DISEASE MAPPING AND ANALYSIS IN THE COMPREHENSIVE PLANNING PROCESS:
A Report on a Case Study Example for Topeka, Kansas

by

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PART I

INTRODUCTION

The subject of this report is not a new one, nor are the methods and techniques of research, analysis, and mapping unique. What is unique, however, is that the information and data assembled in this report deals with a specific goal; that of the feasibility, or better yet, the desirability of including disease mapping studies in the comprehensive planning process.

As urban planning gains wider acceptance in society as a basis for improving and protecting the environment and the people in it, planners are becoming more and more involved in new areas of research and planning. The recent concern about environment and ecology has witnessed the birth of a new breed of planning specialists in such fields as environmental impact, noise and air pollution, conservation and preservation, and social and economic aspects of the community. All of these facets of urban problems need to be dealt with as each has serious effects on man.

Equally important, but lagging far behind in popularity, is health planning. The lack of involvement in health planning by urban planners is evident in the results of a survey made by the American Society of Planning Officials in which it was discovered that an overwhelming 83% of the urban planning agencies sampled spent less than 2% of their time dealing with health planning, and then only maps of hospital and clinic locations or an ambulance survey were typical of the health planning being conducted.[1] Very few agencies had any dealing whatsoever with local health officials, or conducted serious research and analysis into health problems.

THE ROLE OF THE URBAN PLANNER IN HEALTH PLANNING

This marginal effort stems from several misconceptions about the role of planning. Urban planners have long felt the role they play is narrowly defined, and makes no provision for involvement in other problem areas. Coupled with this is the attitude of health officials toward urban planners. Health planners have been reluctant to use the techniques and knowledge of urban planners feeling it would be an intrusion in their field. They view planners as generalists or landuse/transportation planners, and not experts in health. Therefore, they feel any contribution offered by urban planners would be of little worth.

THE CURRENT RECORD

However, not all of the record is fruitless. Recently, planners, through less than direct causes, have become more heavily involved

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[1] American Society of Planning Officials; The Urban Planner in Health Planning, (Washington, D.C., 1968), p. 1.

in phases of planning for health. Perhaps the one most influential factor has been a series of legislated acts which have "forced" some planners into health planning. The Demonstration Cities and Metropolitan Development Act of 1966 is a good example of this legislation. The Model Neighborhoods program established by the act is an attempt to solve complex social and physical problems by concentrating a variety of public services and facilities in a single area, including, but not limited to, health services. The impact of this act on urban planners has been an indirect one with regard to health in that their experience with this act has been the filling out of several hundred applications. This process of making application has served somewhat to orient urban planners to health problems, and in those cities which have received grants, the urban planners will no doubt become further involved in local health issues.

Another such influence has been the Neighborhood Facilities program established by the Housing and Urban Development Act of 1965. This act was designed to establish multipurpose centers to offer concerted community health, recreation, and social services to low and moderate income residents. Planners here have been involved in site location, identifying areas of need, and assisting in determining the proper level and types of services to be offered.

These are but two examples of how recent legislation has, in effect, pushed urban planners into the field of health. Future legislation will no doubt further push planners toward an interdisciplinary approach and cooperation with health planners. In the aforementioned report of the American Society of Planning Officials a checklist of possible contributions a planning agency can make toward improved health planning listed several important items, the most important of which was that the urban planners need to, by choice, play a supportive role in health planning. They must share and utilize data. The planning agency must include a health services and facilities section in the comprehensive plan, and the health agency should, whenever possible, employ the use of planning methods and techniques and even planners themselves toward the preparation of a total package of health planning.

The implication intended through the preceeding introductory comments is not that urban planners should become health planners. Rather, the role of the urban planner in health planning should be a supportive one. Furthermore, the support should benefit both fields. Obviously health planners can and should rely on studies and research conducted by urban planners with regard to physical, social, and economic aspects of the city. Population and housing distribution and density are basic components for almost any urban study as well as health surveys. The question becomes one of why urban planners can not conduct research which utilizes health oriented data to support other research and conclusions about the ills of a community? At the same time the urban planners would be preparing a "case" about some community problem e.g. a portion of the city is a pathological breeding ground, the health officials could be preparing their recommendations for programs of treatment, education, immunization, or whatever the necessary remedy involves. The efforts on the parts of both professions may very well double the action toward a solution to a problem. Each agency backed by the other would in effect give two authoritarian opinions in lieu of the usual, and often biased, one.

There is no doubt a host of further implications that could be discussed about the possible relationships between health and urban planners. The need to discuss them further in this report is unnecessary. Interested individuals are directed to the many and varied volumes on library shelves dealing with this very subject. Instead, the emphasis of this report will be the remaining subject matter.

SPATIAL ANALYSIS AND DISEASE MAPPING

One of the most common techniques used in urban planning is spatial analysis, often best exemplified by the land use map or proposed land use plan. Neighborhood analysis is a form of spatial analysis with its maps and inventories of facilities, open space, dwelling units per acre, population density, and so forth. Unlike the use in urban planning, the spatial approach is not utilized to much extent in health planning. Much of medical geography has either merely described assumed spatial patterns or at best suggested possible association, for example, among diseases and other social and environmental causes. One of the most universal assumptions must be that disease incidence is highest in areas of poor physical, social, and economic conditions. To assume this for every location without actual research into it is to shirk professional responsibility. Furthermore, if the urban planner is to deal effectively with urban problems he should know as much of the problems, causes, and solutions as possible. By investigating disease morbidity simultaneously with other more typical forms of urban inventory, the urban planner can learn more for himself as well as assist the health planner in an endeavor in which he may not wish to participate.

OBJECTIVES OF THE REPORT

In light of the foregoing, this report hopes to accomplish two objectives. The first objective is simply to make the urban planner aware of the existance of a need as well as an opportunity to assist the health planner in his work, and at the same time gain further knowledge of urban complexities for which he must plan the future. The second objective is to illustrate the possibility that this opportunity lies in the inclusion of disease mapping in the comprehensive planning process. This second objective will best be reached through illustrating an example of the procedure, techniques, and results of a case study documentation of disease mapping. The term disease mapping is now defined as a study of spatial patterns of disease morbidity and incidence and the relationship of such patterns to occurences of poor environmental, social, and economic conditions.

There are obviously other studies in which urban planners can become involved in assisting health planners. However, this report contends that disease mapping is perhaps the easiest and most vital to perform. Therefore, the second objective listed above becomes the primary concern and will be the subject of detailed discussion in the remainder of the report.

It should be pointed out that the emphasis of this study is not on the techniques and results, but on the intent of such. In this case the study might be considered a prototype, and rightly so, for it is the first such undertaking by the author. And as is the case with most prototypes, many "bugs" need to be worked out prior to full scale usage. This will be left to those who pursue the issue further.

In the next section of this report, a documentation of a case study example of disease mapping is presented. The documentation covers the course of events of the study from a textbook inspiration to examples of uses of the results to the urban planner and the comprehensive planning process.

PART II

DISEASE MAPPING AND ANALYSIS: CASE STUDY EXAMPLE FOR TOPEKA, KANSAS

PART II: SECTION 1

HISTORICAL PERSPECTIVE

Having established the objectives of the report as well as laying a bit of foundation of what is to follow, a more comprehensive background or history of how this particular subject became of interest is in order. Ian McHarg's book, Design With Nature, contained an impressive section which became the real inspiration for this endeavor. The section dealt with mapping various diseases of man to include, but not limited to, communicable diseases. He too was aware of the widespread assumption that disease concentrations and over-populated and blighted areas of cities were supposedly one and the same. His disease mapping study of Philadelphia convinced him that such was the case there. A disease concentration was centralized in and about high density, blighted areas.

PRELIMINARY RESEARCH

The McHarg study was inspirational to the point that preliminary investigations were conducted to discover if a similar study would be possible for a community the size of Manhattan. An interview with officials at the Riley County Department of Health was all that was needed to confirm two points. First, they too assumed that disease concentrated in poor, blighted areas; and secondly, they felt it would be possible to perform the study but that the information it would require could only be found in the offices of the State Board of Health in Topeka.

In the first of a series of interviews with Mr. Robert A. French, Assistant Director, Division of Epidemiology, it was learned that the possibility of conducting a similar study was indeed good but with certain limitations. The State of Kansas requires by law that physicians report to the State Board of Health the treating of patients who have contracted any one of a list of communicable diseases. The occurences and consequent reporting are the primary source for the establishment of morbidity rates and patterns for the state. The morbidity reporting is accomplished via a card which includes the patients name and address, the name of the disease treated, date, age, etc. Morbidity cards are filed by county or alphabetically depending upon the frequency of the particular disease. Communicable diseases are the only disease that the state requires reporting of. It is much more difficult to obtain information on heart disease, stroke, cancer, and mental disease since the sources of the information are usually private.

To map diseases or locations of diseases entails the plotting on a map, by street address of the residence of the person involved. Space for the address of the patient is provided on the morbidity cards, but at this point one of two setbacks occurred. First, the cards from the smaller communities (Manhattan included) often included no other address than a box number or the city name. This eliminated Manhattan as a possible case study community. The other setback occurred upon the discovery that there were not enough cases of any one disease in the smaller communities to provide the sort of bulk of data that was deemed required for the study. This stage in the preliminary investigation resulted in two decisions: (1) the study would have to be limited to mapping communicable diseases, and then only the several which contained the most cards; (2) in lieu of Manhattan, Topeka would be the case study community. To gather information on other than communicable diseases would be a monumental if not impossible task for one person. Topeka was chosen for its size and therefore more occurences of diseases. Furthermore, Topeka was the seat of the State Board of Health and contained the data needed. Full cooperation was granted by the State Board of Health in providing access to the files and to any other information required. This concluded the preliminary investigation.

ESTABLISHMENT OF DATA SOURCES

Following this preliminary investigation was a series of interviews and research to begin establishing sources for the type of related data that would be required in the analysis of the disease mapping. Interviews were conducted again with Mr. Robert French, as well as Dr. Donald Wilcox, State Epidemiologist and Director of the Department of Epidemiology, the Topeka-Shawnee County Health Department, the Topeka-Shawnee County Metropolitan Planning Commission, and a non-profit organization called Goals for Topeka. Each concern was able to provide specific information and subsequent data that would be needed for the study, as well as opinions as to the merit of such a study.

During the interviews several of the same points brought forth in the ASPO report were confirmed by the health officials and the urban planners. Topeka had experienced no personal interaction between the health department and the planning agency. The planning department had not utilized the county or state health departments as a source of data. The county health department did have in its possesion several neighborhood analysis reports prepared by the local planning department, but were not instrumental in their preparation nor did they appear to question the content of the reports.

Yet the reports were primary sources of data to the health officials for locations of blighted neighborhoods and therefore where to conduct preventive medicine and education programs. When questioned about the relationship they had with the local planning department, no one really knew why there was none. Everyone agreed there should be some.

When the interviewed people were asked about the work of this proposed study there were no negative responses. Furthermore, they could not understand why such a study had never been undertaken before (Veneral Disease and Tuberculosis are the only two diseases which have ever been mapped for Topeka).

A further investigation into the morbidity card files revealed yet another limiting factor. Only five diseases occured with "enough" frequency to suggest their mapping. (Enough implies that some diseases had only one or two occurences in the past few years, while others had several hundred. As it turned out, the methods used in the study would allow a single occurence of a disease to be mapped, but this was not learned until late in the analysis.) The five diseases were: Infectious Hepatitis, Shigellosis, Salmonellosis, Tuberculosis, and Streptococcal Infections. Venereal Disease was high in occurence but because the environmental relationship is so little understood the disease was not suggested for mapping. These five diseases were stated as fairly accurate ones with regard to occurence versus reporting. Even though law requires the reporting of certain diseases not all physicians find the time to report them. Likewise, not all cases seek the attention of a physician, or are diagnosed over the phone. However, accuracy is achieved in some diseases due to the character of the method of diagnosis. Laboratory testing is often the only means of determining the presence of a disease, as in the case of Shigellosis. In these cases the laboratory will submit the report to the state. In other cases manifestations of a reportable disease will cause a more serious disease. While the first may go untreated or unreported, the other usually does not. Of the five diseases included in the study, it is the general feeling of the health officials that the reporting is good; at least 90% or better.

INFLUENTIAL FACTORS IN DISEASE MORBIDITY

The next step in the procedure was to determine what environmental factors were considered to be influential in the spread of disease. This information was found in several texts and verified by the Health Department.

Influential factors were discussed with Dr. Wilcox. He was careful to point out that communicable diseases are not always directly related to environmental and social features. Often the cause-effect relationship is not specifically known. Nevertheless speculation or assumption is omnipresent, "You can take any disease and relate it to lower socio-economic areas."[2] Dr. Wilcox specifically listed such features as poor housing, overcrowding, sanitation, vector control, alcoholism, and pollution as primary influences on disease morbidity.

The link between each of the various diseases and some environmental feature needed to be established in order to understand any relationship found to occur. These links are briefly discussed in the following paragraphs. Medical terminology is eliminated as are any bio-chemical processes or lengthy explanations of how diseases are passed from one person to the next. As a conclusion to each disease discussed, the primary influential factors involved will be listed.

Infectious Hepatitis is caused by a virus and is excreted in the waste from humans. The mode of transmission is fecal to oral, fecal to oral. Common vehicles are polluted water and contaminated food. The implication here is one of sanitation. Improper washing of the hands after bowel movements and subsequent handling of food or contact with other person is a primary source of transmission. Likewise, when fecal matter containing the virus is present in ponds

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[2] Quoted during a personal interview with Dr. Donald Wilcox, State Epidemiologist, on September 13, 1972.

or streams there is chance for contact with people. Multiple outbreaks often occur in a single family. The link here is one involving improper education and personal hygiene as well as poor or inadequate sanitary facilities. Multiple outbreaks in families suggest that the more people, the greater the likelihood for more occurences of the disease. Influential factors: Poor or inadequate sanitary facilities, poor housing, and overcrowding.

Salmonellosis is a form of food poisoning caused by Salmonella bacteria and transmitted by ingestion of the organisms. The ingestion occurs through food contaminated with infected feces of man or animal. Outbreaks of Salmonellosis are often traced to commercially processed foods contaminated by handlers. The major mode of transmission is considered to be person to person contact via the hands. Again the implications are improper sanitation coupled with high contact probability areas (high density population and/or overcrowding).

Shigellosis is an acute bacterial disease of the intestine, similar to Salmonellosis in both cause and effect. Again, the mode of transmission is fecal to oral; indirectly by objects soiled with infected feces, eating of contaminated foods or drinking contaminated water, by flies, or by direct contact. Influential factors are improper sanitation and high density or overcrowded populations.

Tuberculosis is perhaps the most well known of communicable diseases next to venereal disease. Mode of transmission is primarily airborne or contact with the bacilli in sputum or other pulmonary secretions. The contact must be long; over a period of time. High density population and overcrowding provide the contact and closeness required. Tuberculosis is unique in that a person may be infected with the bacteria and not be an active case. Their bodies are able to cope with the disease until such a time as stress breaks down the resistance and the person develops an active case of TB. Medical authorities agree the stresses caused by alcoholism, malnutrition, overwork, self abuse or pregnancy are capable of "releasing" the disease to an active state. Medical authorities further agree that these stresses are common in the lower socio-economic areas.

Streptococcal Infections (Strep Throat, Scarlet Fever) are respiratory infections spread by direct or intimate contact with a carrier. Contaminated food is likewise a source. Sanitation, overcrowding and high density population are considered influential factors in the spread of the disease.

SUMMARY OF INFLUENTIAL FACTORS

The foregoing discussion of diseases and their methods of transmission via the environment can best be summed up by listing below those influential factors which play either direct or indirect roles in their morbidity. It should be noted that not all medical practitioners are likely to agree with the choices. However, they are considered to be the current consensus.

1. Improper Sanitation and Hygiene
2. Overcrowding
3. High Density Population
4. Poor Housing Conditions
5. Low Socio-Economic Groups

The above list is coincidently similar to the contents in many neighborhood analyses and master plans. Urban planners utilize the same factors for determining decadent neighborhoods or an area in need of renewal. Disease mapping merely proposes to use the above data in yet another way.

The preceding several pages have presented a brief history and research background for this report. Obviously, the "preliminary" investigations produced much of the required data needed and therefore must be considered an actual phase of the study. The remaining phases are: final data collection, conversion, and mapping of the various diseases and influential factors; and analysis of the data and maps by visual examination and computer.

PART II: SECTION 2

MAPPING TECHNIQUE

As the name implies, disease mapping uses as a primary technique graphical display of data. The map with data overlayed provides the observer with a clear picture of the relationship of a certain feature to the community. Most often the features mapped are physical objects, but also mapped are social, cultural, economic, and political data. Since the mapping of whatever data was obtained was predetermined, a suitable and consistant method was sought. The Urban Atlas of 20 American Cities provided the technique that is used in this study. Briefly, a grid is superimposed over a city map. Each grid cell then encompasses a certain geographical portion of the city and becomes a common denominator. All information collected is compiled and converted to the grid cell representing its physical location in the city. An appropriate symbol is used on the final maps to represent a certain level of occurence for the particular item being mapped.

This method of mapping was chosen for its objectiveness. Geographical areas common in other studies are the neighborhood, the census tract, or voting precincts. Often the delineation of boundaries is arbitrary or biased. It was felt that a grid composed of equal sized cells would at least help eliminate any bias of boundaries established in past reports.

The grid chosen represents an area of four million square feet or 91.1 acres. A larger grid area would produce areas nearly as large as established neighborhoods, and a smaller area would have produced too numerous of cells for one person to handle. The grid is illustrated by Fig. 1, and contains 305 cells covering the corporate limits of Topeka, Kansas.

FINAL DATA: DISEASES AND INFLUENTIAL FACTORS

Disease information available for mapping was established during the investigative phase of the study. Those diseases to be mapped are:

1. Infectious Hepatitis
2. Shigellosis
3. Salmonellosis
4. Tuberculosis
5. Streptococcal Infections

Data pertaining to the influential factors of housing, population, overcrowding, and sanitation are all contained, in various forms, in reports of the United States Census. The U.S. Census of Housing: 1970, City Blocks, Topeka, Kansas, provided information broken down for individual blocks in the city. Listed below are the physical and social features which were obtained from the City Block report and which corresponded to the list of influential factors in disease morbidity.

