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TRANSPORTATION PLANNING FOR SAIGON

Volume 1

FINAL REPORT

DMJM

DANIEL, MANN, JOHNSON, & MENDENHALL

TRANSPORTATION PLANNING IN SAIGON

VOLUME 1 • FINAL REPORT

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MINISTRY OF PUBLIC WORKS
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DANIEL, MANN, JOHNSON, & MENDENHALL AND
GEO-CONTROL INC. (A JOINT VENTURE)

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PREFACE

This report was prepared in March 1974 to document the advisory tasks performed during the past few months for the Directorate General of Reconstruction and Urban Planning, Ministry of Public Works of the Republic of Vietnam under terms of Contract No. AID-730-3587 between the United States Agency for International Development and Daniel, Mann, Johnson, & Mendenhall and Geo Control Inc. (A Joint Venture).

The report is in three volumes: Volume 1 is a summary of our study and recommendations; Volume 2 is a procedures manual to assist Vietnamese personnel in continuing the study; and Volume 3 documents the computer programs used in the study.

I. INTRODUCTION

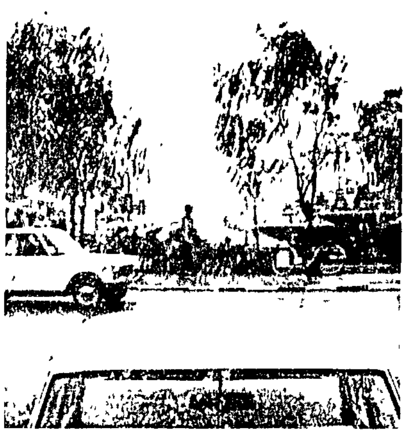
A. Project Objectives

The primary objective of the study was to develop a method for estimating comparative capital costs for the interzonal transportation systems required to serve five alternative land-use plans defined by DGRUP. The transportation planning techniques and computer models used in the analysis were also to serve as an introduction for DGRUP personnel to transportation planning, and the DMJM advisors were responsible for training Vietnamese personnel in the use of the techniques and models for further work.

A secondary objective of the study was to identify transportation planning data requirements, availability, and deficiencies, and to recommend actions that might be taken so that future planning efforts could be more constructive.

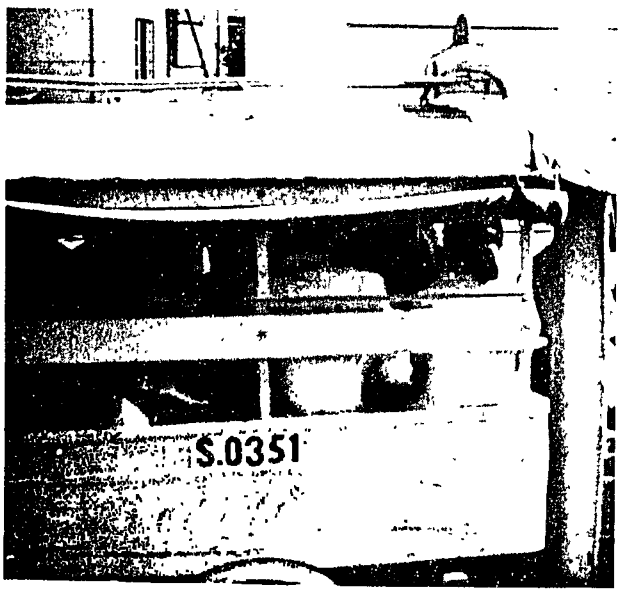
B. Transportation in Saigon Today

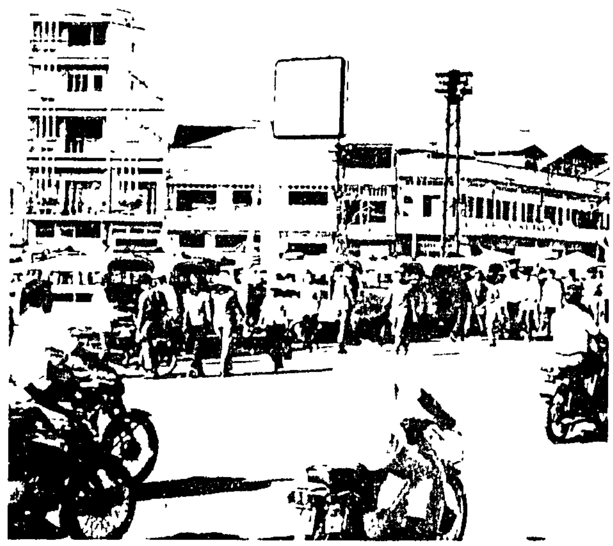
Saigon today is a city of nearly three million people, living and moving in a community that was planned by the French for less than one-half million. The primary street system consists of broad, straight avenues, originally tree-lined but now with few trees remaining. These boulevards are frequently interrupted by traffic circles, and the traffic-bearing capacity of the roadway is often reduced by marketplaces and vendors overflowing the sidewalks into the curb lanes.



The vehicle mix in Saigon is heavily weighted toward motorcycles and other motorized two- or three-wheeled vehicles, and recent increases in gasoline prices have resulted in an upsurge of bicycles and pedicabs as replacement for the Hondas and motorcycles. Approximately 80 percent of the private vehicles are small motorcycles and scooters, and many of the private automobiles are obsolete and poorly maintained French and Japanese imports.

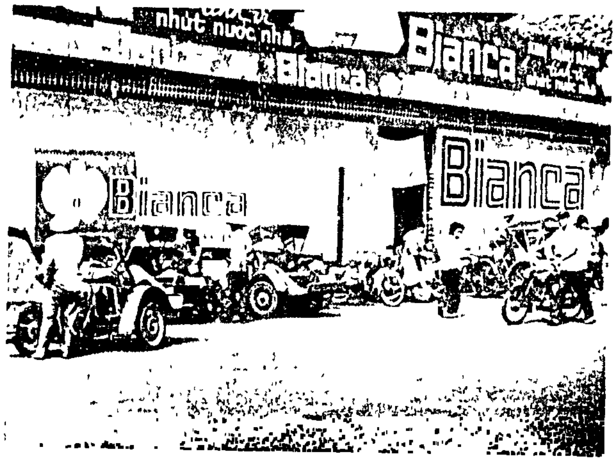
Until late 1973, the principal form of public transportation was an extensive route system of three-wheel, 10-passenger Lambros, powered by motorcycle engines. More than 4,000 of these vehicles operate over many fixed routes, stopping anywhere on demand, and charging very low fares.



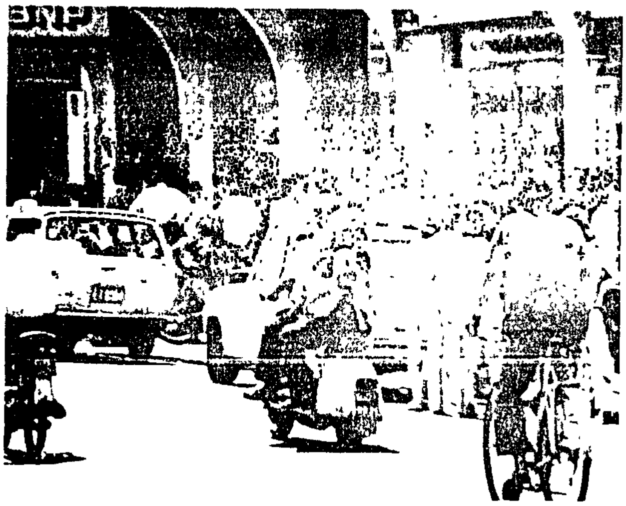


In late 1973 and early 1974 bus service was reintroduced to Saigon, after an absence of more than 5 years; some of the buses are owned by unions of former Lambro drivers and operate over former Lambro routes, while others are privately owned. The bus routes are subject to government control, and the bus lines are very heavily patronized; however, accurate counts of patronage for the system as a whole or for individual lines are not available.

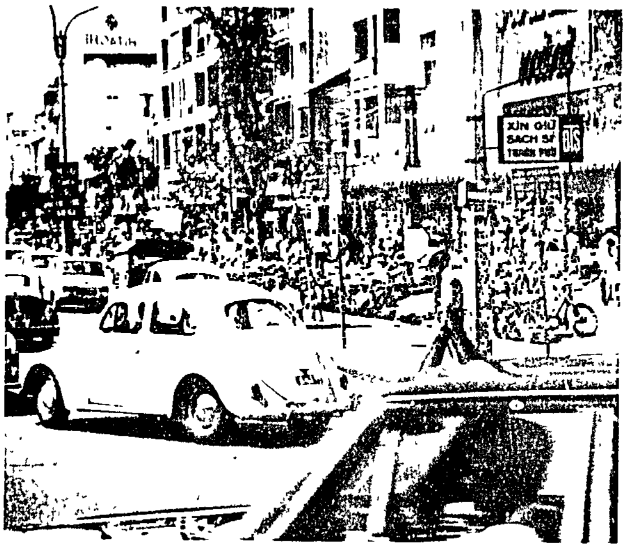
Other forms of public transportation include taxis (most of which are 1950s vintage Renaults and Simcas), motorcycles, and pedicabs. Because of the energy shortage, the pedicabs have made a tremendous resurgence since late 1973 and in 1974. All of these vehicles operate by cruising for passengers or by waiting at busy locations such as markets, government offices, and schools. The passenger must always bargain with the driver to establish a fare.

