A STUDY OF THE RELATIONSHIP BETWEEN LAND-USE AND CIRCULATION SYSTEMS IN DEVELOPING AREAS

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PREFACE

The phenomenon of urbanization has brought great changes in population mobility patterns. Consequently, city planners have become deeply concerned with the dysfunction of the cities' communication channels. Normally, in this country, circulation systems have been determined by the extension and projection of existing patterns and land-use. However there is an increasing awareness that circulation systems should contribute and encourage better development of land-use patterns, and conversely circulation systems should evolve from such improvement in land-use patterns. This study was an attempt to offer proposals concerning the future development of the city of Stillwater in the area of land-use and circulation interactions.

The author wishes to acknowledge, in particular, Mr. R. B. Miller, whose patient guidance and constructive criticism have proved invaluable. I wish to acknowledge my indebtedness to the other members of my graduate committee, Dr. T. S. Dean and Mr. C. D. Elliot, who have generously given so much of their valuable time. A special acknowledgment is given to the City Planning Officers, Mr. B. A. Myers of Stillwater, Mr. J. B. Bennett of Bristol and Mr. G. A. McMillian of Cumbernauld who provided opportunities to gather the necessary data. Further acknowledgment goes to Mr. F. F. Ehrenthal and the Urban Design Class of the Architecture Department of Oklahoma State University, Spring Semester, 1967, for providing plans of Stillwater to be used in this paper.

Finally, the author wishes to thank her parents for their patience and encouragement throughout her studies at Oklahoma State University.

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INTRODUCTION

The present study concerns the circulation problems created by the evergrowing population of the city of Stillwater. More specifically, this project is a proposed plan to illustrate how these problems may be handled in the future.

In the past, attempts to answer the needs of growing cities have been in the direction of expanding and projecting the existing patterns of circulation. However, repeated experiences have shown that this method is no longer effective. There is an urgent need at the present time to find a better solution for the circulation problems created by the recent movement toward urbanization. City planners are now becoming more aware of the high interaction between land-use patterns and circulation systems.

The author realizes that the city of Stillwater also needs an over all planning based on this interaction, to meet the needs of the city as an educational center in the future.

In the following pages the reader will be introduced to what is being done in this area in two cities in Britain. Then, the existing conditions, as well as the future of Stillwater, as projected by the Stillwater City Planning Office, will be examined. Based on the above research, conclusions have been drawn and a plan for the city of Stillwater has been proposed by the author.

CHAPTER I

REVIEW OF SUMMER SURVEY

Bristol, England: The Existing City

Introduction to the City

Bristol is the seventh largest city in England and Wales, having a population of 437,048 (census of 1961). The developed area of Bristol extends for a few miles beyond the Central Survey Area in every direction except to the west where the Avon Gorge has restricted the development (Figure 1).

History

It is not known when the first settlement occured in the center of Bristol, and there is no evidence of Pre-Roman or Roman occupation. The earliest records available come from Saxon times, when there was a small settlement of thirty acres surrounded by two rivers, the Avon and Frome. By the time of the Norman Conquest Bristol was a prosperous trading center, and as a defensive measure a castle was erected to the east of the developed area. The street pattern of this settlement remains today in cruciform layout (Figure 2).

The first major extension of the town took place in 1248 when a new bridge was constructed across the Avon River. In 1373, Bristol was granted a charter. Between 1377 and 1600, the population increased from 10,000 to 15,000. The whole area to the northeast was developed

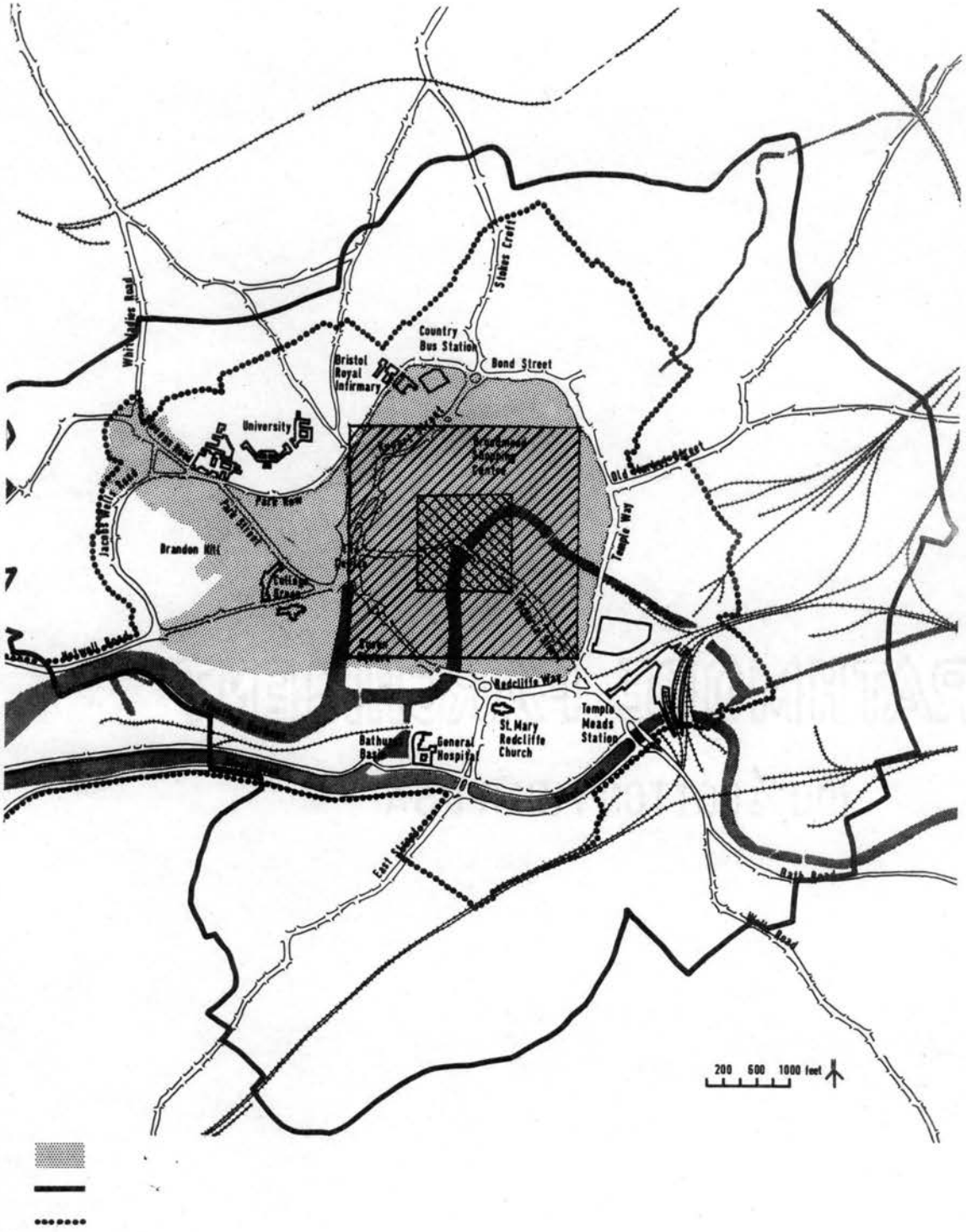
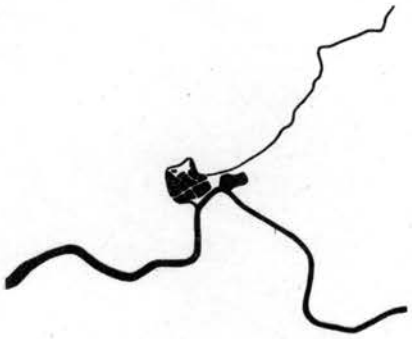
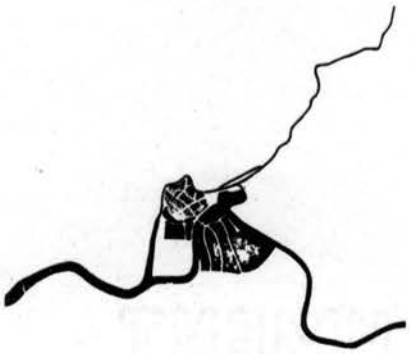


Fig. 1. Central Area Boundaries and Long Term Parking Demand in 2010 A.D.



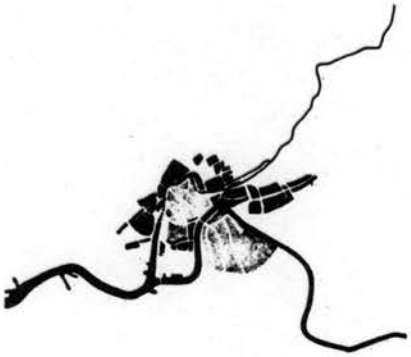
Norman settlement.

Extent of the urban area 1826.



Extent of the urban area circa 1350.

Buildings in the Central Survey Area destroyed during the war.



Extent of the urban area 1673.

Post-war redevelopment in the Central Survey Area.

Fig. 2. Historical Background of the City of Bristol, England.

after the destruction of the castle in 1656. During the 18th century many elegant houses were erected. In 1803, powers were obtained to divert the Avon River along a more southerly course and to convert the old course into a floating harbor connected with the tidal water by means of locks.

The boundaries of the city were extended in 1835. At this time the population had risen to approximately 110,000 which was an increase of 95,000 since 1600. Development continued on the outskirts of the city, which was later coupled with considerable urban renewal in the City Center Area. The activity continued until 1939; the slump of the 1920's and 1930's did not have such an adverse effect as in other parts of the country which were due to the diversity of industry in the city. The Second World War caused extensive damage to the center of the city; however, considerable development has taken place since the war.

Physical Conditions

One of the main determinants of development of the City Center has been the physical form of the land in which it is situated. It lies in the valleys of the Avon and Frome Rivers and has been tightly contained in the past both by the hills to the north and west, which rise sharply to heights of over 225 feet, and by the Avon River to the south.

The sharp contrast in relief has given rise to considerable communication problems. Many of the roads leading from the center are extremely steep and narrow; therefore, traffic is heavily concentrated on a few roads of suitable width, while the railway lines have to follow circuitous routes before reaching the terminus at Temple Meads. The river creates a considerable barrier to the north-south movement of traffic, since limited bridging points have been provided.

Communication

The many functions of the city as a regional center are, in part, a reflection of its position in relation to the region's communications network. In Bristol accessibility by road, rail, air and water is most favorable. It is favorably situated in relation to the proposed motorway pattern with the M4 from London to South Wales intersecting to the north of the city. (Figure 3).

The city is also represented in the national traffic movement through the docks and airport at Lulsgate, which operates domestic and European services.

In common with most large cities of England, Bristol has a ring-radials approach to the center at the present time. A new inner circuit road, approximately one-half mile in diameter, was also started before the war and is now almost completed as a ground level system. The roads between the main radials and within the inner circuit road in many places retain their original medieval alignments, a factor which is further complicated by the physical features of the center of the city.

Proposals

1. Survey: During June and July 1963, a comprehensive traffic survey was carried out in Bristol. The Survey consisted of two parts: a cordon Origin and Destination Traffic Survey and a Business Interview Survey. At the same time a survey was made of all on-street parking in the Central Survey Area. In February 1965, a pedestrian survey was conducted on selected routes on Monday to Friday between the hours of 8:00 A.M. - 10:00 A.M., 11:30 A.M. - 1:30 P.M. and 3:30 P.M. - 6:30 P.M.

2. Growth of Traffic: A major feature of post-war social and economic trends has been the rise in real incomes associated with higher

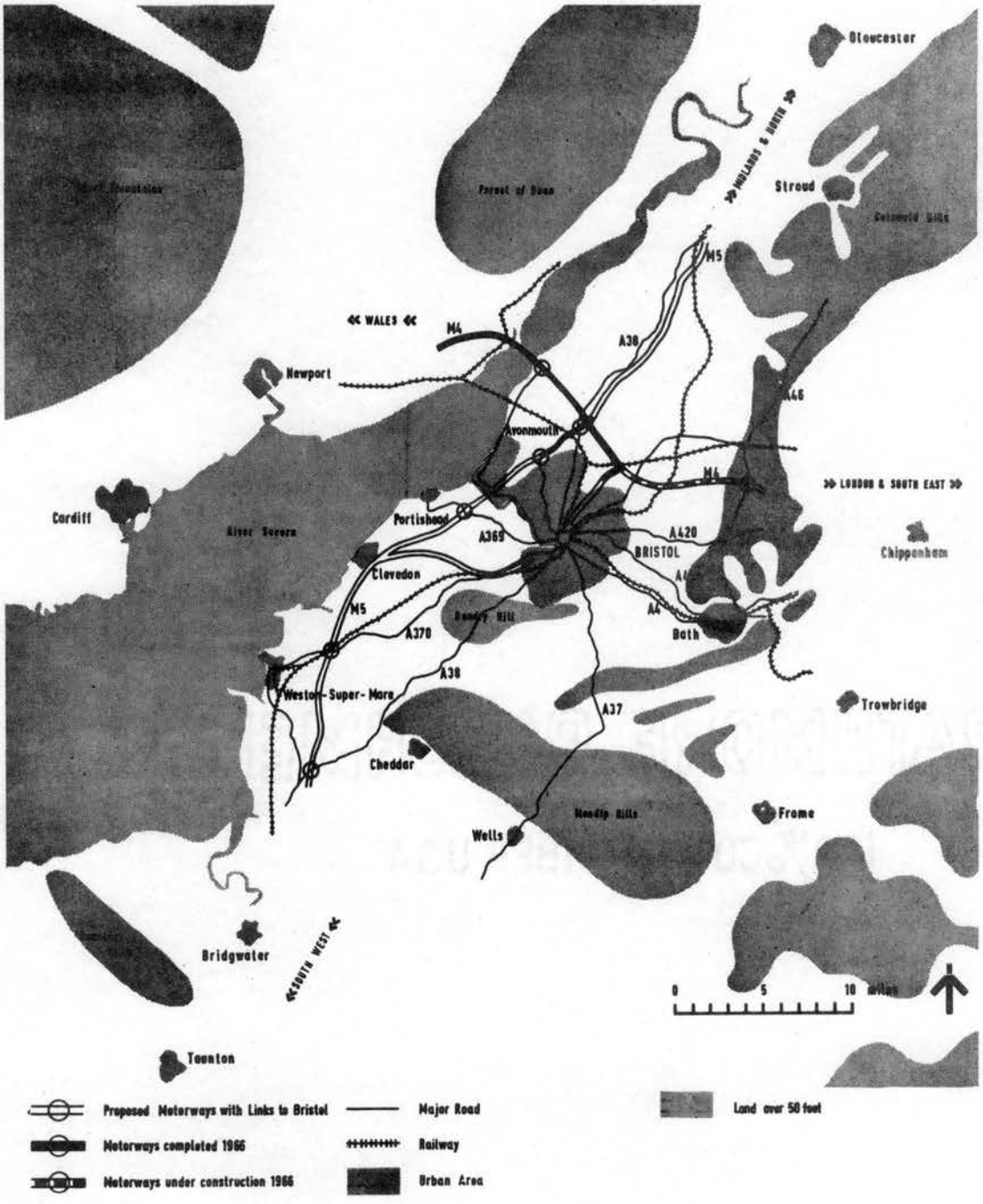


Fig. 3. Regional Communications and Urban Areas of Bristol, England.

living standards and increasing expenditure on durable consumer goods. Of particular importance has been the growth in ownership of private cars.