1. Total Population
2. Negro Population
3. Number of Dwelling Units
4. Number of Dwelling Units without all Plumbing
5. Number of Dwelling Units Overcrowded (1.01 or more persons per room)

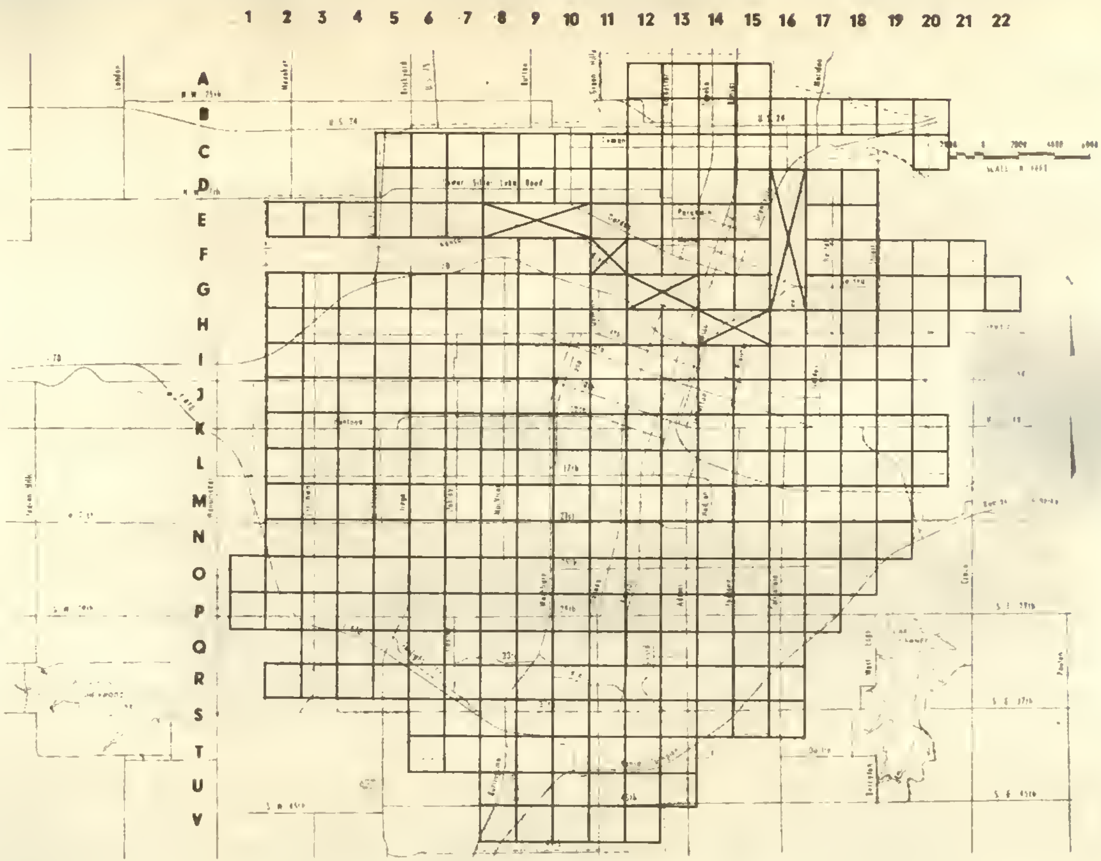

FIG. 1 TOPEKA, KANSAS - STUDY AREA AND GRID DESIGNATION

Further factors to be considered were:

6. Rate (Units/1000) of Dwelling Units without all Plumbing
7. Income

Income figures were obtained from Statistics Report, Topeka Area Planning Study, 1972.

A figure not directly obtainable in the census reports is the number of dilapidated units. This has been included in past census undertakings, but due to the fact that much of the 1970 census was conducted by mail, the public was not expected to appraise the condition of their own residence. This is compensated for by the inclusion of questions aimed at determining units which lack some or all of the plumbing facilities. According to a source in the Topeka Metropolitan Planning Commission, 90% of the dilapidated units are included in the same group as those units lacking some or all plumbing facilities.

DATA CONVERSION FOR MAPPING AND PRESENTATION OF MAPS

All of the census block data had to be converted to totals for each grid cell. In rather tedious fashion, similar techniques used by the authors of The Urban Atlas of 20 American Cities were employed. Each block number contained within each grid cell was recorded. Where a block overlapped into another grid cell or was physically larger than the grid cell, it was "pro-rated" to the appropriate grid cell. Corresponding population, housing, etc., figures for each block in each cell were summed. This data is displayed in Figs. 2 - 8.

As previously mentioned, disease data was obtained from the files of the Kansas State Board of Health. The address of the patient's place of residence was recorded on tape and later plotted by hand on city maps. The grid cells were then projected onto the maps and a total figure of disease incidence within each cell was obtained. These were likewise mapped and are illustrated in Figs. 9, 11, 13, 15, and 17. Figure 19 is a map depicting the incidence of the five diseases combined. Figures 10, 12, 14, 16, and 18 are morbidity[3] rates of disease incidence per 1000 population.

All of the disease and environmental data is compiled for reference in Appendix A.

A general discussion about each map and its contents follows to illustrate the eyeball method of analysis and to prepare the reader for discussion of further analyses conducted by other means.

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[3] See page 35 for an explanation of morbidity rates as used in this report.

Total Population. The 1970 total population for the city of Topeka was reported as 125,011 and is distributed within the city as illustrated in Fig. 2. The highest concentration occurs in a near central location just west of the downtown area. Other concentrations of high population occur in spot locations, many of which are apartment complexes, university housing, etc. As might be assumed, the fringe areas of the city reflect lower population densities.

Negro Population. Negro population comprises approximately 8%[4] of the total population, or 18,000 people. A much wider dispersion of Negroes than is probably assumed is apparent from Fig. 3, although the majority of those cells containing Negro population have less than 100 Negroes. A small concentration appears to the east of the CBD with several cells high in Negro population.

Dwelling Units. Figure 4 illustrates total number of dwelling units. As can be expected, the higher numbers of dwelling units per cell correspond with the cells containing the higher numbers of total population.

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4 U.S. Bureau of the Census, "Block Statistics, Topeka, Kansas, 1970", (Washington, D.C., 1970), p. 1.

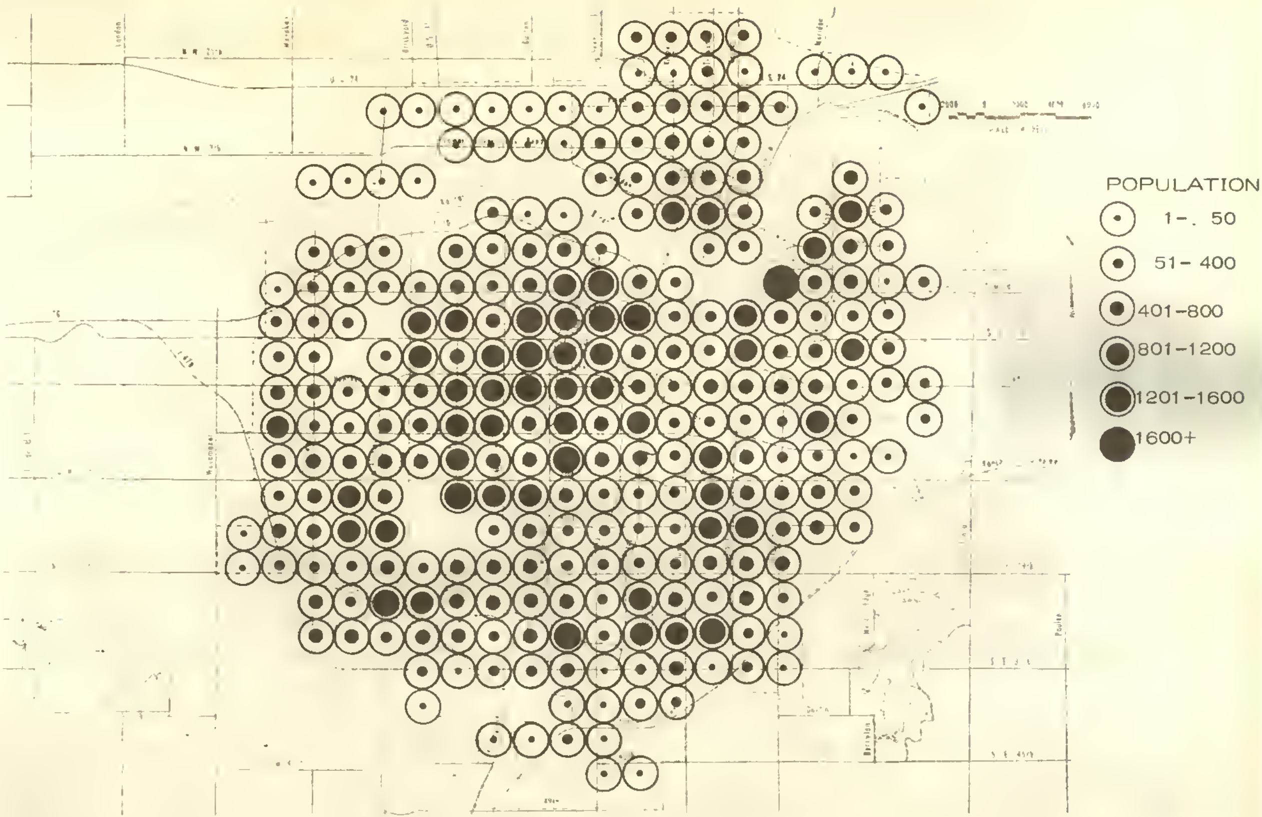

FIG. 2. TOTAL POPULATION 1970

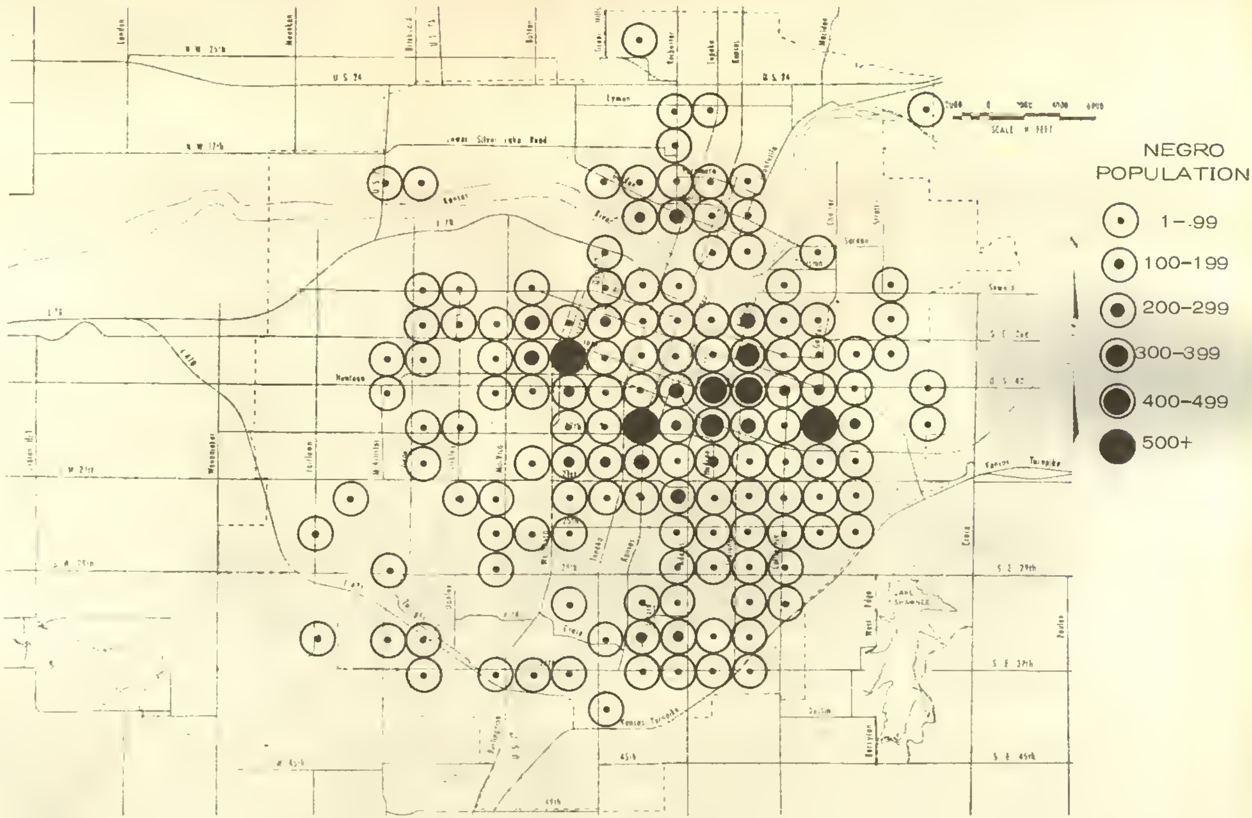

FIG. 3. TOTAL NEGRO POPULATION 1970

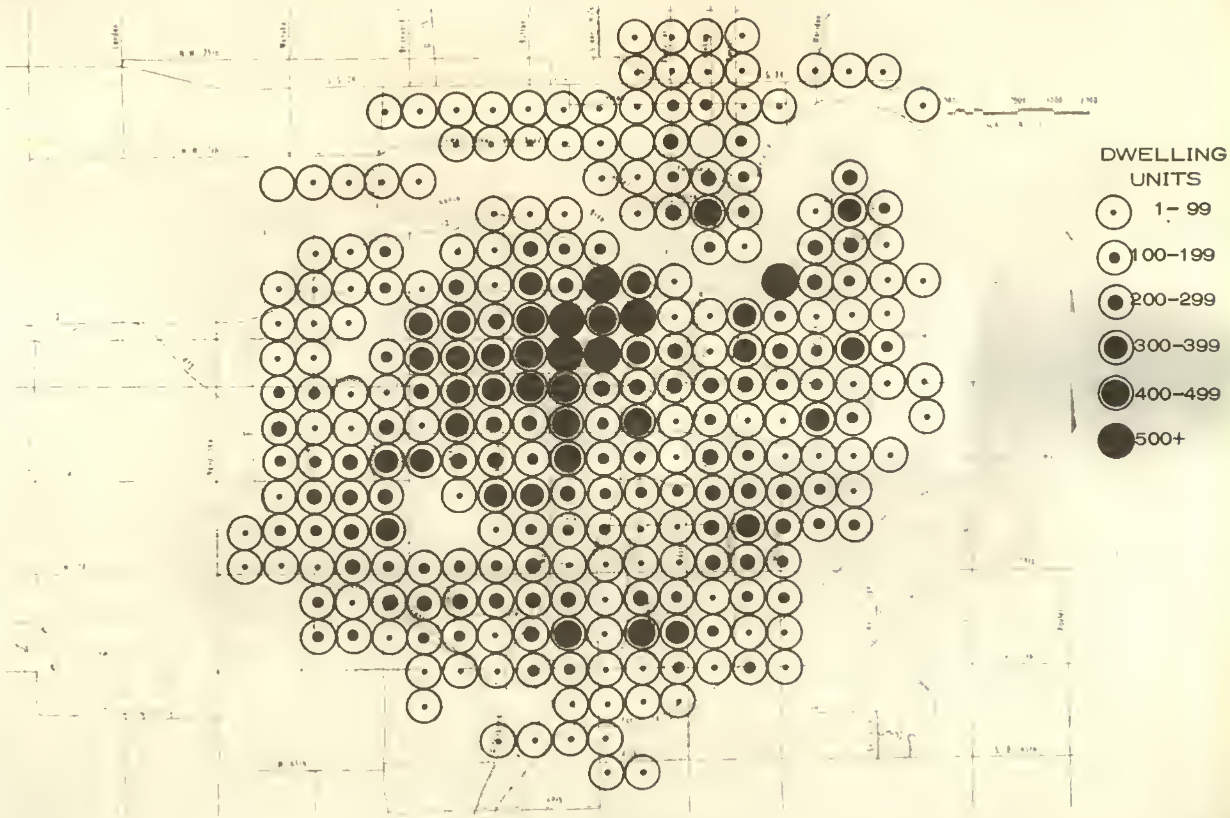

FIG. 4. DWELLING UNITS 1970

Number of Units Without All Plumbing, Rate Without All Plumbing. The total number per cell of dwelling units without all plumbing facilities is illustrated by Fig. 5, while the rate per 1000 dwelling units without all plumbing is illustrated by Fig. 6. The bulk of those units without all plumbing cluster in a near central location very close to the CBD. The map of rates further emphasizes the sanitation situation in the core area. Also high rates of units per 1000 without all plumbing are discernable along the fringes of the city. Although only speculation this is possibly attributable to the older, once rural, housing units which have been incorporated by city expansion. Likewise, since the total number of living units are low in these areas only a few need to be without the proper plumbing facilities to elevate the rate. As a final comment, recall that those units without all plumbing are said to account for 90% of the dilapidated units.

Overcrowded Units. The Census Bureau defines an overcrowded dwelling unit as one which contains 1.01 or more persons per room. Overcrowded units, Fig. 7, are highest in number in the central and eastern portions of the city. The interesting point here is that almost the entire city is marked with overcrowded units. With those cells containing one or more overcrowded units shown on the map, it becomes apparent that few areas of Topeka contain no overcrowded units.