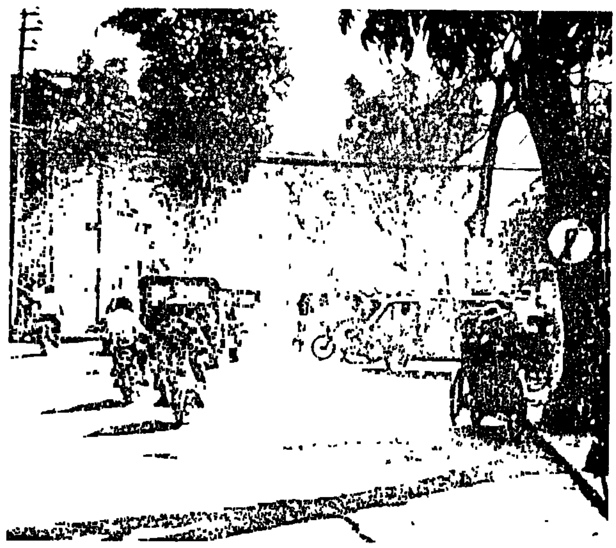


The vehicle occupancies observed in Saigon are substantially higher than in the United States; even the motorcycles and scooters carry up to five persons regularly, and a family of 11 has been sighted by one USAID observer on a single Honda. The traffic mix and occupancy rates are so different from those experienced elsewhere that capacity and volume relationships must be redefined. Observed speeds are also much lower than those elsewhere. Even driver expectations are different from those familiar to United States traffic engineers, since intersection traffic control is frequently nonexistent



or not operating, and those signals that are present are too far from the intersection to be visible to drivers at the heads of queues. Entering an intersection thus becomes a game of "chicken," with opposing drivers





attempting to bluff each other and the bigger vehicle usually winning. There is very little driver lane discipline, even though the traffic department has recently attempted to delineate frontage roads or right lanes for exclusive use of two- and three-wheel vehicles.

In spite of these problems, traffic in Saigon has improved significantly in the last year, but the improvement is due mainly to the great decrease in American military traffic and to the increased gasoline costs (over 200 percent in the last year), reducing the number of vehicles on the road.

The Vietnamese planners recognize their transportation problems, and are aware that uncontrolled growth in population and population density can only lead to further problems. They are attempting to develop long-range urban plans for the Saigon area to provide for orderly growth, and to distribute residential, employment, education, shopping, and government land uses to minimize the requirements for excessive transportation facilities. However, they do recognize the need for an interzonal transportation system to connect the various urban centers within the metropolitan area, and our efforts during the study were directed to assisting them to analyze alternative transportation systems.

II. STUDY APPROACH

A. Transportation Planning Framework*

The state-of-the-art in urban transportation planning may be divided into three overlapping, sequential, and iterative analytical processes: sketch (or strategic long-range) planning, network feasibility analysis, and micro-area or engineering design.

Sketch planning facilitates preliminary screening of alternative systems configurations, which was the primary objective of the Saigon Transportation Planning Study. The level of detail of sketch planning must be at least sufficient to support strategy in transportation investment decisions. This type of analysis is particularly suited to long-range regional planning, yielding preliminary macroscopic estimates of a multimodal network's capital costs, corridor traffic flows, transportation service levels, and land development implications.

The current study has involved a type of sketch planning; the planner should continue iterating in this macro-analysis mode until he has identified strategic plans of high potential that are worthy of more detailed (and more costly) examination.

Network feasibility analysis entails a fairly detailed study appropriate to the data and issues of midrange (5 to 20 years) planning. The cost of examining an alternative here is 10 to 20 times its cost at the sketch planning level, and the data base requirement is much more detailed. It is thus able to provide disaggregated cost and benefit measures and relate them to the needs of citizens affected.

Types of inputs include the location of existing and proposed principal highway and transit facilities, disaggregate travel demand forecasts based on detailed land-use plans, and detailed transportation service strategies. The outputs include estimates of transit fleet size and operating requirements for specific service areas, refined cost and patronage forecasts, household displacements, and environmental and esthetic impacts. The plans that appear promising at this stage can be analyzed in greater detail through micro-area analysis; alternatively, if problems are uncovered in the network analysis, the planner can return to sketch planning to accommodate new constraints.

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* The material in this section is largely based on the Urban Mass Transportation Administration report, A Procedure for Long-Range Transportation (Sketch) Planning, July 1973.

Micro-area analysis is used to refine estimates of design parameters to the level of detail appropriate to enable the design engineer or architect to prepare implementation drawings. Examples of activities addressed in this stage are: detailed simulation of the extension of an existing bus line (for the transit operator), simulation of a bus priority signal system (for the traffic engineer), analysis of passenger and vehicle flows through a transportation terminal (for the architect), and examination of alternative routing and shuttling strategies for a demand-activated system (for the control system designer). This final, costly level of analysis is typically reserved for subsystems whose implementation is highly likely, and the design refinement often yields substantial service level increases and/or significant cost reductions.

The U.S. Department of Transportation is currently funding extensive development of analytical techniques and computer models to support all three planning levels. Existing models are concentrated on network analysis, but a sketch-planning package is scheduled to be released by the Urban Mass Transportation Administration early in 1974, and many components of the micro-area analysis package are also now available. The objectives of the current study and the level of data available in Saigon indicated that we should concentrate on sketch planning during our participation in the study, but we have also turned over all of the UMTA and FHWA planning models to DGRUP, and have attempted to instruct Vietnamese personnel in the operation of some of the network analysis models. We have also registered DGRUP as a user of both the UMTA and FHWA systems, so that future additions, updates, and corrections to the programs and documentation should be forwarded directly to Saigon.

B. Work Plan

The study approach used was influenced by the data available from DGRUP, the computer models available from USDOT, and the limited time available under the contract. In brief, the trip generation and distribution analysis completed by DGRUP was used, although we also attempted to validate their model by comparing its outputs with those of the FHWA self-calibrating gravity model. These analyses used zonal work trip generation and attraction data which were also developed by DGRUP planners, and trip-length distributions that were derived from a travel survey conducted by the Ministries of Public Works and Education during 1972. DGRUP is preparing a companion report to this volume describing their land use planning and trip generation analysis.

We worked jointly with DGRUP in preparing maps of the travel zones and of the existing highway system; we also obtained route information and mapped the Lambro transportation system as it existed in 1971-1972. We prepared and coded spiderweb networks for all five alternative land use plans, with the intention of validating the DGRUP trip distribution model by comparing its outputs with those of a conventional gravity model run on the spiderwebs, but our efforts were thwarted by uncorrectable bugs in the spiderweb analysis programs that we had obtained from Washington. We therefore concentrated our efforts on running the gravity model on a highway network, and were able to calibrate the gravity model to obtain a reasonable match with the DGRUP trip-length distribution.

After we coded and edited the existing arterial highway networks for two of the five land use plans (as models for DGRUP personnel to complete coding for the other alternatives) and computed the shortest interzonal paths on these networks, we attempted to assign the DGRUP trip interchange matrices to the networks. We discovered that the DGRUP data format was incompatible with the program packages that we were using; consequently, we have developed an assembly-language format conversion program to be applied by DGRUP, so that they may continue with the initial traffic assignment.

We have instructed DGRUP personnel in the operation of the planning methodology, both for the portions we were able to complete and for those tasks which they will have to conduct to finish their comparisons. We have turned over the program packages, documentation, and all maps, data cards, data bases, and computer printouts generated during our project, and have prepared both a procedures manual and a computer program manual which comprise Volumes 2 and 3 of this report.

III. DATA INVENTORIES

A. Land Use Plans

DGRUP planners have devoted substantial efforts during the last years to the development of five land-use plan alternatives for the Saigon region. They have prepared very detailed projections of population densities, activity centers, power distribution, water and sewerage lines, communications, employment, and even the local street systems which they consider to be a component of the capital infrastructure. However, they had done very little work on defining or analyzing an interzonal transportation system. All of DGRUP's work will be documented in a separate report.

B. Work Trip Tables

The land use maps for the five alternatives are illustrated in Figures 1 through 5. Analysis was done on 1-square-kilometer units, and the land use plotted represents the predominant use of each unit. It must be recognized that the land uses are really mixed for all zones. DGRUP combined adjoining units with similar land use and population densities into transportation zones; Figures 6 through 10 show the boundaries of these zones. In addition, these figures illustrate the employment data from which the trip tables used in our initial study were developed. For each zone, DGRUP projected the number of employable persons, the number of available jobs and the number of those jobs that would be filled by residents of the zone. Thus, the surplus of employable persons over jobs within the zone could be considered the number of work trips produced by the zone, and the number of positions to be filled by persons from outside the zone could be considered the number of work trips attracted. DGRUP also supplied tables with these employment values; those tables will appear in DGRUP's report.

It is recognized that work trips alone do not really make a sufficient data base for transportation systems analysis; however, some rationale can be identified for using the work trips for this preliminary study. In most Western cities, home-to-work trips comprise the major portion of morning peak-hour trips—as much as 80 percent of the total during the peak 2 hours or so. We have taken the conservative position of assuming that all of the work trips in the day would be concentrated in a single peak hour, so that the total number of trips in our trip table, even though only work trips are included, is probably greater than the total number of hourly trips likely to be observed. Thus a network designed to serve the work trip table should certainly have sufficient capacity.

When DGRUP develops projections of other-purpose trips, however, it would be desirable to prepare trip tables incorporating all purposes. Before