The number of private cars registered in Bristol between 1957 and 1965 rose from 24,127 to 76,830. During the same period the number of motor cycles doubled from 9,320 to 16,310. The number of buses and taxis dropped from 1,873 to 1,530 (Figure 4).

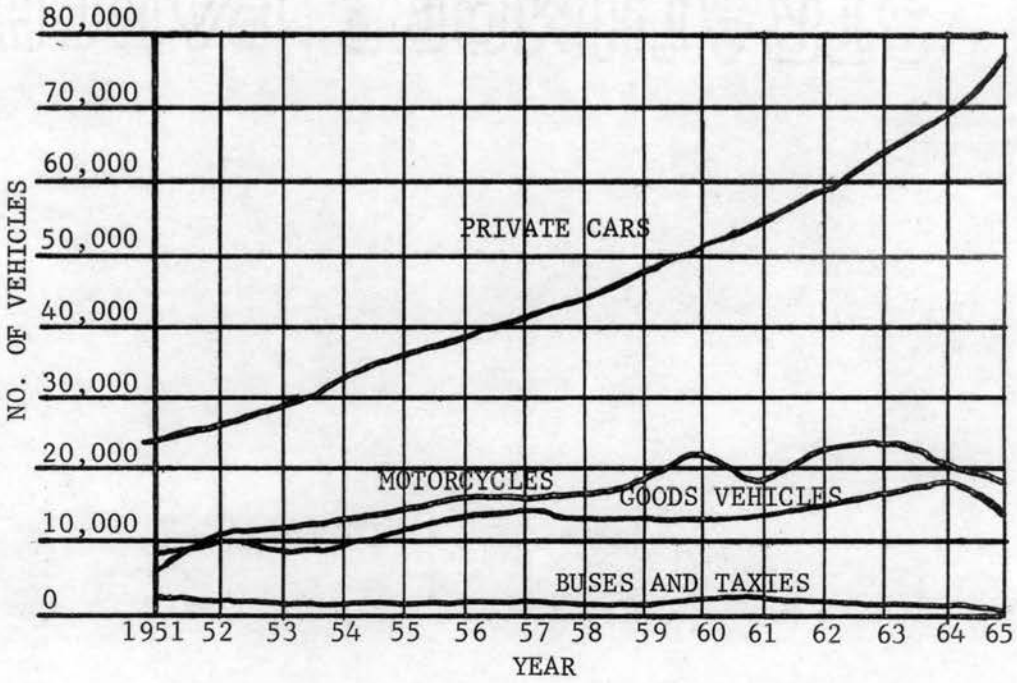


Fig. 4. Vehicle Registration in Bristol, 1951-1965.

3. Elements of Control: In preparing any long term plan, the Planning Authority has direct control over the two main elements which contribute towards the environment, namely land-use and traffic.

Land-use and building densities together have a direct influence on employment and traffic generation. Traffic can be controlled by two essential elements in the land-use patterns, roads and car parks.

Any policy on private transport must be matched by a complementary policy on public transport services. The expansion or concentration

of the public transport services will have marked effects upon the travel habits of the population and are thus very important factors.

4. Future Road Pattern: The proposed future road pattern has two categories of primary and district distributors. (See Figure 5.) The former roads are the main traffic routes, carrying local and long distance through traffic, while the latter act as the main distributors of local traffic in the areas bounded by primary roads.

5. Car Parking: Car parking will have a marked influence upon the effect of traffic in the city, and it must therefore form an integral part of any future balanced transportation plan. (See Figure 1.) When the saturation level of vehicle ownership is reached the majority of car parking spaces which can be provided within the Outer Circuit Road will be required for short term parking. Additional facilities will be needed for long term parking, and it seems that these will have to be sited at or beyond the Outer Circuit Road. Since such car parks will not be in easy walking distance of the City Center, it will be necessary to operate them in conjunction with special public transport services to carry car occupants to and from their destinations. In addition to the potentiality of these areas for the development of interchange centers, there for parking facilities to meet the demand from nearby residential, shopping and commercial uses. Further research on this subject will be required in order to assess the magnitude of demand for such car parks.

6. Public Transport Proposals: As the total number of employees in the Central Survey Area increases and available public facilities are largely taken up by essential business vehicle and short-term parkers, the numbers wishing to use public transport for the journey to work will increase accordingly. (See Figures 6 and 7.)

Fig. 5. The Proposed Future Road Pattern in the Central Survey Area.

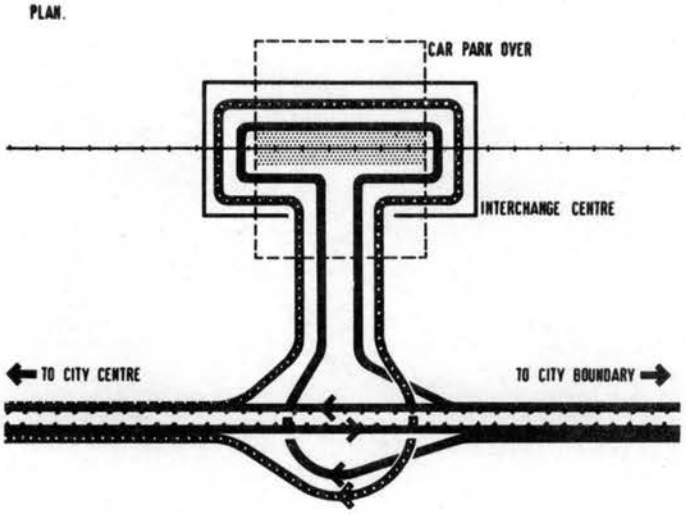


Fig. 6. A Diagrammatic Traffic Circulation Pattern of a Typical Transport Interchange Center.

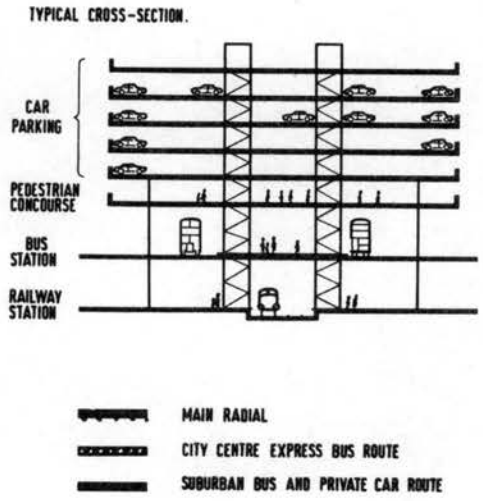


Fig. 7. A Cross-Section of a Typical Transport Interchange Center.

The proposed network is fundamentally a ring-radial pattern and is based on the interim plan prepared in 1961 (Figure 5). It is proposed that a new ring road should be constructed, and is to be known as the Outer Circuit Road. This will be approximately two miles in diameter and at a distance varying from the existing Inner Circuit Road, which will be retained as a primary distributor. Between these two rings, eight radial routes are planned, of which five are along existing roads and three are new roads. Only 49% of the total traffic crossing the cordon line use the existing main radials; the remaining traffic use alternative minor roads. The provisions of adequate primary routes are essential in enabling the efficient movement of traffic and in facilitating environmental improvement and protection. On construction of the Outer Circuit Road, long distance through traffic and cross city local traffic will no longer need to use the Inner Circuit Road, thus allowing it to fulfill its true function as a primary distributor for City Center traffic.

Ultimately all the radials will be designed to achieve a high capacity and maximum safety standards. At present, many of the main radial routes are operating at or near capacity in peak periods due to motorists by-passing congested main roads and junctions. This situation will deteriorate further unless a greater proportion of traffic can be attracted to the main radials.

With the rapid growth of vehicle ownership and usage, it is considered that the majority of these road proposals should be nearing completion by 1981 when it is estimated that traffic volumes in the city will have doubled.

7. City Center Proposals: The preceeding pages have outlined the policy proposals for a large area covering the center of the city. The

area covered is sufficiently wide for comprehensive transportation surveys and proposals to be made, unrestricted by central area boundaries based on only land-use division (Table I).

For specific study the City Center is divided up into eight study areas (Figure 8). Each Study Area is the subject of a separate map addition providing more detailed background information, enabling policies and proposals to be described in greater detail than is possible on the policy map alone.

The boundaries of the Study Area have been defined with regard to important physical features and land-use division and take particular account of both the existing and proposed character of the area contained.

Cumbernauld, Scotland: The New Town

> "The new town of Cumbernauld is the first radically new concept of a town we have since the Romans invented the Forum, the square, the circus and the straight roads that led into them."[1]

Cumbernauld is a new town designated by the Secretary of State for Scotland under the New Towns Act of 1946. Its principal objective is to make a major contribution towards the movement of population arising from Glasgow's "Operation Overspill". A total population of 70,000 is planned for Cumbernauld, at least four-fifths of which will come from Glasgow.

Cumbernauld is being built as a self contained town with its own factories, offices and shops and a full range of social, cultural and recreational facilities. The neighborhood system of planning has been

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[1] Lewis, Peter, Daily Mail, August 26, 1966, p. 6.

TABLE I

USE ZONE CHART FOR AREA ZONED FOR CENTRAL AREA USES

Land-Use	1 College Green & Canons Marsh	2 Park Street & Queen's Road	3 Fragmore Street & Colston Street	4 Lewins Meads	6 Wine Street & Tower Hill	7 Victoria Street	8 The City & Queen Sq.
Residential	X	E	E			X	E
Business Office		E	E	E	E		E
Business Shops		E	E		E		
Business Wholesale, Warehouse	E	X	XE	XE		E	XE
Public Bldgs.	E						
Industrial	XE	X	X	X	X	XE	X
Schools and Colleges	E	E	X	X	X		X
Remarks				Redevelopment Scheme has been proposed	Redevelopment Scheme has been proposed		

NOTE: X indicates uses for which permission will in general be refused.

E indicates the existing land-uses.

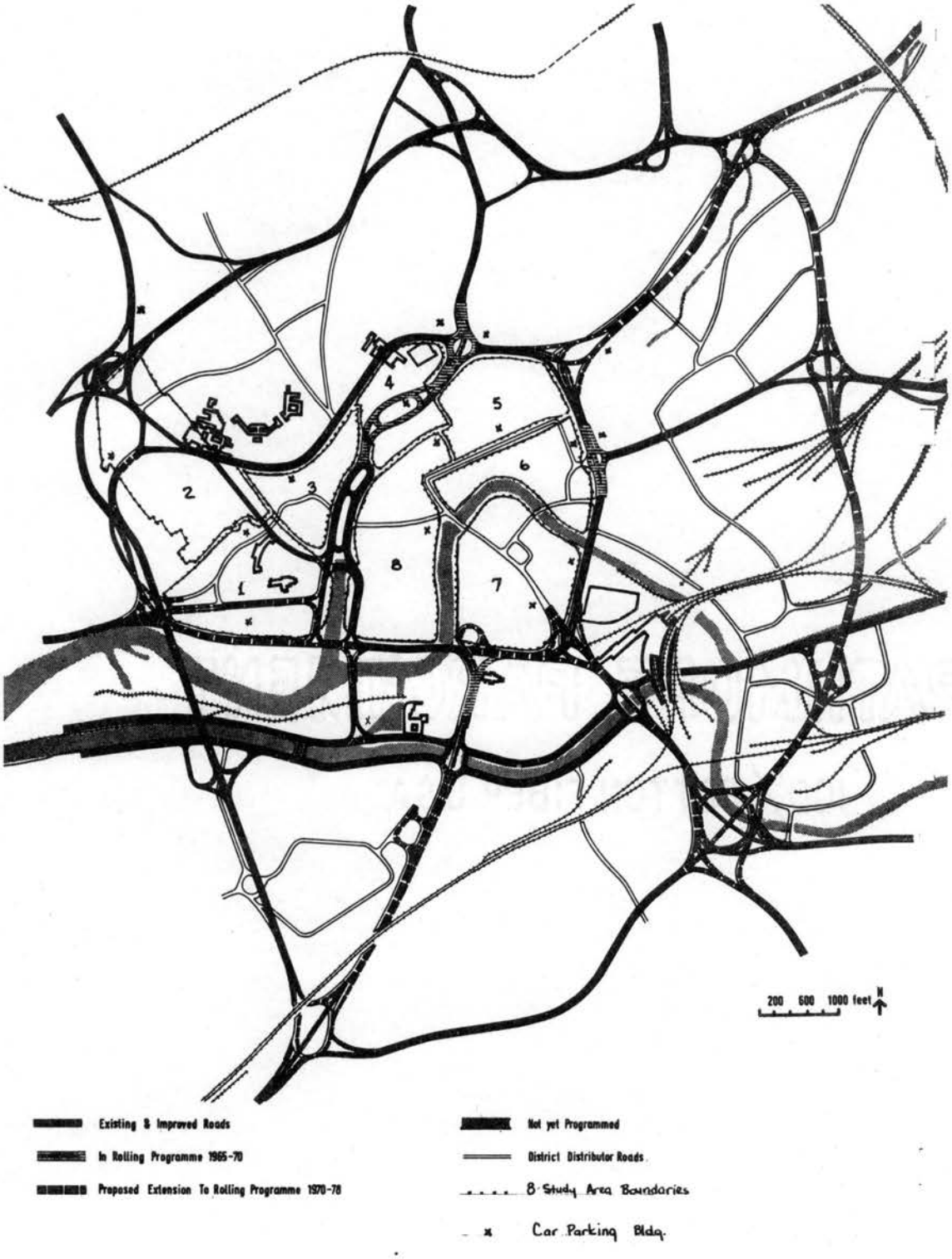

Fig. 8. Proposed Program of Road Construction and Eight Study Area Boundaries.

abandoned in favor of an integrated town in which dwellings are grouped loosely around the central area. The population, served by adequate main roads and separate pedestrian footpath system, will be within easy access of the major shopping, commercial, administrative and cultural buildings while being in close visual and physical contact with the surrounding countryside.

