

THE UNIVERSITY OF MANITOBA

AN ANALYSIS OF COMMERCIAL STRUCTURE ALONG A
MAJOR TRAFFIC ARTERY IN WINNIPEG: A CASE
STUDY OF PORTAGE AVENUE

by

PENG-TONG LING

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CHAPTER 1

INTRODUCTION

1 - 1 Research Problems and The Study Area

The era of the automobile has brought about drastic changes in North America's urban landscape in the last few decades. One of the most obvious effects has been the emergence of commercial ribbons, i.e. the development of business establishments along major urban traffic arteries. Early studies of urban business structure have provided the basis for a general consensus that commercial ribbon development exists because of its ability to attract clientele from the passing traffic.¹ These findings explained the cause of emergence of such phenomena but failed to provide any further insight into the relation of the structure to the functions of the ribbon, or the relative strengths of various businesses in competing for ribbon locations.

Today, commercial ribbons have become an integrated part of the overall commercial structure of many cities, although physically they can still be quite easily distinguished from other types of business districts.² Functions catering to passing traffic no longer dominate the business composition of such streets. In fact, almost any business functions can be found favouring ribbon locations. Each of the establishments on the ribbon serve a unique combination of passing traffic

1. See Chapter 2.

2. Commercial ribbon is defined in this study as "a major street fronted by commercial establishments where the intersecting streets are devoted to a different type of land use."

and the nearby residential area. Due to the complicated nature and functional overlap of all the establishments on the ribbon today, the more recent studies in ribbon developments which aimed at classifying business establishments on ribbons as highway-oriented or hierarchic reveal only part of the true nature of these patterns.

A review of the pertinent literature indicates the limitation of the existing models as aids of understanding the true nature of commercial ribbon development. The structure of commercial ribbons has long been the subject of vague definition, and the ambiguities which have resulted suggest that further examination of the structure of commercial ribbons is warranted. The present study is aimed at clarifying some of these issues through an analysis of establishments in a commercial ribbon of Winnipeg.

Portage Avenue, the major traffic artery and the most prominent and well-developed commercial ribbon in Winnipeg, is selected for the study. This study deals only with the business structure and its spatial pattern along a commercial ribbon outside the central business district (CBD), hence that portion of Portage Avenue which is part of the CBD is excluded.³

The purpose of this study is to examine the structure and spatial pattern of businesses along Portage Avenue. The analysis is carried out in terms of the following framework. First, functional compositions of

3. See Chapter 3 for the delimitation of the study area.

establishments on Portage Avenue is examined to determine the functional structure of the commercial ribbon. Second, the spatial patterns of business classes are examined by means of nearest neighbor and percentile values analysis. Lastly, the spatial associations among different classes are examined in order to understand the spatial relationship existing between different types of functions when located along a commercial ribbon.

1 - 2 Data

The data used in this study are mainly based on field work carried out by the author during 1971. Each business establishment fronting on Portage Avenue is classified in terms of its business type⁴. Each establishment is treated as a single observation i.e. stores with more than one function are entered only once, hence the scheme of classification employed is not a precise measure of function.⁵

The field observations were plotted on a base map of scale 1 inch to 200 feet. Distances used in the nearest neighbor analysis were derived therefrom.

1 - 3 Limitations of the Study

It rarely seems possible for research of this kind to be as comprehensive as one would like since the researcher has to operate within

4 See Appendix I for the classification of business types.

5. e.g. When a gas station also performing repair service is entered under Gasoline Service Station (5541).

a time constraint, and the present case is no exception. Three inevitable deficiencies of the study at hand are evident.

(1) It is concerned with only a particular point in time. This in itself sets constraints upon the usefulness of the results at the practical level, for they can only give a static representation of a dynamic situation. One might hope, though, that as a means of identification of an existing spatial pattern, the study's result would still prove useful.

(2) There is no differentiation between business "units". Commercial establishments are all treated as single units regardless of their size, business volume or quality. Also, multi-purpose stores are treated as single units. Undoubtedly, some information will be lost during the analytical process and it might affect the validity of conclusions which are based on these results.

(3) Only the resultant behaviour, the location of the business, is observed. Thus the varied effects of market accessibility, serviced location availability, and zoning bylaws, in determining those locations are unknown. It is clear that longitudinal studies of some magnitude will be required before the nature of these forces can be delineated.

CHAPTER 2

REVIEW OF LITERATURE

There have been relatively few studies published referring specifically to the structure and functions of commercial ribbons. Earliest reference to this form of business development can be found only as part of studies which dealt with the entire business structure. In 1937 Proudfoot undertook a pioneering effort in studying the pattern of city retail activities.¹ He concluded that business centers within urban areas could be classified into five types: (1) the central business district; (2) the outlying business centers; (3) the principal business thoroughfares; (4) the neighborhood business streets; and (5) the isolated store clusters.

The central business district (CBD) was recognized as the retail heart of the city, with a marked concentration of shopping-goods stores and was at the point of maximum accessibility to the entire city population. Outlying business centers were considered as miniatures of the central business district, developed at focal points of the intra-city transportation system and distinguished from them by having a more restricted customer tributary and a greater proportion of convenience-goods stores. Principal business thoroughfares were characterized by the

1. M.J. Proudfoot, "City Retail Structure," in Readings in Urban Geography ed. by H.M. Mayer and C.F. Kohn (Chicago: University of Chicago Press, 1959), pp. 395-398.

co-existence of two related attributes: as business streets they possessed widely spaced convenience and shopping-goods stores; as traffic arteries they carried a high density of mass and vehicular traffic. The stores in these business centers were catering to and mainly dependent on customers derived from traffic along the thoroughfares. Neighborhood business streets formed a regular network throughout the city with convenience-goods stores dominating and having customer tributary areas restricted to walking distance. Isolated store clusters were characterized by non-competitive convenience-goods stores serving the immediate wants of families living within easy walking distance.

Ten years later, Ratcliff showed that beyond the CBD the pattern of business structure consisted of combinations and variations of two basic conformations: string street development (business thoroughfares) and nucleations.² He introduced patterns of land values and the concept of complementarity to further describe the retail structural types. Nucleations typically appeared at the more important intersections and created a "pyramiding of land values to a peak adjacent to the intersection."³ The essential difference between the nucleations and string streets was "the lack of internal organizations in the case of the string street as compared with the more definite pattern in arrangements of uses characterizing the nucleations."⁴ Ratcliff had found that the nature of uses along the string street depended upon the extent to which

2. R.U. Ratcliff, "Internal Arrangement of Land Use," in Readings in Urban Geography ed. by H. M. Mayer and C. F. Kohn (Chicago: University of Chicago Press, 1959) pp. 410-417.

3. Ibid p.412

4. Ibid p.412

the street was a main traffic artery and the degree to which it was the core of residential area. Business functions catering to the transients and those intended to serve the immediate residential areas were both attracted to the artery.

A more recent attempt to construct a comprehensive classification of urban business structure was undertaken by Berry.⁵ The application of central place theory to the internal business structure of the city has allowed the development of a more precise classificatory scheme. By obtaining groups of spatially associated business types through the use of factor and linkage analysis, Berry has provided empirical evidence of the existence of four conformations of businesses, and the business districts or functional areas they create. These are:

- (1) nucleated shopping centers,
- (2) urban arterial business districts,
- (3) highway-oriented business districts,
- (4) automobile-row functional areas.

The conformations are "mutually exclusive as functional groups but need not be spatially exclusive."⁶ Thus it is not clear whether Berry's scheme is, in the classic context, primarily "formal" or "functional."

5. B.J.L. Berry, "Shopping Centers and the Geography of Urban Areas." (unpublished Ph. D. dissertation, University of Washington, 1958).

B.J.L. Berry, "Ribbon Developments in the Urban Business Pattern," Annals of the Association of American Geographers, Vol. 49, 1959, pp. 145-155.

6. B.J.L. Berry (1959) op. cit. p.149

Within the pattern of nucleated shopping centers, a hierarchy of three levels of centers is distinguished as 'neighborhood', 'community', and 'regional' shopping centers. The names are descriptive of the area served by each level of center. Within each type of center, orders of goods that are characteristic to that center will be found.⁷

Highway-oriented businesses are located with respect to a set of demands occurring spatially as a flow along highways or they are business types requiring large and expansive sites with easy access. Business types characterising this business district are gasoline and service stations and drive-in restaurants.

Urban arterial business districts are found within urban areas but "which within urban areas are apparently most successful when located along urban arterial highways."⁸ Automobile repair is the typical urban arterial function. As the size of urban centers increases, additional members of the group appear. Arterials that are immediately adjacent to the CBD are characterized by the appearance of office equipment and supply establishments, and in large cities, there will usually be a "skid-row".

The automobile row functional area is characterized by a concentration of used and new car dealers.

7. For the list of goods that are characteristic to each level of centers, see B.J.L. Berry (1958, 1959) op.cit.

8. B. J. L. Berry, 1959, op. cit., p.148.

In his studies, Berry had recognized two types of ribbon development: highway-oriented business districts and urban arterial business districts. Differentiation between the two could be achieved by examining the business functions that were present.

In the later study of Chicago,⁹ a similar kind of classification is recognized by Berry, but with important modifications. In this later study, both highway-oriented and urban arterial business districts are combined under a general heading: ribbon. The relative location of ribbon with respect to nucleated business centers is used as the criterion for differentiating the two sub-types: ribbons adjacent to centers and isolated ribbons. Nucleated, urban arterial and highway-oriented business facilities can all be found on ribbons adjacent to centers. These several different elements were intertwined in an inseparable way in many stretches of Chicago's ribbons. The isolated ribbons are far more devoted to convenience and neighborhood-goods stores, to highway-oriented uses and to restaurants, bars, liquor stores etc., than the ribbons adjacent to centers. Such urban arterial uses (like heating and plumbing dealers, lumberyard etc.) are missing on isolated ribbons.¹⁰

As has been mentioned earlier, literature devoted specifically to studies of commercial ribbons alone is relatively scarce. Interest would appear to stem from two main sources. The first is the general disfavor

9. B.J.L. Berry, "Commercial Structure and Commercial Blight", (Chicago: Department of Geography, Research Paper No.85, University of Chicago, 1963).

10. Ibid p.77

with which planners view such developments. The opposition of planners is based on a dislike for the visual character of commercial ribbons and the apparently unfavorable effects these developments have on the free flow of traffic. That such streets fulfill important functions in a city's commercial structure is also recognized by planners, but it is felt that these functions could be performed in some alternative physical form; one that would not have the physical disadvantage of commercial ribbons. However, Wolfe (1964) has shown that many accidents occurring on ribbon streets are associated not with movements into and out from roadside shops, gas stations, and so on, but with normal traffic intersections.¹¹ Berry has also pleaded strongly for the retention of the ribbon function because he found it of such wide spread occurrence that it is obviously a fundamental part of city's overall commercial structure.¹²

The second main source of interest in commercial ribbon studies has been the study of spatial patterns and functional associations of establishments as well as the more abstract problem of how such developments fit into existing theoretical concepts of urban retail and service structure.

Foster and Nelson studied a 15 mile long string street development in suburban Los Angeles for a highway impact study.¹³ Four groups of business establishments were distinguished by them on Ventura Boulevard:

11. R. Wolfe, "Effect of Ribbon Development on Traffic Flow," Traffic Quarterly, Vol 18, 1964, pp. 105-117.

12. B.J.L. Berry, "A Critique of Contemporary Planning for Business Centers," Land Economics, Vol. 30, pp. 306-312, 1959.

- (1) stores serving essentially neighborhood needs;
- (2) stores serving a wider trade area where customers deliberately come to the establishments;
- (3) stores serving casual customers from a wider trade area and
- (4) stores whose location on Ventura Boulevard reflects a peculiarity of the Boulevard itself.

Foster and Nelson noted that ribbon business differed according to its location in one of three zones: extensions of the CBD; inner zones of nodal and arterial retailing; and an outer zone, mainly highway-oriented. They stressed that the important location factor was accessibility to actual or potential purchasers, not the traffic level.

Berry (1959) used his findings and information concerning business groups and conformations developed in the Spokane study to interpret and analyze commercial ribbons.¹⁴ Both intra- and inter-city ribbons were analyzed. He found that using that body of generalization that he had developed in the Spokane study (1958), it was possible to differentiate nucleations, special functional areas, stretches of urban arterial, and highway-oriented business districts on a commercial ribbon.

13. G. J. Foster and H. J. Nelson, "Ventura Boulevard: A String Type Shopping Street," (Los Angeles: Real Estate Research Programme, University of California, 1958).

14. B. J. L. Berry, 1959, op. cit.

Berry found that locational patterns of urban arterial and highway-oriented facilities are highly similar when located on intra-city ribbons. In the case of inter-city ribbons, urban arterial functions are more concentrated than the highway-oriented facilities and are located in or near nucleations.

Boal and Johnson (1965) traced the customers linkages between business establishments along a commercial ribbon in Calgary.¹⁵ Centers and ribbons were distinguished in this study on the basis of consumer linkages rather than by physical proximity. Interviews with customers are conducted at establishments belonging to seven business types in order to determine the customer-use pattern. Using the four functional conformations of Berry they find a considerable overlap of locational and functional attributes along the commercial ribbon. Each establishment serves unique combinations of passing traffic and nearby residential, industrial and shopping areas. Hence, to classify any particular establishment on ribbon as highway-oriented or nucleated is to express only part of the truth. They also point out that the application of central place concepts to the commercial ribbons would seem to be legitimate but operationally complex because of the mixture of business types and their functional overlap. The concept of linear hinterland, as suggested by Marble¹⁶ and Bunge¹⁷, is highly constrained

15. F.W. Boal and D.B. Johnson, "The Functions of Retail and Service Establishments on Commercial Ribbons," Canadian Geographers, Vol. 9, 1965, pp. 154-169.

16. D.E. Marble in "Proceeding of the IGU Symposium in Urban Geography, Lund 1960," (Lund: Department of Geography, University of Lund) 1962, p.159

17. W. Bunge, "Theoretical Geography," (Lund: Department of Geography, University of Lund), 1962, pp. 53-54.

as Boal and Johnson have found that establishments located along ribbons do not depend solely on passing traffic, but a combination of traffic and nearby area.