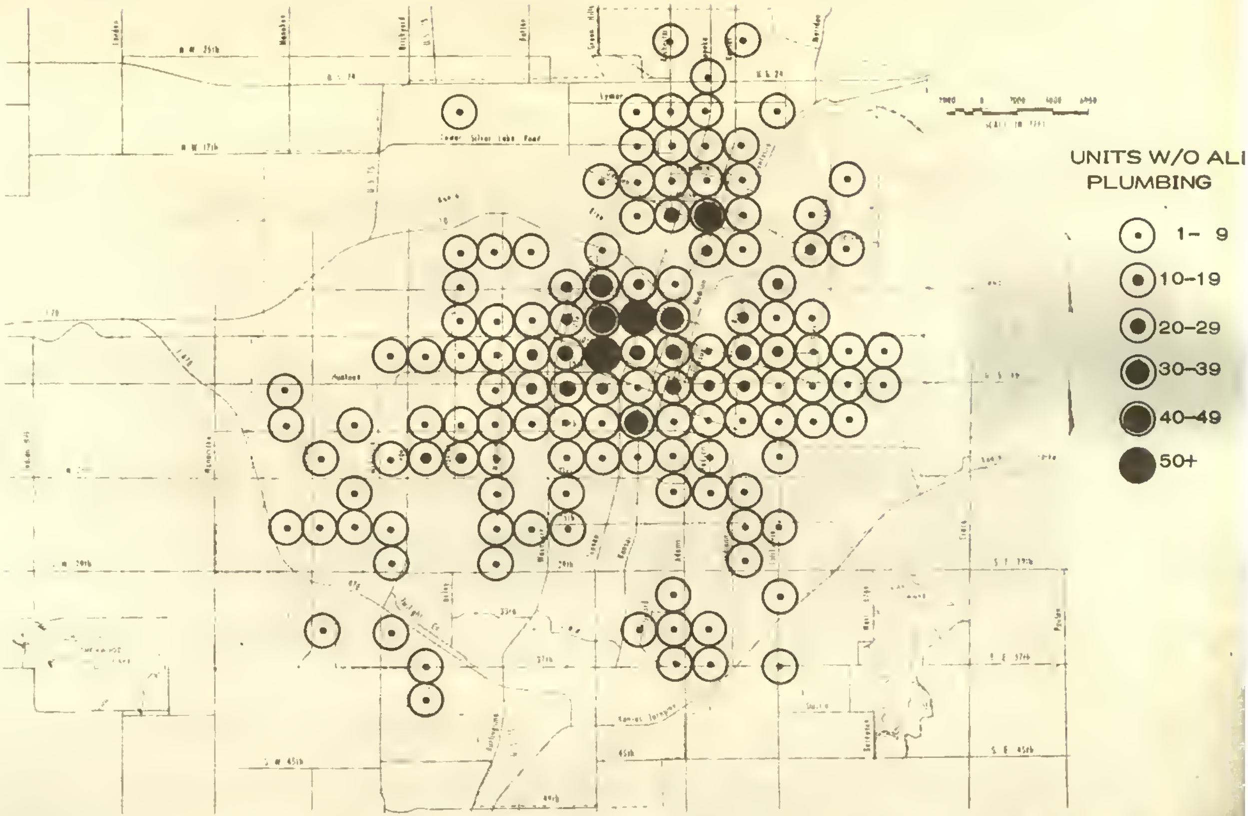

FIG. 5. DWELLING UNITS WITHOUT ALL PLUMBING FACILITIES 1970

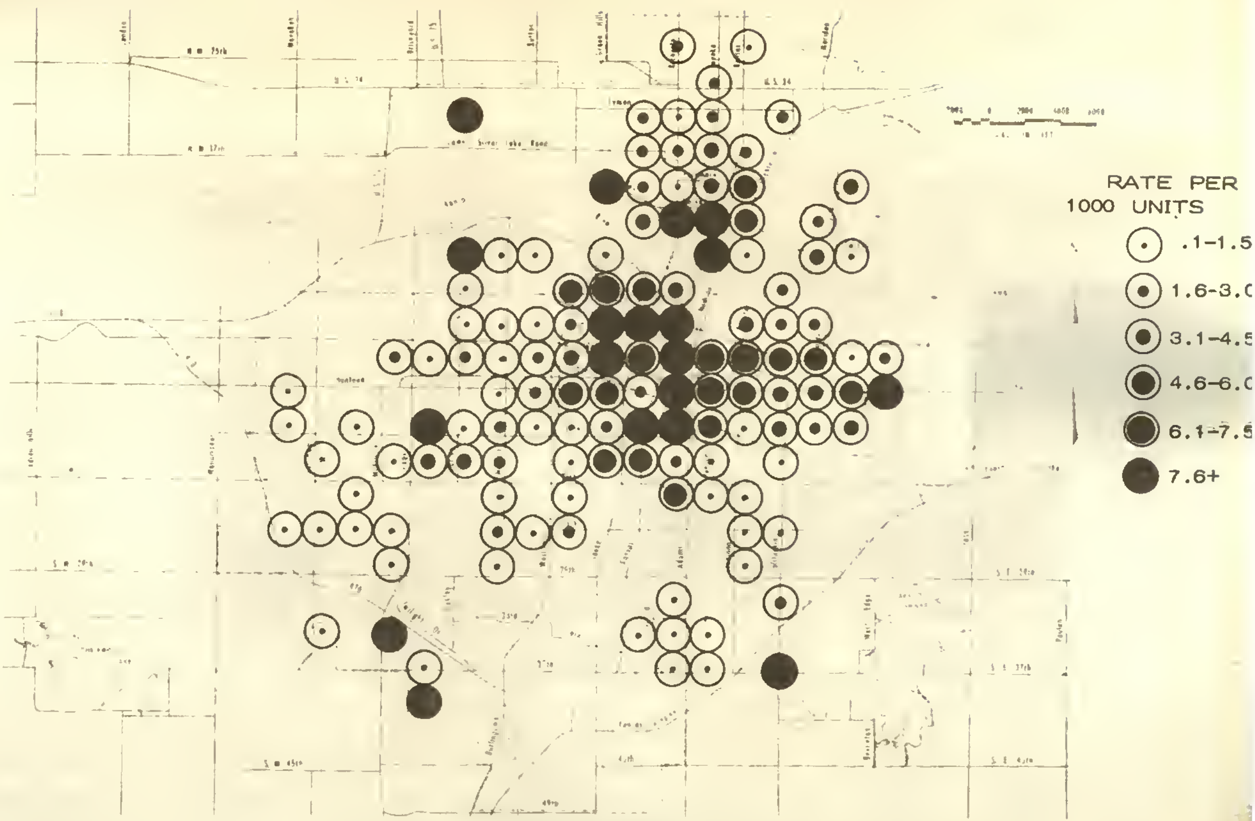

FIG. 6. UNITS WITHOUT ALL PLUMBING FACILITIES
RATE PER 1000 UNITS, 1970

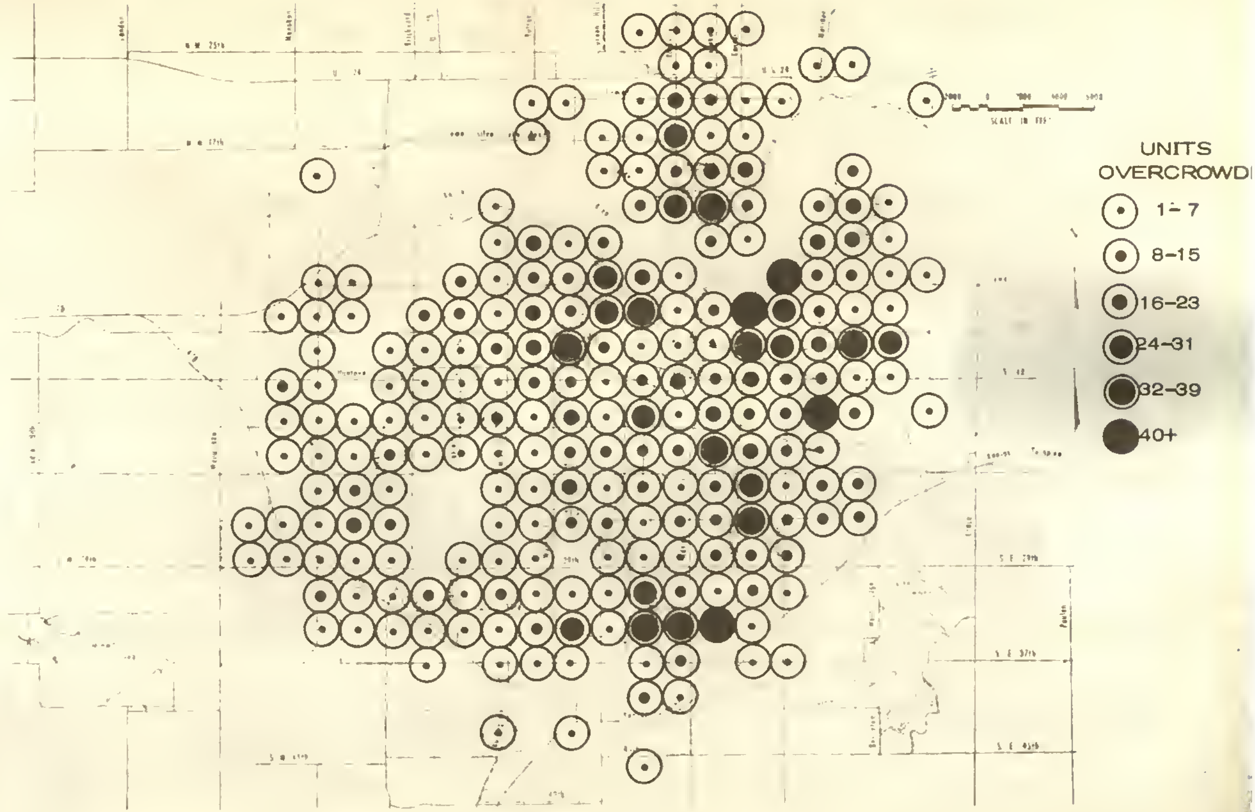

FIG. 7. UNITS OVERCROWDED, 1970

Average Family Income. The final map illustrating environmental, social or economic data is Fig. 8, Average Family Income. Of particular interest is the overall city average income of $10,782.[5] The lowest average for any one cell was $5,585 while the highest was $21,028. Topeka appears to be fairly well off from an average family income standpoint. The west and southwest parts of the city are endowed by the highest incomes. Several equally high averages are found in small concentrations on the east side and to the southeast. Noteworthy is the rather high averages of family income found in the west central area which was also an area of high population. The implication here is that the lowest incomes should be typical of the highest population densities.

The remainder of the illustrations depict the mapping of disease incidence and morbidity. Each disease is represented by two maps. The first illustrates the total number of occurences in each grid cell, while the second illustrates the morbidity rates per 1000 population. The term "rate" used in conjunction with this study and the corresponding rate figures has special meaning. Disease data obtained from the health department was not available for all five diseases for the same time periods. Some information was available as far back as 1962, and some ceased prior to 1968. Therefore, a special rate factor was fashioned for this study. The total disease incidence per cell for the years

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[5] Topeka-Shawnee County Regional Planning Commission, "Statistics Report, Topeka Area Planning Study", (Topeka, Ks., 1970) Appendix A.

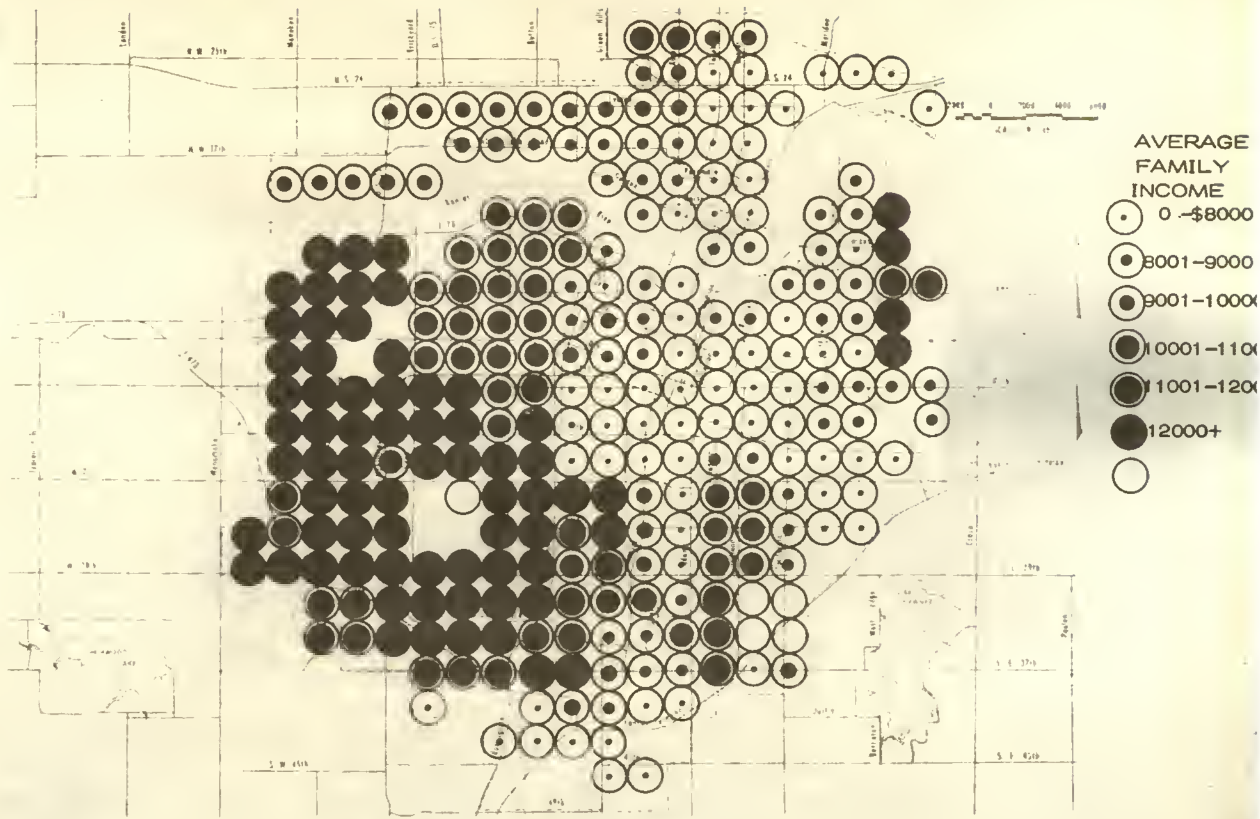

FIG. 8. AVERAGE FAMILY INCOME, 1970

indicated was divided by the total population per cell for 1970. This produced a manufactured factor (not indicative of actual annual rates) which could be used for comparison purposes with state and national rates. These state and national rate factors would be determined in similar fashion by summing total diseases for certain year groups and dividing by total 1970 population. These are provided in the table below

TABLE 1
Disease Rate Factors for Topeka, Ks.; Kansas; and the United States

Disease	Years	Topeka, Ks.	Kansas	United States
Inf. Hep.	1962 - 1971	2.5	1.8	2.2
Shigellosis	1964 - 1971	4.9	1.01	0.5
Salmonellosis	1965 - 1971	1.4	.94	.65
Tuberculosis	1966 - 1971	1.0	.56	1.22
Streptococcal	1969 - 1970	2.8	3.0	4.3

The rate factors are not to be confused with actual rates. (Actual rates per 1000 persons on a year by year basis are presented in the final section of the report.) They are provided to use as comparisons to state and national rates as well as determine above average or below average locations within the city.

Infectious Hepatitis. Figure 9 reveals a rather widespread incidence of Infectious Hepatitis, but in low occurences. Few areas appear to be free of this disease. Only four cells reported more than six cases and of these four none were above nine.

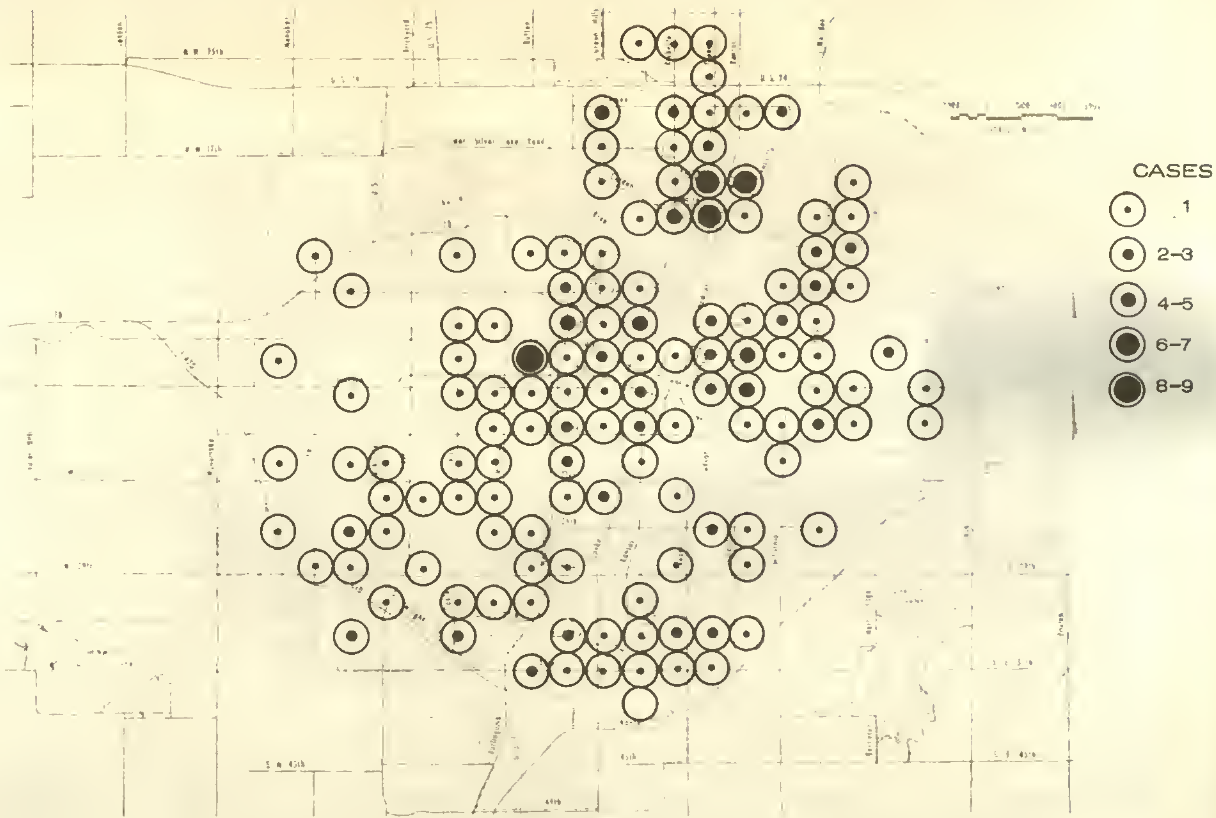

FIG. 9. REPORTED INFECTIOUS HEPATITIS CASES, 1962–1971

Infectious Hepatitis - Rate Per 1000 Population. The rate of infectious hepatitis, Fig. 10, presents a slightly more interesting picture than the preceding map. The higher rates occur at random through much of the city with a concentration beginning to appear in the north section of the city.

Salmonellosis. Figure 11 illustrates the cases of Salmonellosis reported from 1964 to 1971. The distribution is random and to a lesser extent than infectious hepatitis. It should be pointed out that two of the three cells representing the highest level of cases are the locations of the Kansas State Hospital and the Kansas Neurological Institute, both of which had epidemic outbreaks of Salmonellosis during this time period.

Salmonellosis - Rate per 1000 Population. (See Fig. 12) The rate map is not much different than the number of cases map for Salmonellosis. High and low rates occur without pattern.

Shigellosis. Figure 13 illustrates incidence of Shigellosis. Here the beginnings of clustering or concentrations is visible. The disease is more confined to the central and southern areas than were the two previous diseases discussed. The higher numbers of occurences cluster just to either side of the CBD and in an area at the southern part of the city.