Cumbernauld is located in a central position in the narrow belt of Scotland. It is located within easy reach of three major airports (Figure 9). The site of the New Town comprises 4,150 acres; the main area, which is reserved building, is in the form of a broad hogsback approximately two and a half miles long and one mile wide. From much of this area there are magnificent views of the surrounding countryside (Figure 10).

Cumbernauld has been designed for the motor-age. The essential elements of the system are:

a. Pedestrian and vehicular routes are separated, and

b. There is a tier system of roads of different standards serving different functions.

The main development of the town for 50,000 people is being concentrated around a comprehensive urban center. This is a pedestrian shopping center, a person on foot will use the lowest levels only on his way between car or bus and escalators, ramp or lift. All the floors above are for the exclusive use of pedestrians. The whole area in turn is surrounded by recreation areas. The remaining 20,000 population will be accomodated in four adjoining villages linked to the main development by an efficient road and footpath system, but separated from it by recreation areas, open space and woodland. Garages and parking spaces

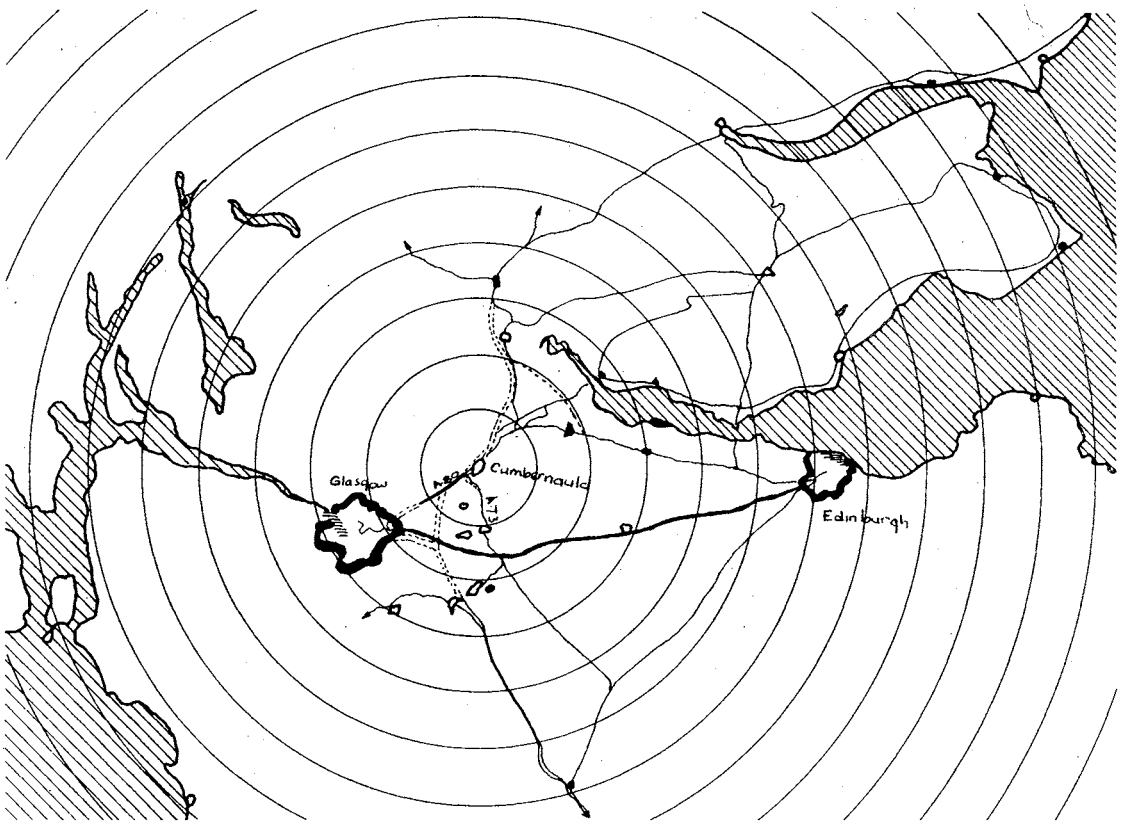

Fig. 9. Regional Plan of Cumbernauld, Scotland.

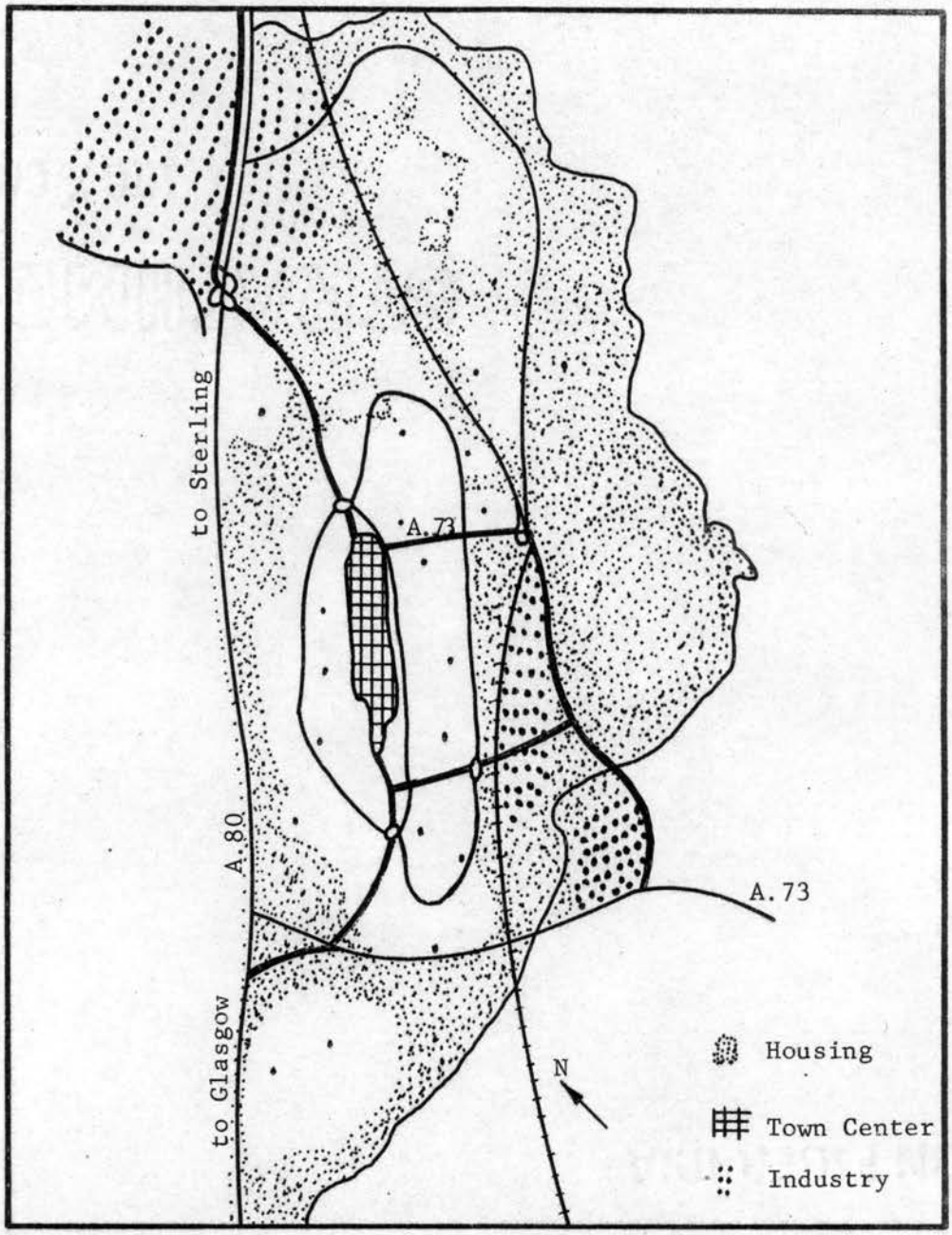

Fig. 10. Basic Plan of Cumbernauld: New Town.

are being provided on the presumption that there will be at least one car per family by 1975. The main junctions have been designed on a two level basis to minimize delay.

In Cumbernauld the majority of the people will be within easy walking distance of the center, but local shopping needs are also cared for in the form of individual shops throughout the residential areas on the basis of one shop to approximately 300 houses. The housing development at Cumbernauld covers a wide range of design depending on the site levels and such matters as views and sunlighting standards. All schemes are based on the maximum separation of pedestrian and vehicles so that there is a safe access to the primary schools and the local shops and other facilities. Sites are also set aside for houses to be built for owner occupation.

The initial construction of Cumbernauld consisted of laying out the roads in skeleton form; traffic planning forms an integral part of the planning of the town. The future development of Cumbernauld is assured by a sixty-year government grant. Hence, the present population of 20,000 will expand to the desired optimum of 70,000. Cumernauld is an excellent example of a logical self-supporting town layout planned as a whole, not patched together after the houses were built.

CHAPTER II

STILLWATER, OKLAHOMA

Existing Stillwater

Historical Background

Stillwater, the county seat and approximate geographical center of Payne County, is located in North Central Oklahoma. The Oklahoma Lands, in which Stillwater is situated, were first opened for settlement on April 22, 1889. The initial Stillwater settlement covered 240 acres.

According to the 1890 Census, Stillwater had a population of 569 with 158 residential buildings, 58 frame buildings and 21 wells. On April 7, 1891, Stillwater citizens voted unanimously to incorporate the town. The elected officials' second recorded action was to propose a 10,000 dollar bond issue to aid in the construction of an Agricultural and Mechanical College. The proposal passed unanimously, and by 1892 seventy-six students were enrolled. During 1894, Old Central, the first college building, was erected.

Physical Factors Affecting Development

The area covered by the city of Stillwater consists of a series of north-south ridges and valleys with a slope not exceeding 20%. The termination point of these ridges is at the Stillwater Creek to the south of the city.

Population

In less than 80 years, Stillwater's population has grown to about 27,000 (as of 1966) and enrollment in the college (since renamed Oklahoma State University) to 16,000 students.

The table below shows past and projected population growth for Stillwater.

TABLE II

POPULATION GROWTH - STILLWATER, OKLAHOMA[2]

Year	Total Population
1940	10,097
1950	20,238
1960	23,965
1965	27,315
1966	27,880
1967	28,445
1968	29,010
1969	29,575
1985	61,171

The age distribution of the Stillwater population is such that 50% of the population is under 21 years of age, and this proportion is expected to remain the same for the next 10 years. The median age of the population at the time of the 1960 census was 22.6 years.

According to the population density map of Stillwater, the highest population density is found adjacent to the campus of Oklahoma State University. This density has a direct effect on overcrowded living conditions, inadequate parking, overloading of existing utilities and

[2]City of Stillwater Community Renewal Program, Stillwater, 1963.

traffic congestion. The projected family income distribution for Stillwater is shown in Figure 11.

The percentage of families with incomes of less than 4,000 dollars is expected to decrease by one third over the next five years. The forecast also shows that the percentage of families with 7,000 dollars annual income will increase by 34% in the same time period. Consequently, this group will represent almost 48% of the total number of families in Stillwater.

The five factors constituting the economic base of Stillwater are:

1. Oklahoma State University
2. Personal Services
3. Retail Trade
4. Entertainment and Recreational Services
5. County Government

Existing Land-Use

In Stillwater, land use for so-called "public purposes"--airport, parks, streets and alleys--covers 70% of the whole urban area. The remaining 29% of the developed land is devoted to private ownership.

Unlike most cities in the state of Oklahoma, Stillwater houses approximately 58% of its population or 13,500 persons in residential structures other than single family dwellings. The highly populated university campus area, bounded by Main Street to the east, McGeorge to the north, Walnut Street to the west and Sixth Street to the south, houses a total of 7,665 persons. An additional 5,480 persons reside in campus housing provided by Oklahoma State University in the area described above. Stillwater devotes 25.6% of its developed land for residential, 1.8% for commercial and 1.1% for industrial purposes.

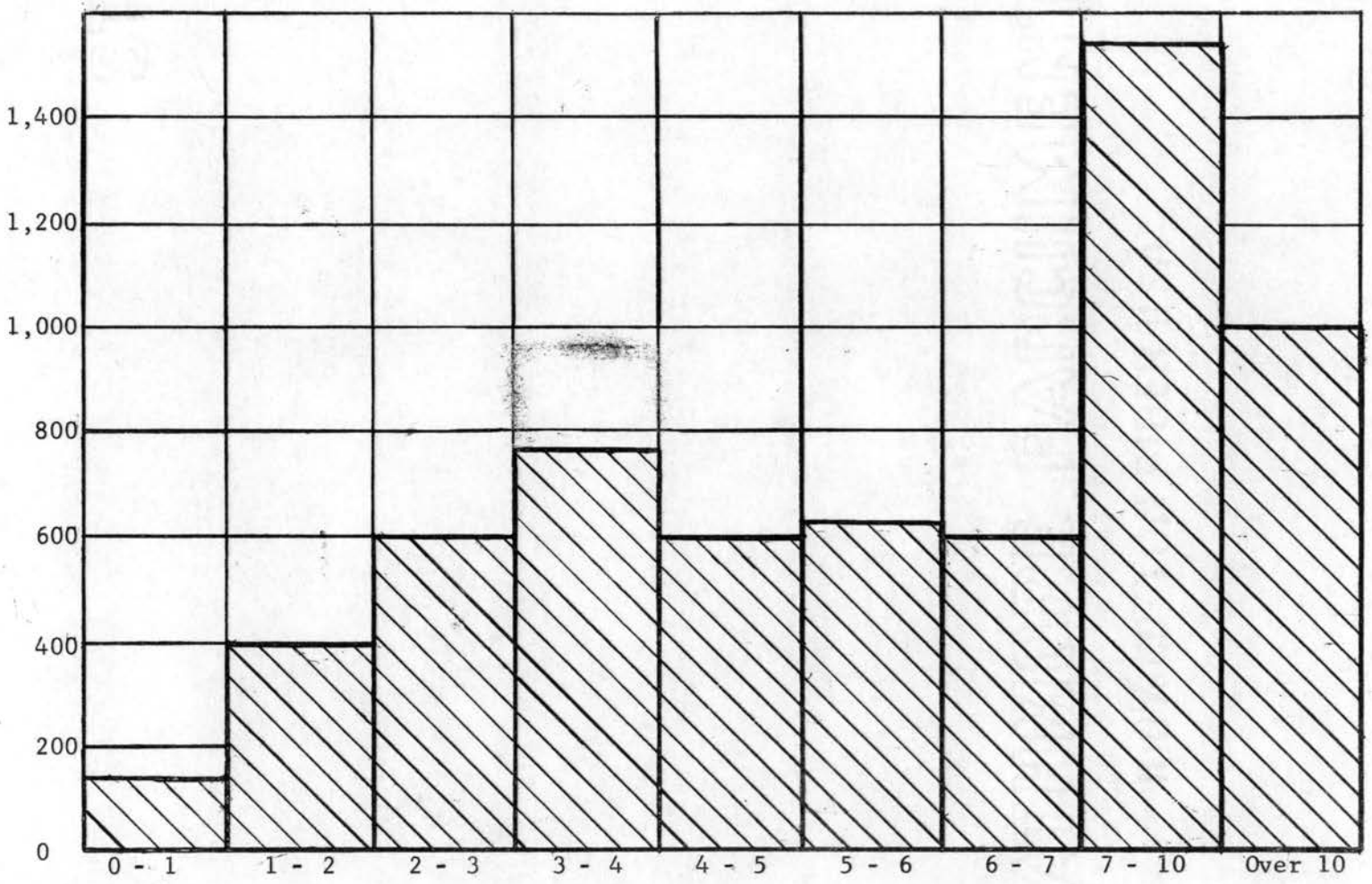

Fig. 11. Annual Family Income[3] (Thousands of Dollars).