This literature as a whole reveals the major weakness of commercial structure studies to date: the confusion of form and function in the classificatory schema. Terms utilized as descriptive labels consistently refer to partly spatial and partly behavioural (functional) identifying characteristics. No doubt, this shortcoming has been unavoidable, and will remain so until studies of this kind become more intensive and longitudinal. The researcher is, after all, faced with an "instantaneous" map which results from the operation of many factors which are variously forcing and retarding change in the pattern which appears on the map. He is armed with a ruler and some concepts about the economic nature of access, distance and congestion. He has no choice but to assume that his map represents some stable equilibrium, and that the pattern on it makes sense. One of the strategies in this study is to relate types of form of pattern to functional aspects of a traffic artery. This development is regarded as a necessary next step in the elaboration of commercial ribbons theory, it is recognized that present resources are inadequate to allow this study to go beyond the formulation of tentative statements of relation.

CHAPTER 3

ANALYSIS OF BUSINESS STRUCTURE ALONG PORTAGE AVENUE

3 - 1 Introduction and Delimitation of Study Area

Commercial development along Portage Avenue is not a recent phenomenon. The development can be traced back to the early twentieth century, when the shift of the retailing capacity in downtown Winnipeg from Main Street to Portage Avenue projected a westward orientation of commercial development along Portage.¹ Furthermore, the growth of Winnipeg during the nineteenth and twentieth centuries, which produced a very marked bias of urban development westward² has also contributed to the development of commercial establishments along this artery.

Today, Portage is not only one of the two busiest traffic arteries in Winnipeg³ but has also become the most prominent and well developed commercial ribbon of the city. The business development on this artery is not only a natural extension of the downtown's business district, but it stretches out almost unbroken to the Perimeter Highway (Map 3- 2).

1. R.G. Morris, "An Evaluation of the Functions and Characteristics of a Regional Shopping Center - Polo Park," (unpublished M.A. thesis, University of Manitoba, 1966), p.16

2. Ibid, p.11

3. Winnipeg Area Transportation Study (The Metropolitan Corporation of Greater Winnipeg: Transportation Division, 1966), Vol.1, p.44

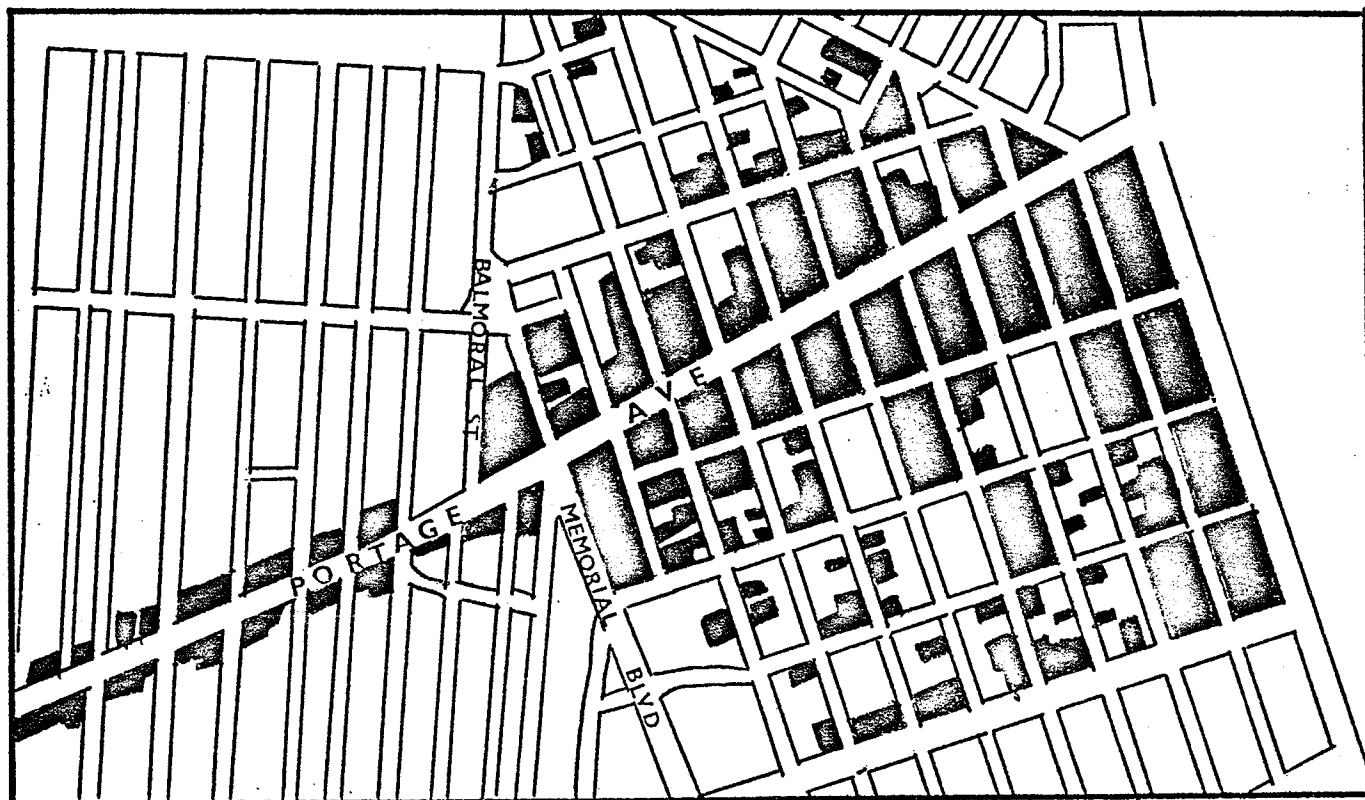
This study deals only with the commercial structure and its spatial pattern along an urban artery outside the central business district (CBD), hence, that portion of Portage Avenue which is part of the CBD will be excluded from this analysis. Most students in ribbon studies generally agree that ribbon development can be defined as being a major street fronted by commercial establishments where the intersecting streets are devoted to a different type of land use.⁴ In other words, ribbon development is linear in form and rarely runs down the intersecting streets. Inspection of Map 3-1 indicates that ribbon development on Portage Avenue starts at Memorial and Balmoral Streets since west of these two intersecting streets commercial establishments front only onto Portage Avenue and show a linear development in form (Map 3-1). Hence, Memorial Boulevard on the south and Balmoral Street on the north side of Portage Avenue will be the eastern boundaries of the study area. The western boundary of the study area is the Perimeter Highway. The total length of this segment is approximately 8.1 miles.

One of the persistent problems in studies of ribbon development has been whether to include planned shopping centers located on commercial ribbons as an integral part of the ribbon development or to exclude them from the analysis. Even though, physically, the planned shopping centers form an inseparable part of commercial structure of the ribbon, the present author would still agree with the resolution that they be excluded from the analysis. The functional make up of the planned shopping

4. e.g. Foster and Nelson, 1960, op. cit., p.7

Map 3-1

Commercial Land Use in Downtown Winnipeg



Scale 1" to 1000'

Sources: 1. The Metropolitan Corporation of Greater Winnipeg,
Planning Division, "Downtown Winnipeg", 1969.

2. Field work, 1971

centers are controlled and planned by some authority before the shopping center begins its operation. The duplication of similar functional types have been kept to a minimum so as to ensure the successful operation of each commercial establishment in the shopping center. They contrast with ribbon developments which are usually considered as a form of 'uncontrolled' commercial development sprawling along major urban arteries. The ribbons are 'uncontrolled' not only in terms of their physical appearance, but also in their functional composition, in contrast to the planned shopping centers. The author feels that the inclusion of planned shopping centers into the study might distort the real pattern of ribbon commercial structure, and consequently, would hamper the understanding of the true nature of these commercial developments.

Altogether, there are four planned shopping centers located within the study area as of September 1971 and they are all excluded from further analysis. The shopping centers, listed according to their distances away from the downtown area, are shown in the following table (see Map 3-2 for their locations):

<u>Shopping Centers</u> ⁵	<u>Number of Business Establishments</u>
1. Polo Park	103
2. Silver Height	18
3. Court of St. James	19
4. Westwood ⁶	56

5. The definition of planned shopping centers is adopted from Winnipeg's Shopping Center 1972 (Planning Division, City of Winnipeg, 1973).

6. According to Winnipeg's Shopping Centers 1972, Westwood shopping center is made up by three separate shopping centers, namely Westwood, Crestview Park and Village Inn. As they are located (cont'd)

3 - 2 Classification of Business Functions

There has been a lack of standardization in business types classification in previous studies of urban commercial structure. A researcher usually uses the classification type which seems most appropriate to his particular study, either adopting an established classification system directly or modifying that classification to accomodate his own needs. In this case, 16 business classes are identified and used as the basic functional units for studying the spatial structure of business land use on Portage Avenue (Table 3-1). Nine retail classes ((1) to (9)) and seven service classes ((10) to (16)) are delineated. The classification of businesses is adopted from Montgomery's Vancouver study.⁷ Individual business functions under each of these 16 headings are directly adopted from Standard Industrial Classification Manual.⁸ (For the list of business functions under each heading, see Appendix I).

(cont'd) ... in close proximity to each other the physical distinction between them is not easily made. Since their functional characteristics are excluded from the study, they are simply referred to as a single shopping center.

7. D. Montgomery, "The Internal Arrangement of Urban Arterial Business Districts", (unpublished M.A. thesis, University of British Columbia, 1969).

8. U.S. Bureau of the Budget, Standard Industrial Classification Manual (Washington: Government Printing Office, 1957).

Table 3-1

Business Classes Used as Basic Functional Units

- (1) Food stores
- (2) Eating places
- (3) General merchandise stores
- (4) Apparel, accessories stores
- (5) Furniture, Home furnishing, Appliance dealers
- (6) Lumber, Building material, Hardware
- (7) Automotive
- (8) Drug stores
- (9) Other retail
- (10) Finance
- (11) Personal service
- (12) Business service
- (13) Professional service
- (14) Household repair
- (15) Entertainment, Recreation
- (16) Hotels, Motels

In the present study, the 16 business classes as designated above, are used in the earlier part of the analysis. The composition of business land use on Portage Avenue and the four subsections of business areas found on this urban artery are described and examined in terms of the above 16 business classes. The spatial character of the class locations is further elucidated by means of percentile value analysis.

In subsequent parts of this study, namely, the analysis of spatial patterns of business distributions and spatial association among different business functions by means of nearest neighbor distance relations, the same classificatory scheme of business functions is inappropriate. Due to the heterogeneity in functional types within a certain business class, such as Other retail (9) and Personal service (11), it is difficult to draw any meaningful conclusions based on nearest neighbor distance relations with regard to classes with such a varied functional nature. In view of these shortcomings, only a selected sample of business types is used in the second part of this study. A total of 12 relatively homogeneous business types are selected for this purpose:⁹

- (I) Food stores
- (II) Eating places
- (III) Furniture, Home furnishing
- (IV) Gas and service stations
- (V) Auto dealers
- (VI) Drug stores
- (VII) Banks
- (VIII) Real estates
- (IX) Barber and beauty shops
- (X) Physicians and Dentists
- (XI) Recreation, Entertainment
- (XII) Hotels, Motels

9. The main criterion employed in selecting these business types is a demonstration of maximum homogeneity among business functions within each business types. These 12 business types are subsets of the business classes mentioned earlier.

3 - 3 Composition of Business Land Use

I. The General Overview

Excluding the stores in the four planned shopping centers, there were a total of 521 different business outlets occupying street frontage on Portage Avenue within the study area by September 1971. The breakdown of numbers and percentages of these establishments by different business classes is shown in Table 3-2. The table shows that the business composition is quite evenly distributed among the two main functional categories, namely, retail and service classes. The retail classes (business classes (1) to (9)) comprise slightly more than one half (53.45%) of the total business establishments, while service classes (business classes (10) to (16)) constitute the remaining 47.55% of business outlets in the study area. Among the individual business classes, the Automotive (7), Other retail(9), Finance(10), Personal service(11), and Professional service(13) are the most prominent in terms of numbers of establishments. They constitute 11.34%, 10.76%, 13.07%, 12.3% and 11.15% respectively out of the total numbers of business establishments on Portage Avenue, accounting together for 58.62% of the total business establishments. The remaining 41.3 % of the business composition is distributed among the other nine business classes. The table also gives a breakdown of numbers of stores in each business class according to the sides of the street (inbound or outbound traffic lane). An unevenness of distribution is evident - as 331 out of the total 521 establishments are located on the outbound lane (north side) of Portage Avenue. The business classes

**Table 3-2 Portage Avenue - Business Composition;
Number of Establishments and Percentages**

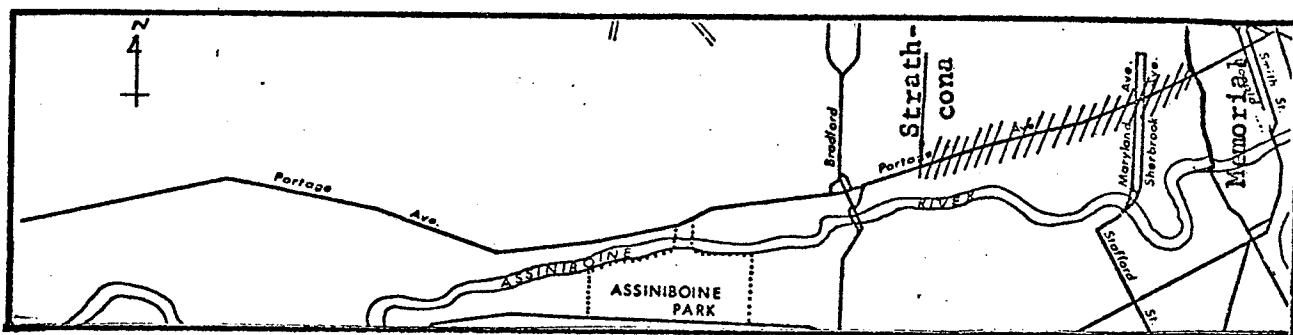
Business Class	Inbound (South)	Outbound (North)	Total	%
Food stores (1)	8	23	31	5.96
Eating places (2)	17	33	50	9.61
General merchandise (3)	2	2	4	0.76
Apparel, accessories (4)	8	10	18	3.46
Furniture, appliance (5)	11	21	32	6.15
Lumber, Hardware (6)	3	13	16	3.07
Automotive (7)	30	29	59	11.34
Drug stores (8)	1	12	13	2.50
Other retail (9)	18	38	56	10.76
Finance (10)	25	43	68	13.07
Personal service (11)	22	42	64	12.30
Business service (12)	14	10	24	4.42
Professional service (13)	20	38	58	11.15
Household repair (14)	3	5	8	1.53
Entertainment, Recreation(15)	2	8	10	1.92
Hotels (16)	6	4	10	1.92
Total	190	331	521	100.00

Source: Field work, 1971

that have a greater proportion (over 65% of their establishments) of stores located on the outbound lane are Food stores(1), Eating places(2), Furniture and Appliance(5), Lumber and Hardware(6), Drug stores(8), Other retail(9), Personal service(11), and Professional service(13).

