilities (2)

Vacant for rent:
Repeat Plumbing Facilities (2)

Vacant for sale only:
Repeat Plumbing Facilities (2)

42. UNITS WITH ALL PLUMBING FACILITIES AND 1.01 OR MORE PERSONS PER ROOM
BY TENURE AND RACE OF HEAD

Count of Occupied Units With All Plumbing Facilities and
1.01 or More Persons Per Room

By: Tenure and Race of Head (6)

Total occupied
Owner occupied

Renter occupied
Total Negro occupied
Negro owner occupied
Negro renter occupied

43. VALUE FOR UNITS WITH ALL PLUMBING FACILITIES (See item 16)

a. Count of Owner-occupied Units with All Plumbing Facilities ^{5/}
for Which Value is Tabulated ^{3/}

By: Value (8)

Less than \$ 5,000
\$ 5,000 - \$ 9,999
\$10,000 - \$14,999
\$15,000 - \$19,999
\$20,000 - \$24,999
\$25,000 - \$34,999
\$35,000 - \$49,999
\$50,000 or more

b. Count of Units With All Plumbing Facilities ^{5/}
for Which Value is Tabulated ^{3/}

By: Occupancy Status and Race of Head (3)

Total owner occupied
Negro owner occupied
Vacant for sale only

44. MONTHLY CONTRACT RENT FOR UNITS WITH ALL PLUMBING FACILITIES (See item 17)

a. Count of Renter-occupied Units With All Plumbing
Facilities ^{5/} for Which Contract Rent is Tabulated ^{4/}

By: Monthly Contract Rent (10)

With cash rent:
Less than \$40
\$ 40 - \$ 59
\$ 60 - \$ 79
\$ 80 - \$ 99
\$100 - \$119
\$120 - \$149
\$150 - \$199
\$200 - \$299
\$300 or more

Without payment of cash rent

b. Count of Units With All Plumbing Facilities ^{5/}
for Which Rent is Tabulated ^{4/}
(does not include "without payment of cash rent")

By: Occupancy Status and Race of Head (3)

Total renter occupied
Negro renter occupied
Vacant for rent

45. TOILET FACILITIES

Count of Occupied and Vacant Year-round Housing Units

Flush toilet for this household only
Flush toilet, but also used by another household
No flush toilet

46. UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY HOUSEHOLD TYPE

Count of Occupied Units with 1.01 or More Persons Per Room

By: Household Type (4)

Husband-wife family
Other family with male head
Family with female head
Primary individual

47. UNITS WITH 1.51 OR MORE PERSONS PER ROOM BY HOUSEHOLD TYPE

Count of Occupied Units with 1.51 or More Persons Per Room

By: Household Type (4)

Husband-wife family
Other family with male head
Family with female head
Primary individual

48. POPULATION IN UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY AGE

Count of Persons in Occupied Units with 1.01 or More
Persons per Room

By: Age (3)

Under 18 years
18-64 years
65 years and over

49. POPULATION IN UNITS WITH 1.51 OR MORE PERSONS PER ROOM BY AGE

Count of Persons in Occupied Units With 1.51 or More
Persons per Room

By: Age (3)

Under 18 years
18-64 years
65 years and over

50. POPULATION IN UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY TENURE AND RACE OF HEAD

Count of Persons in Occupied Units with 1.01 or More Persons Per Room

By: Tenure and Race of Head (6)

Total occupied
Owner occupied
Renter occupied
Total Negro occupied
Negro owner occupied
Negro renter occupied

51. POPULATION IN UNITS BY PLUMBING FACILITIES

Count of Persons in Occupied Units

By: Plumbing Facilities (2)

With all plumbing facilities $\frac{5}{}$
Lacking one or more plumbing facilities $\frac{8}{}$

52. POPULATION IN UNITS WITH 1.01 OR MORE PERSONS PER ROOM BY PLUMBING FACILITIES

Count of Persons in Occupied Units with 1.01 or More Persons per Room

By: Plumbing Facilities (2)

With all plumbing facilities $\frac{5}{}$
Lacking one or more plumbing facilities $\frac{8}{}$

53. FAMILIES BY PLUMBING FACILITIES

Count of Families

By: Plumbing Facilities (2)

With all plumbing facilities $\frac{5}{}$
Lacking one or more plumbing facilities $\frac{8}{}$

54. HOUSING ALLOCATIONS

Count of Housing Units With Allocations

By: Occupancy Status (2) By: Housing Allocations (23)

Occupied:

Telephone available (Occupied only)

Access to unit

Complete kitchen facilities:

Indirect

Direct

Number of rooms

Hot and cold piped water:

Indirect

Direct

Toilet facilities:

Indirect

Direct

Bathing facilities: (bathtub or shower)

Indirect

Direct

Type of foundation (basement)

Tenure: (Occupied only)

Indirect

Direct

Type of structure:

Indirect

Direct

Use of property

Value of unit

Contract rent

Vacancy status (Vacant only)

Duration of vacancy (Vacant only)

Units at address:

Indirect

Direct

Vacant:

Repeat Housing Allocations (23)

55. POPULATION SUBSTITUTIONS AND ALLOCATIONS

Count of Persons Substituted or With Allocations

(If a person was substituted, he is counted only as substituted and if any of his items were allocated there were not tallied here as allocations.)