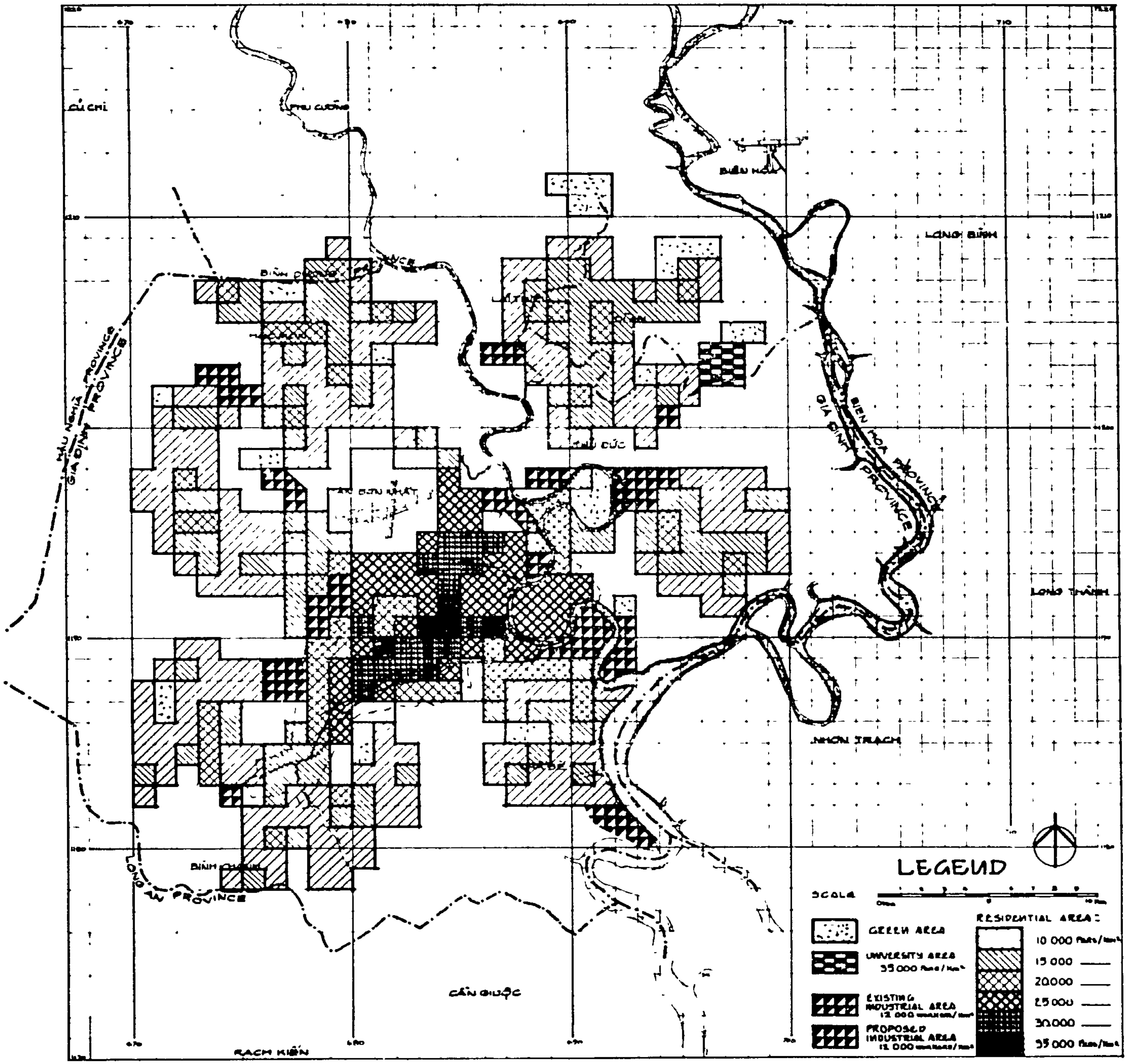

FIGURE 1
SAIGON METROPOLITAN AREA
LAND USE MAP – YEAR 2.000
PROPOSAL NO. 1
RING SYSTEM

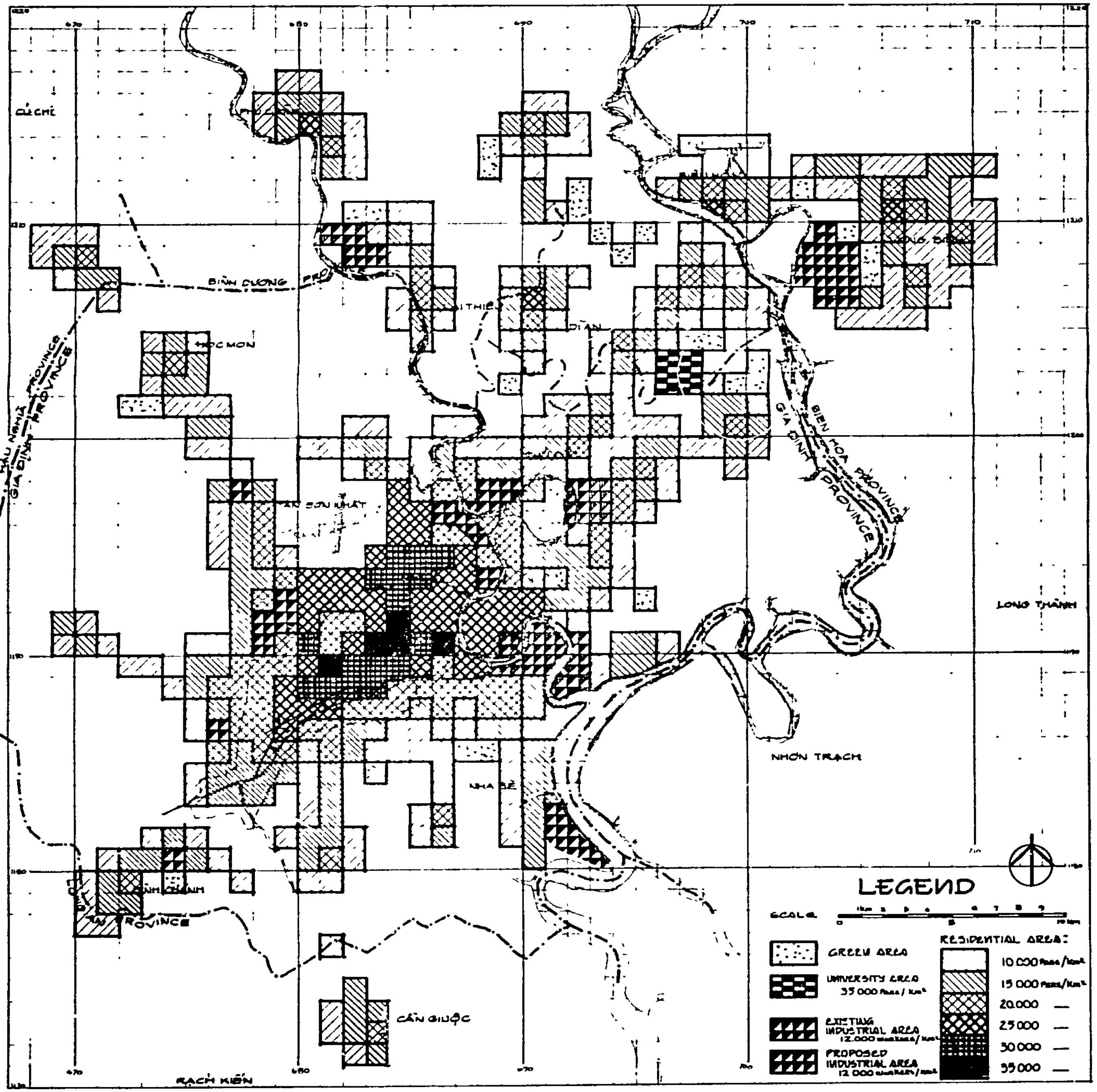

FIGURE 2
SAIGON METROPOLITAN AREA
LAND USE MAP – YEAR 2.000
PROPOSAL NO. 2
RADIAL SYSTEM

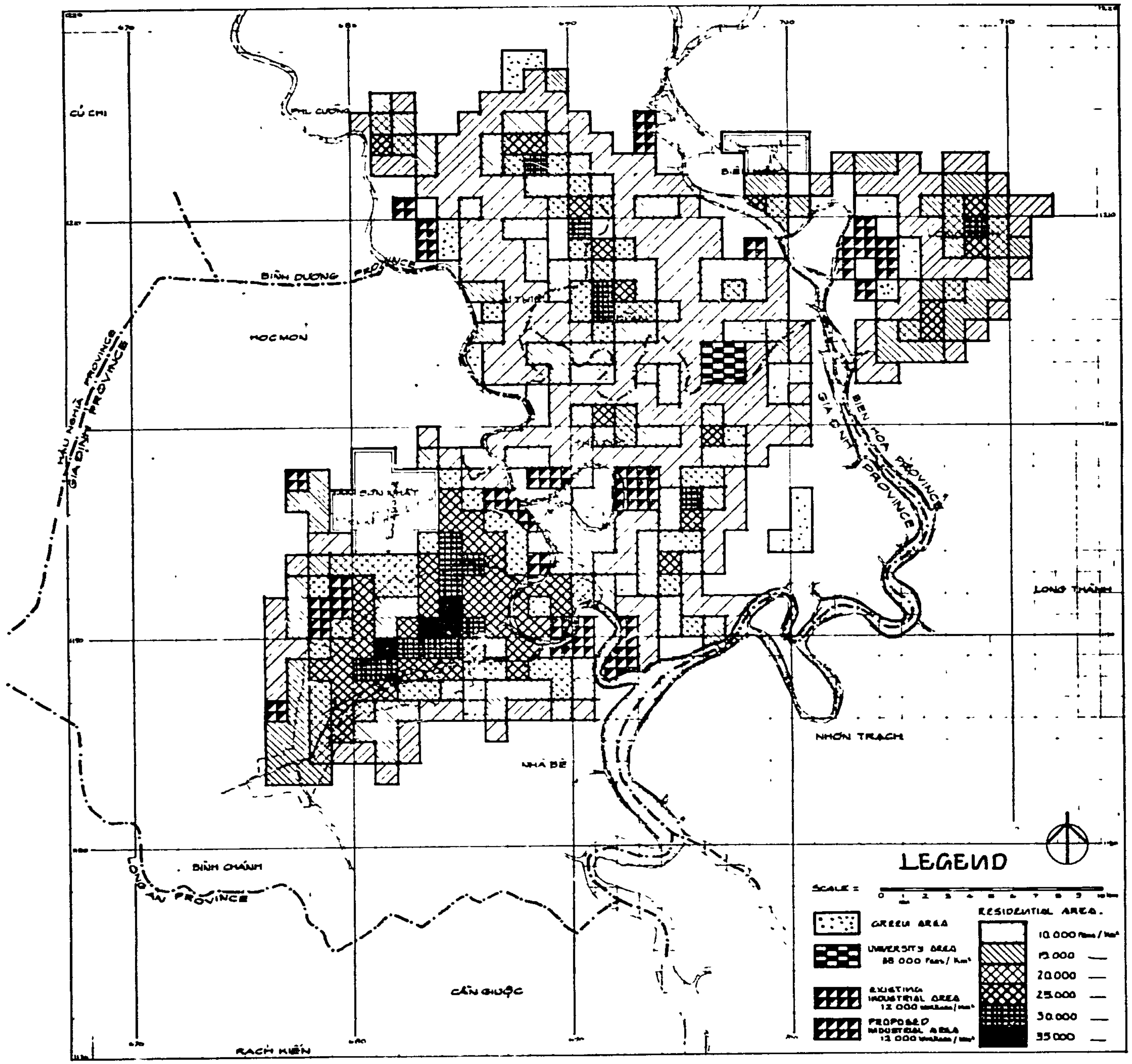

FIGURE 4

SAIGON METROPOLITAN AREA
LAND USE MAP – YEAR 2.000
PROPOSAL NO. 4
AXIAL NORTHWARDS SYSTEM

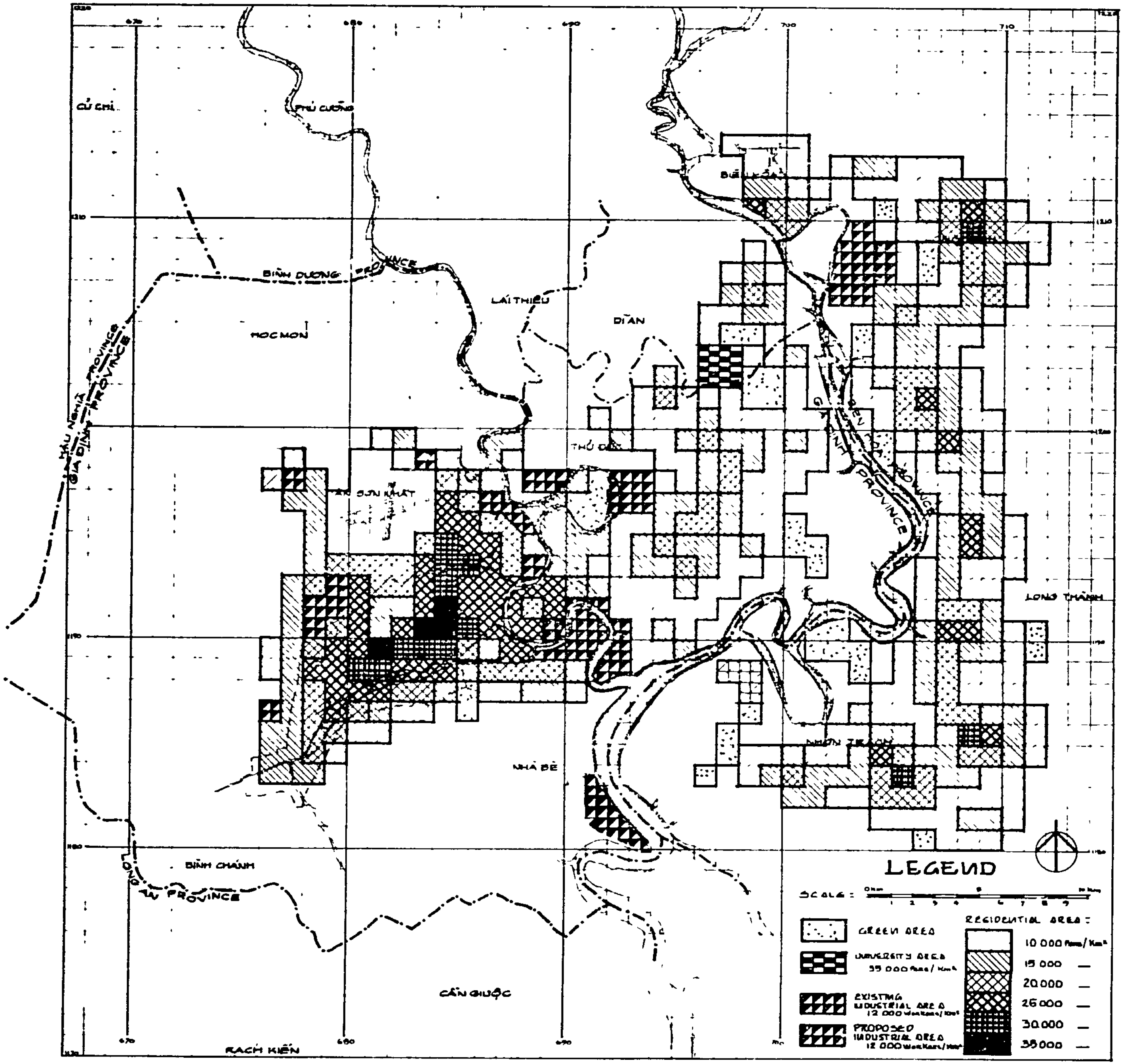

FIGURE 3

SAIGON METROPOLITAN AREA
LAND USE MAP – YEAR 2.000
PROPOSAL NO. 3
PARALLEL CENTERS SYSTEM

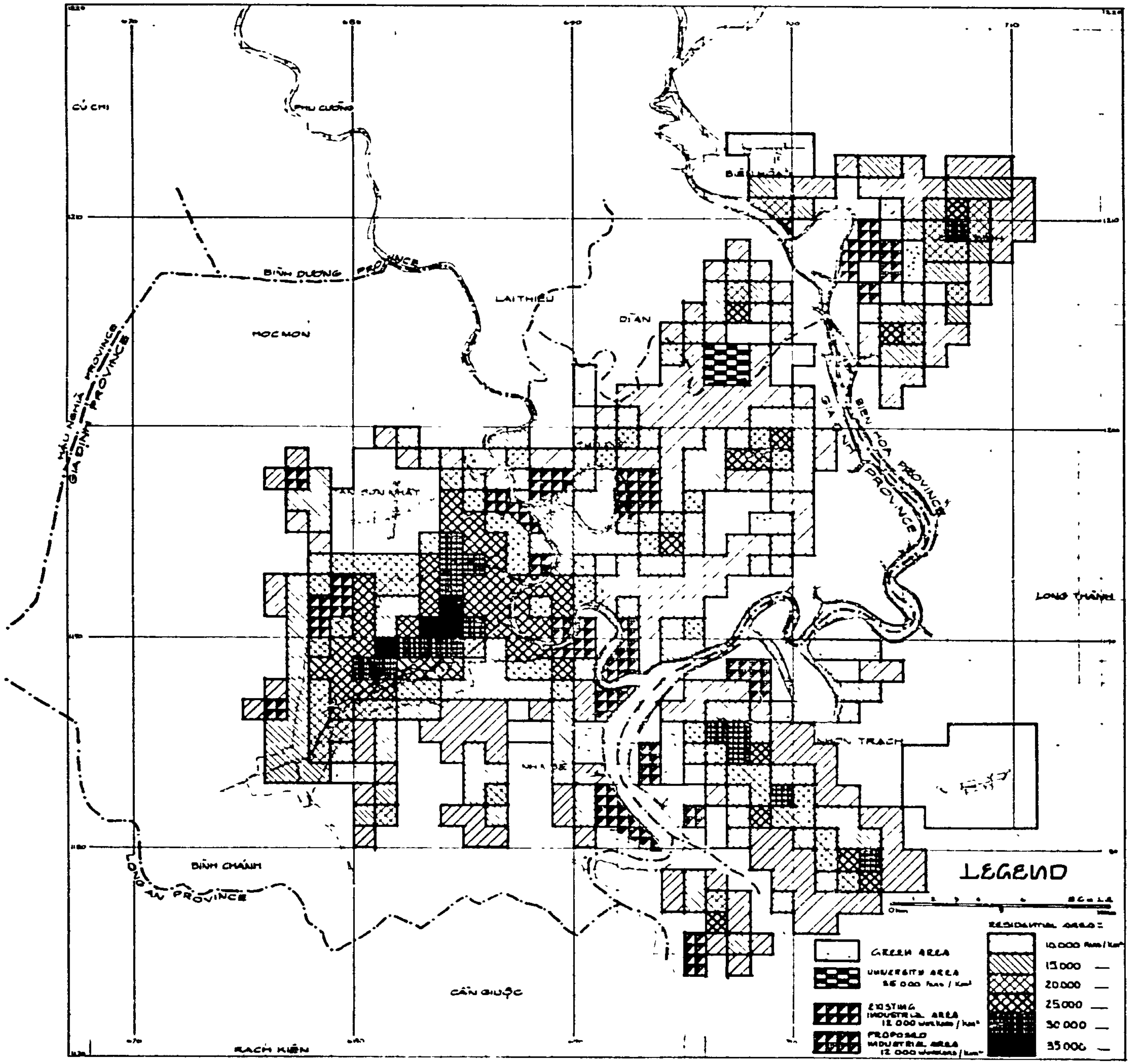

FIGURE 5

SAIGON METROPOLITAN AREA
LAND USE MAP – YEAR 2.000
PROPOSAL NO. 5
AXIAL SOUTHWARDS SYSTEM

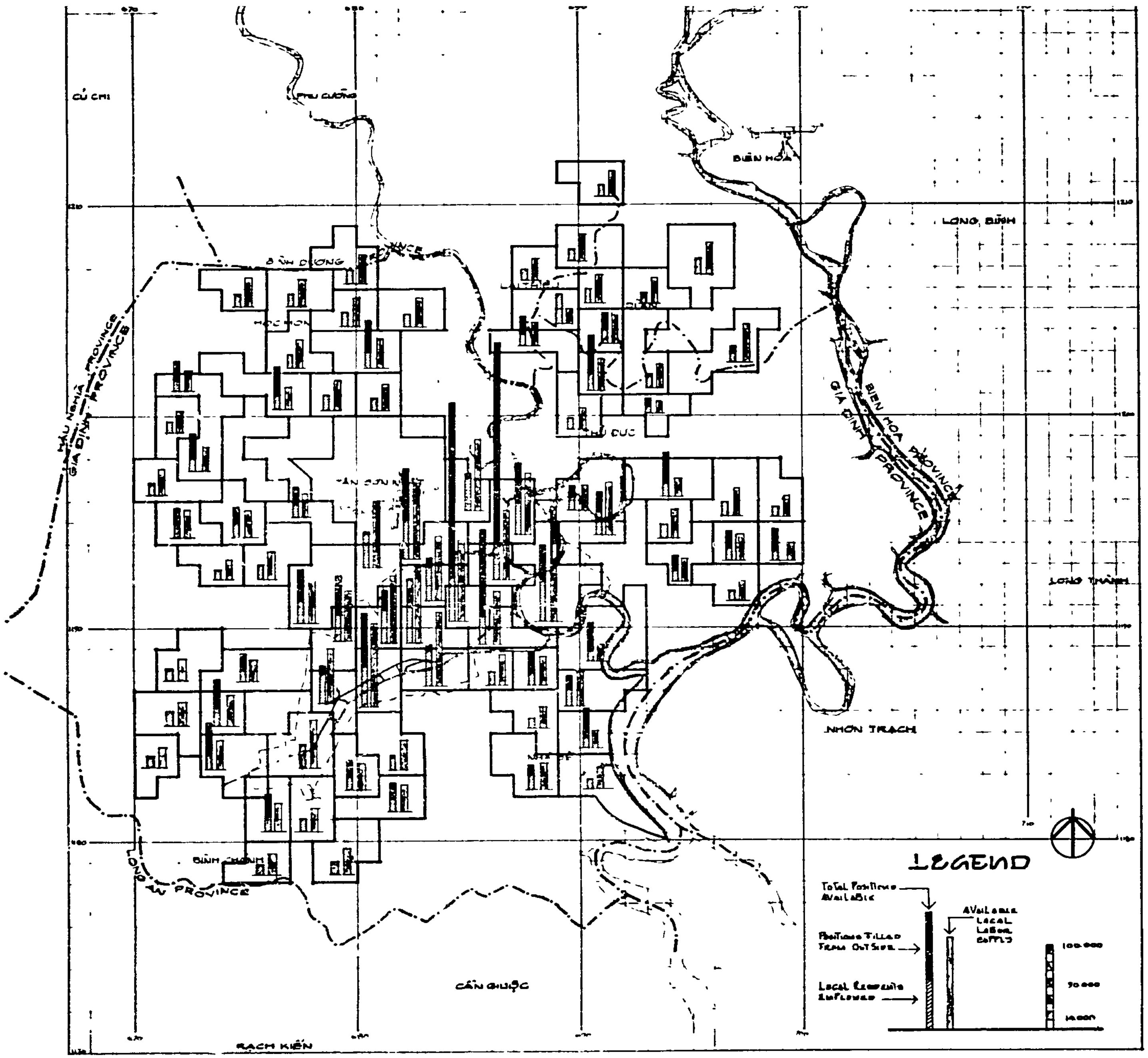

FIGURE 6

SAIGON METROPOLITAN AREA
EMPLOYMENT MAP – YEAR 2.000
PROPOSAL NO. 1
RING SYSTEM

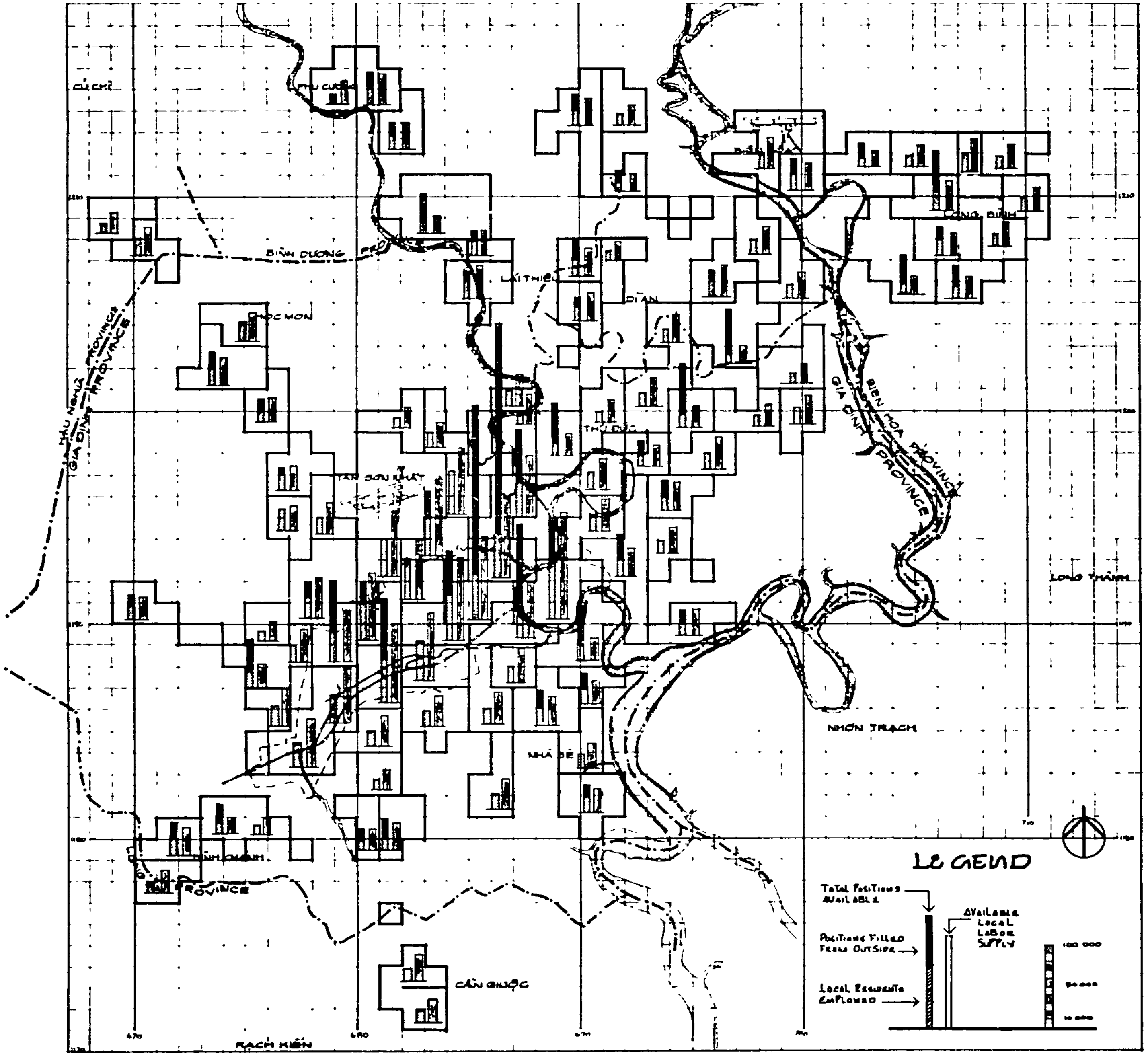

FIGURE 7

SAIGON METROPOLITAN AREA