II. Divisions of Portage Avenue

(1) Memorial to Strathcona



The business land use distribution and its development pattern along Portage can be divided into interval for the purpose of description. This is effected visually, using spatial continuity of commercial land use as the major criterion for division (see Map 3-2 for commercial land use). The first subsection runs west from Memorial Boulevard to Strathcona Street. In this subsection, commercial development is continuous along both sides of the street except for two blocks of land on the south side of Portage between Canora Street and Home Street that are devoted to park utilities.

In fact, this stretch of business ribbon is a natural extension of the central business district (CBD) westward to the Polo Park shopping center. It is confined within the boundary of the City of Winnipeg

proper, has the longest history in commercial development of all the study area and has the highest intensity of business land use in the study area (Table 3-7). The total length of this interval is about two miles and its functional composition is shown as in Table 3-3.

In this interval, Finance(10), Automotive(7), and Other retail(9) are found to be the most numerous in terms of the number of establishments. These three business classes combined constitute 44.4% of all the business outlets in this area. Individually, Finance(10) alone accounts for 18.37% of the total number of establishments. Automotive(7) has the second largest number of outlets, accounting for 13.24%. The establishments are fairly evenly distributed on both sides of the street. The breakdown for each class shows a similar pattern of distribution of outlets on both sides of the street in most cases. Only Business service(12) and Automotive(7) have a greater proportion of outlets (greater than 65%) located on the inbound lane(south side).

(ii) Queen to Woodlawn

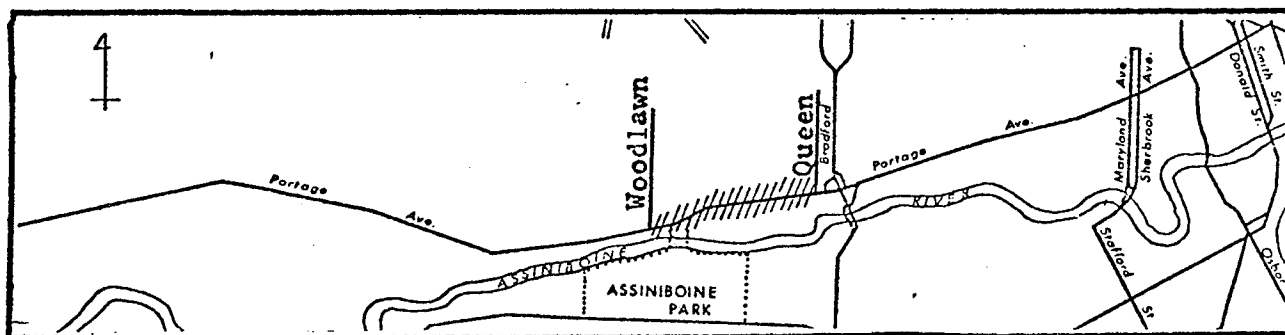


Table 3-3

Section 1 (Memorial to Strathcona)
 Business Composition: Number of
 Establishments and Percentages

Business Class	Inbound (South)	Outbound (North)	Total	%
Food stores (1)	5	6	11	4.72
Eating places (2)	10	10	20	8.58
General merchandise (3)	1	0	1	0.42
Apparel, accessories (4)	6	5	11	4.72
Furniture, appliance (5)	7	6	13	5.57
Lumber, Hardware (6)	2	5	7	3.00
Automotive (7)	19	12	31	13.30
Drug stores (8)	1	4	5	2.14
Other retail (9)	15	15	30	12.87
Finance (10)	22	21	43	18.45
Personal service (11)	10	11	21	9.01
Business service (12)	13	2	15	6.43
Professional service (13)	6	9	15	6.43
Household repair (14)	3	2	5	2.14
Entertainment, Recreation (15)	1	4	5	2.14
Hotels (16)	0	0	0	0.00
Total	121	113	234	100.00

Source: Field work, 1971

Table 3-4

Section 2 (Queen to Woodlawn)
 Business Composition: Number of
 Establishments and Percentages

Business Class	In-bound (South)	Out-bound (North)	Total	%
Food stores (1)	0	6	6	4.91
Eating places (2)	0	11	11	9.01
General merchandise (3)	0	2	2	1.63
Apparel, accessories (4)	1	2	3	2.45
Furniture, appliance (5)	1	13	14	11.47
Lumber, Hardware (6)	0	3	3	2.45
Automotive (7)	3	5	8	6.55
Drug stores (8)	0	3	3	2.45
Other retail (9)	0	15	15	12.29
Finance (10)	2	13	15	12.29
Personal service (11)	1	15	16	13.11
Business service (12)	0	2	2	1.63
Professional service (13)	7	9	16	13.11
Household repair (14)	0	2	2	1.63
Entertainment, Recreation (15)	0	4	4	3.27
Hotels (16)	0	2	2	1.63
Total	15	107	123	100.00

Source: Field work, 1971

Between Strathcona and Queen Street, the commercial land use intensity has been relatively low. This section of Portage, as viewed from the land use map, shows a lack of spatial continuity of business development and can be regarded as a break between the business subsections east of Strathcona and west of Polo Park. The second subsection of ribbon development on Portage runs west from Queen Street to Woodlawn Avenue.

Within this interval, the length of which is approximately 1.3 miles, commercial development is continuous on the north side of the street. The south side of the street is largely occupied by residential structures, both apartment blocks and single family units. Commercial activities on this side of the street are to be found only within a five block section bounded by Riveroaks and Assiniboine Avenue.

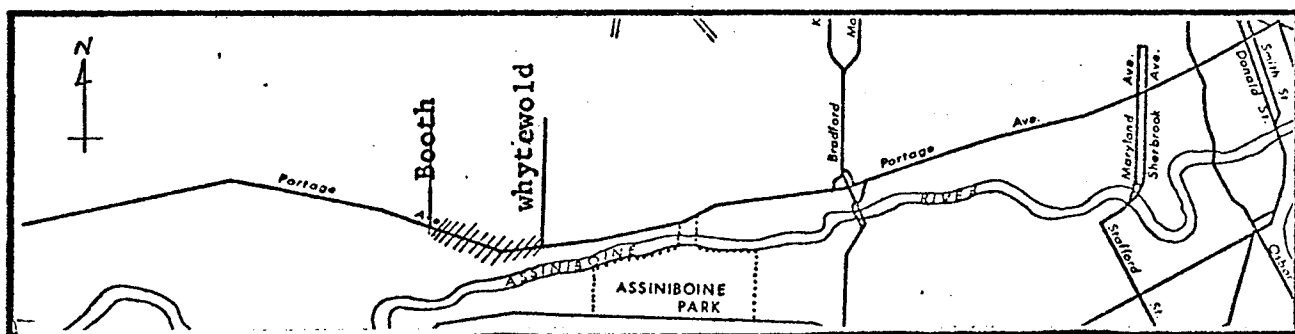
Table 3-4 lists the business composition of this subsection. Finance(10), Personal service(11), Professional service(13), Furniture, appliance(5), and Other retail(9) are the most numerous business functions. They constitute 62.0% of the total establishments. A concentration of establishments of the Furniture and appliance(5) is noted where almost one half (14 out of 32) of the outlets of this functional class in the whole study area are found located within this interval.

The number of business establishments in this section of Portage totalled 122 and 107 of them located on the north side of the street.

This phenomenon could be attributed to two factors. First, the physical characteristics of the surrounding area could be the major factor of such an uneven distribution. In this stretch of Portage Avenue, the Assiniboine River runs to within a few hundred feet on the south, prohibiting the development of a substantial local market. In this respect it is noteworthy that all food stores in this segment are located on the south side.

In addition, the extended distance from the CBD and the reduced inbound traffic flow west of the St. James interchange make the probability of inbound stop-overs here during the journey to work quite unlikely. Shopping has to be restricted to the homeward bound traffic. This indeed prohibits, to a certain degree, a successful business operation on the inbound side of the major traffic artery.

(iii) Whtewold to Booth



Proceeding westward from Woodlawn Avenue the commercial land use tends to give way to residential uses. Between Woodlawn and Whytefold, residential is the major form of land use. Business development is only observed in the Silver Height shopping center, which is excluded from this study, and within two blocks of land bounded by Sharp Avenue and Cornwall Street (Map 3-2). At this point, Portage comes to its closest proximity to the Assiniboine River and at some points the river is only two to three hundred feet away from the street. Throughout the interval, space for residential development south of the street is severely restricted, as is the scope for any intensive commercial development on this side.

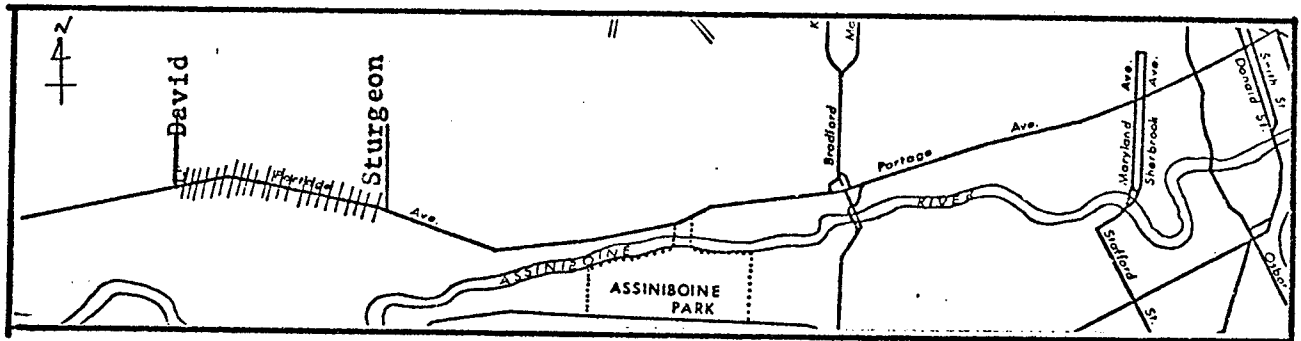
Beginning at Whytefold, commercial land use is continuous until it reaches Booth Drive. This interval, about one mile in length, is regarded as the third business subsection on Portage. The majority (greater than 80%) of the business establishments in this interval are located on the north side of the street (Table 3-5). Land use on the south side is dominantly residential, with only 16 commercial outlets. Among these 16 establishments, six of them belong to the Personal service(11) and three are Professional service(13) functions. Similar to the preceeding subsection, no outlets of the Food stores(1) and Eating places(2) are located on this side of the street. For the interval as a whole, Personal service(11) is the most prominent business class which constitutes 19.76% of all the business establishments here. Other major business classes include Professional service(13.95%), Finance (10.46%), Other retail (10.46%) and Food stores (9.3%).

Table 3-5

Section 3 (Whytefold to Booth)
 Business Composition: Number of
 Establishments and Percentages

Business Class	In-bound (South)	Out-bound (North)	Total	%
Food stores (1)	0	8	8	9.30
Eating places (2)	0	7	7	8.13
General merchandise (3)	0	0	0	0.00
Apparel, accessories (4)	0	2	2	2.32
Furniture, appliance (5)	0	2	2	2.32
Lumber, Hardware (6)	0	1	1	1.16
Automotive (7)	2	5	7	8.13
Drug stores (8)	0	4	4	4.65
Other retail (9)	2	7	9	10.46
Finance (10)	1	8	9	10.46
Personal service (11)	6	11	17	19.76
Business service (12)	0	6	6	6.97
Professional service (13)	3	9	12	13.95
Entertainment, Recreation (15)	1	0	1	1.16
Household repair (14)	0	0	0	0.00
Hotels (16)	1	0	1	1.16
Total	16	70	86	100.00

Source: Field work, 1971

(iv) Sturgeon to David

The final subsection runs west of Sturgeon to David Street. Business land use here is not as continuous as in the preceeding three subsections. Westwood shopping center, which serves as the major shopping center for residents in this rapidly developing residential area of winnipeg, is located within this interval. The Westwood shopping center, is in fact composed of three different shopping centers.¹⁰ Their functional composition are all excluded in this study.

The business composition of this subsection, excluding those of Westwood Shopping center, is tabulated and is shown in Table 3-6. The table indicates a fairly even distribution of establishments on both sides of the street. Almost every business class is represented here. Automotive(7) has the largest number of business establishments. Other prominent business classes include Personal service (15.51%), Food stores (10.34%), Eating places (12.06%), and Professional service (10.43%). Another feature to be noted is that one-half of the Hotels(16) on Portage

10. See footnote 5 in section 3-1.

are located in this interval.

The business intensity of this subsection is the lowest among all four subsections (Table 3-7). This is understandable since the location of this interval of business district is at the edge of the city which usually has a lower intensity of business land use than places closer to downtown.