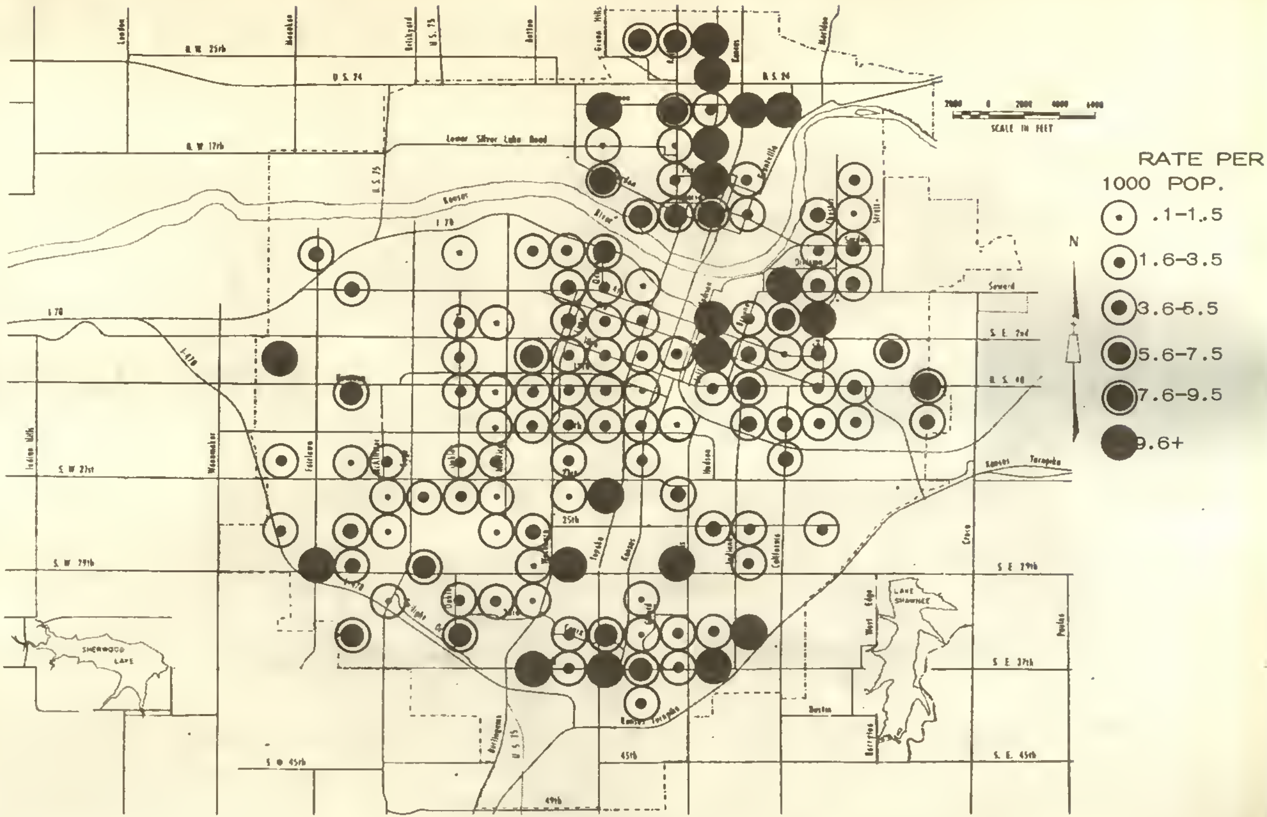

FIG. 10. INFECTIOUS HEPATITIS MORBIDITY RATES, 1962–1971

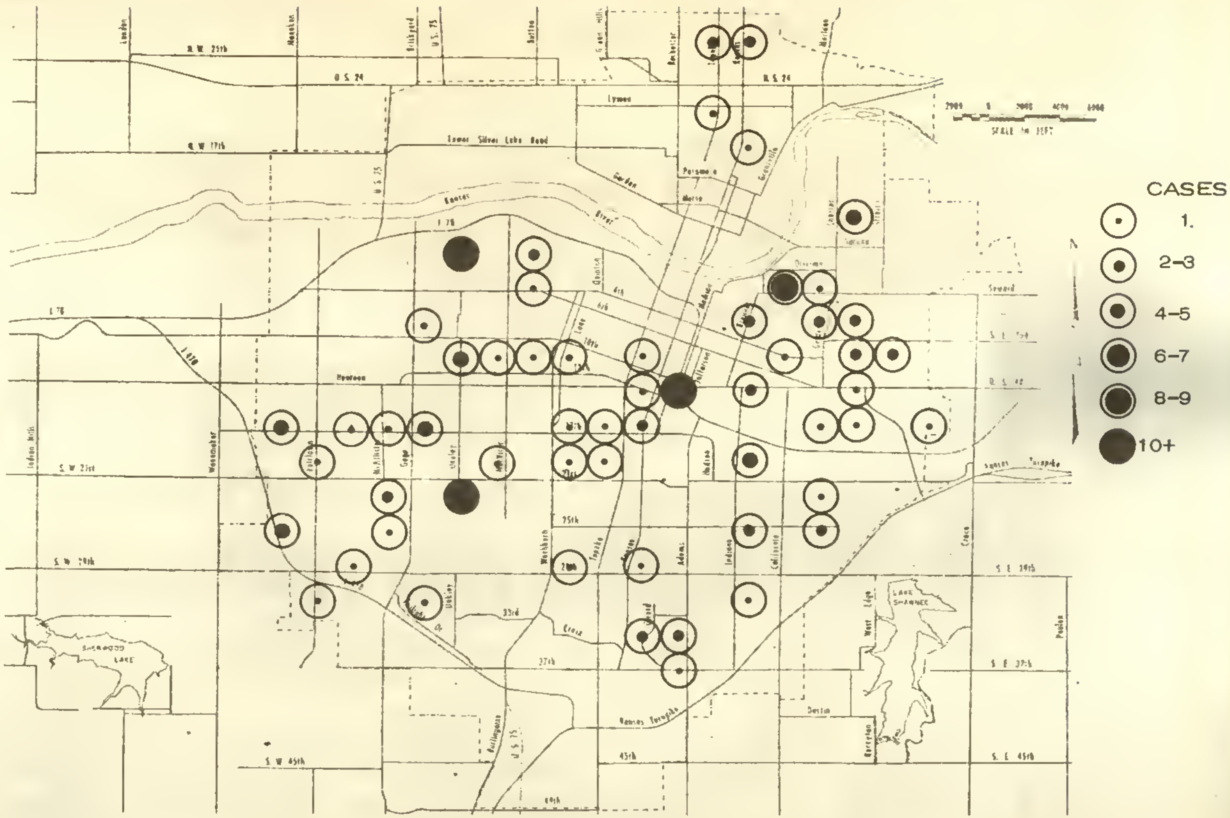

FIG. 11. REPORTED SALMONELLOSIS CASES, 1965–1971

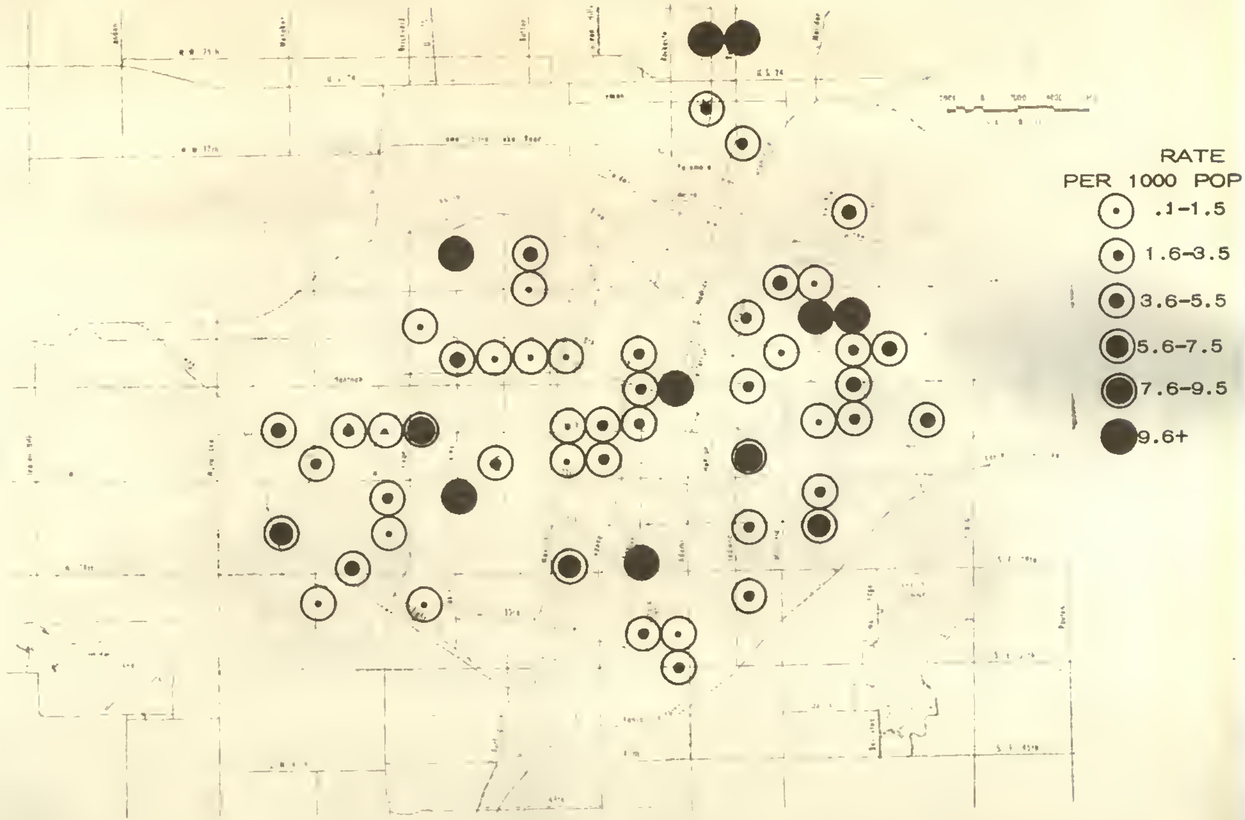

FIG. 12. SALMONELLOSIS MORBIDITY RATES, 1965-1971

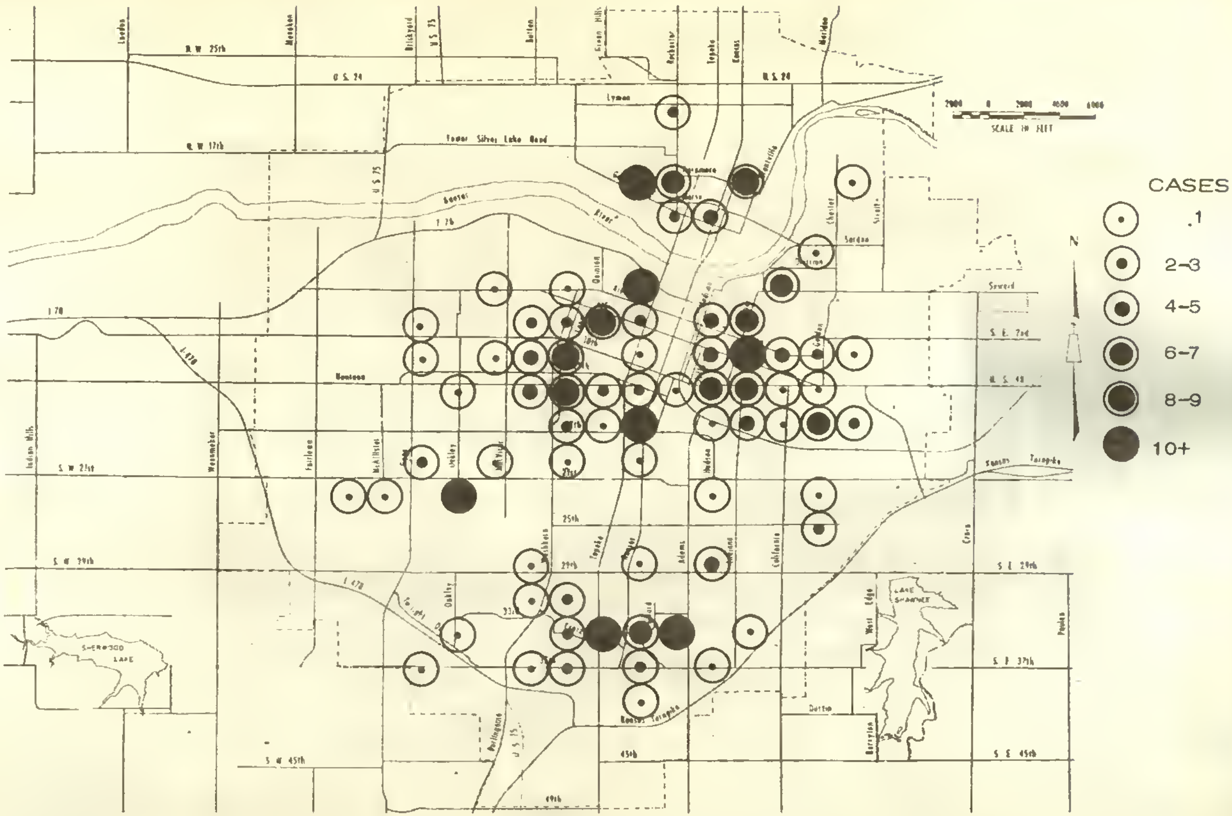

FIG. 13. REPORTED SHIGELLOSIS CASES, 1964-1971

Shigellosis - Rate Per 1000 Population. Rates of Shigellosis, as shown in Fig. 14, follow a similar pattern as numbers of occurences. The east central area stands out from the rest of the city with its high rates. A recheck of the figures illustrating influential factors will reveal that this same general area had the highest rates per 1000 dwelling units of units without all plumbing facilities, the lowest average family incomes and several cells high in overcrowded units.

Tuberculosis. The number and location of cases of tuberculosis is shown in Fig. 15. An even distribution of tuberculosis is visible with few cells having more than three cases. Only one had more than nine and is located to the east of the CBD.

Tuberculosis - Rate per 1000 Population. Morbidity of tuberculosis, Fig. 16, is highest in an east central, central, and north central area. Other higher rates occur in a less compact area to the south of the CBD.

Streptococcal Infections. Figure 17 represents occurences of streptococcal infections in Topeka. A southwestward "shift" in location of the majority of cells is apparent. A probable explanation is the earlier comment made with regard to the income levels of families who are more than likely to seek medical attention for this disease. The map illustrating average family incomes shows the higher incomes to