EMPLOYMENT MAP – YEAR 2.000
PROPOSAL NO. 2
RADIAL SYSTEM

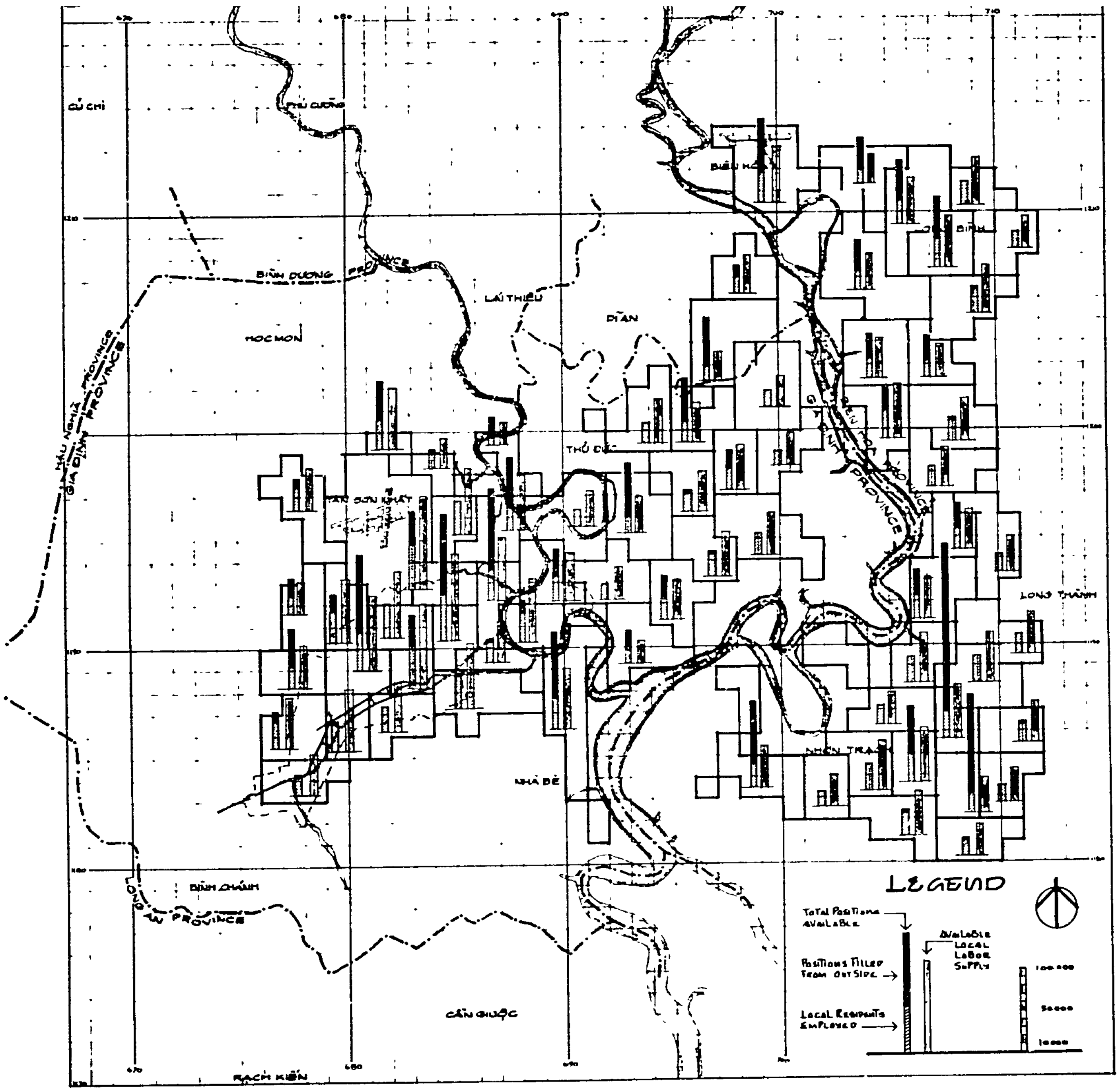

FIGURE 8
SAIGON METROPOLITAN AREA
EMPLOYMENT MAP – YEAR 2.000
PROPOSAL NO. 3
PARALLEL CENTERS SYSTEM

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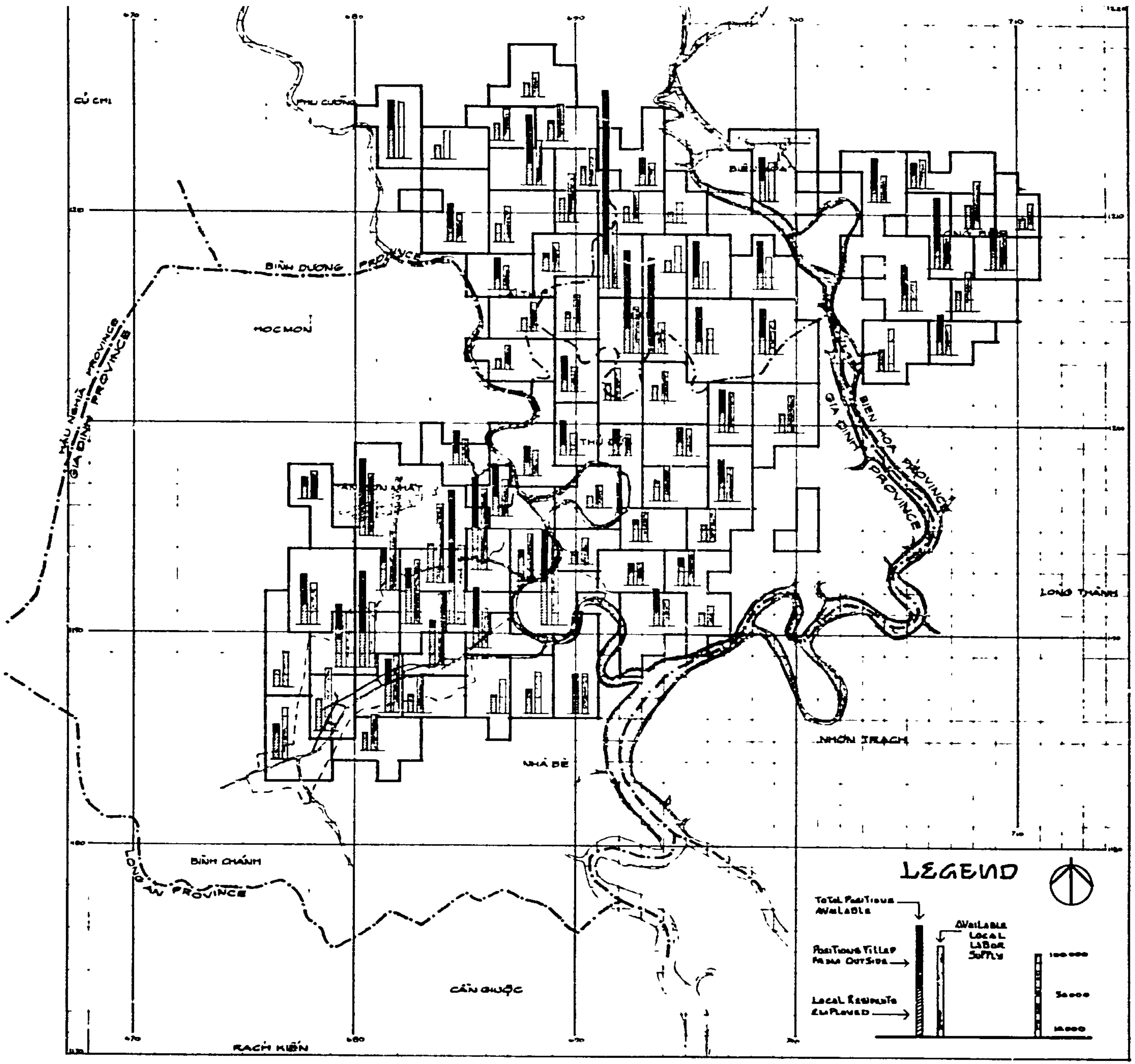

FIGURE 9

SAIGON METROPOLITAN AREA EMPLOYMENT MAP – YEAR 2.000 PROPOSAL NO. 4 AXIAL NORTHWARDS SYSTEM

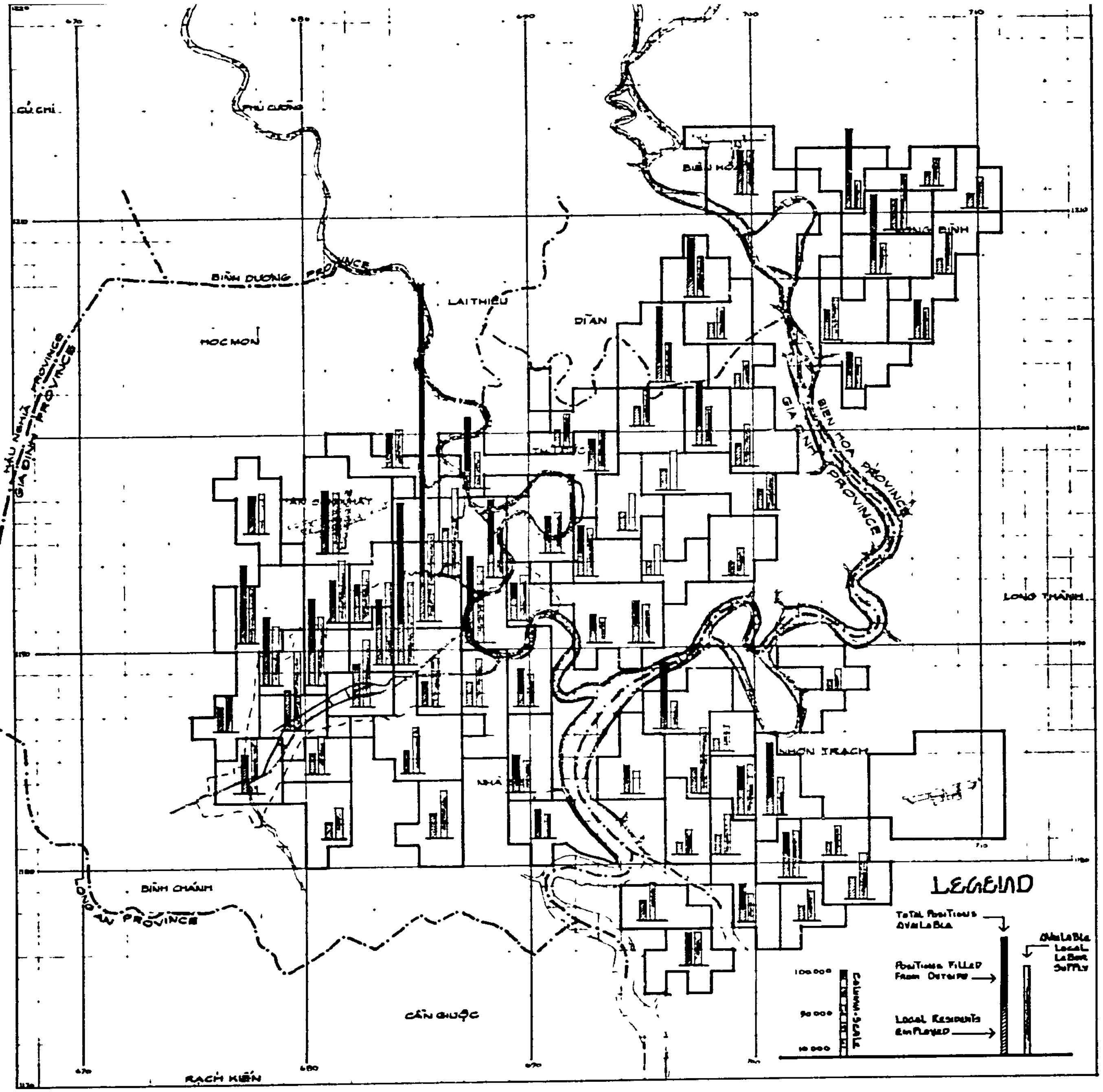

FIGURE 10

SAIGON METROPOLITAN AREA
EMPLOYMENT MAP – YEAR 2.000
PROPOSAL NO. 5
AXIAL SOUTHWARDS SYSTEM

such tables can be developed, it will be necessary to conduct a much more comprehensive travel survey than is now available in Saigon.

C. Travel Survey

A limited travel survey was conducted in Saigon during 1972, and some of its results were used during our study. The Ministries of Public Works and Education jointly conducted the survey by interviewing students at school