Table 3-7 gives a summary of some important features of these four business subsections on Portage. The table shows that, in general, the density of business establishments per linear mile decreases as the distance away from CBD increases. The major business classes to be found within interval also show a change as distance away from CBD increases. In the first subsection, where it is closest to the CBD, Finance(10), Automotive(7) and Other retail(9) are dominant. Personal service(11) and Professional service(13) seem to emerge as dominant classes as the distance from CBD increases. The emergence of these two classes as the leading functions in subsections 2 and 3 is mainly due to the fact that they are business types catering to the adjacent residential area (St. James). The Automotive(7) class, mainly gas stations, comes into prominence as one approaches the periphery of the city.

Table 3-6

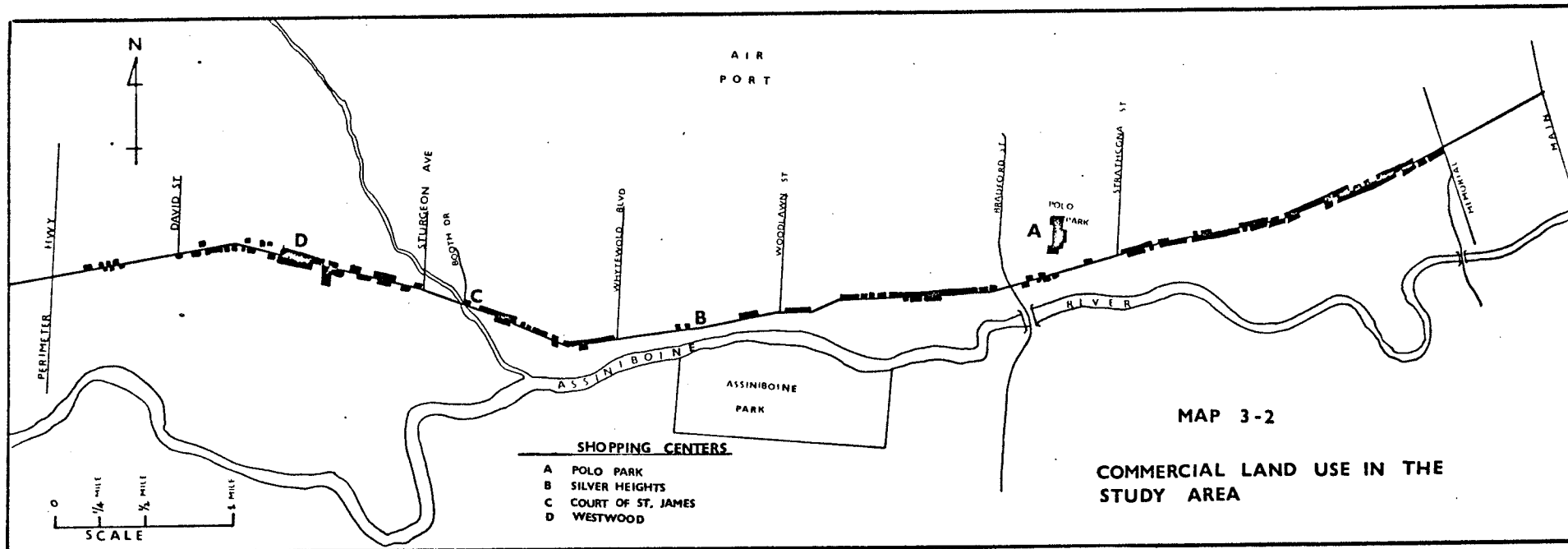
Section 4 (Sturgeon to David)
 Business Composition: Number of
 Establishments and Percentages

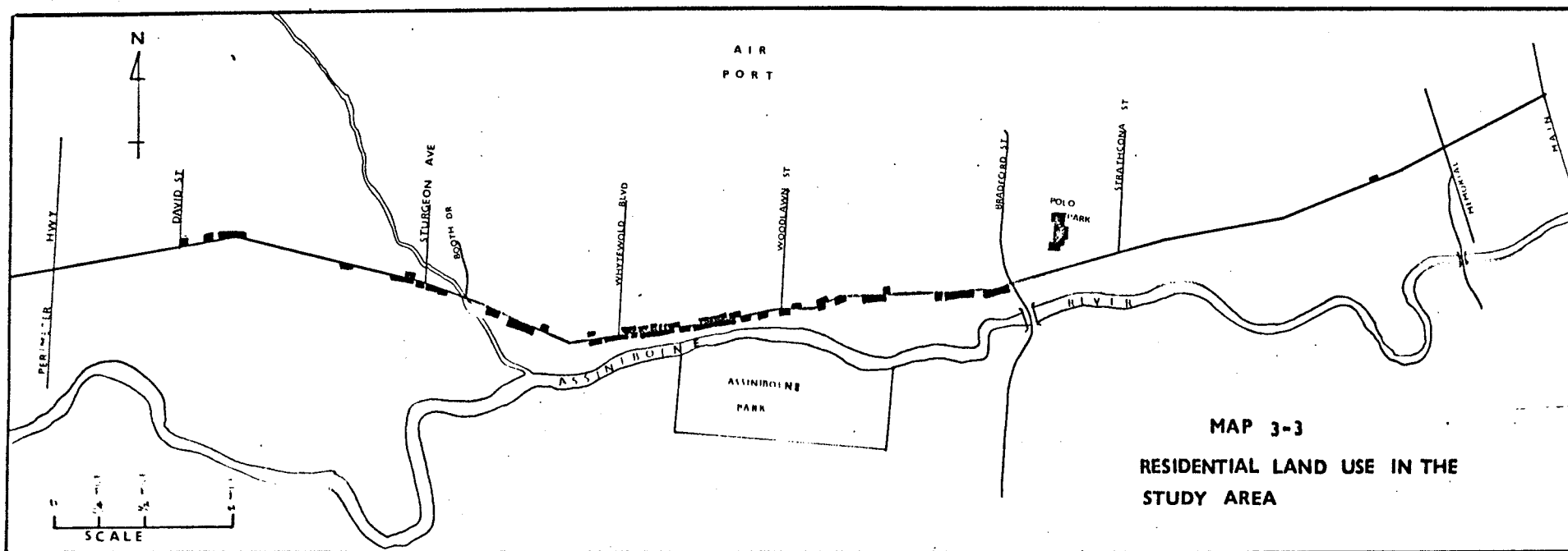
Business Class	In-bound (South)	Out-bound (North)	Total	%
Food stores (1)	3	3	6	10.34
Eating places (2)	5	2	7	12.06
General merchandise (3)	1	0	1	1.72
Apparel, accessories (4)	1	1	2	3.44
Furniture, appliance (5)	3	1	4	6.89
Lumber, Hardware (6)	0	2	2	3.44
Automotive (7)	6	5	11	18.96
Drug stores (8)	0	1	1	1.72
Other retail (9)	0	2	2	3.44
Finance (10)	1	1	2	3.44
Personal service (11)	5	4	9	15.51
Business service (12)	0	0	0	0.00
Professional service (13)	6	0	6	10.34
Household repair (14)	0	0	0	0.00
Entertainment, Recreation (15)	0	0	0	0.00
Hotels (16)	3	2	5	8.62
Total	24	34	58	100.00

Source: Field work, 1971

Table 3--7 Subsections of Business Districts on Portage Avenue

Subsection	Starts	Ends	Length	Number of Establishments	Density per Linear mile	Major Business Classes
1	Memorial	Strathcona	1.91 mi.	233	121.98	Finance(10), Auto- motive(7), Other retail (9)
2	Queen	Woodlawn	1.30 mi.	123	91.97	Personal service(11), Prof. service(13), Finance(10), Other retail(9), Furniture(5)
3	Wytewold	Booth	0.91 mi.	86	94.71	Personal service(11), Prof. service(13), Finance(10), Other retail(9)
4	Sturgeon	David	1.43 mi.	58	40.85	Automotive(7), Personal service(11), Prof. service(13) Eating places(2), Food stores(1)
Total strip				521	65.13	





3 - 4 Spatial Patterns of Business Establishments

(A) Percentile Value Analysis

This section examines the spatial pattern of business establishments of each functional class on Portage Avenue. In the first part (section 3-4(A)), the spatial pattern is examined by means of graphic analysis of the percentile value of each of the 16 business classes. Establishments that belong to the same class are arrayed according to their distance away from the origin point of the study area (intersection of Portage Avenue and Memorial Boulevard). Their ribbon locations are then plotted against the cumulative percentage of business units in the study area. The resulting series of graphs (Figures 3-1 to 3-7) provides the basis for analysis of the spatial character of each business class. The vertical dotted line in the graphs represents the mid-point and is located approximately 4.1 miles west of the origin point. The intersection of the mid-point with the cumulative percentage curve shows the percentage of business units of that business class located east or west of the mid-point on Portage Avenue. If the linear distribution of a business class is equally distributed on both sides of the mid-point of the artery, then the mid-point would intersect at the 50% mark of the cumulative percentage curve. A displacement away from the 50% mark would indicate that the distribution is concentrated either towards the origin or the end of the artery. In this study, the displacement would mean either the distribution pattern is biased towards the downtown area or the fringe of the city.

On the basis of the data at hand, four types of curves seem to exist distinctly. These general kinds of spatial patterns can be conceived as a typology of business classes which are ordered by their relation to traffic on the ribbon:

- (I) Heavy downtown orientation (with 80% or more of its business units located east of the mid-point). Business classes of this type include Recreation and Entertainment(93%), Household repair(85%), Finance(84%), Business service(81%), and Apparel and accessories stores(80%).
- (II) Slight downtown orientation (with 60% to 80% of its business units located east of the mid-point). Business classes in this category include Other retail(78%), Lumber and Hardware (77%), Eating places(68%), Automotive(67%), Drug stores(66%), and Personal service(63%).
- (III) No orientation (with 40 % to 60% of its business units located east of the mid-point). Businesses of this type include Professional service(51%), and Food stores(58%).
- (IV) Fringe orientation (with less than 40% of its business units located east of the mid-point). Businesses in this category include only Hotels and Motels(39%).

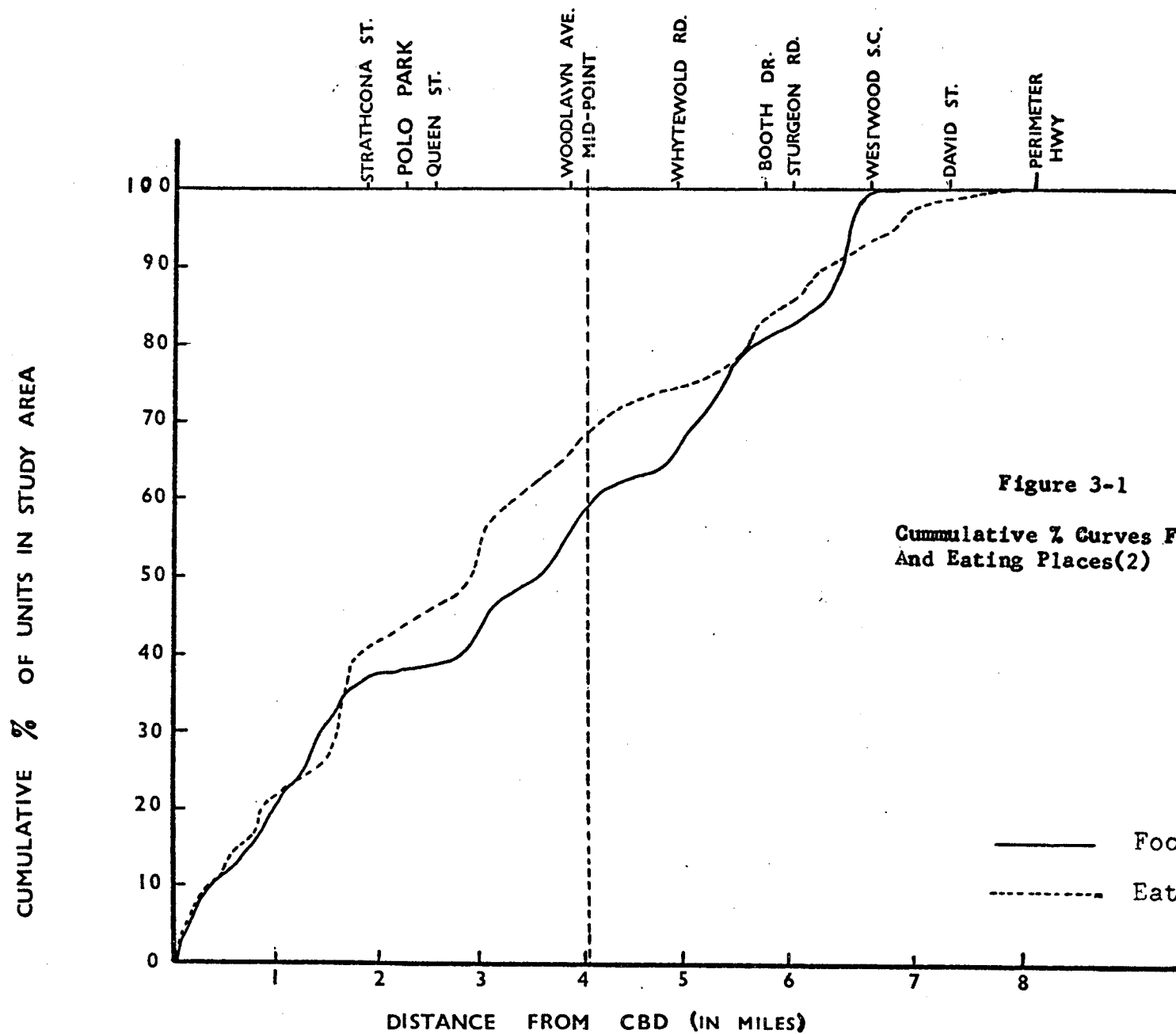
For these four kinds of pattern to have meaning as a typology of business classes, some interpretation of their relation to the ribbon and its function must be provided which applies for each class of a particular pattern. Concentration of establishments near the CBD, or downtown, could result from a necessity to contact maximum in- or