By: Population Substitutions and Allocations (10)

Person substituted because of equipment malfunction
Person substituted because of nonresponse
Person with one or more allocations
Household relationship
Sex
Color
Age
Age, decade unknown
Age, decade known
Marital status (if age is 14+)

Padding

-
- 1/ This aggregate along with the relevant count of units will permit the computation of a mean value (e.g., average number of rooms, average number of persons per unit, average rent, etc.).
 - 2/ Multiply the aggregate value by \$250 to obtain the true value. The tabulated value was scaled by a factor of \$250 for tally purposes.
 - 3/ Value is tabulated for owner-occupied and vacant-for-sale-only one-family houses which are on a place of less than 10 acres and have no business or medical office on the property. Value is not tabulated for mobile homes, trailers, cooperatives or condominiums.
 - 4/ Contract rent is tabulated for all renter-occupied and vacant-for-rent units except one-family houses on a place of 10 acres or more. No-cash-rent one-family houses must be on a place of less than 10 acres.
 - 5/ Units with "all plumbing facilities" have all of the following: hot piped water, flush toilet for this household only and a bathtub or shower for this household only.
 - 6/ Direct Access is an entrance to a living quarters directly from outside the structure or through a common hall.
 - 7/ Complete Kitchen Facilities are all of the following: a range or cook-stove, a sink with piped water and a mechanical refrigerator.
 - 8/ Lacking one or more of the following facilities: hot piped water, flush toilet for this household only, or bathtub or shower for this household only.

APPENDIX D

FIND: PROC OPTIONS (MAIN);

```
1          FIND:  PROC OPTIONS (MAIN);
2              DCL STRING CHAR (1800) VARYING;
3              DCL TAPE FILE RECORD SEQUENTIAL;
4              DCL COUNT BIN FIXED (31) INITIAL (0);
5              DCL COUNTY CHAR (3);
6              OPEN FILE (TAPE) INPUT;
7              ON ENDFILE (TAPE) GO TO LAB1;
9              DO WHILE ('1'B);
10             COUNT=COUNT+1;
11             READ FILE (TAPE) INTO (STRING);
12             COUNTY=SUBSTR (STRING,4,3);
13             IF COUNTY='161' THEN
14                 DO;
15                     PUT SKIP(3) DATA(COUNT);
16                     PUT SKIP FILE(SYSPRINT) EDIT(STRING) (A);
17                     READ FILE(TAPE) INTO (STRING);
18                     PUT SKIP FILE(SYSPRINT) EDIT(STRING) (A);
19                 END;
20             ELSE READ FILE(TAPE) IGNORE (1);
21             END;
22 LAB1:        CLOSE FILE(TAPE);
23             PUT SKIP DATA(COUNT);
24             END FIND;
```

BIBLIOGRAPHY

1. Auerbach, Auerbach on Digital Plotters and Image Digitizers, (Auerbach Publishers, Inc.: 1972).
2. Dudnik, Elliott, SYMAP User's Reference Manual for Synagraphic Computer Mapping, (University of Illinois at Chicago Circle: 1971).
3. Gruenberger, Fred, Computer Graphics, (Thompson Book Co, : 1967).
4. McAdoo, Stan, A Resource Evaluation for the Flint Hills Region, (Kansas State University: 1970).
5. Michael, George A., "Computer Display Systems," Physics Today, (July, 1970).
6. Parslow, R.D., R.W. Prowse and R.E. Green, Computer Graphics, (Plenum Press: 1969).
7. Parslow, R.D. and R.E. Green, Advanced Computer Graphics, (Plenum Press: 1971).
8. Robinson, Arthur, Elements of Cartography, (John Wiley & Sons, Inc.: 1953).
9. Shastack, Kenneth and Charles Eddy, "Management by Computer Graphics," Harvard Business Review, (November-December, 1971).
10. U.S. Department of Commerce, Census Use Study, (Bureau of the Census: 1970).
11. U.S. Department of Commerce, 1970 Census User's Guide, (Bureau of the Census: 1970).
12. Wolf, Jack, "SYMAP: Computer Graphics for Marketing Management," Journal of Marketing Research, (August, 1969).