rather than by home interviews (Vietnamese experience with any type of home interview survey has been disappointing, since the people are reluctant to answer questions for fear of being subjected to increased taxes; the continued state of war has also contributed to the population's reluctance to provide any accurate information.) Figures 11a and 11b show the survey questionnaire and an English translation. The questionnaire was distributed to over 80,000 students throughout the Saigon metrop litan area, and the answers were coded and processed on a computer.

Unfortunately, transportation planners were not consulted in the design of the questionnaire, and the sample selection was not statistically designed It therefore was not possible to factor the survey results to represent the total population, and the information collected was not sufficient to give more than an indication of travel behavior. DGRUP was able to derive an approximation to a trip-length distribution from the survey data, and that distribution proved useful in calibrating the traffic assignment models. We have recommended that a more comprehensive, scientifically designed survey be conducted to support future planning, and we have provided DGRUP with several reference manuals to guide them in designing such a survey.

D. Transportation Facilities

We were supplied detailed road maps, both for the Saigon prefecture and for the entire region. We also obtained descriptions of the Lambro transit route structures within Saigon, and prepared a detailed map of the Lambro itineraries (see Appendix B).

We overlaid the regional highway map with the maps of zone centroids, then selected those routes which were necessary to provide connecting service between all zones. Figure 12 is the basic network selected for coding and analysis.