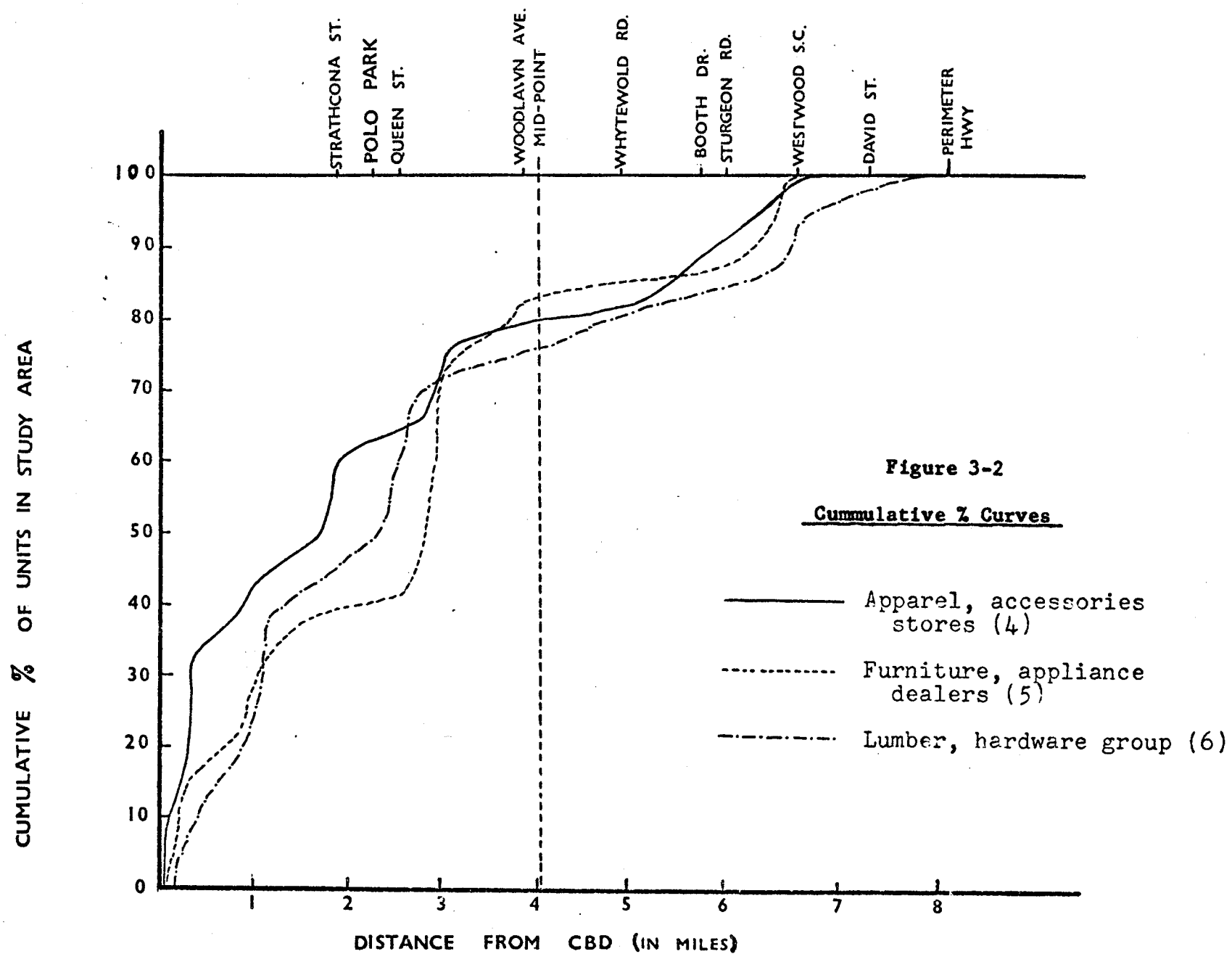
outflow traffic volume as well as a necessity for access to the entire urban network, as in the classic argument on urban land rent. In the case of mobility-oriented establishments, locations on major ribbons near the CBD would provide adequate network connections to the entire urban area, and thereby avoid the image of neighborhood-oriented services.

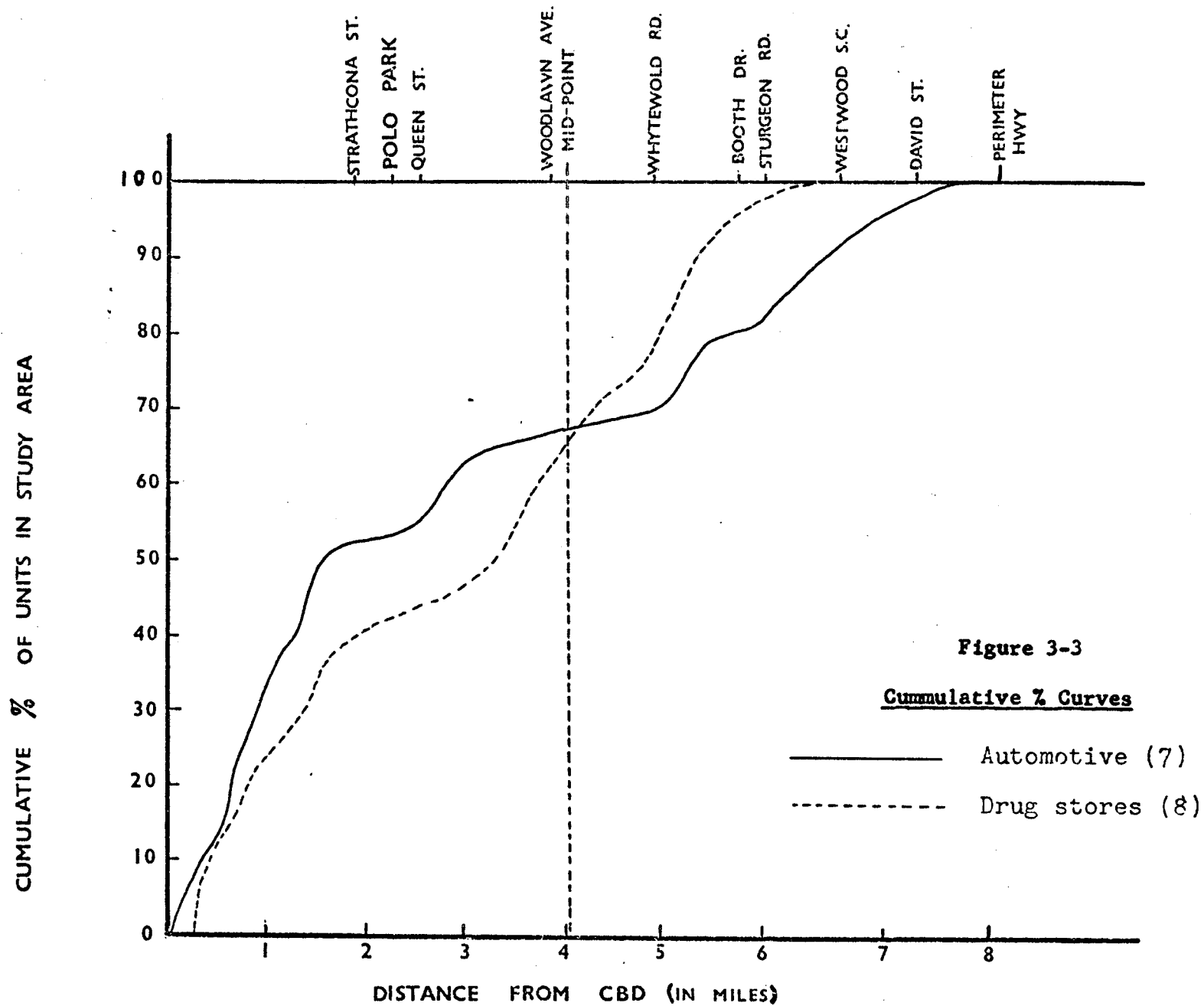
Firms that are neighborhood-oriented are expected to locate close to their market area, and thereby no preference for downtown or fringe orientation should be discerned in this type of business class. Food stores and Professional service (especially medical and dental services) are basically businesses of this nature and their spatial patterns on ribbon conform to the expectation.

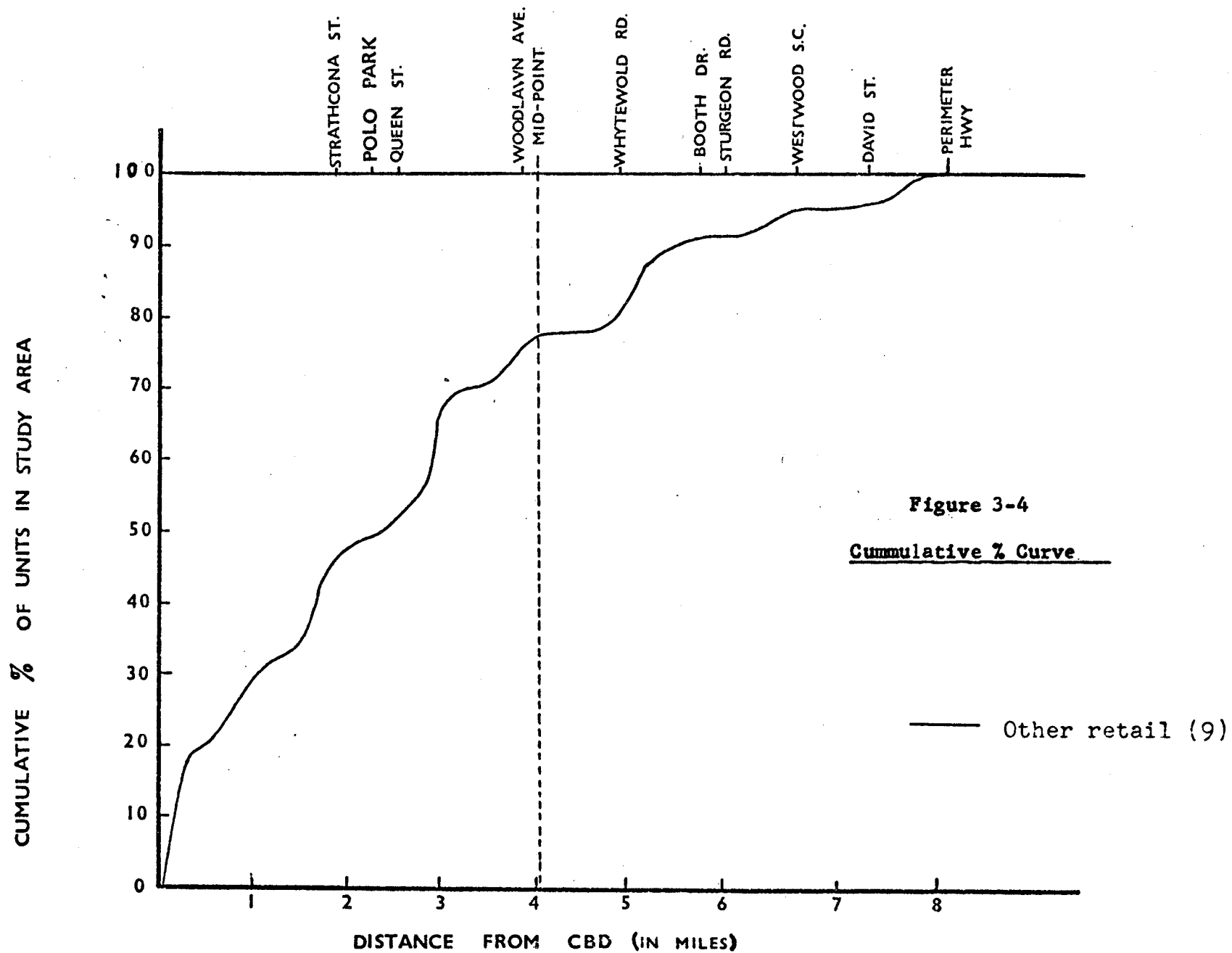
Fringe orientation provides the maximum proximity to inflow traffic from out of town. Hotels and motels are the businesses that will benefit most from this location on ribbon and their relation to the inflow traffic is confirmed by their locational pattern on Portage Avenue.

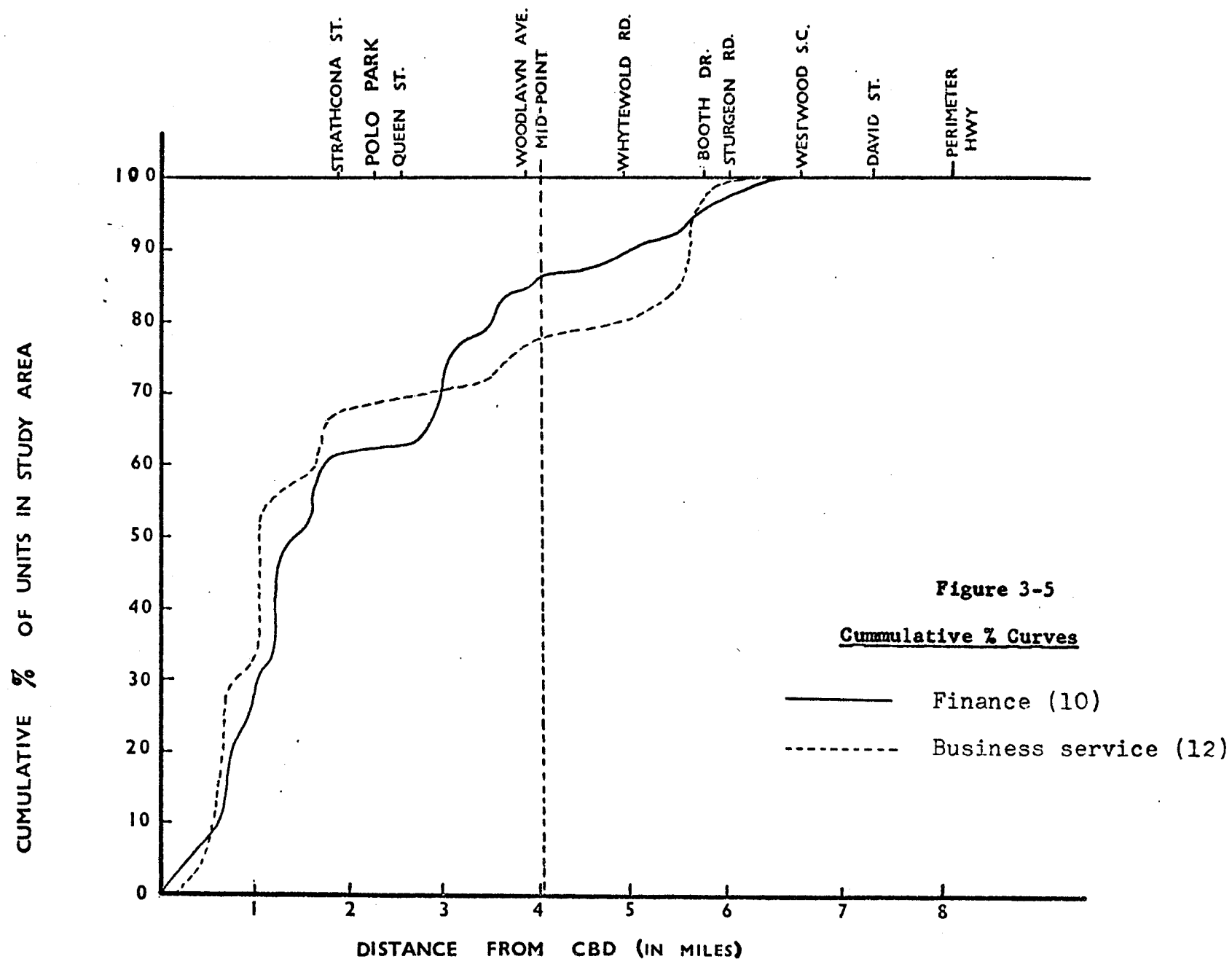
Although the above typology of business classes are based merely on observations of the cumulative percentage curves, it nevertheless poses several hypotheses for testing in any future study of ribbon commercial structure. The question of to what extent the business's spatial pattern on the ribbon is influenced by the factor of more accessibility to passby traffic warrants further investigation. From the point of view of the entrepreneur, one might ask how the ribbon and its alternatives are perceived^e regarding access, land rent, servicing, and zoning.