[3] City of Stillwater Community Renewal Program, Stillwater, 1963.

The pattern of the existing commercial use of land is strip commercial development, most of which may be found extanding in all four directions from the central business district, and on Washington and Knoblock Streets. The latter two areas are due mainly to the proximity of the university.

A study made in Stillwater[4] between 1954 and 1960 shows that 84% of the construction and remodeling of commercial buildings took place in areas outside the down town area. This pattern of development is robbing the downtown area of the very stimulus needed to solve the problems with which it is faced. Two major problems facing the central business district of Stillwater are traffic congestion and inadequate off-street parking.

Existing Circulation

Stillwater has developed a gridiron street system. This street pattern existed throughout history as a satisfactory method of providing access and communication until the era of mass automobile ownership.

According to the Stillwater Comprehensive Plan,[5] the gridiron street system has become the least satisfactory pattern of streets a community can develop, for the following reasons:

1. The accident frequency is five times greater at a four-way intersection than at a three-way or tee intersection.
2. The gridiron street system is the least economical pattern of streets a community may employ. While an average gridiron system would devote about 33% of the land area to

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[4] Metropolitan Comprehensive Plan, Stillwater, Oklahoma, 1961, p.22.

[5] Ibid, pp. 24, 26.

streets and alleys, the Stillwater downtown area devotes much more, 44%.

Barriers to Development

The City Planning Office has pointed out that in almost every community certain factors exist, which by their dominant nature, will tend to halt the growth of the community in certain directions. In the case of Stillwater these factors are:

1. The barriers established to the west by publicly owned land.
2. The barrier established to the northwest by the hazard areas of the airport approach zone.
3. The barrier established to the west and north by the Sanitary Sewer System.

The previous pages have summarized the existing situation of Stillwater and the basic facts and principles upon which the proposals of the 1961 Stillwater Comprehensive Report were based. The next section presents a summary of the proposals themselves as contained in the Metropolitan Comprehensive Plan of Stillwater.

Proposed Stillwater

Land-Use

Land use proposals in the Comprehensive Plan for the city of Stillwater are made in three functional groups:

1. Residential Areas - The following space and location requirement studies have been made:

TABLE III

RESIDENTIAL SPACE REQUIREMENTS[6]

	(1960) Existing	Net Growth	Total 1985
Population	23,965	37,206	61,171[5]
Residential Area (in Acres)	1,235	1,815	3,150

The above table shows required land increases; however, 25% of this area will be used for streets and alleys, 10-20% for vacant land use, and approximately 6% for schools and playgrounds, churches and shopping centers. Taking these factors into account, it is necessary to plan for residential areas to occupy an additional five and one-half square miles over existing land use by 1985.

TABLE IV

MAXIMUM RECOMMENDED RESIDENTIAL DENSITY STANDARDS[7]

Type of Residential Structure	Minimum Net Lot Area Per Family (Sq. Feet)		
	Low Density	Medium Density	High Density
One-Family Unit	21,000	10,000	6,000
Two-Family Unit	5,000	4,250	3,500
Multi-Family Unit	3,000	2,600	2,200

It is intended that the residential areas of Stillwater should be developed as a series of neighborhood units wherever possible. To be

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[6] Metropolitan Comprehensive Plan, Stillwater, Oklahoma, 1961.

[7] Same ratio (39%) used in estimating both Population and Residential.

[7] Metropolitan Comprehensive Plan, Stillwater, Oklahoma, 1961.

able to create and maintain a healthy, safe and satisfactory environment, the four elements shown below should be taken in consideration:

a) A centrally located elementary school,

b) A centrally located playground,

c) A functional street system, and

d) Shopping areas located at the edge of each neighborhood.

2. Commercial Areas - Four major types of commercial areas are envisaged.

a) Central Business District,

b) Shopping Centers,

c) Medical Center Area, and

d) Open Display Commercial Area.

3. Industrial Areas - Planners are starting to give more attention to planned industrial districts to provide space for expanding industrial activity. Studies of industrial parks across the United States indicate that most districts have tracts of land of less than 500 acres, the average being near 450 acres. Using this average as a guide, a new area of approximately 320 acres in the northeast quadrant of Stillwater is indicated on the Comprehensive Plan for industrial uses. In addition, an area north of this portion was designated for possible future expansion.

Major Thoroughfare Plan

According to the Metropolitan Comprehensive Plan Report, the planning of major thoroughfares in an urban area must be based on the land use plan for the community. First, the future land use of an area will determine the amount of traffic in goods and people for which transportation will be necessary. Second, the provision of adequate major

streets will be one of the largest financial obligations the city will be required to meet. (See Figure 12,)

The objectives of the plan are the following:

1. Logical development of the city in accordance with the land use plan.
2. Safe and efficient movement of traffic within and through the urban area.
3. Most economical expenditure of public funds.

Development of the city in accordance with the land use plan requires the five following principles:

1. That the major thoroughfare plan provide for the safe and efficient movement of people and goods through the urban area.
2. That major traffic-carrying streets connect the central business district with all other functional areas of the city.
3. That the major thoroughfare system provide the basic framework for the various elements of the community, places for living, working and leisure time.
4. That neighborhoods, elementary schools and neighborhood playgrounds be protected from through traffic.
5. That the major traffic ways for the city be tied to the overall highway development plans for the region and state.

Traffic Circulation System

1. East-West By-Pass Route - It is proposed that a by-pass route on the south side of Stillwater, by Stillwater Creek, be developed to connect the East Tulsa Metropolitan Area to Inter-State Highway 35 in the west. (See Appendix B for all Stillwater Maps.)

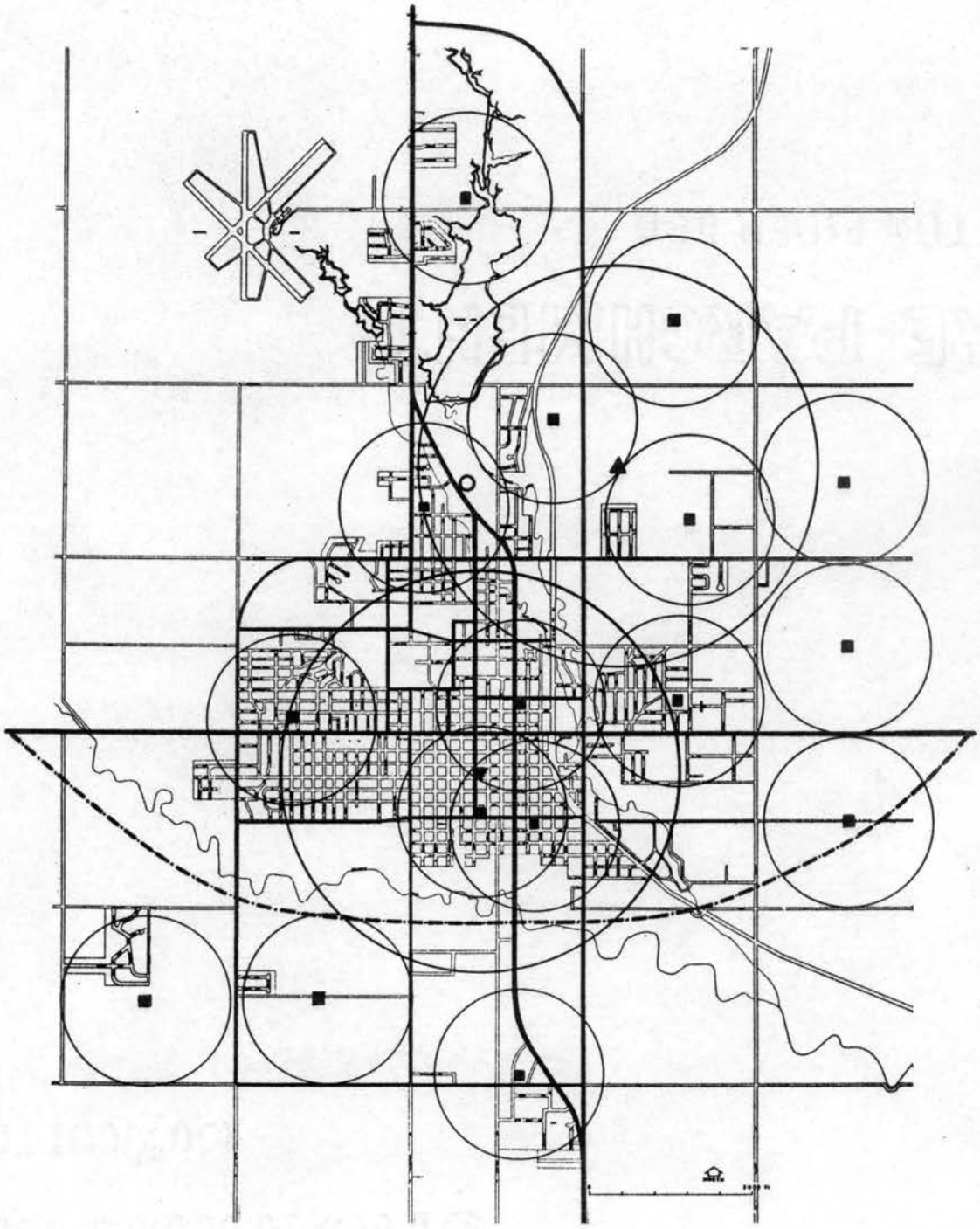

Fig. 12. Major Thoroughfare and Educational Facilities, Plan of Stillwater.

2. Primary Thoroughfares -

a) State Highway 51 - The existing Highway 51 is expected to meet future needs adequately.

b) State Highway 40 - According to the Comprehensive Plan, this highway has been over-used. Hence, provisions will be made to ensure that in the future it will serve only urban areas. The alternative route should be developed to serve through, commercial and industrial traffic.

c) Perkins Road - It is anticipated that the complete development of Perkins Road as a primary thoroughfare between its departure from State Highway 40 south of Stillwater, to an intersection with State Highway 40 in the north, south of the Municipal Golf Course, will take place. In this manner, north-south through traffic needs will be answered.

d) Duck Street - According to the Comprehensive Plan, Duck Street should be used as a primary thoroughfare between Twelfth Street and State Highway 40. Thus, the east side of the Oklahoma State University campus will be connected to the west side of the Central Business District.

e) Washington Street - Between State Highway 40 in the north and Farm Road in the south, Washington Street should be developed as a primary thoroughfare to serve the function of bringing traffic from the north into Oklahoma State University area.

f) Twelfth Street - Twelfth Street between Perkins Road and Duck Street should be developed as a primary thoroughfare to serve the function of connecting the major north-south primary thoroughfares.

The remainder of the major streets have been classified as secondary thoroughfares. Secondary thoroughfares serve to connect all functional areas of the city to all other parts, and will provide loops around certain portions of these areas.

CHAPTER III

METHOD AND PROCEDURES

Comparative Study

The previous three chapters have described the existing situation in three cities and the proposals of the respective City Planning Authorities. The next section will summarize the considerations to be taken into account in developing proposals for Stillwater.

As was seen in the detailed description, each of the cities was characterized by a different population composition with respect to age, employment and other factors. During their early development and later evolution, historical and physical characteristics played a pertinent role in guiding the growth of the cities. However, the common denominator was the attempt to answer the needs of their citizens sufficiently, a need which becomes more complex as the pace of the technological change accelerates. During this process, serious problems were encountered; for example, each city was forced to find a means of dealing with mass automobile ownership. At the same time, they had to supply more efficient and pleasant circulation patterns for an urbanized, mobile society.

Even if the purpose of action was the same for each city, it was impossible for them to use the same tools and processes. They had to make an extensive study of a number of characteristics of their

respective cities. At this point, a comparison of the three main characteristics of the cities may be drawn.

1. Historical Characteristics
2. Physical Characteristics
3. Sociological Characteristics

Historical Characteristics

1. Bristol, England - As far as may be ascertained from the inadequate records which have survived, the first settlement occurred in the center of Bristol during Saxon times. In 1373, Bristol became a chartered town. This date gives an assurance that the city of Bristol has been in existence as a city for at least six centuries. Naturally, this long history left distinct marks on the city. The city at present possesses the characteristics of modernization and extension of a medieval town.

Historically conscious citizens of Bristol have treasured those remains with a great pride. They have found the remains to be a true reflection of their city's past, and to provide a continuity which made them feel that Bristol would be a good place in which to live in the future.

However, if these same remains are regarded from the planner's point of view, it may seem that the remains of the medieval town left behind disadvantages in the form of narrow and steep medieval streets in the middle of the town. However, these disadvantages were successfully turned into good effects in the hands of able city planners, who used the center as a basis for developing a radio-centric pattern for Bristol. The radio-centric pattern is one of the more workable forms that a city assume in dealing with the transportation needs of the 20th century city.

2. Cumbernauld, Scotland - the reader may initially ask himself "how can a city that is still in the process of completion be discussed under the heading of historical characteristics?" However, to the author, Cumbernauld is the city of both history and future. Despite this, it is called a new town and was created by The Town Planning Act of 1946. Designers of this town were far-sighted enough to study the advantages and disadvantages of historical settlements, and were aware of the needs of people of our time, and how these needs were likely to change in the future. The thorough study which was undertaken leads the author to feel that the city will be most successful.

3. Stillwater, Oklahoma - The city was officially founded at the time when the Oklahoma lands were opened for settlement. Becoming an incorporated town by 1891, Stillwater was laid out for the days of the horse and buggy, with gridiron street pattern. It was after the founding of Oklahoma Agricultural and Mechanical College in 1892, that the town started to take on the character that now exists.