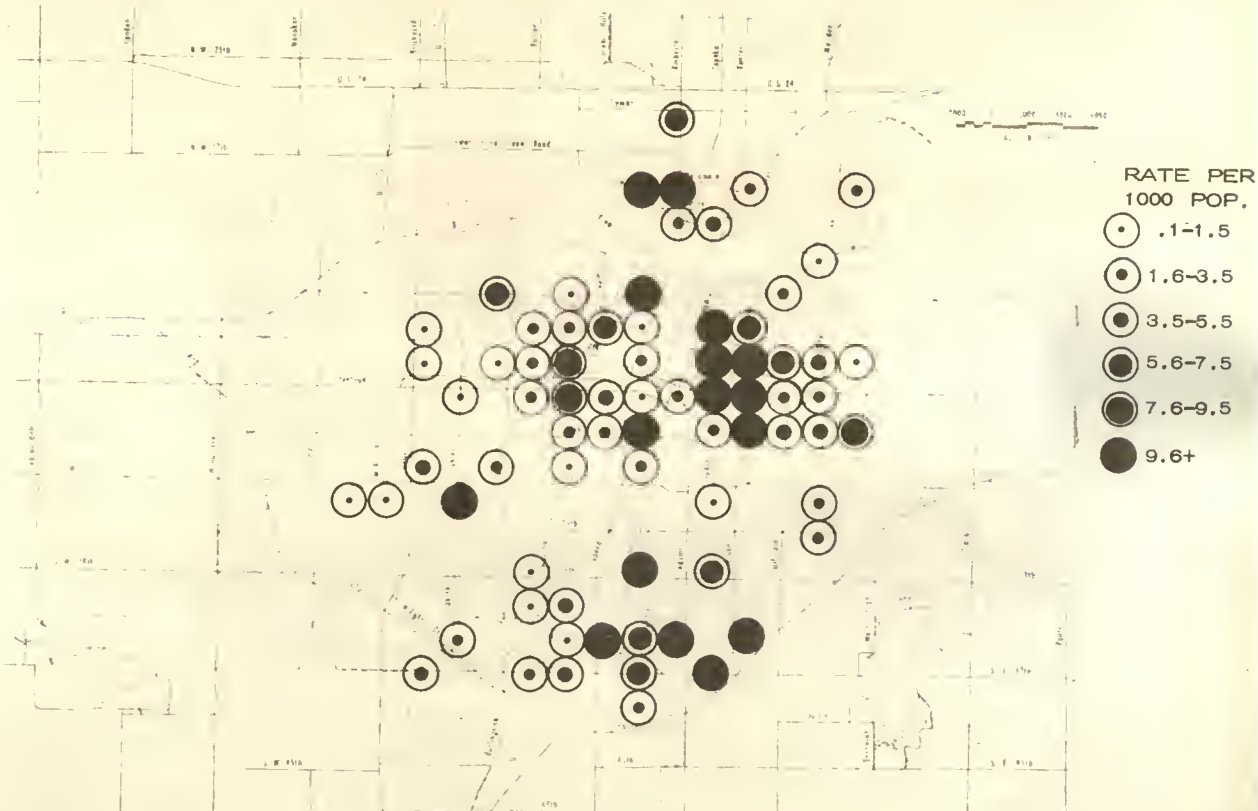

FIG. 14. SHIGELLOSIS MORBIDTY RATES, 1964-1971

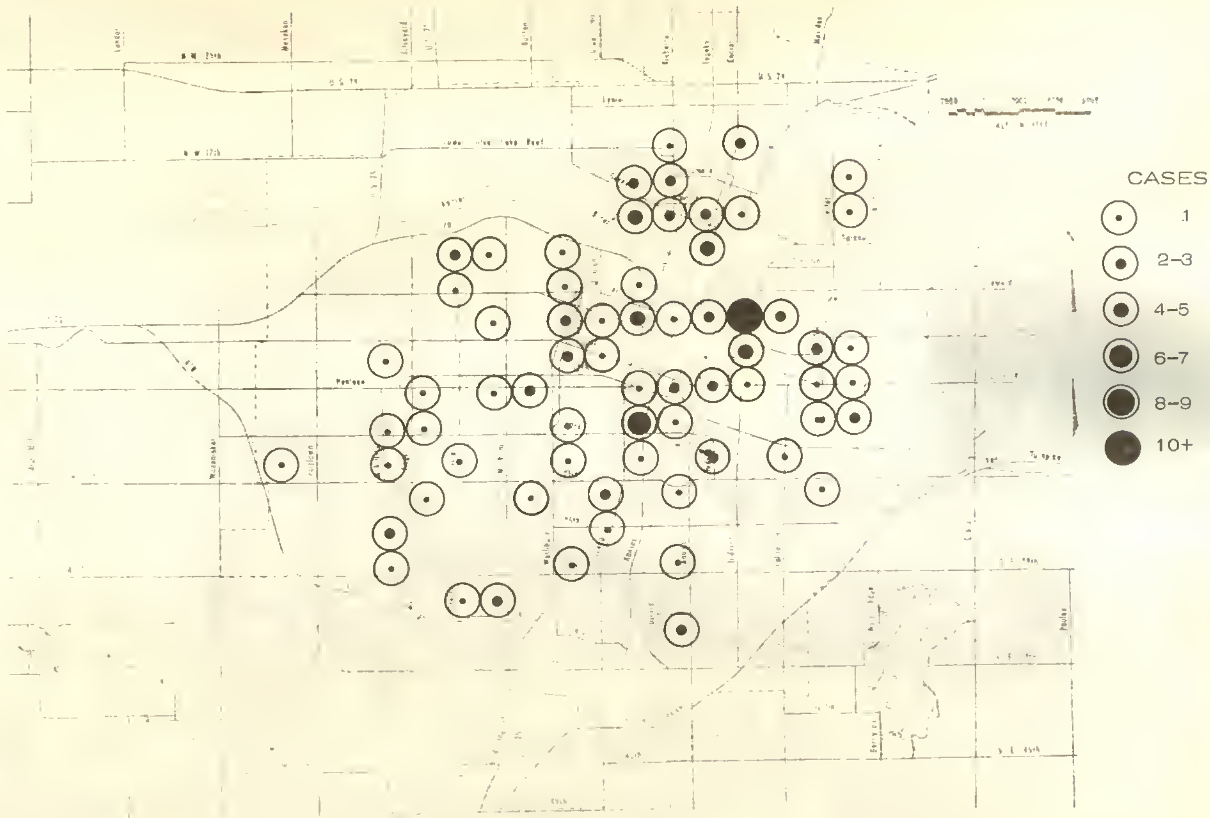

FIG. 15. REPORTED TUBERCULOSIS CASES, 1966–1971

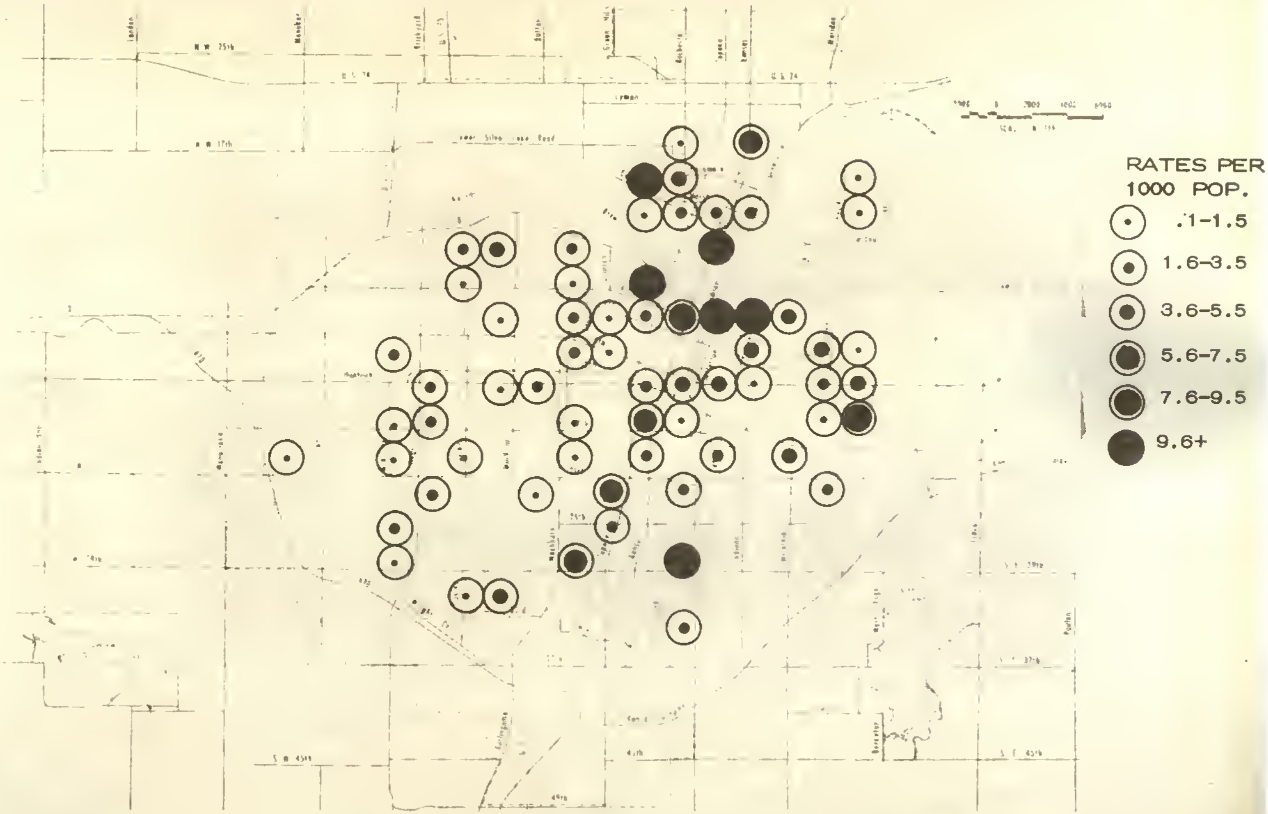

FIG. 16. TUBERCULOSIS MORBIDITY RATES, 1966-1971

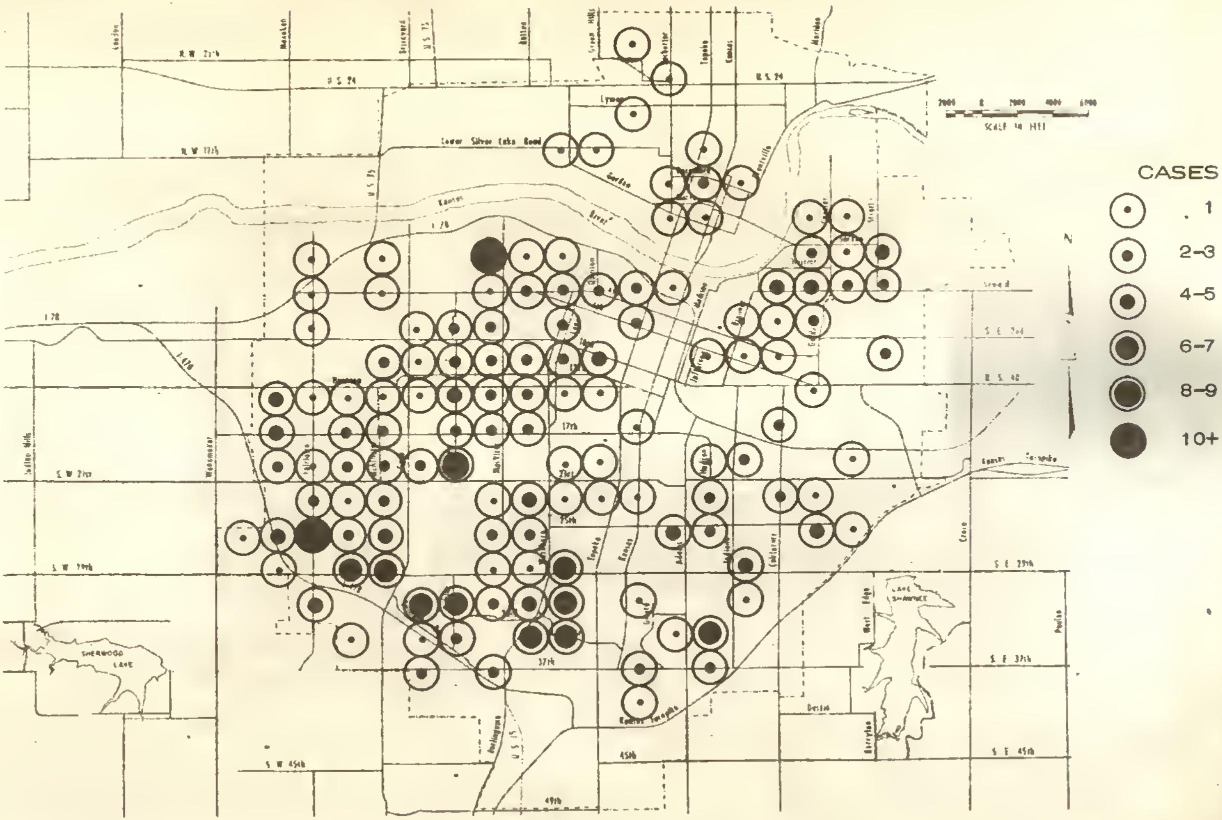

FIG. 17. REPORTED STREPTOCOCCAL INFECTION CASES, 1969–1971

in the west and southwest portions of the city. This corresponds to the general "heaviness" of streptococcal infections in the same area.

Streptococcal Infections - Rate Per 1000 Population. Morbidity is high in several locations in the southwest as well as other spot locations throughout the city, as shown in Fig. 18. However, there is a definite lack of high rates in the central locations, which have been the locations of high rates for some of the other diseases discussed.

Total Disease Occurences. The final map in this part of the study is Fig. 19, Total Disease Occurence. This map presents a composite picture of occurences of the five diseases. Perhaps the most striking feature of this illustration is that very few locations reported no occurences of any of the five diseases. It was hoped that this map would produce some indication of an area with the highest disease occurence. This did not occur. Rather, several areas are beginning to show a concentration of disease such as the west central, east central, and north central, and a string along the southern fringe. These would have to be considered the problem areas with respect to disease incidence.

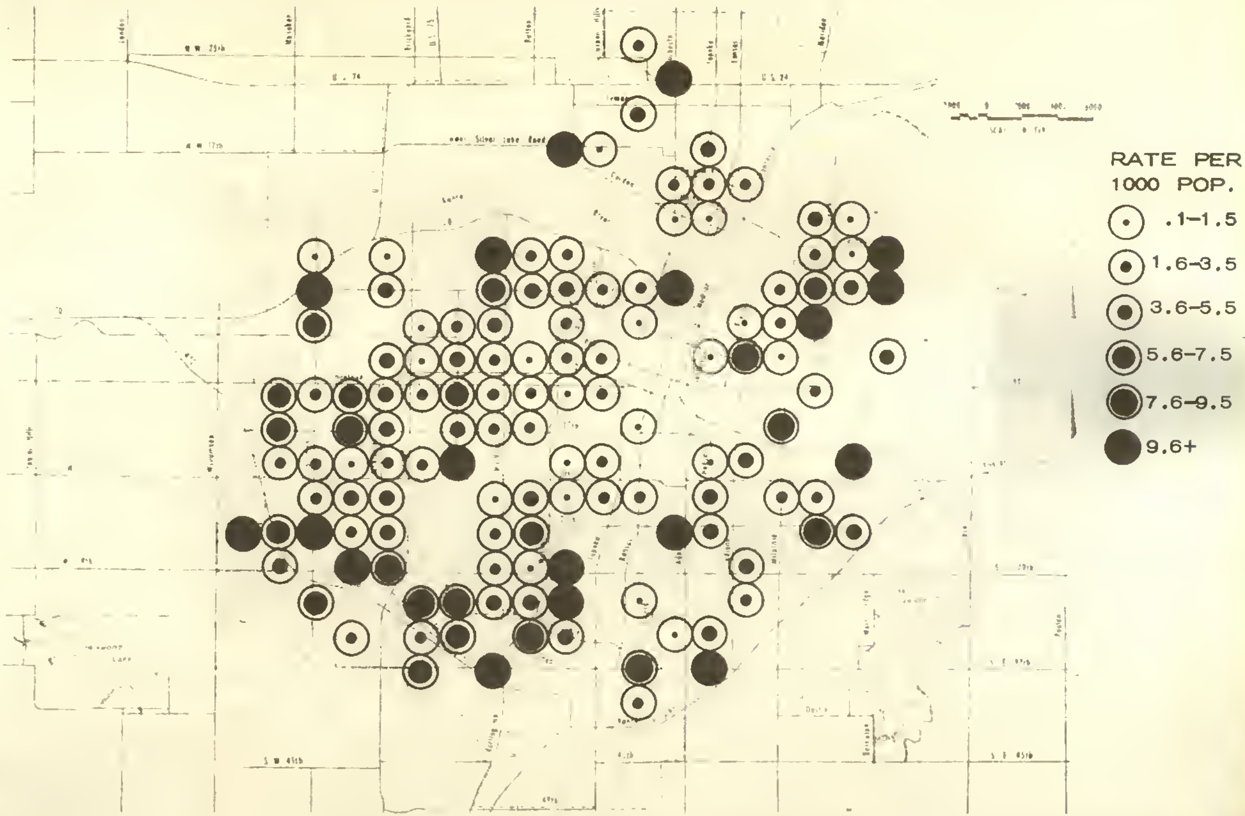

FIG. 18. STREPTOCOCCAL INFECTION MORBIDITY RATES, 1969–1971

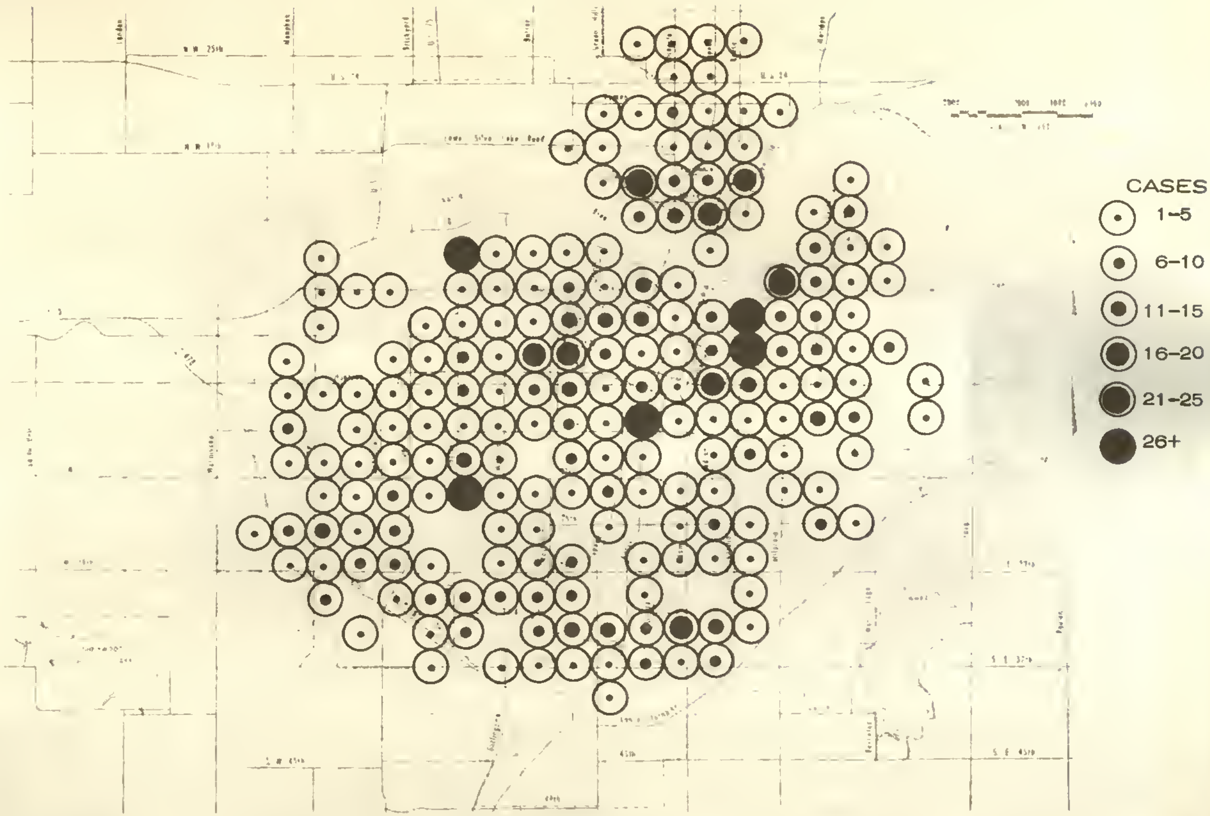

FIG. 19. TOTAL REPORTED CASES OF FIVE DISEASES

SUMMARY: VISUAL ANALYSIS OF MAPS

Specific conclusions could be stated about the maps and study at this point. However, the validity of such conclusions would be questionable. In this case the study was conducted to show that diseases occur most frequently in the lower physical, social, and economic areas. Planners as well as other disciplines are often guilty of predetermining the results of a study. A primary example of this comes to mine in transportation planning and route location. Extensive research and "objective analysis" prove that the best route was the one chosen in the first place. Nevertheless, if conclusions were stated now about any results thus far they would have to be negative. It is impossible to conclude anything from the maps except that further analysis must sift through all the data, and that the maps do illustrate the patterns or lack of patterns for all features and diseases mapped. The analysis of the data is discussed in the following section.

PART II: SECTION 3

ANALYTIC METHODOLOGY

In this section of the report, the explanation and results of the objective analysis conducted on the accumulated data is presented. Statistical methods available for such an analysis are almost too numerous to imagine. Some of these are highly sophisticated while others are quite simple to use and understand. With the aid of the Department of Statistics, Kansas State University, a computer program was selected which would provide the opportunity to arrive at a series of statistical measurements from which to better determine the relationship between diseases and the environment.

The primary statistical measurement to be utilized in the analysis was that of correlation, (r.) This measurement would be indicative of how closely two features, or variables, are related. The second statistical device used involved an analysis which was designed to formulate a model which can be used for a variety of purposes. This model could be obtained from any of several programs of multiple regression analysis. The specific regression variety finally accepted was step-wise deletion. This program conducts an analysis using all available data to form a model. During the analysis, the computer determines which of the supplied variables are not significantly contributing to the model formulation and subsequently drops them from further usage.

Multiple regression has three basic uses : (1) constructing an equation (model) using independent variables to give the best prediction of the value of some dependent variable, (2) where there are many independent variables finding the subset that gives the best equation, and (3) where the objective is not prediction, to discover which variables are related to the dependent one, and, if possible, to rate these variables in order of their importance. Since the predictability of future occurences of diseases is dependent upon entirely too many factors, all of which would have to be considered in the formulation of a predicting model, this use of multiple regression was not acceptable. However, what was acceptable was discovering which variables the computer felt were good for predicting future occurences and likewise which variables it felt were best related to the selected dependent variable (in this instance, the five diseases are the dependent variables). Thus, while the program was developing a model or equation for predicting purposes, the other information could be extracted at the same time.

ANALYSES PERFORMED

Listed below are the various analyses performed on the disease - environment data previously presented on maps, and an explanation of each.

Analysis #1 An analysis to obtain correlations and best related variables between diseases and environmental data. All variables (dependent and independent) for all points (cells) were utilized.

Analysis #2 An analysis to obtain correlations and best related variables between diseases and environmental data. All variables were used, and those point which contained zero occurences of the disease being analyzed were dropped from the analysis.

Analysis #3 An analysis to obtain correlations and best related variables between diseases and environmental data. Dropped from the analysis were all variables except environmental data (population, dwelling units, etc.), and all points with zero occurences of the disease being analyzed. (The difference between this analysis and Analysis #2 is that #2 included the other diseases and morbidity rates as independent variables whereas this analysis dropped the other diseases and rates from the analysis.)

Analysis #4 An analysis to obtain correlations and best related variables between diseases and environmental data. Dropped from the analysis were all disease and rate data except the disease being analyzed, all points which contained zero occurences of the disease, and all points which contained less than a total population of fifty.

Prior to presenting the results of the various analyses conducted on each of the five diseases, a brief discussion of some things to look for in the following results is needed. First, with regard to correlations, recall that a perfect correlation between two variables is represented by 1.0000, and no correlation whatsoever is represented by 0.0000. All other correlations occur between these two extremes. Furthermore, a correlation may be directly or inversely related. Those variables which are inversely correlated with another are preceded with a negative (−) sign. A final comment on this subject is that statistical sources state that correlations between two variables might actually be zero, but due to sampling methods or other causes a correlation greater than zero results. By utilizing various levels of significance we are able to set a "cut off" point at which we must conclude that the correlation is actually zero. These levels of significance refer to a probability that a higher correlation will result in a sample study when the correlation is actually zero. Common levels of significance used are 5% and 1%. Further indicated in statistical sources is that with large samples, smaller levels of significance should be used. For this study, a 1% level was chosen. In each of the analyses performed, the numbers of samples, or degrees of freedom as they are expressed in statistical terms, coupled with the level of significance determine the lowest correlation that could occur without the possibility that the actual correlation is really zero. These cutoff points for each of the diseases for each analysis is given in Table 2 below.