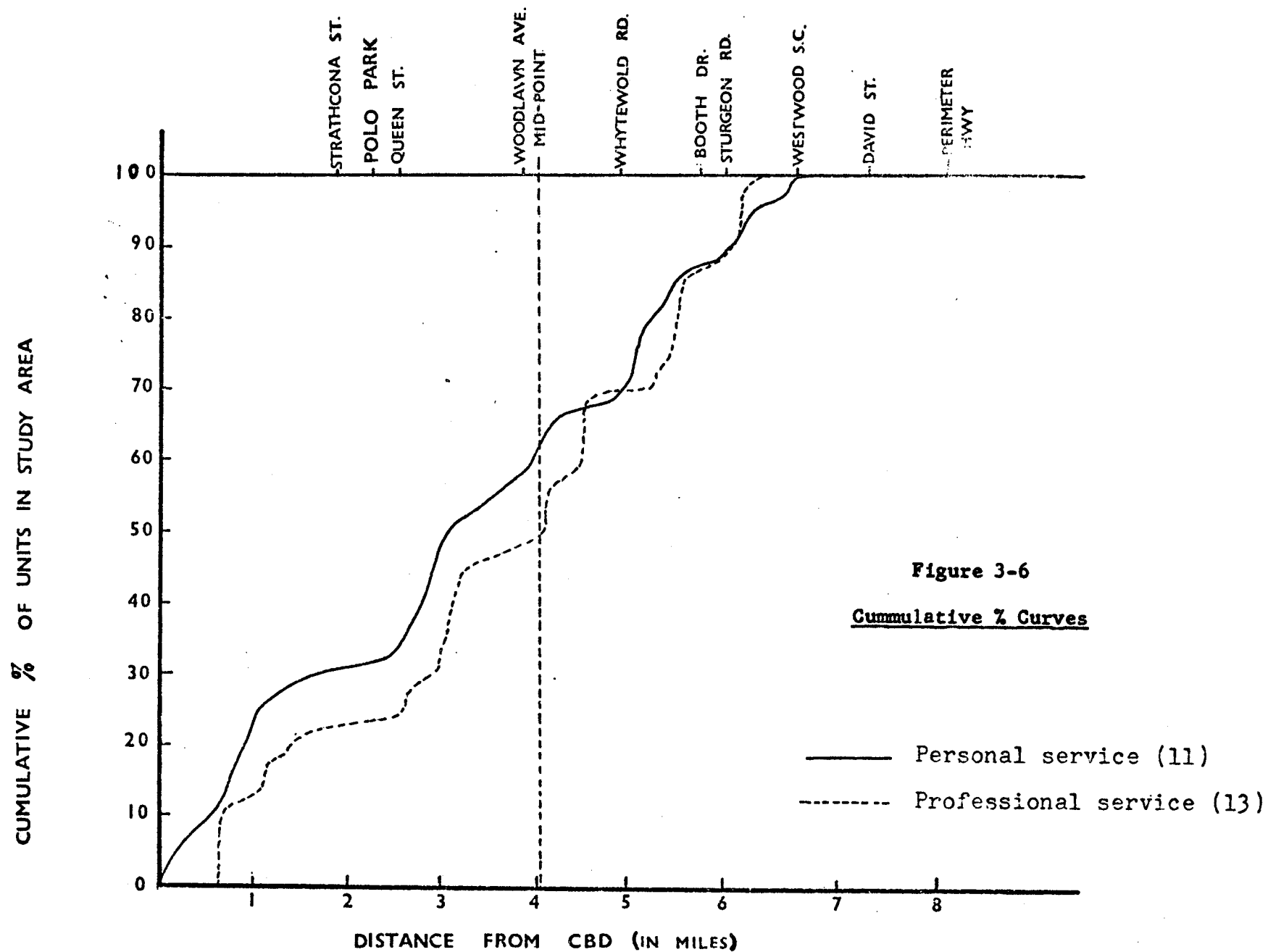


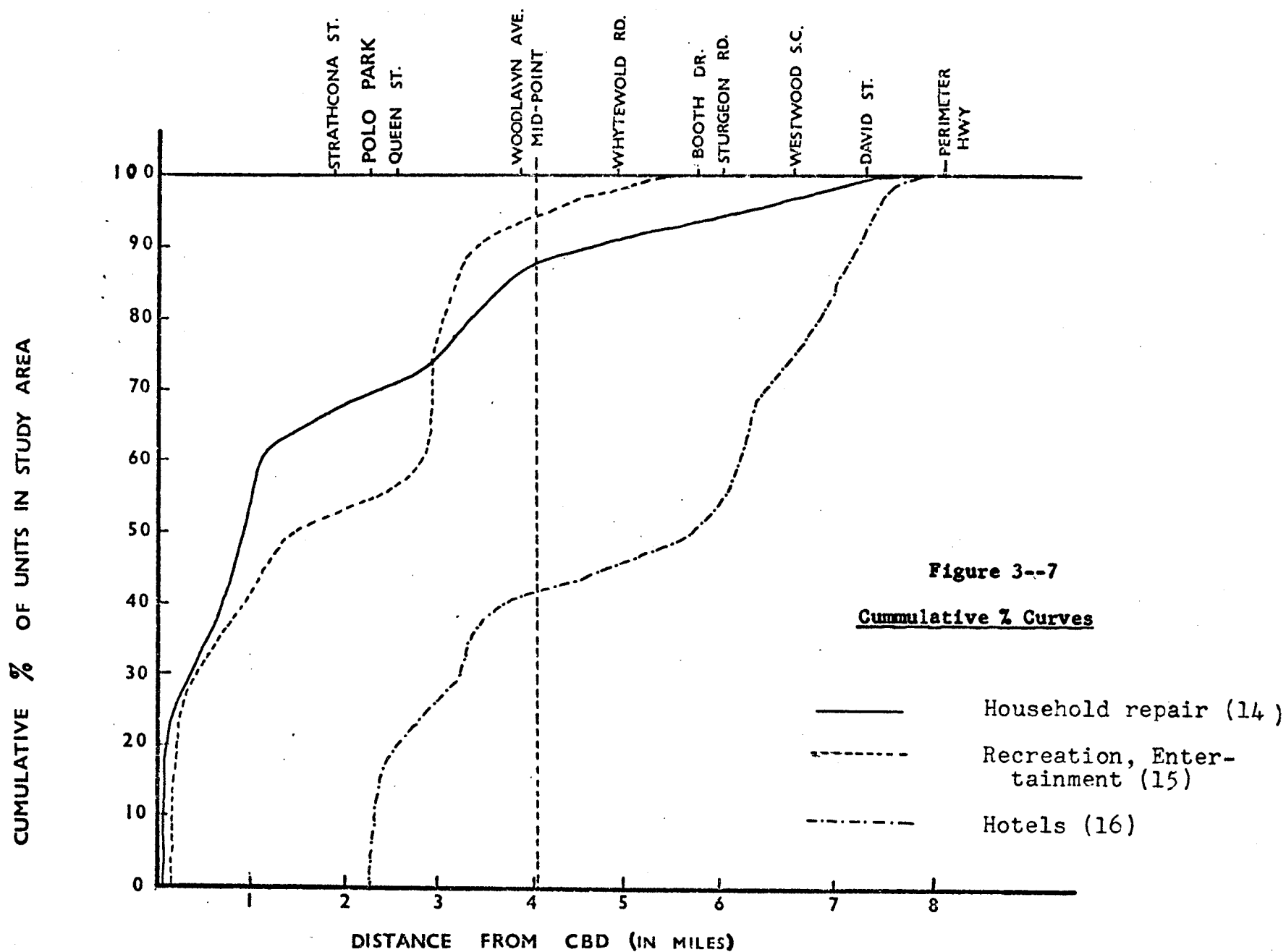












(B) Test of Randomness of Spatial Point Patterns

The locational pattern of business establishments on Portage Avenue is examined here by detecting the randomness of the distribution pattern. To say that a distribution of business establishments is random, in a non-technical sense, is to say that the pattern has no discernable order and that cause of the pattern is undeterminable. In the terminology of mathematical statistics, the term "random" has a precise meaning which refer to the generating process of a random pattern, and the random pattern is a realization of a random process. A random process is synonymous with pure chance since each event has an equal chance of occurrence. In terms of the pattern of business establishment along an urban artery, pure chance means that each unit length (or possible location) of the artery has an equal probability of receiving an establishment. In reverse, each establishment has an equal probability of being located on each unit length. In addition, the events generated in a random process are mutually (statistically) independent. That is to say that the probability of each unit length receiving a store would not be affected ^{by} the prior location of stores nearby, or, strictly speaking, in the same place. Because the number of establishments of any one kind is small with respect to the number of possible locations, the probability of two events having the same address is sufficiently small to warrant using this model to define the expectation of a "random" location process.

It is unlikely that geographic distributions, particularly locational patterns involving human decision-making, are the results of

equi-probable events. Hence, it is expected that most spatial patterns reflect some system or order. For each business class, the dominating locational factors should tend to distort the distribution toward a clustered or evenly-spaced pattern.

Although existing geographic theory does not lend strong support to what forces give rise to clustering or even distribution of certain establishments, previous findings in urban commercial studies do give us some notion of expectation in this matter. They reveal that shopping-type establishments have a tendency to cluster as to facilitate comparative shopping on a single shopping trip, whereas goods that belong to a lower order, i.e. convenience-type goods, tend to be more uniformly distributed since comparative shopping for convenience-goods is not a common practice.¹¹

A random distribution of establishments would occur only if the generating process is random. This implies that the locational decisions are, individually and severally, the result of many factors, none of which strongly dominates the others. A test of randomness provides a norm against which empirical patterns can be measured for detecting the presence of dominating locational factors. The type of test used here is the analysis of order neighbor distances where statistics derived from empirical spatial patterns will be compared with expected values from a random distribution. Before analysing the pattern of commercial

11. W.L. Garrison, et.al., Studies of Highway Development and Geographic Change (Seattle: University of Washington Press, 1959).

establishments on Portage Avenue by means of order neighbor distances, a brief discussion of the development of this method in geographic literature is in order.

Much of the recent interest in spatial point pattern analysis via order nearest neighbor distances has resulted from the work of two plant ecologists, Clark and Evans (1954). In their original study they derived a formula for the mean expected distance to the nearest neighbor of each point in a randomly dispersed population of specified density. They then derived an index, R , for measuring the departure from randomness. This index, R , is defined as the ratio of the observed mean nearest neighbor distance to the mean expected nearest neighbor distance of a randomly dispersed population. Their analysis considered the first order nearest neighbor only, whereas second (the second closest) and higher orders were mentioned as being potentially useful in pattern description.

In a subsequent analysis, Clark (1955) explored the utility of applying the concept of reflexivity to analyze grouping in spatial distribution. By determining the proportion of points with a reflexive nearest neighbor,¹² Clark estimated the degree to which groups of points are isolated. He interpreted isolation as indicative of aggregated distribution and decreased isolation as representing a tendency towards uniformity.

12. Reflexive nearest neighbor is defined as points which are the nearest neighbor of their nearest neighbor.

Clark and Evans (1955, p.397) have also investigated the proportion of individuals serving as the nearest neighbor to one or more individuals. On their investigation of reflexivity (1955), they analysed patterns for successively higher order neighbor distances. Their work has contributed significantly to the ability of scientists to study spatial patterns.¹³

Generalizing Clark and Evans' procedure for measuring departures from randomness in first order neighbor distribution patterns, Thompson (1956, p.391) has provided the formulae for measuring departure from randomness in higher order patterns. He showed that distributions of higher order neighbor distances in a random pattern have a Chi-square distribution.