Physical Characteristics

1. Bristol, England - As was mentioned previously, one of the major determinants of the development of the City Center has been the physical form of the land on which it is situated. The city of Bristol lies in the valleys of the Avon and Frome Rivers. The sharp change of elevation in the center of the town has presented considerable transportation problems. Part of the river in the central area has been covered. However, even with the technological advances of our time, the river has still created great problems for further vertical development in the area. Additional consideration has to be given to the barrier on the west side of the city, which is bordered by the Avon Gorge.

2. Cumbernauld, Scotland - Cumbernauld is a planned city that has made the best use of existing physical characteristics. The city covers a long hilltop and two sloping sides of this hill. The Central Business District is located on the hilltop in a compact building. The rest of the area is being left for well-planned residential areas, with extensive surrounding green space.

It is evident that during the process of planning, physical characteristics have been taken as one of the important initial factors and the plan has been developed accordingly.

3. Stillwater, Oklahoma - The area covered by the city of Stillwater consists of a series of north-south direction ridges which terminate at Stillwater Creek with slopes not exceeding 20%. The area is also characterized by various sizes and shapes of water resources, which create occasional flooding, especially on the south side of the city.

Sociological Characteristics

1. Bristol, England - Bristol is the seventh largest city in England and Wales with almost half a million population. Located within an easy reach of the main traffic routes of England and containing well developed small and large industries, Bristol is a self-contained metropolitan city.

2. Cumbernauld, Scotland - Cumbernauld, as was explained earlier, is a population over-spill for Glasgow. It lies within 15 miles of Glasgow, centrally located within the three largest cities of Scotland. The population is expected to reach 70,000, but at present, only 20,000 persons reside in the town. With a number of industries already

established, it is planned to be a dynamic, self-supporting town of the 20th century.

3. Stillwater, Oklahoma - The 1965 census placed the city's population at 27,315. Over half of this total pupulation consists of the enrollment at Oklahoma State University, the main source of economic growth and well being of Stillwater. Stillwater is located in easy reach of the two metropolitan areas of the state of Oklahoma, Tulsa and Oklahoma City. In the fullest sense of the description, Stillwater is an educational town.

Figure 13 illustrates how the city's population growth has paralleled the growth of enrollment at OSU. The age composition of the city is such that the median age according to the 1960 census was 22.6 years, and this median age was not expected to exceed 25 years by the year 1985.

The above facts clearly indicate that Stillwater posses sociological characteristics distinctly different from the average city of its size. With very high mobility, it is a transit town for a young population with an age range of 18-25.

Comparison

As a result of this brief summary, it may be seen that in each of these three cities one of the three aforementioned characteristics has been weighted heavier than the others in determining the course of future evolution. In the case of Bristol, historical characteristics predominated; whereas, in Cumbernauld, physical characteristics played the most important part in shaping the city. The author feels that sociological characteristics should be the foremost consideration in the

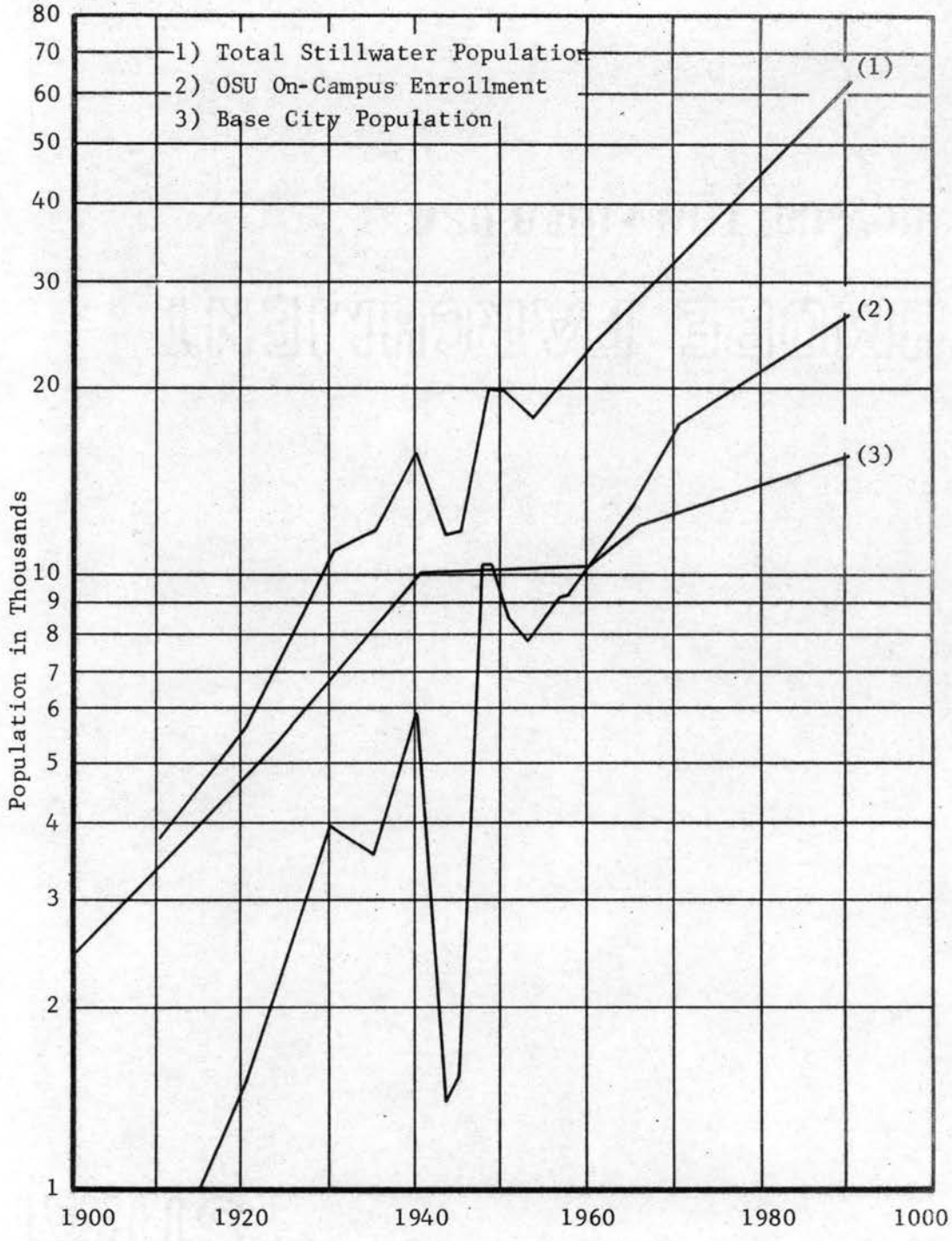

Fig. 13. Population Growth Pattern of Stillwater.

formation of proposals for the city of Stillwater. Nevertheless, it can be concluded that Stillwater possesses certain similarities and dissimilarities to these two above mentioned British cities.

There exist certain similarities between Stillwater and Bristol due to the fact that they both present an existing city characteristics with developed circulation patterns and travel habits of their citizens. However, they differ in their population composition that will have a marked effect on their need of public facilities.

With a design population of 70,000, Cumbernauld, although a new town, possesses some similarities to Stillwater--size, area, and population--in the regional settlement pattern. Both of these cities are located in easy reach of the metropolitan areas of their respective regions. Due to the fact that Stillwater is not as highly developed as Bristol, some techniques which have been used in Cumbernauld related to better use of physical features may be simularly applied beneficially to new developing areas of Stillwater. This will result in better utilization of natural features in Stillwater. However, considering the state of existing development in the central part of Stillwater, the use of high density or compact design found in the CBD of Cumbernauld would be questionable.

Therefore, it can be stated that: first, Stillwater can approach a solution of its problems found in the central areas in a somewhat similar manner as that of Bristol by basing the proposals on the valid patterns which exist and are worth preserving or strengthening, but at a different scale. Secondly, Stillwater can control its growth, create a stronger internal physical structure, strengthen its community interaction, and react functionally to its strong ties with the metropolitan

areas of the region by following certain techniques used in Cumbernauld, Scotland. The proposals in the next chapter have been made bearing these thoughts in mind.

Method Used

As the studies show, Stillwater's present population status is largely due to Oklahoma State University. Stillwater is predominantly an educational town, located within easy reach of the two metropolitan areas of the state of Oklahoma. Again, due to the location of the university, there are certain high concentration areas of population in the city. The graph on page 37 shows the correlation between total population and enrollment at OSU in the past and the future. These figures are clear enough evidence that Stillwater is and has been an educational town.

The most important step to take now is to show how this character of Stillwater as an educational town can be emphasized, and how the city can be improved by making it a more livable town, without any loss of character.

Area Covered

The city of Stillwater covers 4,824.3 acres, with north-south direction ridges. These ridges, which do not exceed a 20% slope, terminate in the south part of the city, at the Stillwater Creek channels.

The barriers to development of the city can be summarized in three areas: 1) the airport hazard areas in the northwest, 2) the publicly owned land in the west, and 3) the existing Sanitary Sewer System to the west and south. In addition to these barriers, great consideration must be given to drainage channels of the city as barriers; otherwise

repeating floods that periodically cause great damage will continue to be a threat. These areas could easily be turned into attractive leisure time areas for the city.

Population

Total population of the city of Stillwater in 1967 is approximately 28,445 with about 16,000 students. Expected population for the year of 1989 is 65,000 and almost 25,000 of this population would consist of students enrolled in the university. The enrollment projection for the university is illustrated in Table V.

TABLE V

ENROLLMENT PROJECTION AT OSU[8]

Year	Total OSU Enrollment
1960-1961	10,854
1964-1965	13,150
1970-1971	17,600
1980-1981	22,000
1990-1991	27,000

Origin and Destination Studies

The results of the Origin and Destination Studies are extremely important factors, forming the factual base for circulation planning and forecasting.

According to Clarkson H. Oglisby and Lawrence I. Hewes,[9] certain groups of data are fundamental for integral highway planning. They

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[8]Data obtained by Architecture 539 Class from Oklahoma State University Administration, 1965.

[9]Clarkson H. Oglisby and Lawrence I. Hewes, Highway Engineering, Revised Edition, 1963, pp. 189-191.

fall into several classes:

1. Road inventory,
2. Rural traffic surveys,
3. Urban travel studies,
4. Highway financing,
5. Vehicle ownership and use, and
6. Special studies.

Origin and destination studies which would rank between rural traffic surveys and urban travel studies, could be handled several ways, of which are shown below:

1. External-cordon home-interview O-D studies,
2. External-cordon O-D studies,
3. External-internal cordon O-D studies, and
4. Post card O-D studies.

The Stillwater O-D survey, which was conducted by the Planning Division of the Oklahoma Department of Highways in conjection with the United States Bureau of Public Roads during the summer of 1963, was an external-internal cordon O-D study according to the above classification.

To provide the necessary data, Stillwater was divided into five major zones, and these zones were divided into sub-zones. Interview stations, which were operated during a 16 hour period per normal day from 6:00 a.m. to 10:00 p.m., were set up on routes radiating from the survey area to external points. (See Figure 14.)

Data was obtained by automatic traffic recorders, which were located at the interview stations for a period of one week. From this data the volumes of trips have been adjusted to represent the total traffic during an average day of the year. From a summary of the data,

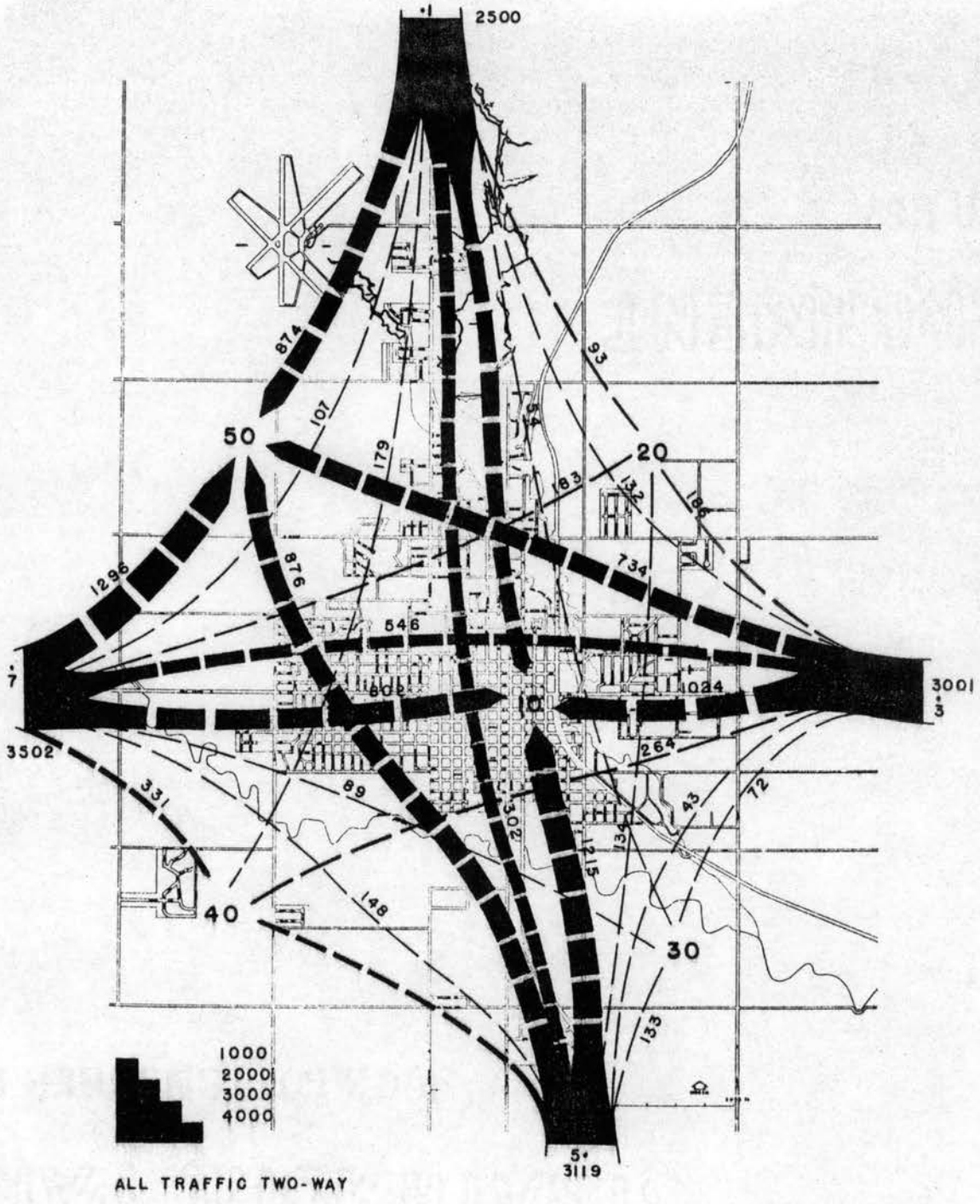

Fig. 14. Results of Origin and Destination Survey, 1963.

as indicated by the publication, the following may be concluded:

1. The interviews obtained the origin and destination of each vehicle, as well as other trip data, for 12,202 vehicle movements.
2. Of these 12,202 vehicle movements 19.71% were passenger cars, pickups and panel trucks; 5.7% were medium trucks; and 2.5% were heavy trucks.
3. Local vehicle movements comprised the 78.94% of the total vehicle movements recorded.
4. Local trips were composed of 93.51% passenger cars, 5.45% medium size trucks and 1.04% heavy trucks.
5. Of the total local traffic, 39.3% was destinated for, or originated from the central area.
6. Of the total vehicle movements, 21.06% were recorded as through traffic.
7. Of the total 2,570 vehicle movements classified as through trips, 40.78% were recorded on State Highway 40 and 59.22% were recorded on State Highway 51.
8. For passenger cars, the average vehicle occupancy for all stations was 2.11 persons per vehicle.