Since the base year for the travel survey was 1972 and no bus service existed at that time, we did not include bus routes on our base maps.

The information available to us indicated that the major railroad line in Saigon served mostly intercity traffic, so we decided not to include it in our planning network. We did observe that there is a network of unused rail

FIGURE 11a

CÂU HỎI THƯỜNG THỨC

Bài số 01

(BÀI LÀM Ở NHÀ)

Em hãy nhớ lại thật kỹ và trả lời ngay trên tờ giấy này các câu hỏi sau đây :

1.- Nhà em có tất cả mấy người ? [người]

2.- Diện-tích nhà em, kể cả lầu (hoặc gác) nếu có, được mấy thước vuông ? [m^2]

3.- Nhà em ở số [ ] , đường [ ] , khóm [ ]
phường [ ] , quận [ ] , đô thị [ ]

Nhà em có mấy người đi học ?	Học ở các trường nào ?	Trường cách nhà bao xa? (m)	Đi học bằng xe gì ?	Đi học vào những giờ nào ?	Mỗi bận đi tốn bao nhiêu tiền xe ?
___người	1.				
	2.				
	3.				
	4.				
	5.				

Mỗi ngày nhà em có mấy người đi chợ ?	Thường đi chợ nào?	Chợ cách nhà bao xa (m)	Đi chợ bằng xe gì ?	Thường đi chợ vào giờ nào ?	Mỗi bận đi tốn bao nhiêu tiền xe ?
___người	1.				
	2.				

Nhà em có mấy người đi làm việc ?	Làm việc ở đâu ? (phường và quận nào?)	Nơi làm cách nhà bao xa? (m)	Đi làm bằng xe gì ?	Đi làm vào những giờ nào?	Mỗi bận đi tốn bao nhiêu tiền xe ?
	1.				
	2.				
___người	3.				
	4.				

Nhà em có mấy người thường đi chơi hoặc đi các công việc khác ?	Thường đi đến đâu? (phường và quận nào?)	Cách nhà bao xa ? (m)	Đi bằng xe gì ?	Mỗi tuần đi mấy bận ?	Mỗi bận đi tốn bao nhiêu tiền xe ?
	1.				
	2.				
	3.				
___người	4.				
	5.				

Nhà em có mấy người thường ra khỏi đô thị ?	Thường đi đến tỉnh nào ?	Cách nhà bao xa ? (m)	Đi bằng xe gì ?	Mỗi tháng đi mấy bận ?	Mỗi bận đi tốn bao nhiêu tiền xe ?
	1.				
	2.				
___người	3.				

FIGURE 11b

QUESTIONS

You have to remember and to answer the following questions:

1. How many persons are in your family? ________ persons

2. What is the total floor area in your house (including the semi-floor)? ________ m²

3. What is your home-number? ________, street? ________, khom? ________,
   phuong? ________, Quan? ________, City? ________.

4. How many persons go to school in your family? ____ pers.	Name of the school?	Distance from the house? (m)	By what manner?	At what time they start?	How much it cost by trip? (for the transportation)
	1				
	2				
	3				
	4				
	5				

5. How many persons go to the market in your family? ____ pers.	Name of the market?	Distance from the house? (m)	By what manner?	At what time they start?	How much it cost by trip? (for the transportation)
	1				
	2				

6. How many persons go to work? ____ pers.	Where they work? (Phuong District)	Distance from the house? (m)	By what manner?	At what time they start?	How much it cost by trip? (for the transportation)
	1				
	2				
	3				
	4				

7. Number of persons who often go out? (for any other purpose) ____ pers.	Where they go? (Phuong District)	Distance from the house? (m)	By what manner?	No. of times per week?	How much it cost by trip? (for the transportation)
	1				
	2				
	3				
	4				
	5				

8. Number of persons who often go out of the city? ____ pers.	Where they go? (Province)	Distance from the house? (m)	By what manner?	No. of times per month?	How much it cost by trip? (for the transportation)
	1				
	2				
	3				

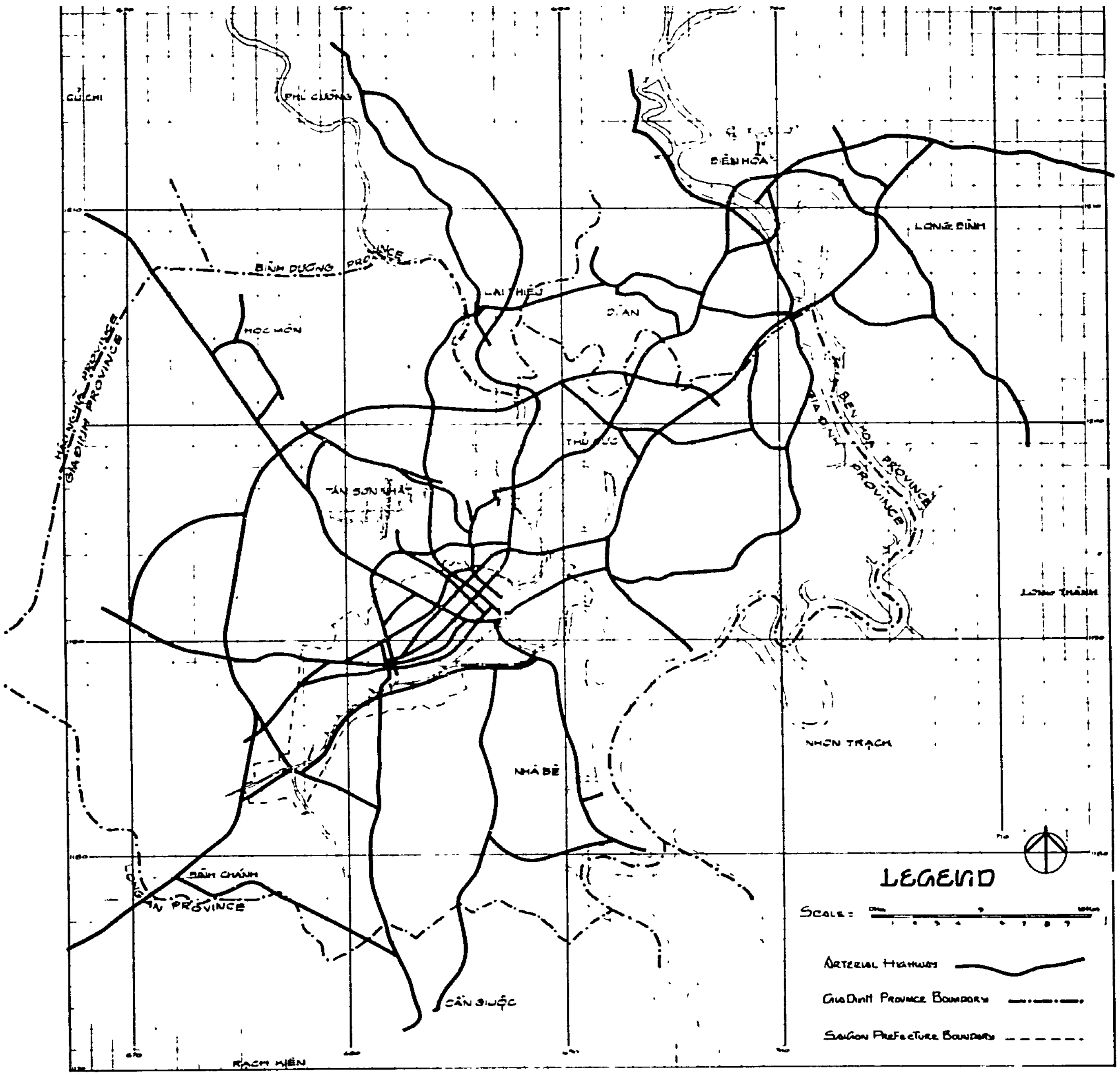

FIGURE 12
SAIGON METROPOLITAN AREA
EXISTING ARTERIAL HIGHWAY SYST

right-of-way throughout the city (some of it remaining from a long-defunct trolley system), and it would be desirable to prepare a map or inventory of this system to aid in future planning.

E. Unit Costs

The final data inventory prepared for the study was a set of unit costs for construction of rapid transit and highway facilities. For rapid transit, DMJM examined costs derived for several rapid transit systems which have been planned during the past few years. The system that appeared to have the most in common with what might eventually be constructed in Saigon was one designed for Honolulu, Hawaii; that system features elevated guideways as a system in Saigon probably would, and also is designed for a climate quite similar to Saigon's. We prepared a table giving the unit costs for the major components of the Honolulu system. The table also has comparative costs for designs for Baltimore and for Minneapolis-St. Paul. (Appendix A) We recommend using the Honolulu costs for the comparative analysis in the current study.

For highway construction, we analyzed the costs experienced recently by firms building roads in South Vietnam, and prepared the detailed cost estimates presented in Appendix A. It must be recognized that these costs are based on the experience of American construction firms, and local firms might estimate them differently.

IV. TRANSPORTATION PLANNING ANALYSIS

A. Validation of DGRUP Trip Distribution Model

One of the tasks we hoped to accomplish very early in the study was a validation of the trip distribution methodology that had been devised by DGRUP. We eventually accomplished the task, but only after at least one false start, and only near the end of our participation in the project.

Our approach was to attempt to run a conventional gravity distribution model on the production/attraction data developed by DGRUP, to calibrate the gravity model to the trip length distribution obtained from the travel survey, and to compare the gravity model outputs with those from the DGRUP model. The DGRUP trip interchanges had been developed using the airline distances between zone centroids as impedances; we hoped to use the link distances of spiderweb networks as a better approximation. We therefore prepared spiderweb networks for all five land use plans, and spent several days coding and editing the spiderwebs. At the same time, we proceeded with our attempts to reformat the DGRUP trip interchanges so that the trips could be loaded onto the spiderweb networks. However, both of these efforts were finally frustrated when we discovered that the program that was supposed to be used to load spiderwebs still contained errors, and that it was not possible for us to overcome the program bugs.