TABLE 2
CORRELATION COEFFICIENTS AT THE 1% LEVEL OF SIGNIFICANCE

Analysis	Inf. Hep.	Shig.	Salmon.	TB	Strep.	Tot. Dis.
#1	(301) .148	(301) .148	(301) .148	(301) .148	(301) .148	(301) .148
#2	(130) .228	(74) .302	(57) .325			
#3	(130) .228	(74) .302	(57) .325	(68) .302	(129) .228	(196) .181
#4	(127) .228	(73) .302	(56) .325	(68) .302	(123) .228	(187) .181

Degrees of freedom are indicated in parenthesis.
Source: Statistical Methods by Snedecor and Cochran.

The second observation to make is which variables the computer has chosen as the best related to the disease being analyzed. This selection was accomplished by step-wise deletion of variables not significant to the model. As will be seen in the tables, the choice was as few as one and sometimes as many as twelve of the variables. Of the variables chosen as significant, the best, or most significant, is indicated by the highest numerical value in the corresponding row. The numerical value iteself is a measure of the fraction of variance of the disease attributable to its linear regression on one of the environmental variables. For example, if total population were selected as the best variable with a .500 value, the effect on disease occurence would be that for every increase in population, the increase in disease occurence would only be .5, or half that of the population.

The tables also provide a place for recording the mean value of the various variables in the analysis. They are not used for any particular decision making process. Rather they are listed as a convenience and as an illustration of the increases in the variables as the aforementioned cells are dropped from the analysis.

One final point must be discussed prior to the presentation of results of the various analyses. This concerns Table 2 which displays the correlations obtained between the various environmental, social, and economic data used in conjunction with the analyses. It should be expected that if the environmental data is related to disease incidence to the point that it is assumed to be, then the environmental data should be equally related, or correlated, among each other.

In general, the correlations (above .148 considered "significant") between the various environmental, social, and economic factors are as good or better than was expected. For example, overcrowded units were highly correlated with total population and dwelling units. The highest correlation, .9204, occured between total population and number of dwelling units, perhaps understandably so. Average family

TABLE 3

CORRELATION MATRIX - ENVIRONMENTAL, SOCIAL AND ECONOMIC DATA

	Rate W/O Plmbg.	Total Pop.	Negro Pop.	Dwelling Units	W/O All Plmbg.	Units Over-Crowded	Avg. Income
Rate W/O Plmbg.	1.0000						
Total Pop.	.1830	1.0000					
Negro Pop.	.2596	.3500	1.0000				
Dwelling Units	.2629	.9204	.3651	1.0000			
W/O All Plmbg.	.5864	.3997	.2837	.6116	1.0000		
Units Overcrowded	.2336	.7295	.5430	.6645	.3836	1.0000	
Avg. Income	-.0227	.2833	-.0865	.2439	-.0421	.0311	1.0000

income should have produced more favorable correlations if the statements made about income decreasing in low physical and social areas is true. (The trend was inverse with several of those factors considered typical of low physical and social areas, but the correlation was below .148 [sign ignored] and will have to be ignored.) On this same question regarding income it was expected that the correlation between it and total population would be inverse. Perhaps this is explained well enough by the lower correlation obtained between income and population than between some of the other variables. Only four correlations in the table are unacceptable, or below .148, and these four involved income. The rest support the general theories discussed previously.

STATISTICAL SUMMARIES

Keeping the foregoing comments of what to look for and the correlations between the influential factors in mind, the discussion will turn to the results obtained in the four analyses on the diseases. Each disease is provided with a table of statistical data resultant from the four analyses and should be referred to as the need arises.

Infectious Hepatitis (Table 4)

Analysis #1 produced favorable results. Correlations with the influential factors were all above the .148 level with the exception of income. All were positive correlations. Those variables considered best related to infectious hepatitis were total population, units without all plumbing, and overcrowding. These were precisely the expected results.

Analysis #2 was slightly less favorable as the correlations decreased while the cutoff level remained the same. A possible explanation for the decrease in correlation could lie in the fact that Analysis #2 dropped all points not containing 1 or more occurences of infectious hepatitis. By so doing, perhaps the computer eliminated points with good correlations in that those points eliminated had all zeros for disease occurence. The general decrease in correlations from Analysis #1 to Analysis #2 will be noticed through the remainder of the study.

The most striking result obtained from the second analysis is its choice of best related variables. None of the influential factors were chosen. Only other diseases were chosen. This also became a trend in further studies. As a result of this, Analysis #2 was dropped from use after the same trend appeared in the third disease analyzed, and was substituted with Analysis #3.

TABLE 4

STATISTICAL SUMMARY - INFECTIOUS HEPATITIS

	CORRELATIONS				MEAN				*MOST RLLATED VARIABLE			
	1	2	3	4	1	2	3	4	1	2	3	4
Infect. Hep.	1.000	1.000	1.000	1.000	.92	2.13	2.13	2.12				
Shigellosis	.0575	-.0287			1.91	4.07				17.51		
Salmonellosis	.0416	-.1117			.56	.94				1.91		
Tuberculosis	.1909	.1845			.47	.75				1.01		
Strep. Infect.	.1927	.0762			1.08	1.53				1.26		
Rate Inf. Hep.	.2503	.1064			3.54	8.19			.2725			
Rate Shig.	.0361	-.0568			3.60	7.10						
Rate Salmon.	-.0134	-.1565			1.34	1.77						
Rate Tub.	.1805	.0514			.79	1.33						
Rate Strep.	-.0012	-.0149			3.17	3.25						
Total Olsease	.1729	.0303			4.82	9.43				18.49		
Total Pop.	.4753	.3086	.3086	.3349	399.0	596.9	596.9	610.5	.2343			
Negro Pop.	.3344	.2227	.2227	.2312	30.8	55.6	55.6	56.8				
Dwelling Units	.4870	.3214	.3214	.3428	138.3	212.5	212.5	216.8				
w/o All Plmbg.	.3821	.3053	.3053	.3143	3.57	6.87	6.87	7.03	.1944		.2017	
Rate w/o Plmbg.	.2236	.2337	.2337	.2455	1.62	2.35	2.35	2.41				
Units Overcrwd	.4968	.3775	.3775	.3982	7.42	11.94	11.94	12.16	.2531		.3102	.3982
Avg. Income	.0640	-.0728	-.0728	-.0713	9291	9962	9962	9960				

* Rows containing numerical values indicate those variables which best predict the disease. Numerical value (higher) indicates "best", or most related.

Analysis #3 did not incorporate the other diseases and rates into the analysis as independent variables as did the first and second analyses. The correlations remained as in Analysis #2, but selected as best related to infectious hepatitis were units overcrowded and units without all plumbing.

In the final analysis, #4, those points with no occurences of the disease and with less than fifty population were dropped. Only three points contained less than fifty population which contained one or more occurences of infectious hepatitis. This aids in explaining the marginal increase in correlations from #3 to #4. This final analysis produced a single best related variable in overcrowded units.

Conclusions: The various analyses conducted on infectious hepatitis are favorable toward supporting the general hypothesis about the relationship between disease and environment.

Shigellosis (Table 5)

Analysis #1. Correlations with the influential factors were all well below the level of acceptance. As an interesting sidelight note the near perfect correlations between shigellosis, rate of shigellosis, and total disease. Aside from several disease variables total

TABLE 5

STATISTICAL SUMMARY - SHIGELLOSIS

	CORRELATIONS				MEAN				*MOST RELATED VARIABLE			
	1	2	3	4	1	2	3	4	1	2	3	4
Infect. Hep.	.0575	-.0209			.92	1.89				.0596		
Shigellosis	1.000	1.000	1.000	1.000	1.91	7.77	7.77	7.86				
Salmonellosis	.3951	.5261			.56	1.17				.1662		
Tuberculosis	.0291	-.0237			.47	1.21				.0672		
Strep. Infect.	-.0353	-.1119			1.08	1.31				.0420		
Rate Inf. Hep.	-.0058	-.0377			3.54	4.06				.0120		
Rate Shig.	.9774	.9768			3.60	14.64			.9789	.0223		
Rate Salmon.	.2070	.2149			1.34	2.75				.1753		
Rate Tub.	.0388	-.0050			.79	1.67			.0555	.0094		
Rate Strep.	-.0275	-.0482			3.17	3.26			.0309	.0108		
Total Disease	.9791	.9944			4.82	12.82				1.0278		
Total Pop.	.0810	-.0031	-.0031	-.0077	399.0	686.3	686.3	695.3	.0371		1.343	.9282
Negro Pop.	.0899	.0088	.0088	.0073	30.85	91.90	91.90	92.90	.0305	.0060	.1672	
Dwelling Units	.0008	-.1591	-.1591	-.1633	138.3	254.9	254.9	257.3		.0071	1.3988	.7028
w/o All Plmbg.	.0231	-.0404	-.0404	-.0418	3.57	9.35	9.35	9.50		.0068	.7253	
Rate w/o Plmbg	.0034	-.0759	-.0759	-.0788	1.62	2.81	2.81	2.85			.3423	
Units Overcrwd	.0268	-.0912	-.0912	-.0951	7.42	15.04	15.04	15.20		.0105	.4875	.3888
Avg. Income	-.1163	-.3576	-.3576	-.3571	9291	9279	9279	9247			.4059	.4689

* Rows containing numerical values indicate those variables which best predict the disease. Numerical value (higher) indicates "best", or most related.

population and Negro population were chosen as best related to shigellosis incidence, but the low correlation obtained casts a shadow over these results.

Analysis #2 produced results almost beyond belief! The correlations remained low, as in the first analysis, but for reasons unexplained all but Negro population turned inversely related. Only average family income could be salvaged from this part of Analysis #2. The level of acceptance for this analysis rose to .302 while income went to -.3576. Further mystifying is the choices of most significant variables. All but three were chosen. Perhaps in this instance the computer was indicating that there are no significant variables by choosing almost all of them.

Analysis #3. This analysis provided nothing further of value than was provided from the second analysis. This time all the variables were selected as significant, or best related.

Analysis #4 contained slight fluctuations in the correlation coefficients but with little significance. This time the choice of best variables was limited to four.

Conclusions: Extremely low correlation coefficients and other poor results with the exception of income make it difficult to accept that shigellosis is a disease typical to only those areas of low physical and social status. Furthermore, income might be an acceptable compromise, but it is difficult to conclude that low income is the only influential factor significant in the incidence of shigellosis.

Nevertheless, that is what the numbers indicate and therefore will have to be accepted.

Salmonellosis (Table 6)

Analyses #1 and #2 both produced results of little use or value. Correlations never surpassed the .148 and .325 levels needed for consideration for acceptance. Similar results in the quest for the most significantly related variable were found. (This represents the last use of Analysis #2, due to its nonconclusive information.)

Analysis #3 followed the same pattern of #1 and #2.

Analysis #4 seems to have been on the verge of producing an acceptable result. The rate without all plumbing factor nearly approached the level of significance for the correlation coefficient. Likewise, this same variable was the sole choice as best related. Speculation could reveal that this is one of those 1 in 100 times that the correlation coefficient fell below the acceptable level. There is no way to determine this however, and therefore once again the numbers will have to be accepted as they fall. In this case, there is no evidence to support that salmonellosis is a disease whose incidence is highest in low physical, social, and economic areas.

TABLE 6

STATISTICAL SUMMARY - SALMONELLOSIS

	CORRELATIONS				MEAN				*MOST RELATED VARIABLE			
	1	2	3	4	1	2	3	4	1	2	3	4
Infect. Hep.	.0416	-.0795			.92	1.36				.1643		
Shigellosis	.3957	.3849			1.91	6.98				7.45		
Salmonellosis	1.000	1.000	1.000	1.000	.56	2.96	2.96	2.73				
Tuberculosis	.4408	.4431			.47	1.19						
Strep. Infect.	.2074	.2232			1.08	1.84				.1797		
Rate Inf. Hep.	-.0173	-.0292			3.54	2.52				.0482		
Rate Shig.	.3761	.3868			3.60	10.70			.2063	2.34		
Rate Salmon.	.7994	.7551			1.34	7.09			.7470	.6306		
Rate Tub.	.0641	.0310			.79	1.25				.1969		
Rate Strep.	.0161	.0588			3.17	3.28						
Total Disease	.4899	.4575			4.82	13.68				5.41		
Total Pop.	.1257	-.1133	-.1160	-.1160	399.0	655.4	655.4	656.2	.3494		.4937	
Negro Pop.	.1231	-.0339	-.0339	-.0229	30.85	78.00	78.00	78.7				
Dwelling Units	.0512	-.2480	-.2480	-.1859	138.3	219.4	219.4	223.2	.2591	.1424	.5328	
w/o All Plmbg.	.0288	.0141	.0141	.0533	3.57	4.75	4.75	4.8		.0887		
Rate w/o Plmbg	.1536	.2476	.2476	.3045	1.62	2.39	2.39	2.43	.1186	.1327	.2807	.3045
Units Overcrwd'	.1180	-.0995	-.0995	-.0515	7.42	14.33	14.33	14.5			.1772	
Avg. Income	-.0218	-.1399	-.1399	-.0206	9291	9526	9526	9696		.0779	.2401	

* Rows containing numerical values indicate those variables which best predict the disease. Numerical value (higher) indicates "best", or most related.

Tuberculosis (Table 7)

Analysis #1. All but one of the variables (influential factors) had acceptable correlations. Income developed an inverse trend, but fell way short of being significant. Most related variables were: Negro population, units without all plumbing facilities, rate of units without all plumbing facilities, and units overcrowded.

Analysis #2. Not performed.

Analysis #3 gave no conclusive results. In the process of dropping the points with no occurences of tuberculosis, all but 68 were eliminated. This pushed the acceptance level of correlation coefficient to .302, which none of the variables even approach. Even though total population and units overcrowded were selected as best related and are the two variables most often associated with incidence of tuberculosis. they should not be considered positive due to their low correlations.

Analysis #4 produced the exact results of #3 simply because tuberculosis did not occur in any cell with less than fifty population.

Conclusions: Unacceptable results through the analyses give no basis for positive conclusions with regard to tuberculosis and its relationship to features of the environment which supposedly contribute to the incidence of this disease.

TABLE 7

STATISTICAL SUMMARY - TUBERCULOSIS

	CORRELATIONS				MEAN				*MOST RELATED VARIABLE			
	1	2	3	4	1	2	3	4	1	2	3	4
Infect. Hep.	.1909				.92							
Shigellosis	.0291				1.91							
Salmonellosis	.4899				.56							
Tuberculosis	1.000		1.000	1.000	.47		2.10	2.10				
Strep. Infect.	.0064				1.08							
Rate Inf. Hep.	-.0139				3.54							
Rate Shig.	.0216				3.60				.1515			
Rate Salmon.	.6245				1.34				.6498			
Rate Tub.	.4907				.79				.4505			
Rate Strep.	-.0516				3.17							
Total Disease	.0957				4.82							
Total Pop.	.1810		-.0600	-.0600	399.0		653.7	653.7			.2788	.2788
Negro Pop.	.3105		.1457	.1457	30.85		87.2	87.2	.1267			
Dwelling Units	.2082		-.0134	-.0134	138.3		241.3	241.3				
w/o All Plmbg.	.2583		.0939	.0939	3.57		10.7	10.7	.1641			
Rate w/o Plmbg	.2224		.0172	.0172	1.62		4.11	4.11	.1360			
Units Overcrwd	.3045		.2267	.2267	7.42		13.9	13.9	.0805		.3851	.3851
Avg. Income	-.0019		-.0799	-.0799	9291		9632	9632				

* Rows containing numerical values indicate those variables which best predict the disease. Numerical value (higher) indicates "best", or most related.

Streptococcal Infections (Table 8)

Analysis #1. Those factors considered to contribute to streptococcal infections receive favorable support in this first analysis. This includes a positive correlation with income. Total population, Negro population, number of dwelling units, and overcrowded units were choices for best related variables. Negro population must be eliminated, however, due to the low correlation coefficient it has with streptococcal incidence.

Analysis #2. Not performed.

Analysis #3 found the same trend of decrease in correlation coefficients occur as it has for the other diseases. In this case, the decrease pushed all but one variable below a .228 significant level. The choice of best related variables was not limited in that all but one variable was chosen.

Analysis #4 produced some fluctuations in correlation coefficients. Total population fell below the cutoff point. The same six variables were again rated among the most significant, but the low correlation figure negates these choices.

Conclusions: Add streptococcal to the list of diseases that did not produce favorable results in the attempt to establish a relationship between its incidence and certain environmental features.

TABLE 8

STATISTICAL SUMMARY – STREPTOCOCCAL DISEASE

	CORRELATIONS				MEAN				*MOST RELATED VARIABLE			
	1	2	3	4	1	2	3	4	1	2	3	4
Infect. Hep.	.1729				.92							
Shigellosis	.9791				1.91							
Salmonellosis	.4899				.56							
Tuberculosis	.0957				.47							
Strep. Infect.	1.000		1.000	1.000	1.08		2.53	2.58				
Rate Inf. Hep.	-.0259				3.54							
Rate Shig.	-.0446				3.60				.1124			
Rate Salmon.	.0552				1.34				.0900			
Rate Tub.	-.0077				.79				.3910			
Rate Strep.	.3692				3.17							
Total Disease	.1080				4.82							
Total Pop.	.4691		.2322	.2083	399.0		627.1	656.3	1.055		1.079	1.057
Negro Pop.	-.0690		-.1987	-.2112	30.85		34.9	36.4	.1555		.1845	.1866
Dwelling Units	.3770		.0689	.0348	138.3		220.8	230.6	.3766		.1047	.8088
w/o All Plmbg.	.0658		-.0532	-.0626	3.57		5.50	5.77				
Rate w/o Plmbg	-.0011		-.0079	-.0236	1.62		1.63	1.71			.2848	.2971
Units Overcrwd	.1978		-.0082	-.0318	7.42		10.79	11.27	.2120		.2334	.2396
Avg. Income	.3115		.2240	.2185	9291		11202	11242			.1546	.1540

* Rows containing numerical values indicate those variables which best predict the disease. Numerical value (higher) indicates "best", or most related.

Total Disease (Table 9)

Analysis #1 had no pertinent results.

Analysis #2 was not performed.

Analysis #3. Average family income had a good correlation coefficient. All variables were selected significant, but all except income were rejected.

Analysis #4. This was perhaps the most significant analysis of all those conducted. The correlation coefficients were dramatically increased by eliminating points with less than fifty population. Only income did not reach an acceptable level. Number of units overcrowded had a correlation of .4873, which was only exceeded once in any of the other analyses (.4968, Analysis #1, infectious hepatitis vs. units overcrowded). Total disease represents somewhat of a summary for all the analyses performed on the individual diseases. While the real intention here is not to determine results and conclusions about individual diseases, it is the intention to gather evidence to make a decision about the statement, "disease incidence is higher in the lower physical, social, and economic areas."