As is mentioned above, the O-D survey was done in the summer of 1963, and this caused the formation of misleading information due to the population composition of the city. Usually the population movement slows down during the summer months because of the vacationing of a large number of students, employees and faculty. However, further studies were done during January and April of 1965 and October of 1966, which gave unbiased results. As a result of these studies, it was found

that the destination of through traffic was higher in the east-west direction than in the north-south direction, the ratio being almost 2:1.

After obtaining general information from these counts, with the aid of simple arithmetic and practical knowledge, the heavy traffic generating areas may be determined, and the overall pattern of traffic circulation entering and leaving, as well as within the city, may be exposed. To be able to use this data effectively, the city has had to make further studies of the streets. Also, projection of these counts to 1989 is necessary to be able to check the efficiency of the existing roads for the given future date. This information is utilized in Chapter V to develop the author's suggestions for Stillwater. (Appendix A illustrates more detailed use of the results of Origin and Destination Studies.)

CHAPTER IV

CITY OF STILLWATER, 1989

For the purpose of testing the principle it would be useful to analyze studies of the city of Stillwater being prepared by the Urban Design class of the School of Architecture, Oklahoma State University, during the spring semester, 1967. In these studies it has been assumed that an optimum enrollment at OSU will be reached by 1989. Therefore, population growth of the city of Stillwater, which historically has been closely related to enrollment at Oklahoma State University, may have a tendency to stabilize at this stage, unless there is a major change in growth patterns and industrial development in the central region between Oklahoma City and Tulsa.

Having collected the data, the teams formulated two hypotheses. The first by Team 10, was that a proposed turnpike, which is to connect Interstate Highway 35 with the Tulsa Metropolitan Area, will pass five miles north of Stillwater. This team assumed that the enrollment at OSU will reach 25,000 in 1989 and the population of the city will show the characteristics of stability at 65,000 persons.

The second by Team 20, assumed that a proposed SST will be built in the vicinity of Cushing and that the proposed Central Oklahoma Waterway System will be completed with the result that highly developed industry is expected to locate in the central region around these installations. The direct effect of this industrial area and its expansion is

expected to be seen in Stillwater. With this development, it is stated that by the 1989 period the university enrollment will reach 30,000 students, but with a possible rapid transit system connection to the SST/ industrial area the city's population should continue to grow beyond 1989 to a possible maximum of 120,000 persons (Figure 15). A second assumption included a more northerly location of the Tulsa-I-35 turnpike with a diagonal connection to Stillwater from the northeast. This pattern would result in a further need to improve Highway 51 from the west side of Stillwater to I-35 in addition to the southeast link with the industrial area.

Following a summary of these studies, the author will give her proposals for Stillwater based on a study period ending in 1989.

Team 10

This team further based their hypothesis on the desirability of the continuous development of every inhibitant's opportunity to participate through community interaction of people and elements (cultural, natural, educational, commercial, and so forth).

The results of their study showed that the city of Stillwater will need to provide housing for 52,500 persons in the year 1989, including high density or multi-family dwellings near the prime activity areas. The university, continuing as the primary employer, will create the need for more service occupations. Growth of the university may also encourage growth of light industry related to research programs. Projections indicated that the university will double in size by 1989. Further studies indicated that high school enrollment will fall between 2100 and 2400 students. This resulted in the decision to retain one high school,

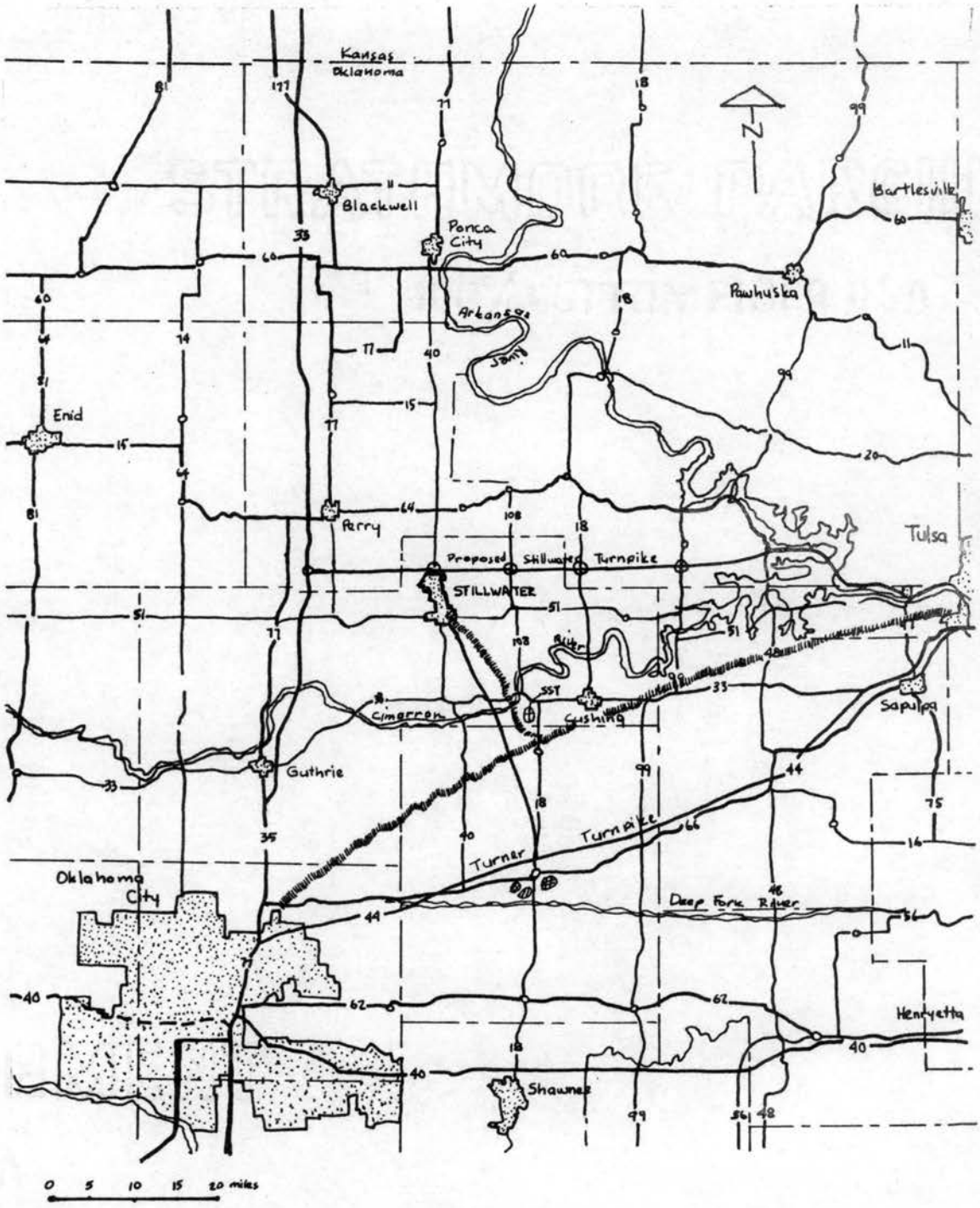

Fig. 15. Regional Plan of Stillwater, Oklahoma.

which would be serviced by two middle schools and one lower school for each of the neighborhoods. This can be accomplished by providing expanding facilities at existing locations and/or new facilities in growth areas. In addition to this, it is also pointed out that Stillwater needs to give more attention to its community and cultural facilities by placing certain activities in locations independent of OSU's campus. Finally, Stillwater's natural land features offer potential for developing desirable recreation areas.

In the case of shopping needs, it is expected that the existing central business district (CBD) will remain the primary commercial area, with additional neighborhood centers for convenience goods, thereby accomplishing the goal of providing adequate facilities, conveniently located.

Concerning circulation, the importance of inter-city circulation has been considered primary. This requires adequate and fast access from the surrounding highway approaches to important areas within the city. It also requires improvement of inter-city travel and elimination or reduction of vehicular traffic from major pedestrian areas, such as the campus and the heart of the CBD, and effective development of a local transit system (Figure 16).

Future standards for Stillwater have been outlined on the following basis:

Projected 1989 Population:

Off-campus	52,5000 persons
On-campus	12,500 persons

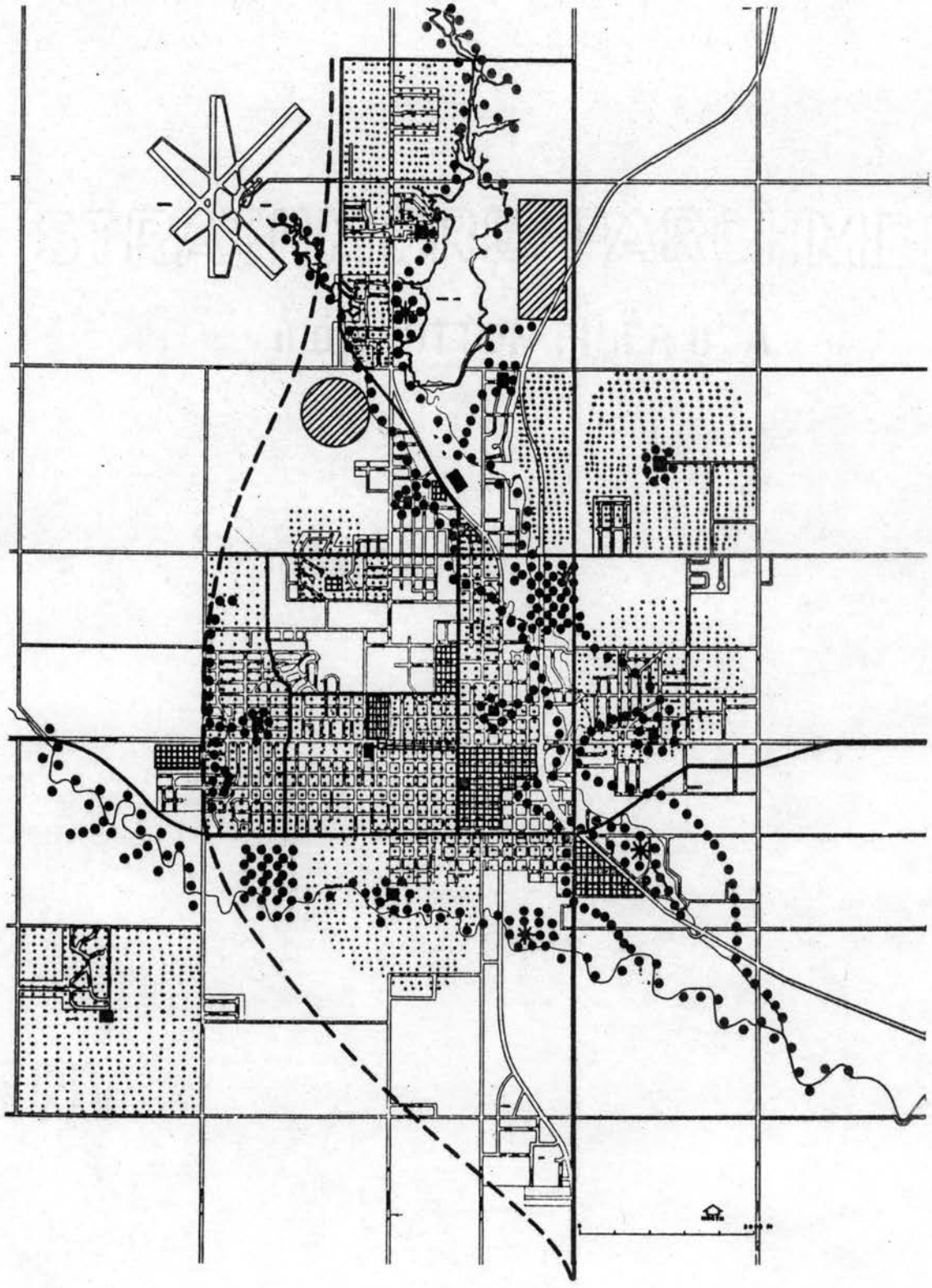

Fig. 16. Team 10's Proposed Plan of Stillwater.

Incorporated Area - September 1966:	
Off-campus	3,230 acres
On-campus	920 acres
Average Residential Neighborhood Standards:	
Population - 1375 families	5,000 persons
Area	138 acres
Housing	78 acres
Community facilities	39 acres
Circulation	21 acres
Overall City Area - Ratio to Neighborhood 2.23:1:	
138 x 10.5 x 2.23	
Population - 52,500	3,230 acres
Elementary school	2.2 acres
semi-public	22.0 acres
Playground	6.0 acres
Shopping	3.8 acres
Park	5.0 acres

(OSU and the airport are not included.)

Team 20

This team based their goals on the concept of providing community services for every individual, family or group and on opportunities for privacy at all levels--individual, family, group, and so forth. The main assumption is that the greatest possible number and variety of opportunities for meeting and interacting, both on the neighborhood and the larger community levels, should be available to each citizen with the location of such facilities within residential neighborhoods, though not necessarily repeated in all neighborhoods.

Their studies showed that the city of Stillwater will need to provide housing for 110,000 persons to which would be expanded in an ultimate development. For this population they concluded that there will be need for two high school-junior high school complexes, and an elementary school for each neighborhood unit except in areas adjacent to the university campus which provide housing for students.

It has been stated by the team that the main cultural and commercial facilities will be relocated in an area next to the existing CBD. Further use of this area will be restricted to pedestrian traffic and fringe and underground parking facilities will be provided for vehicles. In addition, development of the natural drainage system, with pedestrian paths and greenways, can be used for recreational uses on neighborhood and community levels.