Our next task was to attempt to run the gravity model on the highway networks we had coded. After overcoming some minor problems caused by the lack of observed trips of lengths between 0 and 1 kilometer (since the only trips in our table were interzonal, and minimum zone separation was 1 kilometer), we were finally able to obtain a reasonable match with the observed trip length distribution. The computer runs supporting this analysis have been turned over to DGRUP, and are hence unavailable for reproduction in this report. We were also unable to reformat the DGRUP trip tables for successful network loading, and eventually determined that an assembly-language program would have to be written to complete the reformatting. Such a program has been prepared at DMJM/Los Angeles and has been forwarded to DGRUP.

B. Preparation of Networks

The highway network we finally used in the model validation and also as the basis for all further analysis is illustrated in Figure 13. This network represents an abstract of the highways shown on Figure 12, with zone centroids and connectors added (for Plan 2 in the illustration), and node numbers assigned to all intersections. Networks were completed for Plans 2

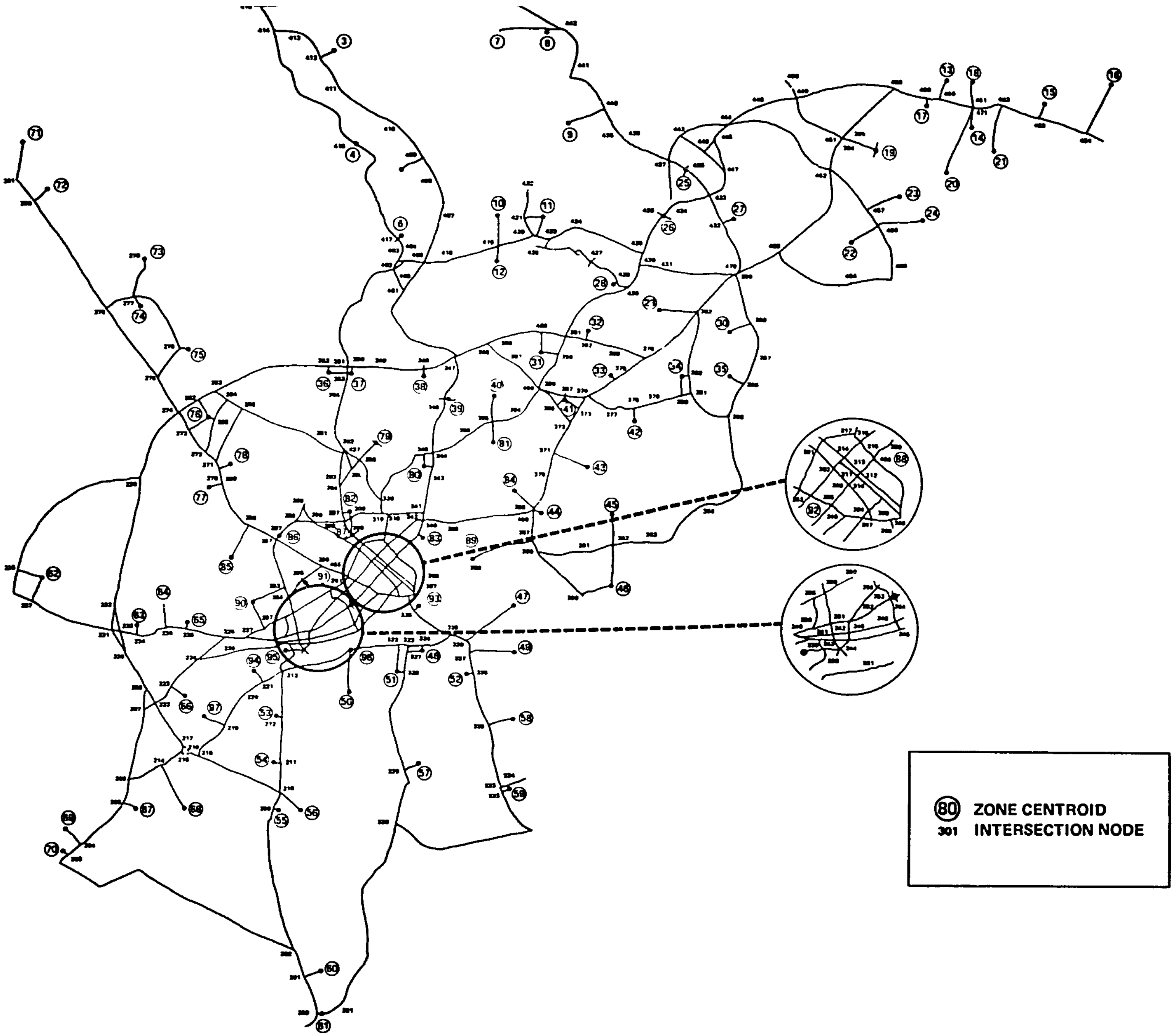

FIGURE 13

PLAN 2.
HIGHWAY TEST NETWORK

and 4, including all coding, editing, and computation of shortest zone-to-zone paths. Again, all of the maps and printouts of these networks were turned over to DGRUP, along with the instructions on how they were built; DGRUP now must complete the same process for the other three alternative plans, or for any additional combinations they may wish to test.

A second type of network which was prepared and tested to a limited extent was the Lambro network illustrated in Appendix B. While it was recognized that this network could not be used for the present analysis, we felt that building it would be a useful exercise to demonstrate the application of the UTPS programs to a transit network. It will be desirable to do some analysis of transit networks later in the current project, and these programs may also be used to study short-term improvements in the existing bus system.

We chose to use the Lambro system rather than the bus system because in late 1973, when we started the project, accurate information on bus routes was not yet available. We plotted the Lambro routes on a large-scale map, assigned node numbers, and coded all of the street links as well as the line sequences. We completed editing of the network, computed shortest paths, and even loaded the network with some artificial trip tables derived from gravity model outputs. The UTPS Network Development Manual presents very complete instructions on preparing transit system networks, and we recommend that such networks be prepared for the existing bus system.

C. Traffic Assignment and Network Analysis

The remaining steps in the planning process are to be carried out by DGRUP, using the procedures and program models which have been provided to them. The procedures are detailed in Volume 2 of this report, and the programs in Volume 3; in this volume those procedures will be summarized.

The next step to be completed is traffic assignment. The DGRUP trip interchanges must first be reformatted, using the TDREFMT program which we have forwarded. Then the interchanges may be loaded on the highway network, using the program LOADVN. This program automatically accumulates the link usage over shortest interzonal paths for all trips in the tables. The programs PRINTLD and/or FORMAT can be used to print summaries of the link loads. The planners should then record the loads on the network map.

To analyze the results of traffic assignment, the DGRUP planners should work with traffic engineers from the Directorate General of Highways. Information is required about the design capacities of the links of the highway network, in terms of the vehicle mix and occupancy factors that are experienced in Saigon. The link volumes from the traffic assignment must be compared with the capacities, and those links with insufficient capacity identified and flagged.

The planners and highway engineers must then determine how to increase capacities to meet excess demands. In some cases, alternate routes may be available, or it may be possible to widen the existing roads to add lanes. Another means of increasing capacity is to provide frequent bus service, thereby increasing the vehicle occupancy factors.

When these measures are insufficient, new highways or expressways must be designed, or even, when the demand is high enough, a fixed-guideway rapid-transit route. These new links must be added to the test network, the network rebuilt and edited, and the trips reassigned. The process continues until a balance is obtained between demand and capacity throughout the network.

The primary objective of the study is to determine the comparative capital costs of transportation system alternatives. The program packages provide a means of doing this. The network building and formatting routines allow the planner to output the total length of the street and/or transit systems; the lengths of any additions to the basic system can be computed, and unit construction costs applied to develop comparative capital cost estimates. Development of operating cost estimates, however, would require more data, more detailed analysis, and more resources than are now available.

V. SUGGESTED RESEARCH

Needed Tasks

Throughout our involvement in this study, in response to our own observations and to requests from Vietnamese personnel, we have identified areas in which additional research is required. The research is needed both for the current preliminary analysis, and for the comprehensive transportation planning study which must ultimately be conducted before a new transportation system can be implemented.

Before the present study can be completed, it will be necessary to compile information on traffic volumes, capacities, and vehicle occupancies. The best way to collect such data is to assign observers to make counts at key points throughout the city, counts of number of vehicles (by type) passing a point during time intervals, and counts of the number of passengers in each vehicle. These counts should be taken during peak hours at high-volume locations, to obtain a reasonable estimate of street capacities.

A comprehensive travel survey is needed, conducted through home interviews, work interviews, or through the schools as the previous survey was. The survey should attempt to collect information both on travel behavior of a large sample of Saigon residents and on attitudes toward time valuation, mode preferences, and transportation costs. Preferably, the survey and traffic count operations should be conducted during the same time period, so that the traffic observations can be used to calibrate the travel behavior data when it has been processed through trip generation, distribution and assignment models.

The new bus system should be carefully studied through observing passenger volumes and boarding and alighting points, determining operating and stop times and speeds, and surveying passengers about their travel patterns. The bus system should be simulated using some of the programs we have supplied, and the effects of changes in the operations analyzed.

There is need to conduct further socioeconomic analysis, concerning population, employment, income, household size, and travel behavior, to support more extensive trip generation analysis. Supporting transportation studies of parking, pedestrian movements, freight traffic, and railroad activity are also needed.

Vietnamese personnel need more training in transportation planning and design; the advisory services provided by foreign consultants and the formal courses of study have some utility, but it would be even more useful if selected personnel could spend periods of time working with public and private transportation agencies in advanced countries.

Program Continuation

All of these tasks are components of a comprehensive planning process: data collection to develop extensive inventories of travel, land use, and transportation facilities; preparation of forecasts of population, employment, and trip-making; determining the goals of urban development and the criteria against which plans may be measured; designing alternative highway and transit networks for testing; testing those networks through computer simulation; and evaluating the results of each test in terms of the objectives which have previously been specified. By comparing the test results of different plans, it is possible to determine which types, configurations, and quantities of transportation facilities provide the best combination of acceptable service and low transportation costs for the investment involved. A series of tests and evaluations gradually permits planners to identify a best plan of land use, highway construction, and mass transit installation, or at least a plan which cannot reasonably be bettered; this plan can then be recommended for adoption.

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