The four best related variables to total disease incidence are: total population, Negro population, rate of units without all plumbing facilities, and units overcrowded.

TABLE 9

STATISTICAL SUMMARY - TOTAL DISEASE

	CORRELATIONS				MEAN				*MOST RELATED VARIABLE			
	1	2	3	4	1	2	3	4	1	2	3	4
Infect. Hep.	.1729				.92							
Shigellosis	.9791				1.91							
Salmonellosis	.4899				.56							
Tuberculosis	.0957				.47							
Strep. Infect.	.1080				1.08							
Rate Inf. Hep.	.0094				3.54				.0092			
Rate Shig.	.9528				3.60				.9243			
Rate Salmon.	.2466				1.34							
Rate Tub.	.1004				.79							
Rate Strep.	.0099				3.17							
Total Disease	1.0000		1.000	1.000	4.82		7.40	5.94				
Total Pop.	.1935		.1143	.4104	399.0		556.5	578.8			.9641	.2140
Negro Pop.	.1460		.1051	.4334	30.8		45.4	47.2			.1258	.2471
Dwelling Units	.1035		.0045	.3692	138.3		198.8	203.4			.9137	
w/o All Plmbg.	.0843		.0466	.2966	3.57		5.34	5.60			.3586	
Rate w/o Plmbg	.0604		.0189	.2251	1.62		2.22	2.33			.1237	.1391
Units Overcrwd	.1233		.0531	.4873	7.42		10.59	10.89			.2918	.2094
Avg. Income	-.0767		-.2280	-.1314	9291		10442	10513			.2535	

* Rows containing numerical values indicate those variables which best predict the disease. Numerical value (higher) indicates "best", or most related.

Conclusions: The final analysis on the last of the categories to be analyzed produced the best results of any one analysis. From this analysis it appears that the evidence assembled generally supports the theory.

CONCLUSIONS: STATISTICAL ANALYSIS

The foregoing material presented the highlights of the outcomes of the various analyses performed on the disease, environmental, social, and income data previously discussed and mapped. Some of the conclusions or opinions stated in this material were in general support of the hypothesis being "tested" in this study. Some were not. While several of the diseases analyzed did not give any support to the theory by itself, when combined with all the other diseases the conclusion was no less than a favorable one. In this sense, the conclusion is one of support of the statement that disease incidence is related to the stated influential factors.

Nevertheless, this conclusion is by no means grounds for world wide acceptance. First, this study was conducted for a single city; Topeka, Kansas. Topeka is not the epitome of all cities. It is not exemplary of every other city. Therefore the conclusions arrived at are only for Topeka, Kansas, and pertain only to this study and its methods.

With regard to the methods of the study, the completion of any similar undertaking usually makes the researcher more aware of mistakes in data input, methodology, etc. In this case, the computer determined correlations, means, best related variables, etc. from the data supplied to it. The data supplied will have to be considered biased because only data regarding those factors considered influential in diseases incidence in the first place were used. Therefore the computer had no choice but to select its best related variables from the list supplied. No matter which variables were selected as best related to a particular disease, it would have been concluded as favorably supporting the hypothesis. Had the list of variables been expanded to include some that are considered only slightly or remotely influential plus a few nonsense variables having nothing to do with disease at all, and then had the results still been the same then there would be a little less doubt as to the results.

Another possible problem area are the statistical levels of significance, best related variable, etc. The whole principle of statistics seems to revolve around probability and arbitrary selection of some level of significance. In several cases, had the level of significance been raised to a 5% level, results and conclusions may have been entirely different. The word significant is usually preceded by the word, how. How significant is it that the correlation coefficient between two variables is .40, .75, .99? For the most part, this study produced correlation coefficients from .0005 to nearly .5000 (between disease and influential factors). Again, statistical texts tell us that, for example, a .5 correlation indicates that only 25% of the variance of the dependent variable is attributable to its linear regression on the independent variable. A .2 correlation has only 4% of the variance explained. A correlation as high as .9 explains only 81% of the variance. What is a significant percent of explained variation? Even the texts of statistical methods, after presenting long explanations of a statistical procedure filled with half the Greek alphabet, state that the results obtained are not always conclusive; that experience or personal judgement must often be the final test.

This is not to succumb to failure. Not all is lost in this type of study. Much more is known about the relationship between disease incidence and environmental features now than was known at the outset. But regardless of results, conclusions, techniques used, and criticism received, all are beneficial toward improving second, third, and nth attempts. This was a first attempt. The challenge stands to try again. This is the topic of the final section of the report.

PART III

DISEASE MAPPING AND ANALYSIS IN THE COMPREHENSIVE PLANNING PROCESS

DISEASE MAPPING WITHIN THE COMPREHENSIVE PLANNING PROCESS

In the introduction it was stated that this report hoped to accomplish two objectives, of which the primary one was to give basis for the inclusion of disease mapping studies in the comprehensive planning process. The introduction further stated that the way the primary objective would be reached would be through an illustration or example of a disease mapping study. A secondary objective was to make aware to the urban planner a need and an opportunity to assist health planners in their work, and vice versa. The bulk of the material already presented has been involved with a case study example of disease mapping and analysis. This final section will summarize some of the earlier points as well as present several examples of the use of results obtained from the analysis.

Other opening remarks of the report emphasized that it is not the contention here that urban planners should become the health planners. The role played in the field of health is intended to be supportive. "The urban planning agency should support health planning organizations by supplying them with any information, advice, and manpower that the health planners require to carry out their responsibilities."[6] The same report responsible for this statement suggests that the planning agencies should include a health services

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[6] American Society of Planning Officials, The Urban Planner in Health Planning, (Washington, D.C., 1968), p. 65.

and facilities section in its comprehensive plan. Another source states, "Planning for a health environment is an essential consideration in urban design. Immediate steps must be taken by those responsible for the control of landuse, transportation, economic development, and related physical and social planning to coordinate their efforts."[7]

Planning for health is much more involved and complex than mapping a few diseases and conducting several analyses on them. But the process must begin somewhere. It is not the responsibility of an urban planning agency to plan for health. It is their responsibility to demonstrate the capabilities they possess and to encourage the proper people to do so while offering all the assistance they can. The International City Manager's Association states that there should be an exchange of information and data between the two agencies. They further suggest that the planning agency operate and maintain a data bank, and that "When information is gathered for a data bank the health agency may request that specific types of information, such as the incidence of certain diseases by population groups and census tracts, be collected and correlated with other data."[8]

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7 U.S. Department of H.E.W., "Environmental Health Planning", (Washington, D.C., 1964), p. 77.

8 William I. Goodman, (editor), Principles and Practice of Urban Planning, (Washington, D.C., 1968), p. 212.

The idea of including disease mapping into the comprehensive planning process is not limited to communities of any particular size. Furthermore, it is not limited to those communities which have yet to develop master plans. The comprehensive planning process is not a one time happening. It is constantly undergoing new approaches, new techniques, and updatings. Therefore, disease mapping should not be considered an intrusion into an established process.

The usage of results of disease mapping and analysis are, of course, not intended to benefit only those personnel involved in health planning. Whoever uses the results, they are likely to be used for the common good of the residents of a city. Health officials may use results to aid in decisions about health services. Urban planners may use results to aid in decisions regarding problems of housing, open space, or renewal.

It has been suggested that before beginning any study of this kind, the need to do such must be validated by determining to what extent disease incidence is a problem. In other words, a comparison of morbidity rates for the particular community should be made with state and national rates. This suggests that should the rates for the community fall below the state and national averages, then there would be no need to conduct the study. If such is the case, then the same logic should apply to other areas as well. If, for example, a community was found to have 25 dilapidated dwelling units for every

1000 and the state or national average was 50, then there would be basis for no concern or action on the situation. Yet the fact remains that there would be 25 families for every 1000 living in unwholesome conditions. Part of planning should be to at least try to provide all families with a decent place to live. So goes the same argument for disease incidence. If by conducting disease analysis and mapping, one firm relationship can be established which when removed would eliminate five cases of a disease, then it should well be worth the effort.

The preceeding paragraph does not suggest that state or national rates should be totally ignored. Rather they should be used with discretion and with less emphasis than commonly used. Their use may be in the establishment of priorities or objectives; to cut the disease rate in half by 1975, or to begin with those areas with highest disease rates first. Tables 10, 11, and 12 provide disease and population data as well as comparable rates of diseases for Topeka, Kansas, and the United States. The rates reveal that for Topeka over the past several years, rates for diseases have been both above and below the state or national levels. This provides no insight, however, to any patterns or relationships within the city itself. Disease mapping will.

TABLE 10

REPORTED DISEASE CASES FOR TOPEKA, KANSAS, AND THE UNITED STATES

	Infectious Hepatitis	Shigellosis	Salmonellosis	Tuberculosis	Streptococcal Infections
			Topeka		
1971	57	343	43		97
1970	133	117	19		
1969	20			125	
1968	12				249
1967	8	137	11		
1966	12		8		
1965			34		
1964	11				
1963	11		44		
1962	24				
			Kansas		
1971	615	909	531	153	5,100
1970	560	268	295	194	4,272
1969	303	91	190	185	2,131
1968	405	110	284	224	2,805
1967	218	439	211	223	3,371
1966	189	64	284	279	2,487
1965	459	118	309		3,080
1964	626	277	286	234	1,975
1963	312	123	300	283	2,121
1962	408	73	338	273	1,649
			United States		
1971	59,606	16,143	21,928	35,035	379,444
1970	56,797	13,845	22,096	37,137	433,405
1969	48,416	11,946	18,419	39,120	450,008
1968	45,893	12,180	16,514	42,758	435,013
1967	38,909	13,474	18,120	45,647	453,351
1966	32,859	11,888	16,841	47,767	427,752
1965	33,856	11,027	17,161	49,016	395,167
1964	37,740	12,984	17,144	50,874	402,334
1963	42,974	13,009	15,390	54,062	342,161
1962	53,016	12,443	9,680	53,788	315,809

Source: Morbidity and Mortality Weekly Report, annual summary supplements for 1962-1971 (Kansas and U.S. data) and Kansas State Department of Health (Topeka data)

TABLE 11

1962-1971 POPULATION FOR TOPEKA, KANSAS, AND THE UNITED STATES

Year	Topeka	Kansas	United States
1971	125,564	2,249,248	204,000,000
1970	125,011	2,249,071	203,184,772
1969	124,461	2,287,302	202,071,000
1968	123,908	2,265,981	200,956,000
1967	123,355	2,224,259	198,762,000
1966	122,802	2,220,537	196,000,000
1965	122,249	2,197,815	193,815,000
1964	121,696	2,193,975	191,369,000
1963	121,143	2,190,138	188,656,000
1962	120,590	2,186,293	185,880,000

Source: U.S. Census. Years between census interpolated.

TABLE 12

ANNUAL DISEASE RATES PER 1000 POPULATION;
TOPEKA, KANSAS, AND THE UNITED STATES

Year	Inf. Hep.			Shigellosis			Salmonellosis			Tuberculosis			Streptococcal		
	T	K	U	T	K	U	T	K	U	T	K	U	T	K	U
1971	.46	.27	.29	2.75	.40	.08	.34	.24	.10						
1970	1.06	.25	.28	.93	.12	.07	.15	.13	.10				.77	1.92	2.13
1969	.16	.13	.24										2.01	.93	2.22
1968	.10	.18	.23				.03	.10	.09	.20	.09	.20			
1967	.06	.10	.19				.09	.09	.09						
1966				.16	.08	.06	.06	.13	.08						
1965	.05	.15	.17				.27	.14	.08						
1964	.09	.29	.20												
1963	.09	.14	.23												
1962	.20	.19	.29												

Up to this point this final section of the report, the discussion has been argumentative, aimed at presenting convincing reasons for including disease mapping in the comprehensive planning process. All that remains to accomplish is a brief illustration of several examples of the use of results obtained. Although the following examples apply to this study and to Topeka, the same general applications are possible for any community.

USE OF STUDY RESULTS

The Topeka Area Planning Study has been divided into many elements and phases. One such element is a report dealing with housing; the Initial Housing Element. This report is an inventory of housing conditions, markets, needs, etc. Its function is to establish priorities and target locations for such federal programs as Operation Breakthrough, 701 planning funds, etc. The report contains various statements of problems, objectives, obstacles, planning activities and implementation actions all pertaining to the future of housing in the Topeka metropolitan area. Although the report establishes the need for gathering additional and updated data, it will rely on much of the information gathered in previous reports.

Disease mapping is a study which could be of benefit in the housing study. Since one of the objectives of the housing study is to establish project target locations for renewal, the knowledge of substandard and blighted conditions in certain locations being considered for action might be reinforced if it is known that these same areas are likewise plagued with high disease morbidity.

As an example, the Neighborhood Analysis: Master Plan Report #5, for Topeka established the locations of the sixteen most blighted and the sixteen least blighted neighborhoods in the city. See Fig. 20. Comparing the locations of these neighborhoods to total disease locations, there is an overlapping of the higher disease morbidity locations with neighborhoods most blighted. But the overlapping is not absolute. Small concentrations of higher disease incidence are contained within the areas of most blight. This information could well be the deciding factor in making decisions as to project locations.

Other uses of the mapping study may stem from several of the correlations established. For example, units without all plumbing facilities were often better correlated to disease incidence than some other feature. Overcrowded units likewise resulted in better correlations. Topeka may decide that an objective of planning is to provide for a reduction in units without all plumbing facilities and units overcrowded.

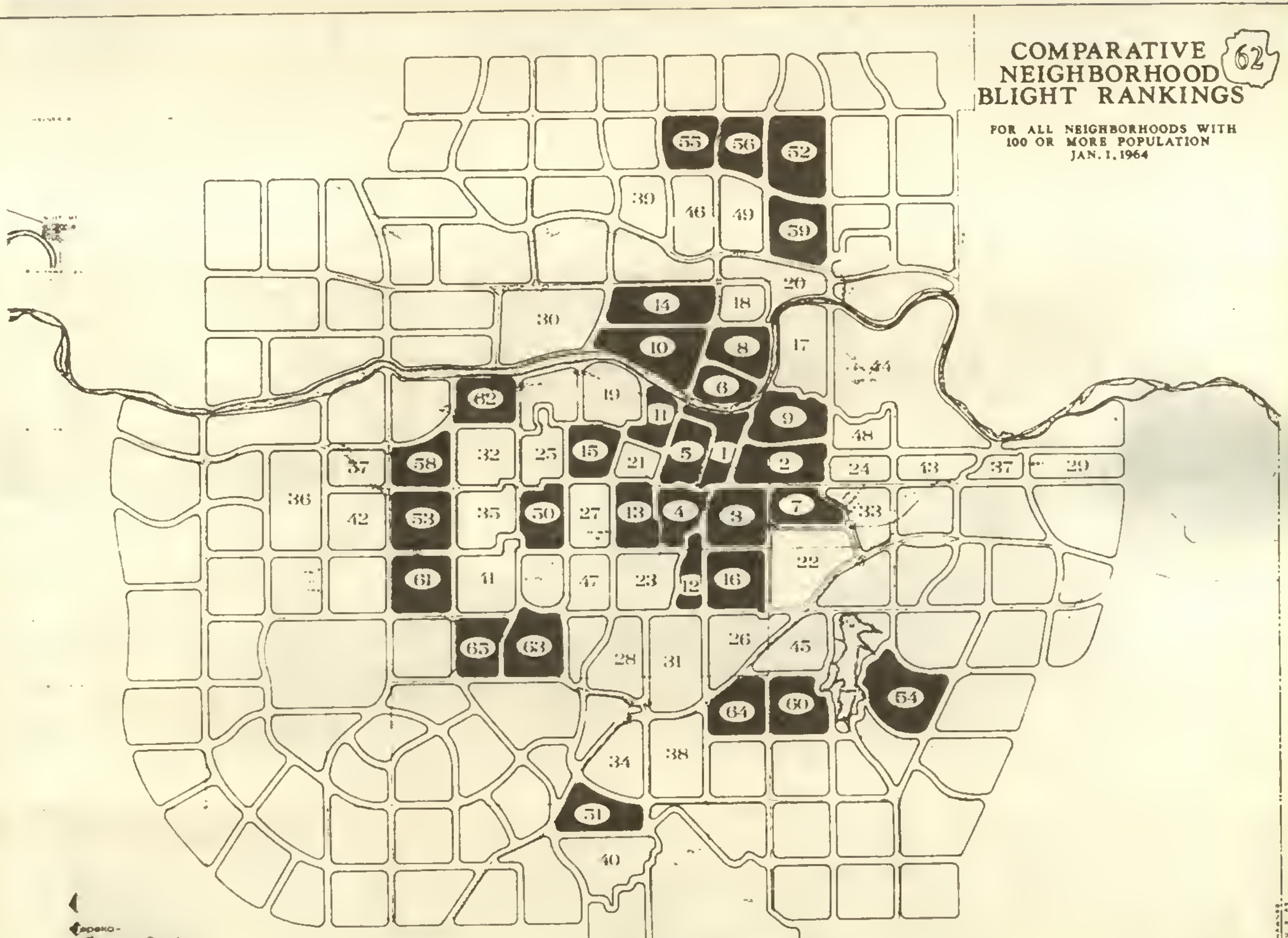

FIG. 20. COMPARATIVE NEIGHBORHOOD BLIGHT RANKINGS

The same information given to the health officials would find further usage. Perhaps it could assist in evaluating immunization, education, public health, or health services programs, or aid in decisions regarding future programs, locations, and services to be provided.

These are but a few of the examples utilizing information obtained from disease mapping and analysis. Other areas of use are open space studies, recreation planning, transportation, zoning, and landuse and regulatory control establishment.

CONCLUSIONS

In conclusion, this report contends that no matter how favorable or unfavorable the results of such an undertaking turn out, they can be beneficial to the community. Perhaps the study methods and the several diseases mapped are not enough. It has been suggested that efforts be made to map cancer, heart disease, mental disease, alcoholism, and even accident incidence such as automobile collisions, broken limbs, etc., in an attempt to link these occurences with urban features. The list is a long one; the task monumental. We, as urban planners, must decide to what extent these studies should be pursued. We must decide which are the responsibility of the urban planner and which are the responsibility of the health planner. Regardless of who conducts the investigations, we must learn to incorporate it in our own field and benefit from it.

We are not far from the day when health services and planning sections will be as common and fundamental in the comprehensive planning process as are sections now included on parks, recreation, and transportation. Hopefully disease mapping will be a part of this section.

The resources, the methods, and the manpower exist. Where they do not, they can be obtained. The final stumbling block to overcome is one of acceptance. The entire realm of disease mapping is complex and a subject for lengthy debate and criticism. It is hopeful that the presentation made in this report will at least make aware to those who read it the potential value of disease mapping. Should but one person become convinced that disease mapping has potential use in the comprehensive planning process, then this report will be considered a worthwhile venture and a total success.