Concerning the circulation, due to the high ultimate population projection of 120,000 persons, the need for a circumferential highway to answer the by-pass needs of the city, and at the same time provide connection to the proposed SST/industrial area, has been taken into consideration (Figure 17). For this system to work, utilization of a rapid transit system, and the prohibition of vehicular traffic at certain parts of the CBD, has been further proposed.

Future standards for Stillwater have been outlined on the following basis:

Projected 1989 Population:

Off-campus	52,500 persons
On-campus	12,500 persons

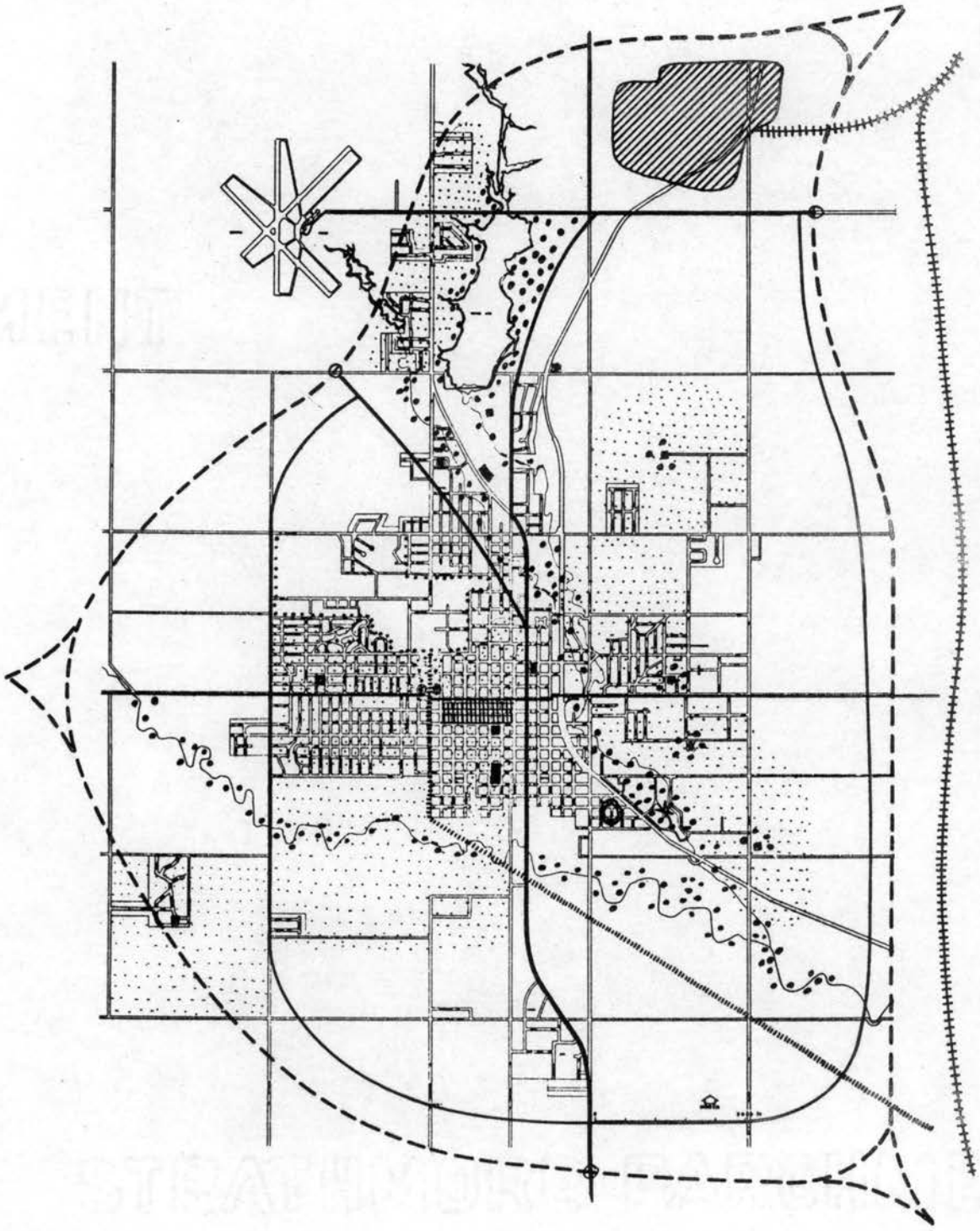

Fig. 17. Team 20's Proposed Plan of Stillwater.

Incorporated Area - September 1966:

Off-campus	3,230 acres
On-campus	920 acres

Average Residential Neighborhood Standards:

Neighborhoods - 10.5, 112 acres each with 5000 persons

Population	52,500 persons
Area	1,176 acres
Community facilities	40 acres
Circulation	21 acres
Elementary school	2.2 acres
semi-public	22.0 acres
Playground	6.0 acres
Park	5.0 acres
Shopping CBD	40 acres

Author's Proposal

From these two team studies, certain common conclusions may be drawn. Even if these teams made different assumptions on communication channels in respect to Stillwater's regional setting, both teams pointed out the need for a main by-pass route in a north-south direction, which would be located on the west side of the city. To be able to obtain the best results from their proposals, they emphasize the need for a community interaction by providing a greenway plan following natural drainage systems to make the best use of the city's existing features in creating better recreational areas. Both teams also pointed out the need for additional adequate educational and cultural facilities. As a result, they both gave emphasis to parking and public transportation facilities. This, in turn, was intended to encourage the possibility of more

pedestrian circulation which should be provided in an educational town of this size. A synthesis of these factors indicate a final model for study and analysis.

Therefore, in this section, the author would like to present her proposals for Stillwater. The basic data used for projection in this study are the same as that used in developing the Comprehensive Plan outlined in Chapter II and additional data included in Chapter III. In addition to this, predominant existing features of Stillwater are shown in Figure 18. The proposal is presented under two main headings: Circulation Patterns and Land-Use Patterns.

Circulation Patterns

The Oklahoma Turnpike Authority has not reached a decision on the location of the proposed turnpike which is intended to connect the Tulsa Metropolitan Area with Interstate Highway 35. Three alternative proposals have been made by the Authority, but for the purpose of this study, it is assumed that the southern route, which passes five miles north of Stillwater, will be built. Based on this assumption, it can be concluded that a high percentage of through traffic within the city in an east-west direction will be rerouted by construction of this turnpike. Therefore, primary consideration has to be given to providing a route which will make possible the handling of north-south traffic with a destination in the city and beyond.

Major Vehicular Circulation

The proposed road pattern shown on Figure 19 has been classified under four main groups.

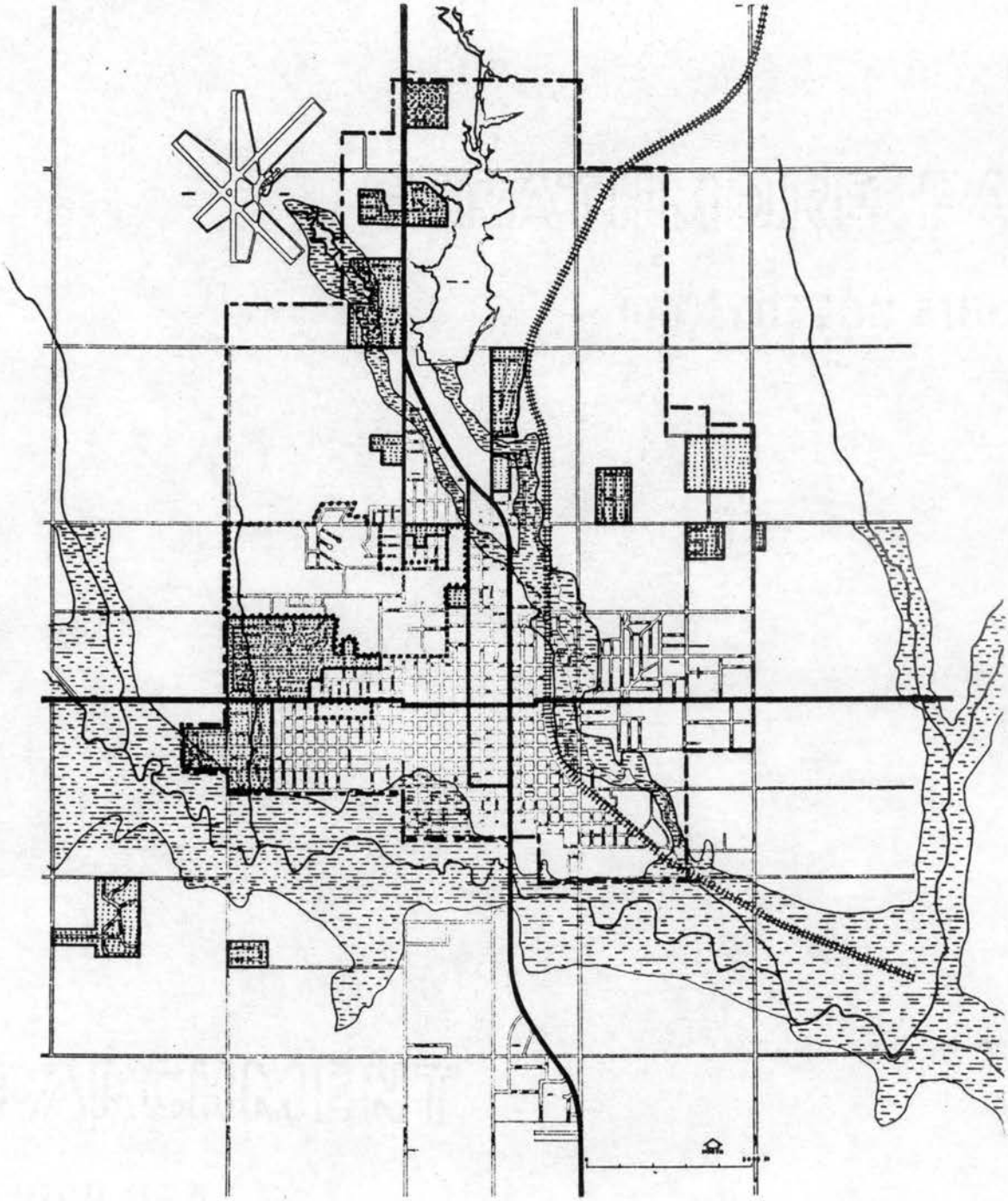

Fig. 18. Predominant Existing Features of Stillwater.

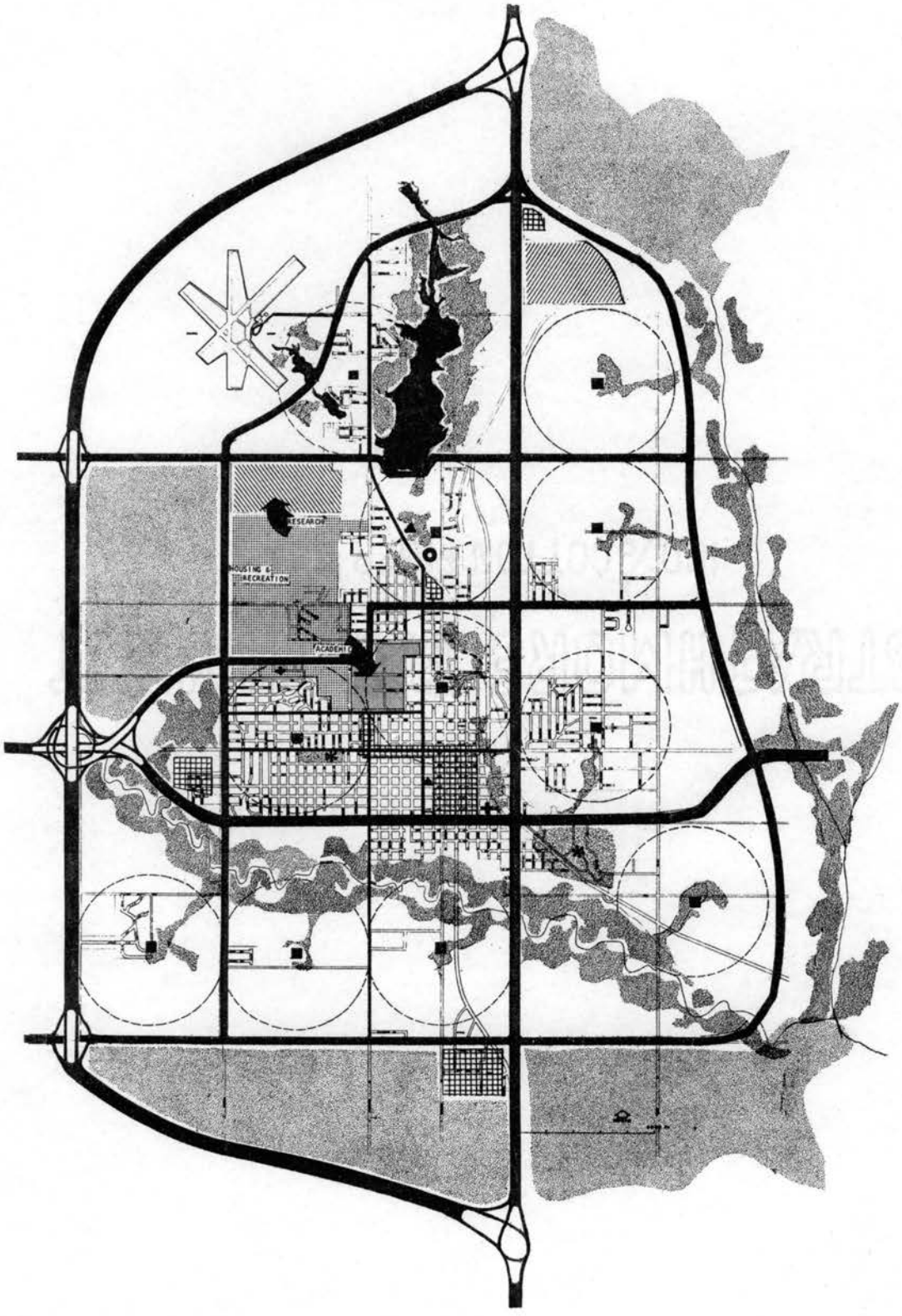

Fig. 19. Author's Proposed Plan of Stillwater.

1. Limited Access (By-pass) - The location of a by-pass, as shown in Figure 19, has been chosen for the following reasons:

a) The demonstrated need, outlined above, for a road to carry major north-south traffic.

b) The major traffic generator of the Stillwater area is founded by the university, which is most accessible from the west.

c) Due to the location of university-owned land in the northwest portion of the city and the location of the airport in this same quadrant, provides a means of land-use control which will make possible the retention of open space along the route. This factor also permits construction with a minimum disturbance of existing land-use patterns.