In the field of geography, Clark and Evans' work with first order nearest neighbor statistics to describe spatial point pattern has been followed by Dacey.¹⁴ As part of his extensive analysis of the relationship between actual and theoretical spatial patterns, Dacey (1963) has suggested the use of Chi-square statistics for analysing nearest neighbor distances for succeeding higher order neighbors. However, apart from Dacey's analysis of urban places in Iowa, very few other geographers have applied either j^{th} order nearest neighbor distances analyses or Chi-

13. Other early contributions along these lines are reviewed excellently in Greg-Smith (1964).

14. For a summary of Dacey's work, see L.J. King (1968, p. 89-92, 100-113).

square statistics to study randomness in spatial point patterns.¹⁵

Dacey generalized the nearest neighbor statistics up to j^{th} order and extended the applicability to a multi-dimensional space, where other studies were mostly restricted to spatial patterns of a two dimensional space, like, settlement patterns on a plain. The location of business establishments along an urban artery can be viewed as points along a line, i.e. a one dimensional space. By appropriate substitution, Dacey's (1963) method may be applied directly to study the spatial patterns of business types distributed along Portage Avenue.

Dacey shows that the expected mean distance from a point i to the j^{th} nearest neighbor in a k -dimensional space of random pattern is as follows:

$$E(r_{jk}) = \frac{\Gamma\left(\frac{kj}{k} + 1\right)}{(v_k d)^{1/k} (j-1)!} \quad (1)$$

where k = dimension of the space;

j = the order nearest neighbor;

Γ = gamma function (order neighbor distances belong to the gamma function);

d = density of points per unit content;

v_k = the mean frequency of points within unit k dimensional content; it is assumed that

15. Barr, Lindsay and Reinelt (1971) have been one of the very few studies that have used Chi-square and j^{th} order nearest neighbor distances analysis in this regard.

a random arrangement of point conforms to the Poisson distribution, accordingly,¹⁶ where for k even = 2 ,

$$v_k = \frac{\pi^\alpha}{\alpha!}$$

and k odd = $2\alpha + 1$

$$v_k = \frac{\pi^\alpha \alpha! + 2^k}{k}$$

Since in this study $k = 1$, equation (1) becomes,

$$E(r_{1j}) = \frac{\Gamma(j+1)}{(v_k d)(j-1)!} \quad (2)$$

where j = order neighbor;
 d = density;

$$v_k = \frac{\pi^\alpha \alpha! + 2^k}{k!} = 2$$

In the present study, the analysis is based on distances up to third order neighbors, as suggested by Dacey. He has stated that "experience with the method indicates that for any practical purposes an adequate analysis is based upon distances up to three or four order neighbors." (Dacey 1963, p.509).

16. For the detailed derivation of these parameters, see Dacey (1963, p. 510).

Therefore, $j=1,2,3$ are substituted into equation (2). The expected mean distance from point i to its first, second, and third nearest neighbor of a random point pattern are¹⁷:

$$E(r_{11}) = 1/2d$$

$$E(r_{12}) = 2/2d$$

$$E(r_{13}) = 3/3d.$$

Dacey (1963, p.505) has shown that order neighbor distances for a random distribution follow a Chi-square distribution. Accordingly, a Chi-square statistic may be used to detect the deviation of the spatial pattern from randomness. The appropriate statistic is given by Dacey as:

$$\chi_j^2 = kv_k d \sum_{i=1}^n (r_{ij}^k)^k \quad (3)$$

with njk degrees of freedom.

Where in this case $k=1$, then (3) becomes

$$\chi_j^2 = 2d \sum_{i=1}^n (r_{ij}) \quad \text{with d.f.} = nj \quad (4)$$

In cases where nj is greater than the tabulated χ^2 value, the normal approximation to χ^2 is used, viz.,

$$Z = ((2\chi^2)^{1/2} - (2N-1)^{1/2}) \quad (5)$$

where $N=d.f.$

17. For the detailed derivation of these equations, see Appendix II.

The above formulae provide the testing apparatus for the pattern of commercial establishments along Portage Avenue. For each business type, the null hypothesis that the distribution of point location on Portage Avenue is random is tested by use of the appropriate statistics above.¹⁸ At this stage, a word of caution is necessary before proceeding into the testing of hypotheses. As mentioned earlier in section 3-3, the business land use along Portage Avenue was found continuous only within the four subsections. If the ribbon is viewed as a whole, business establishments are clustered within these four subsections. In order to draw any meaningful conclusions, the testing of point patterns for each business type should be applied to each of these four subsections individually. Unfortunately such a testing procedure cannot be performed as the sample size of most business types within each subsection is too small to permit any meaningful inferences to be drawn. Hence, point patterns of business classes are tested here for the whole artery. Consequently, there is the *a priori* expectation of clustering.

For the sake of convenience, the procedures for testing the hypothesis of randomness for Food stores are illustrated and the same procedures are applied to the other eleven business types. First, the distance up to the third order nearest neighbor ($j=3$) for each business establishment in Food stores class were measured, subject to the restriction that the j nearest neighbor for the i th establishment was closer to i than i is to the boundary of the study area. The measurements were made on a base map of 1" to

18. See section 3-2 for the 12 business types used in these tests.

200 ' and the measurements made in centimeters. These distances were standardized.¹⁹ The standardized mean distances (\bar{r}_j) and the random expected mean distances ($E(r_j)$) are tabulated for j order nearest neighbor distances. χ^2 values for each of these j order distances are obtained by using equation (4). Table 3-9 lists all the tabulated statistics for the test of randomness in point pattern for Food stores on Portage Avenue. Since the degrees of freedom (N) for all three order nearest neighbor distances are greater than the tabulated χ^2 values, the normal approximation to χ^2 has to be used to detect the deviation from randomness. Standard units (Z) for each order neighbor distances obtained from the test show that they are all significant at the 0.05 level of confidence,²⁰ the null hypothesis of random point pattern for Food stores is rejected at this level of confidence.

Since departure from randomness implies a systematic distribution of objects, the point pattern is biased either towards a clustered or uniform distribution. The observed standardized mean distance (\bar{r}_j) is then compared with the expected mean distance ($E(r_j)$) of a random pattern. If $\bar{r}_j < E(r_j)$, the spatial point pattern was categorized^z as more grouped than random. In the reverse situation where $\bar{r}_j > E(r_j)$, the spatial pattern was said to be more regular than random (Dacey 1963, p.509). Tables 3-9 to 3-20 show that for all business types $E(r_j)$ are significantly larger than the \bar{r}_j for all three order nearest neighbor distances,

19. The standardized equation is given by Dacey (1963, p.510) as $r_j = R_j d$ where R_j = measured distance to the j th closest place and d = density of points per unit length.

20. For the 0.05 level of confidence the significant value is ± 1.96 for a two-tailed test.

hence, it was concluded that the 12 different business types under investigation had a more grouped than random point pattern on Portage Avenue. This relationship is true for order neighbor distances up to the third order. With the exception of a few classes, like drug stores, the above findings are collaborated by the distribution maps (Map 3-4 to 3-15). Each business type distribution does reveal some degree of clustering.

However, it is important to note that while the business type is more grouped than random does not necessarily imply that association between members of the same group is higher than with members of different groups. The relationship of spatial association of business establishments among different business classes are examined in further details in the next section of this chapter.

Table 3-9 Order Neighbor Statistics for Food Stores

j	n	$E(r_j)^{**}$	\bar{r}_j	$2d \sum_{i=1}^n r_{ij}$	N	Standard Unit
1	31	8.6206	1.2560	4.5159	31	-4.80
2	31	17.2413	3.3497	12.0454	62	-6.18
3	28	25.8620	5.3096	17.2457	82	-7.05

The statistics shown in the above table are as follows:

j = the order nearest neighbor;

n = the number of measurements made in j th order; measurements from each business establishment i is recorded only to those j nearest neighbors which are more closer to i than i is to the boundary;

$E(r_j)$ = the expected mean distance to the j th order neighbor in a random distribution;

\bar{r}_j = the standardized mean distance to the j th order neighbor;

$2d \sum_{i=1}^n r_{ij}$ = the value of Chi-square (see Appendix II),

N = degrees of freedom = nj (Appendix II);

Z = standard unit (Appendix II, equation (7)).

**

all the distance units shown in this table are in centimeters which based on measurements made on the base map of 1" to 200'.

Table 3 - 10 Order Neighbor Statistics for Eating Places

j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	$N=nj$	Standard units
1	46	5.4524	1.2802	10.3728	46	-4.98
2	46	10.9051	3.0192	25.2403	92	-6.38
3	45	16.3576	4.4977	36.4321	135	-7.87

Table 3 - 11 Order Neighbor Statistics for Furniture, Home Furnishing

j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	$N=nj$	Standard units
1	15	18.0180	0.4533	0.3774	15	-4.52
2	14	36.0360	0.6721	0.5222	28	-6.46
3	14	54.0540	1.1421	0.8874	42	-7.78

Table 3 -12 Order Neighbor Statistics for Gas & Service Stations

j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	N	Standard Units
1	31	8.4459	0.5387	1.9773	31	-5.82
2	30	16.8918	1.0260	3.6443	60	-8.21
3	29	25.3378	1.3886	4.7679	87	-3.62

Table 3-13 Order Neighbor Statistics for Auto Dealers

j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	N	Standard Units
1	19	14.2166	0.2820	0.3769	19	-5.21
2	19	28.4332	0.5991	0.8007	38	-7.39
3	16	42.6498	0.8466	0.9529	48	-8.36

Table 3 - 14 Order Neighbor Statistics for Drug Stores

j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	N	Standard Units
1	13	20.5761	3.9361	2.4869	13	-2.77
2	12	41.1522	6.3591	3.7087	24	-4.13
3	11	61.7283	8.3518	4.4649	33	-5.07

Table 3 - 15 Order Neighbor Statistics for Banks

j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	$N=nj$	Standard Units
1	28	9.3196	0.4552	1.3677	28	-6.25
2	27	18.6393	1.0130	1.7131	54	-8.63
3	27	27.9589	1.1994	3.4743	81	-10.82

Table 3-16 Order Neighbor Statistics For Real Estates

j	n	$E(r_j)$	\bar{r}_j	$2d\sum r_{ij}$	N	Standard Units
1	13	19.3050	0.4617	0.3109	13	-4.21
2	13	38.6100	0.5916	0.3984	26	-6.25
3	13	57.9150	0.9018	0.6073	39	-7.32

Table 3-17 Order Neighbor Statistics For Barber & Beauty

j	n	$E(r_j)$	\bar{r}_j	$2d\sum r_{ij}$	N	Standard Units
1	35	7.5030	0.1866	0.8704	35	-6.99
2	35	15.0060	0.6207	2.8956	70	-9.38
3	35	22.5090	1.1379	5.3084	105	-11.19

Table 3--18 Order neighbor Statistics for Physicians and Dentists

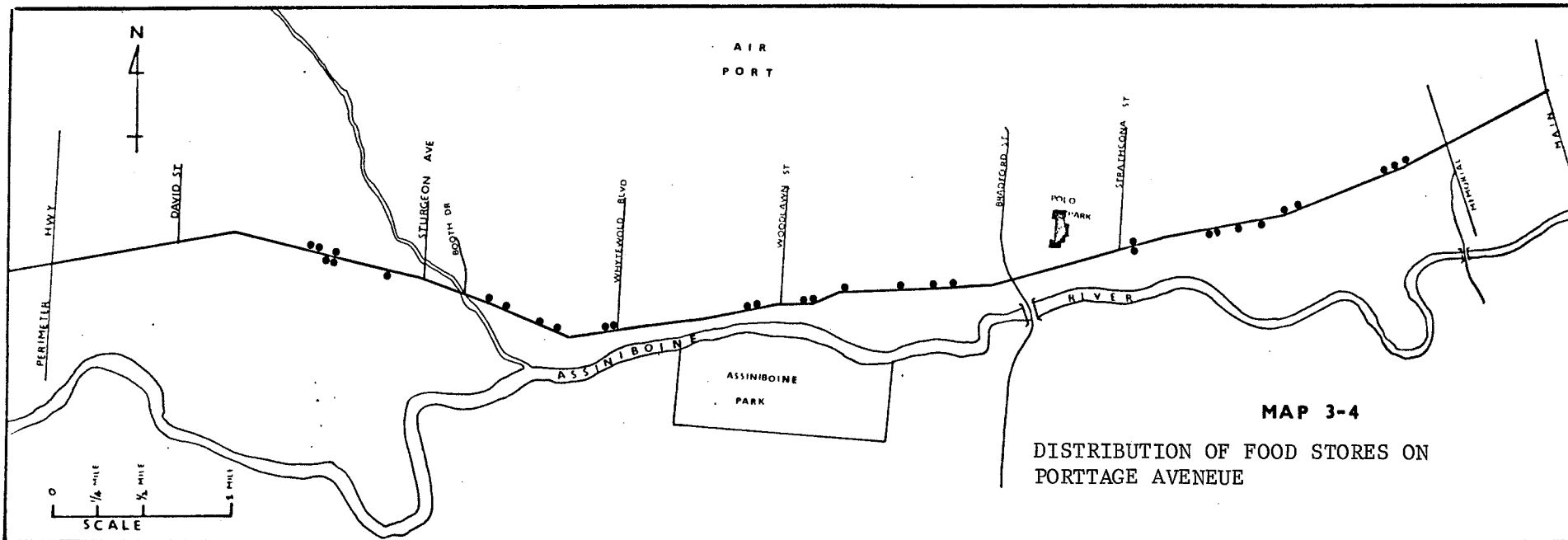
j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	N	Standard Units
1	36	5.7471	0.1750	1.0967	36	-6.64
2	36	11.4943	0.2662	1.6678	72	-10.12
3	36	17.2414	0.6539	4.0964	108	-11.80