APPENDIX A

Grid Cell Designation	Cases of Infect. Hepatitis	Rate per 1000 Population Infectious Hepatitis	Cases of Shigellosis	Rate per 1000 Population Shigellosis	Cases of Salomonellosis	Rate per 1000 Population Salmonellosis	Cases of Tuberculosis	Rate per 1000 Population Tuberculosis	Streptococcal Infections	Rate per 1000 Population Streptococcal Infections	Total Cases, All Diseases	Rate per 1000 Units, Units w/o All Plumbing	Total Population	Negro Population	Number of Dwelling Units	No. Units w/o All Plumb.	No. Units overcrowded	Average Family Income
A12	2	6.6							1	3.3	3		301	92	20		2	10899
A13	1	6.9									1	2.0	146		49	1	2	10600
A14	1	15.0			2	30.0					3		67		22		1	9606
A15					3	10.0					3	1.1	296		88	1	7	9114
B12													14		7			9055
B13									1	59.0	1		17		6		1	9012
B14	2	19.0										2.3	117		43	1	1	7996
B15													6		2			7059
B16													0					
B17													22		13		1	7187
B18													15		3		1	7187
B19													18		6			7135
B20													0					
C5													34		12			9112
C6													25		10			9112
C7												10.0	25		10	1		9112
C8													25		6		1	9112
C9													25		6		1	9118
C10													18		6			9164
C11	5	185.0									5		27		11			9164
C12									1	3.8	1	2.3	264		85	2	7	9164
C13	4	8.5	3	6.4							7	1.3	469	32	159	2	22	9601
C14	1	3.3			1	3.3					2	2.8	299	32	106	3	11	7914
C15	2	11.5									2		173		57		7	6991
C16	3	23.8									3	1.8	126		54	1	3	7231
C20													40	6	13		2	7135
D5													0					
D6													0					
D7													24		10			9112
D8													43		11		1	9112
D9													30		8			8881
010									1	63.0	1		16		5		1	8766
D11	1	1.1							1	1.1	2		92		29		2	8766
D12												2.8	223		71	2	6	8766
D13	1	1.5					1	1.5			2	3.0	670	60	230	7	24	8795

D14	3	16.7							1	5.5	4	4.4	180		68	3	4	7051
D15					1	3.5	2	7.1			3	2.6	282		117	3	4	7051
D17													0					
D18													0					
E2													0					
E3													26		8		1	9898
E4													13		4			9898
E5													8	6	3			9112
E6													16	12	6			9112
E7													0					
E11	1	7.6									1	8.5	131	6	47	4	3	8368
E12			19	114.0			2	12.0			21	1.7	167	2	60	1	4	8368
E13	1	1.8	6	10.6			2	3.6	1	1.8	10	1.0	562	49	199	2	15	8589
E14	7	11.5							2	3.3	9	4.0	611	2	223	9	17	7112
E15	8	1.7	8	1.7					1	2.2	17	4.6	460	26	151	7	17	7112
E17													0					
E18	1	1.6	1	1.6			1	1.6			3	4.0	619		200	8	14	8801
F8													71		33		1	10115
F9													7		2			10115
F10													6		1			10176
F12	2	6.7					4	1.3			6	4.0	300	199	96	4	8	8368
F13	6	6.2	3	3.1			3	3.1	1	1.0	13	9.6	967	235	292	28	31	7850
F14	8	8.1	4	4.1			3	3.1	1	1.0	16	9.1	983	9	460	42	33	7743
F15	1	2.4					1	2.4			2	4.7	411	87	128	6	14	7579
F17	1	4.4							1	4.4	2	2.9	227		70	2	9	8801
F18	1	1.0			5	5.3	1	1.0	1	1.0	8		947		376		16	8801
F19													353		122		7	12646
F20													0					
F21													0					
G2													0					
G3	1	5.0									1		202		61			18256
G4													299		93			17290
G5													233		105			17290
G6													0					
G7	1	1.3			25	33.6	2	2.7	10	13.5	38	13.5	745		52	7		
G8							1	3.8	1	3.8	2	1.1	264		93	1	4	10055
G9	1	1.8			3	5.3			1	1.8	5	1.0	566		204	2	16	10055
G10	2	3.4					1	1.7	1	1.7	4		587		190		7	10055
G11	2	5.9									2	.7	338	4	139	1	8	8025
G14							5	15.3			5	15.2	326	8	112	17	12	8226
G15												1.4	182	8	71	1	7	8562
G17	3	3.5	1	1.2					3	3.5	7	3.8	858	2	288	11	17	8828

G18	3	4.0							1	1.3	4	.7	758		270	2	21	7975
G19									4	15.7	4		254		81		6	12646
G20													0					
G21													0					
G22													0					
H2													4		2			18200
H3									1	13.0	1		77		6		1	18160
H4	1	5.2									1		193		41		1	18160
H5									1	4.0	1		248		110			18160
H6													246	20	2			11253
H7							1	1.4			1	1.2	719	5	249	3	9	11253
H8			1	7.5					1	7.5	2		133		56		3	10019
H9					1	1.3			3	3.9	4		767	3	318		10	10184
H10	3	3.7	1	1.2			1	1.2	3	3.7	8	5.5	802		236	13	11	8614
H11	2	1.6							3	2.4	5	6.1	1239	11	525	32	25	7711
H12	1	1.3	10	12.9			1	13.0	2	2.6	14	5.5	773	21	325	18	21	8122
H13									1	15.6	1	4.0	64	14	25	1	2	6573
H16	2	11.3	6	3.4	8	4.5			5	2.8	21	1.8	1774	56	567	10	54	8838
H17	3	4.5			1	1.5			5	7.4	9		677		224		14	8838
H18	2	3.6							2	3.6	4		557		179		14	8838
H19									2	57.0	2		35	3	10		1	11700
H20													60		20		5	11700
I2													91		19		2	20038
I3									1	6.2	1		161		45		1	19031
I4													140		43		2	20029
I5													0					
I6			1	1.2	1	1.2			1	1.2	3		844	7	322		8	10836
I7	2	2.1							3	3.2	5	.8	935	3	371	3	11	10838
I8	1	1.5					1	1.5	3	4.4	5	1.0	690	5	298	3	5	10207
I9			3	2.4							3	1.2	1225	218	486	6	16	10583
I10	5	4.3	2	1.7			2	1.7	3	2.5	12	3.0	1177	93	540	16	8	8904
I11	2	1.6	8	6.5			1	.8			11	10.0	1237	146	446	46	26	9471
I12	5	3.5	2	1.4			4	2.8	2	1.4	13	15.0	1441	20	907	14	34	8382
I13							1	9.5			1	35.0	105	3	88	31	2	7442
I14	3	20.0	4	26.4			2	13.2			9		151	38	49		10	8198
I15	2	2.1	7	7.2	3	3.1	13	13.4	1	1.0	26	3.5	970	263	319	11	45	8341
I16	4	6.8					3	5.1	1	1.7	8	1.9	583	42	160	3	28	7828
I17	2	9.6			3	14.4			2	9.6	7	2.0	209	4	50	1	14	8156
I18					2	24.0					2		83		16		4	8156
I19													123	8	19		2	15242
J2	2	34.4									2		58		16			20038
J3													252		75		3	21028

J4													0					
J5							1	2.7	2	5.4	3	2.2	368	18	138	3	4	21028
J6			1	1.2					1	1.2	2	.3	821	14	303	1	7	10424
J7	2	2.7			4	5.4			3	4.0	9	2.0	749		300	6	3	10424
J8			1	1.0	1	1.0			2	2.0	4	1.4	992	91	366	5	13	10620
J9	9	6.2	4	2.8	1	.7			2	1.4	16	2.3	1449	225	476	11	19	10854
J10	2	1.8	9	8.1	1	.9	2	1.8	2	1.8	16	4.0	1.104	534	525	21	32	9009
J11	3	2.7					1	.9	3	2.7	7	11.5	1118	47	768	87	12	8383
J12	1	2.1	1	2.1	1	2.1					3	6.0	486	2	333	20	3	8242
J13	1	1.9									1	10.0	526	46	236	23	3	6140
J14	3	25.2	4	33.6					1	8.4	8	7.5	119	29	40	3	3	6755
J15	5	5.1	26	26.6			5	5.1	1	1.0	37	7.4	980	340	333	24	38	7174
J16	1	1.4	4	5.6	1	1.4					6	5.5	719	96	254	14	25	7324
J17	2	4.0	2	4.0			2	4.0			6	5.1	503	30	177	9	16	7474
J18			1	1.0	2	1.9	1	1.0			4	.9	1026	58	338	3	34	7474
J19	4	7.3			3	5.5			3	5.5	10	1.8	547	45	163	3	25	12628
K2									5	7.0	5	.5	719		187	i	9	14721
K3									1	2.2	1		459		158		7	13571
K4	1	5.8							1	5.8	2		171		60			13571
K5									1	5.3	1		190	18	67		2	13571
K6							1	1.7	1	1.7	2		597		241		2	18059
K7	2	2.3	1	1.2					5	5.8			858		331		1	18059
K8	1	1.1					1	1.1	3	3.4	5	.3	883	10	328	1	7	10159
K9	2	1.6	4	3.2			2	1.6	2	1.6	10	2.4	1262	8	460	11	12	11595
K10	2	2.0	8	7.9					1	1.0	11	4.6	1017	134	453	21	13	7923
K11	1	2.2	2	4.4					1	2.2	4	6.0	456	34	253	15	7	7651
K12	3	1.0	3	1.0	1	3.4	1	3.4		.	8	2.3	294	34	219	5	15	6952
K13			1	2.1	1	2.1	2	4.1			4	9.0	483	130	220	20	16	6227
K14	1	2.1	6	12.7	11	23.4	2	4.3		.	20	7.4	470	400	203	15	13	7758
K15	5	7.5	7	10.6	2	3.0	1	1.5			15	4.8	663	443	273	13	19	7758
K16			1	2.2							1	3.1	462	102	160	5	14	7897
K17	1	2.3	1	2.3			1	2.3	1	2.3	4	4.3	444	109	187	8	13	8036
K18	1	4.8			1	4.8	1	4.8			3	4.7	208	19	64	3	3	8036
K19												11.0	126		18	2	6	8213
K20	2	8.5									2		237	1	77			8213
L2					4	4.9			5	6.1	9	1.3	815		224	3	3	14721
L3													77		25		1	13337
L4					1	3.1			3	9.2	4	.9	325		108	1	4	13337
L5					1	1.3	1	1.3	3	4.0	5		775		258		5	13337
L6					4	7.7	1	1.9			5	23.0	521	3	30	7	6	18404
L7									3	3.6	3	1.2	830	10	320	4	5	18404
L8	1	1.1							2	2.3	3	1.7	880		295	5	8	11177
L9	2	1.8							2	1.8	4	1.3	556		227	3	5	16372

L10	3	2.9	3	3.9	1	1.0	1	1.0			8	1.1	1050	32	455	5	16	7717
L11	1	2.5	1	2.5	1	2.5					3	3.0	401	51	166	5	5	7956
L12	3	3.2	12	12.7	3	3.2	6	6.3	1	1.1	25	7.8	945	518	490	38	31	6958
L13	1	.7					1	.7			2	8.0	148	127	62	5	4	6738
L14			1	2.8							1	5.8	356	300	138	8	16	6244
L15	1	4.0	4	16.0							5	1.3	252	219	77	1	10	7001
L16	1	4.0	1	4.0					2	8.0	4	3.1	251	97	65	2	10	7897
L17	4	3.5	6	5.2	1	.9	1	.9			12	2.1	1151	534	332	7	55	8036
L18	1	3.2	3	9.5	1	3.2	3	9.5			8	3.9	315	137	102	4	15	8036
L19													0					
L20	1	4.2			1	4.2					2		237	1	77		3	8213
M2	2	3.0					1	1.5	2	3.0	5		676		186		1	14721
M3					1	1.7			1	1.7	2	.5	599		188	1	4	13103
M4	2	1.5							2	1.5	4		689		230		2	13103
M5	2	3.5					1	1.3	2	2.5	5	.3	797		306	1	11	10961
M6			3	4.6					2	3.1	5	3.6	646	3	308	11	6	18749
M7	2	2.3					1	1.2	9	10.4	12	3.6	869		278	10	5	18749
M8	1	2.1	1	2.1	1	2.1					3	2.5	471		203	5	4	15997
M9													436	3	116		2	21149
M10	3	2.4	1	.8	1	.8	1	.8	1	.8	7	1.0	1233	131	404	4	14	7512
M11					1	2.1			1	2.1	2	5.4	469	185	167	9	13	7337
M12	1	2.3	1	2.3			1	2.3			3	4.7	433	237	169	8	11	6670
M13												2.1	293	62	93	2	12	5585
M14							2	2.3	1	1.2	3	.8	859	162	260	2	38	8856
M15					5	9.3			2	3.7	7		538	28	136		21	8856
M16	1	3.6					1	3.6			2	1.1	281	18	95	1	8	7971
M17													65	17	24		1	7087
M18									1	38.6	1		26	12	8			7087
M19													0					
N2													236		73			11669
N3									2	2.7	2		747		228		6	12673
N4			1	1.0					4	4.2	5	.7	956	1	289	2	14	12673
N5	1	1.5	1	1.5	2	3.1			3	4.6	7		651		229		4	12673
N6	1	1.6					1	1.6			2		612	43	9			14197
N7	1	1.6	306	50.0	16	26.2					322		612	43	9			14197
N8	1	1.1							1	1.1	2	.8	895	2	383	3	7	16039
N9							1	1.1	4	4.5	5		884		356		2	15430
N10	1	1.5							1	1.5	2	.8	669	76	262	2	17	13295
N11	4	13.4					2	6.7	1	3.4	7		298	74	109		4	15529
N12									1	3.0	1		331	1	138		8	9918
N13	2	5.4					1	2.7			3	4.8	373	228	124	6	3	6806
N14			1	1.2					3	3.7	4	1.1	816	35	286	3	11	10227
N15												1.1	767	10	263	3	27	10192

N16									2	3.0	2		669	24	210		7	8968
N17			1	1.6	1	1.6	1	1.6	1	1.6	4		611	44	155		11	7745
N18													275	22	84		8	7668
N19													0					
O1									1	20.4	1		49		14		1	14040
O2	1	1.7			4	6.7			4	6.7	9	1.3	597		152	2	6	11669
O3									12	21.6	12	.7	557	4	153	1	7	12673
O4	3	3.5							2	2.3	5	.4	870		258	1	18	12673
O5	1	.9			1	.9	2	1.9	4	3.2	8	.3	1041		311	1	10	12673
O6													0					
O7													0					
O8	2	1.1							3	1.6	5	2.8	189	2	71	2	1	15805
O9	2	3.8							3	5.7	5	.6	529	8	176	1	3	15260
O10												2.0	258	46	102	2	9	11655
O11							1	3.3			1		303		110		14	12676
O12													146		56		4	9918
O13									4	35.0	4		114	77	34		8	6806
O14	3	3.7							3	3.7	6		809	21	269		13	10227
O15	2	2.1			3	3.1					5	1.0	966	16	312	3	38	10192
O16												1.3	734	43	222	3	15	8968
O17	1	2.3	1	2.3	3	6.8			4	9.1	9		441	38	134		11	7745
O18									1	3.6	1		280	25	134		8	7668
P1													49		14		1	14040
P2									1	3.9	1		256		66		3	12854
P3	2	11.6									2		172		44		1	13621
P4	1	3.8			1	3.8			6	22.3	8		269		202		4	13147
P5							1	1.3	6	7.9	7	.5	758	2	185	1	1	13147
P6	2	5.8									2		348		132			14197
P7													479		179		3	14197
P8									1	2.1	1	.6	478	1	179	1	3	16053
P9	1	1.4	1	1.4					1	1.4	3		717		219		2	15091
P10	2	11.6			1	5.8	1	5.8	6	34.6	10		173		57			10015
P11													254		81		3	11249
P12			1	17.2	1	17.2					2		58		24		5	9918
P13	1	12.2					1	12.2			2		82	2	26		3	6806
P14			4	7.0							4		571	30	211		13	10227
P15	2	2.6							3	4.0	5	.4	757	8	264	1	14	10192
P16													522	31	136		15	8968
P17													0					
Q3					1	1.4			5	7.4	6		676		165		13	11794
Q4													77		19		1	11799
Q5	1	.8									1		1311		258		7	13312

Q6					1	1.1			7	7.9	8		879		229		8	14820
Q7	2	2.8					1	1.4	6	8.5	9		712		238		7	14820
Q8	2	2.5					3	3.8	3	3.8	8		786		256		8	15389
Q9	1	1.3	1	1.3					4	5.1	6		786		212		5	15402
Q10			3	3.2					7	9.7	10		723	5	213		6	11867
Q11													90		41		1	9272
Q12	1	1.1							1	1.1	2		914	52	270		24	9009
Q13												.6	729	74	173	1	11	8796
Q14													101		37		1	11631
Q15					1	1.7			1	1.7	2		576	38	109		14	6917
Q16												2.9	375	1	137	4	5	6917
R2													0					
R3												.5	495	5	198	1	6	11794
R4	3	7.3							1	2.4	4		413		192		6	11794
R5												8.1	122	5	37	3	1	15524
R6									1	1.7	1		589	8	170		6	15172
R7	3	6.1	1	2.0					3	6.1	7		489		127		4	14820
R8													177		46		1	15395
R9									7	9.5	7		736		203		10	11867
R10	3	2.0	2	1.4					7	4.8	12		1460		410		31	11867
R11	1	5.7	11	63.0							12		175	8	68		2	8592
R12	1	1.0	7	9.8							8	.2	1030	107	413	1	37	8955
R13	4	3.4	10	8.4	2	1.7	2	1.7	1	.8	19	.3	1164	162	325	1	37	10135
R14	3	2.0			2	1.3			7	4.7	12	1.0	1505	33	194	2	56	11631
R15	1	12.8	1	12.8							2		78	3	21		1	6917
R16													28		7			6917
S6			1	3.6					2	7.2	3	1.0	276	3	98	1	1	11523
S7													44		12			11523
S8									2	21.5	2		93	1	39		1	11480
S9	3	9.7	1	3.2							4		310	4	116		6	15906
S10	1	2.2	2	4.4							3		455	3	194		7	15906
S11	1	200.0									1		5		2			9392
S12	2	6.0	2	6.0					3	9.0	7		335	6	83		7	8236
S13	1	2.2			1	2.2					2	.8	451	41	120	1	8	8877
S14	2	64.6	1	32.2					3	97.0	6		31	18	82			11631
S15												1.0	304	3	105	1	1	6917
S16												9.1	41		11	1	1	9218
T6												8.3	44		12	1		7523
T7													0					
T8													0					
T9													0					
T10													14		4			9103

T11													29		13			8915
T12	1	3.1	1	3.1					1	3.1	3		320	3	76		9	7676
T13													140		34		2	7620
U8													29		7		1	7622
U9													7		2			7722
U10													216		284		2	7792
U11													30		15			7517
U12													0					
U13													0					
V8													0					
V9													0					
V10													0					
V11													13		4			7517
V12													39		15		2	7512

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