At this location of the proposed by-pass, provisions have to be made for a road with an annual average 24-hour count of 11,257. However, construction of the road can easily follow a number of stages satisfactorily. At first the road can be built as a divided roadway with surface intersections and sufficient green space between the lanes and edges to permit later addition of construction necessary to upgrade the system to limited access standards. Special attention has to be included in the design of this road in the segment south of the intersection with Highway 51 to ensure a number of underpasses which will maintain a tie between neighborhood units on either side. With proper buffer zones and good design, this road will provide an attractive edge to the city in addition to its service capabilities. It has been

established that this proposed location of a by-pass is also desirable in case the SST/industrial area proposal becomes a reality.

2. Primary Arterials - Primary arterials will be the main traffic routes, connecting the main parts of the city.

3. Secondary Arterials - Secondary arterials are intended to supplement by acting as the main distributors of traffic within areas bounded by major arterials or at the edge of the city to complete a loop around a district where traffic volume does not warrant construction of a primary arterial.

4. Collectors/Boulevards - Collectors serve as distributors of local traffic within districts. They should be designed to discourage through traffic. Boulevards are a category of collectors designed to provide a road with low speed limits and well developed attractive sidewalks. Therefore, it is a type of road that encourages pedestrian activities parallel to vehicular traffic, thereby contributing to a natural relaxed atmosphere that provides community interaction.

It has been found necessary to discuss Highways 40 and 51 within the city limits separately. As shown on the map, Highway 51, after completion of West 12th Street, will be converted to a boulevard and through traffic will be encouraged to take West 12th Street. A similar conversion of Highway 40 will be possible after the completion of Perkins Road.

Car Parking

With ever-increasing numbers of automobiles, car parking has been one of the main problems of cities throughout the world. Stillwater, with its highly mobile population, is becoming increasingly aware of this problem. This problem is particularly acute within the two main

traffic generating areas of the city--the OSU campus and the CBD. There is a desperate need to answer this problem as soon as possible. For the CBD between West 12th Street and Perkins Road it is proposed to have garage buildings, which will help to relieve congestion within this area. In the case of the campus, no traffic would be allowed in the area bounded by Monroe, University, McGeorge and Knoblock Streets except for emergency purposes. The area covered by these roads has been demonstrated to be within a 10 minute walking radius (Architecture Class 539, Fall, 1964) around the center of the campus. Other existing roads in this area can very easily be turned into attractive pathways for pedestrians, and parking lots may be used for green spaces or open display exhibit areas with benches and other street furniture for student and faculty use.

However, as mentioned earlier, almost half of the student population lives off-campus. For those who drive to school, garage facilities are provided north of the campus as shown on Figure 19.

Parking for the Student Union area may also have to be expanded; however, it is assumed that sufficient land exists to permit improved facilities for this purpose.

Public Transportation

At the present, due to the compact design of the city, need for public transportation is not considered to be critical. However, the use of mini-buses are proposed for this purpose in the near future. The proposed network of roads will provide very satisfactory service with this type of public transportation.

In the campus area, the use of buses between residential areas and the academic center of the campus has been initiated. However,

frequency of schedule runs, continuation of service at all times, and use of improved equipment more suited to shuttle service need to be examined. It is also believed that much more satisfactory results will be obtained from this service after the prohibition of traffic in the campus area. With a main route established between the garage facilites, located north of the library, and residential areas of the campus, the transportation needs of faculty and students will be satisfactorily met.

In addition, it is found necessary to emphasize the need of Stillwater to provide a well planned pedestrian system. For the purpose of establishing the strong connection between these various nodes of the city. Also, extension of this system throughout the city is proposed, to permit free movement of pedestrian and non-motor vehicles. This is specifically true of areas near major activity generators such as the campus and CBD.

In development of all circulation systems and related activities, successful development and subsequent use will be dependent on detailed solutions to such problems as maintenance, proper design of sidewalks, street furniture, street lighting and other street hardware and a good signing technique.

Land-Use Patterns

Public Open Space

Throughout this study it has been seen that, in Stillwater, interaction between land-use and circulation systems has not been taken into consideration. The natural features of the city have been allowed to deteriorate. A first improvement can be made by maintaining the existing parks and natural resources, the public usage of land around Boomer

Lake, and development of land along the water drainage systems. Secondly, new park development can be accomplished, existing Couch Park, with minimum expansion indicated in Figure 19, and improved maintenance, will become the main park of the city. Certain additional public facilities will also be necessary in this location. A second proposed park is located on Sixth Street in the area presently occupied by temporary barracks. This park, with a cafe, book stand and other similar amenities, may very well become a very desirable space for students and hospital employees in the vicinity. Further, it is an advantageous location, being within easy walking distance of the university housing area and the hospital. Such action should contribute to the strengthened use of this type facility to form a basic framework which, if properly integrated with the circulation systems, should provide a guide line for orderly growth of the balance of the city and its private developed areas.

Privately Developed Areas

This proposal has been made under the following three main areas:

1. Residential Areas - Land-use development as indicated in Figure 19, shows expansion of residential areas to the northeast and southwest. At present, the areas adjacent to the university campus have been developed to a higher-than-average density, without the accompanying amities of usable open space, satisfactory parking or workable circulation patterns. With proper control, this type of development can be corrected and prevented from reoccurring. The remaining areas indicated for residential use on the land-use map are proposed to be developed and/or redeveloped by using the neighborhood unit concept as a base, with centrally located schools and playgrounds, and convenience shopping

This may be accomplished by reordering the circulation patterns to permit such grouping in existing areas and/or design of new patterns, which more fully respond to this criteria while recognizing the influence of physical features, both natural and man-made.

The south part of the city by Stillwater Creek is in need of redevelopment at present. The case study has indicated the possibility of developing the area into multi-family developments with dwellings to be limited to four stories. Throughout the development of these residential areas consideration has to be given to two main points. First, to provide some kind of physical tie between these neighborhood units and of the community to eliminate isolation within a given neighborhood. Second, public use of the available natural open land resources, instead of continuing existing proprietory control of these areas.

2. Commercial Areas - As mentioned in Chapter II, Stillwater has developed predominantly a strip commercial system of retail activity. Due to the composition of the population, it is believed that the area presently used for this function is sufficient to meet general requirements. Developing neighborhood units with centrally located shops will answer any new requirements. Any kind of development of new shopping centers should be avoided. As reorganization of neighborhood elements becomes effective, it may also be desirable to reassign certain current commercial zoning to other uses. As a result, the commercial area will be located on Main Street between West 12th Street and West 6th Street. In the future this area with near-by parking garages can be redesigned utilizing pedestrian malls in existing right-of-way. This core area can be extended west on West 6th Street using Washington and Knoblock Streets as connections to the campus. The University Shopping Center on

existing Highway 40 will also be retained as a sub-center for the northern districts.

It is proposed that with the improvement and addition of specialty shops, restaurants and other activities related to student needs, the Washington Street commercial development can become a center of social life for university students outside the campus.

3. Industrial Areas - In the city of Stillwater industry has been located in the vicinity of existing rail facilities. This has been a logical selection and is therefore being expanded in this general area as indicated in Figure .

As stated previously, Stillwater is primarily an educational town and should retain this characteristic. Therefore, further development of certain types of industry could create conflicts in the city development. To prevent this, it is proposed that the university encourage more compatible industrial development through establishing more research centers on the northern part of the campus. These research activities will also contribute additionally to the economic standards of the city and its character as an educational center will be strengthened. The proposed location of both research centers and industrial areas are located so that they can be served effectively by the proposed road system.

CHAPTER V

SUMMARY

The purpose of this study was to investigate problems dealing with land-use and circulation interactions. With the rapid growth of industrialization and social mobility, the resulting outward expansion of cities is creating increasingly heavy demands for land-use circulation interaction studies.

For the purpose of this investigation, it has seemed pertinent to introduce two examples in this direction. Both of the selected projects have been successfully applied in Cumbernauld and Bristol.

The measures taken by the respective city planning authorities to meet the future needs of these cities have been reviewed. Following a thorough study of this study of the existing characteristics and the future plans proposed by the City Planning Office for the city of Stillwater, comparisons have been made between the latter and the two above mentioned British cities. Based on the results of this study, it was concluded that previous planning in Stillwater seems to have been based primarily on extension of existing land-use and street plans; whereas, the author is convinced that the major concern of Stillwater's plan should be to preserve and strengthen its characteristics as an educational center through the development of circulation systems, which encourage more appropriate land-use relations.

It is proposed that future expansion of the city should be limited to natural boundaries such as West Brush Creek on the east and existing university agricultural areas along the proposed by-pass on the west. These physical limits will contribute greater integrity to the developing city form. Such integrity will more fully provide an identity which recognizes the presence of selective population.

For more accuracy in developing practical designs, additional information concerning existing traffic counts within the city and economic feasibility are needed. It is most desirable to have such factual data available for future studies.

An increasing need is also needed for studies related to future demand for the parking facilities. The location of two garage buildings has been suggested in this study; however, verification of actual capacity requirements would also have to be determined. Due to the fact that a large segment of Stillwater's population currently indicates an eagerness to learn more about the characteristics of their city in order to better their future environment education, of all citizens in a manner that will permit them to more effectively participate in the development of the city, becomes an important goal.

Finally, it is further recommended that special studies of residential areas be made, with the purpose of improving methods of creating community interaction of city residents by providing more meaningful neighborhood unit concepts particularly applicable to local needs.

It is hoped that this study may provide a basis for such further investigation.

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APPENDICES

APPENDIX A

STILLWATER ORIGIN AND DESTINATION SURVEY

Results of the 1963 Stillwater O-D Survey

Through Traffic	
East-West	309
North-South	546
Oklahoma State University Campus	
From Highway 51 (West)	1,296
From Highway 51 (East)	734
From Highway 40 (North)	874
From Highway 40 (South)	876
Total	3,780
Central Business District (CBD)	
From Highway 51 (West)	802
From Highway 51 (East)	1,024
From Highway 40 (North)	752
From Highway 40 (South)	1,215
Total	3,793
New Housing Addition	
From Highway 51 (West)	331
From Highway 51 (East)	264
From Highway 40 (North)	179
From Highway 40 (South)	341
Total	1,115
North-East of the City	
From Highway 51 (West)	183
From Highway 51 (East)	186
From Highway 40 (North)	93
From Highway 40 (South)	134
Total	596

South-East of the City

From Highway 51 (West)	89
From Highway 51 (East)	72
From Highway 40 (North)	54
From Highway 40 (South)	133
Total	348

Application of the O-D Survey for Long Range Planning

Projected Traffic Count

1. Projected Traffic Count - existing traffic count x gross rate where gross rate = vehicle registration rate x gas consumption rate x population projection rate.

For vehicle registration rate of the city of Stillwater the only obtainable data was from the University Campus Security Office, which is shown below:

Year	No. of Cars Registered
1961-1962	9481
1962-1963	9943
1963-1964	9670
1964-1965	10,071
1965-1966	12,197
1966-1967	10,869 (Sept. and Oct.)

These figures present registration at OSU's Security Office for a nine months period (September to May), and is evidenced, this data is insufficient.

Therefore, it can be concluded that the projected traffic count for Stillwater for 1989, based on 1963 traffic survey results, are not possible to be forecasted by the above formula. The only available rate is the population projection rate.

2. Practical application is by taking the projected population rate as equal to the projected traffic count rate. This is going to be used in the last part of this appendix.

Application of the Projected Traffic Counts

1. For the purpose of checking the existing road junction efficiency for a given date, it is necessary to follow the following steps:

a) Get the width of the given road, and specify it as being one or two-way.

b) For the given width and location either downtown, intermediate or outskirt area get the possible and practical capacity of the road from a table.

c) Make the necessary connections as for parking, bus stops, percentage right or left turns, on this possible and practical capacity.

d) Compare this capacity after the connections with the projected capacity and point out the places requiring repair or further study.

Example:

Because of the unavailability of any traffic counts in Stillwater for any intersection, this example has been taken from the Highway Capacity Manual, U.S. Department of Commerce and Bureau of Public Roads.

Problem: What are the possible and practical capacities of one approach to an intersection on a two-way street, 45 feet wide, downtown area, parking is prohibited, 20% of the traffic turns right, 15% turns left, 5% of the total traffic is commercial during the peak hours. There are bus stops on the near side of the intersection, and the traffic lights are green for a period of 35 seconds out of a 60 second cycle.

Solution: From a table for a road with 45 feet width, curb to curb, in a downtown area, with parking prohibited, from the table capacity of one approach is 1,660 vehicles/hour of green light. The following adjustments are rigid because conditions are not average:

Course	Effect	Factor
Right Turn	$(10-20)\frac{1}{2} = -5\%$	0.95
Left Turn	$(10-15) = -5\%$	0.95
Commercial Vehicles	$(10-15) = -5\%$	1.05
Near-Side Bus Stop	$= -10\%$	0.90
Total Factor	$.95 \times .95 \times 1.05 \times .90$	0.85

$$\text{Possible Capacity} = 1.10 \times .85 \times \frac{35}{60} \times 1.660$$

= 905 vehicles/hr. in the direction of heavier flow.

$$\text{Practical Capacity} = .90 \times .85 \times \frac{35}{60} \times 1.660$$

= 741 vehicles/hr. in the direction of heavier flow.

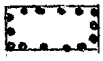
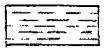
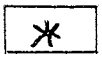
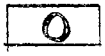
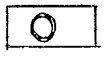
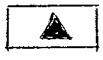
If this road had an estimated capacity of greater than 905 vehicles/hr. repairs and studies are necessary at this intersection.

2. Projected traffic counts are also used for the purpose of obtaining approximate capacities of proposed roads. For the purpose of this study, projected traffic counts were obtained by taking 1963 traffic count as an existing count and projected population rate for 1963 to 1989 as a gross rate. Estimated annual average, 24-hour count, for the proposed by-pass = 11.257, and the proposed Perkins Road = 9.500.

APPENDIX B

KEY TO STILLWATER MAPS

Land-Use Pattern

Maps: Figs. 12, 16, 17 & 18		Map: Fig. 19
	Residential	
	Commercial	
	Industrial	
	O. S. U.	
	Academic	
	Housing and Recreation	
	Research	
	Leisure-Time	
	Agricultural Land	
	Flood Plain	
	City Limits	
	Major Parks	
	High Schools	
	Junior High School	
	High School-Junior High School Complex	
	Elementary School	

Circulation Pattern

Maps: Figs. 12, 16, 17 & 18		Map: Fig. 19
	Limited Access (By-Pass)	
	Primary Arterials	
	Secondary Arterials	
	Collector/Boulevard	
	Railroad	
	Rapid Transit	
	Garage Buildings	

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