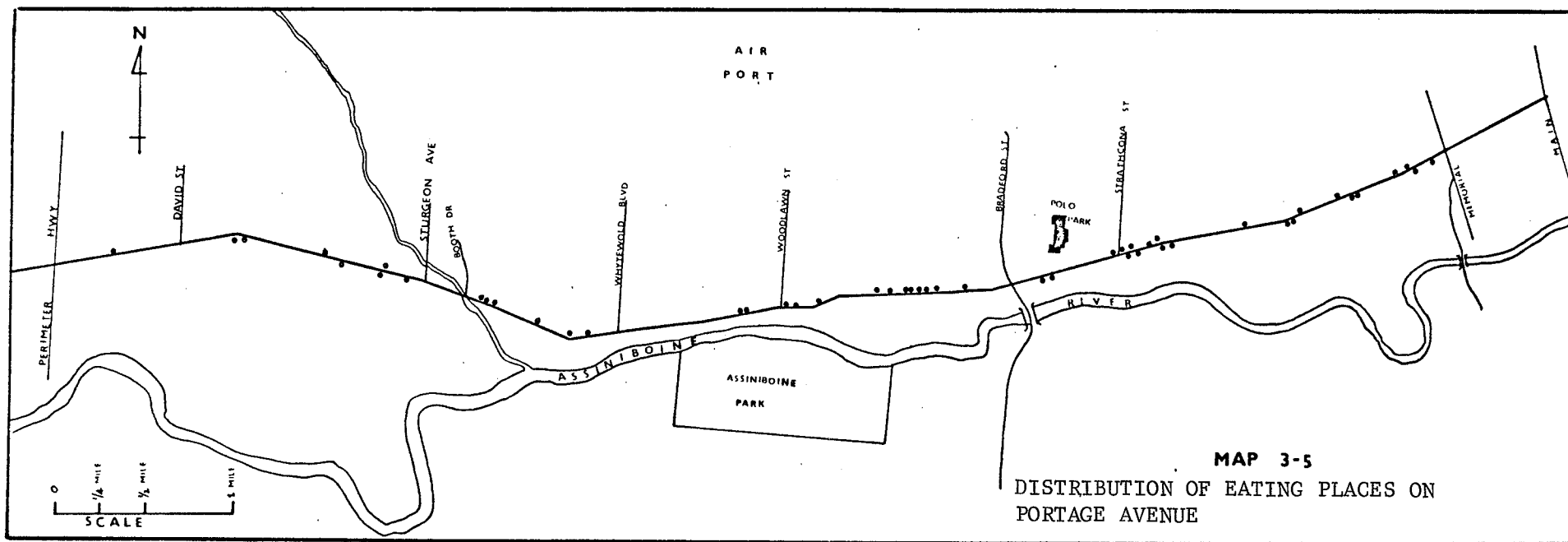
Table 3-19 Order Neighbor Statistics for Recreation

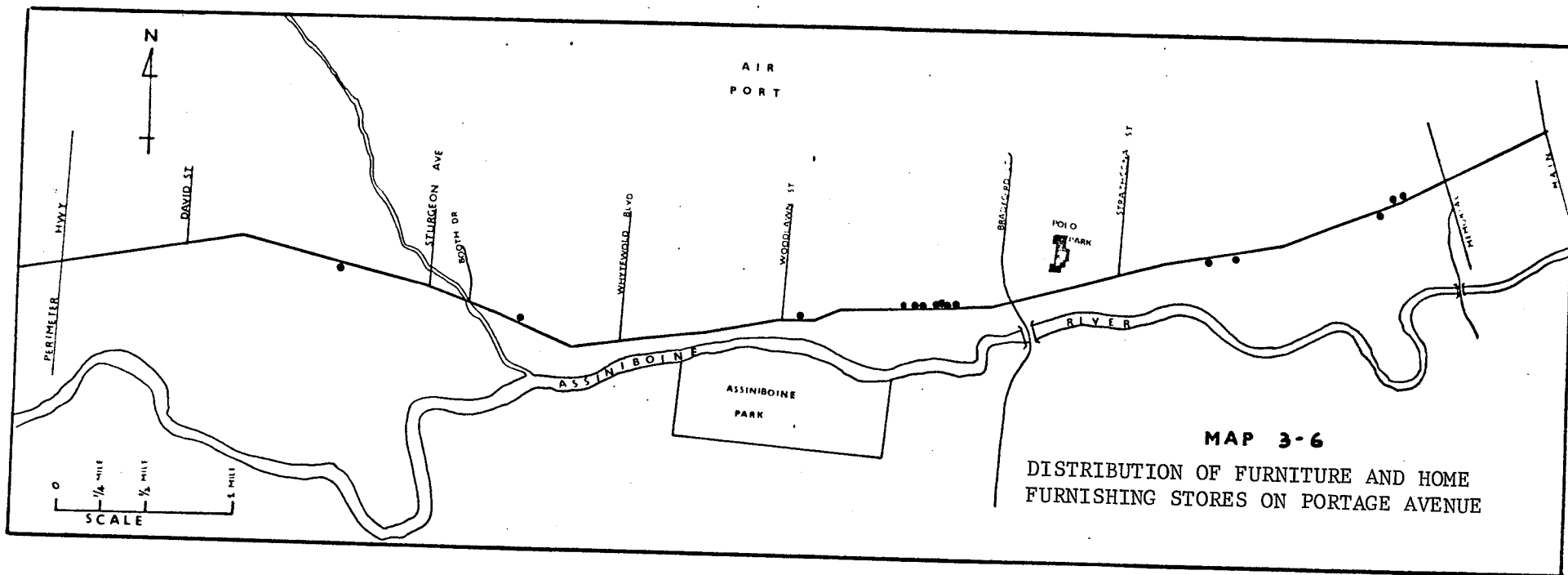
j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	N	Standard Units
1	9	29.7619	2.0589	0.6226	9	-3.01
2	9	59.5238	3.4044	1.0295	18	-4.48
3	6	89.2857	7.9683	1.6064	18	-4.12

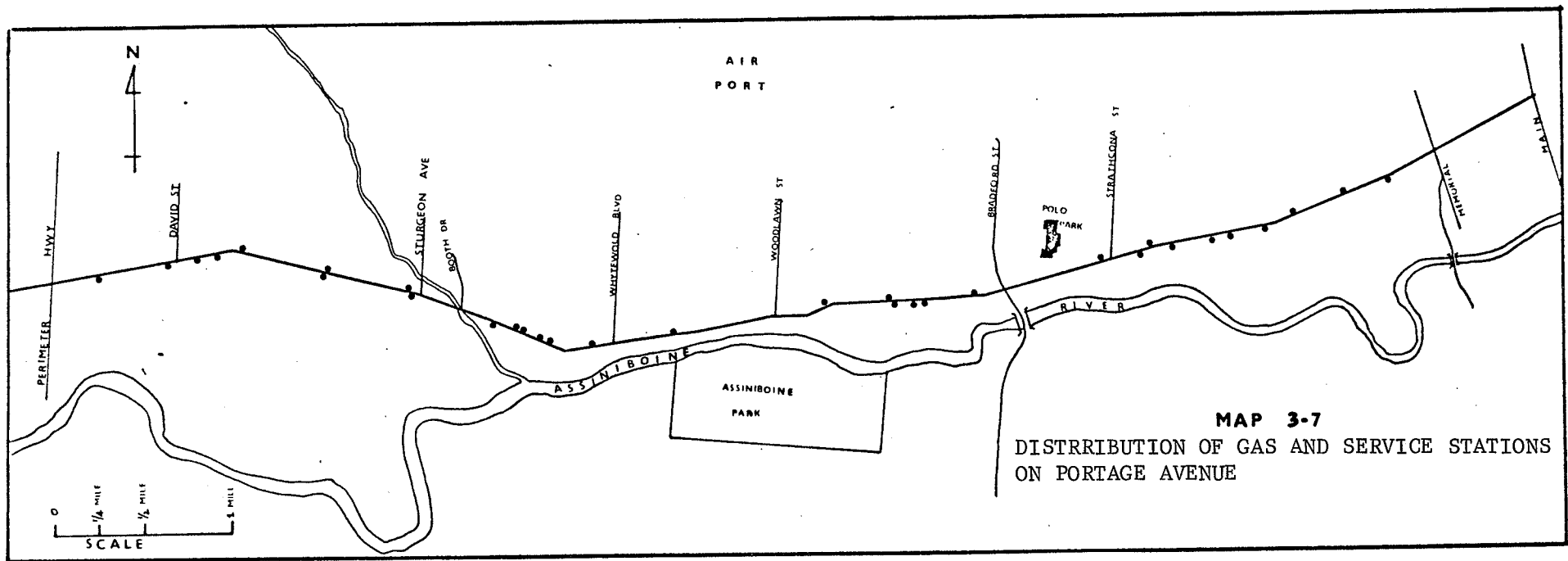
Table 3-20 Order Neighbor Statistics for Hotels

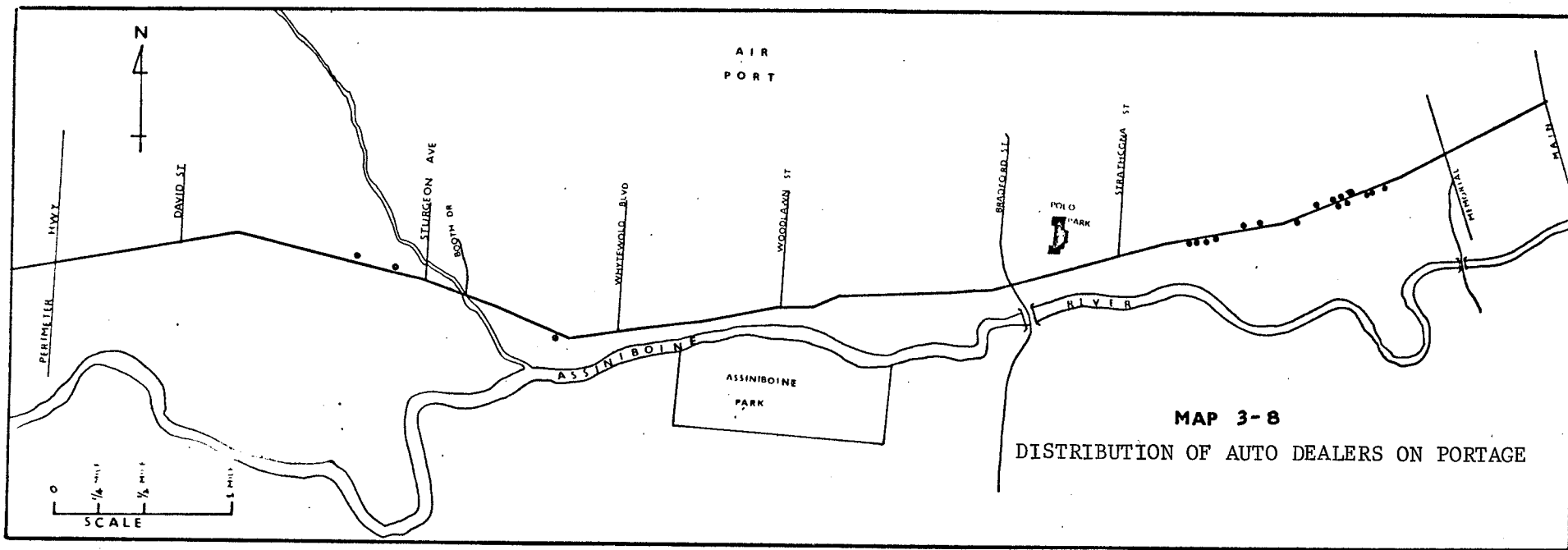
j	n	$E(r_j)$	\bar{r}_j	$2d \sum r_{ij}$	N	Standard Units
1	9	24.2718	1.6044	0.5949	9	-3.13
2	9	48.5436	7.9122	2.9339	18	-3.49
3	9	72.8155	9.2678	3.4356	27	-4.66

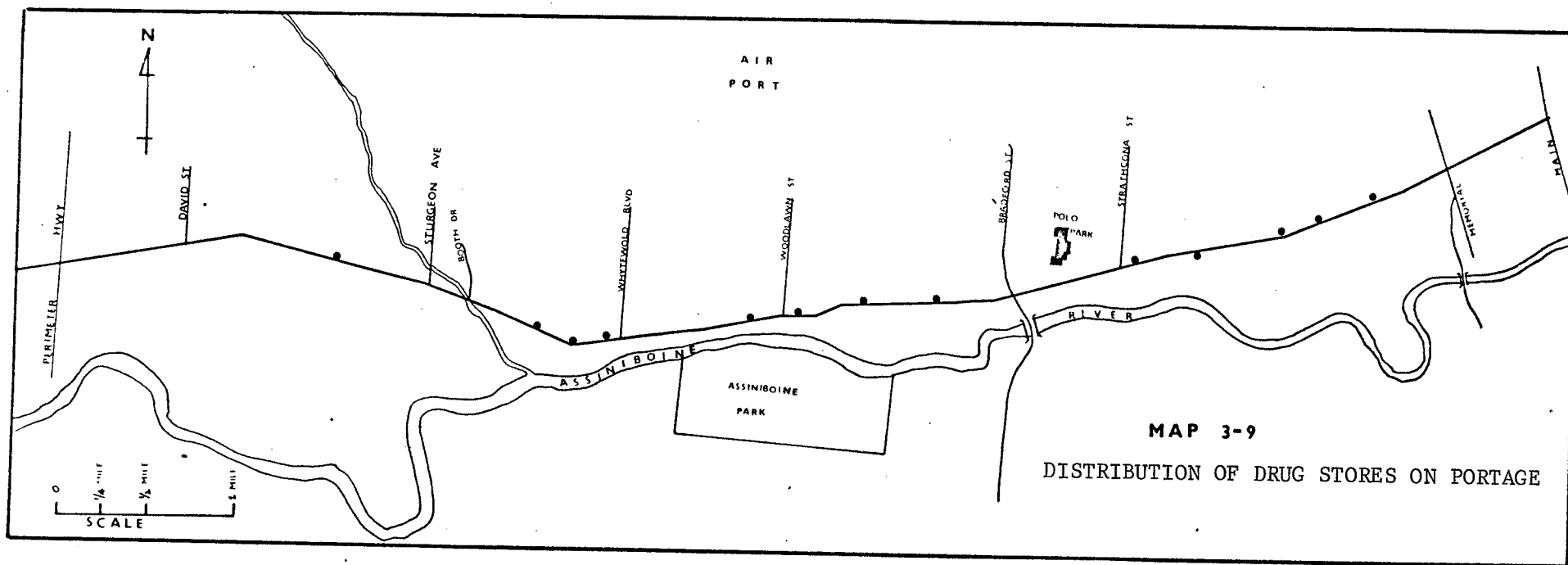


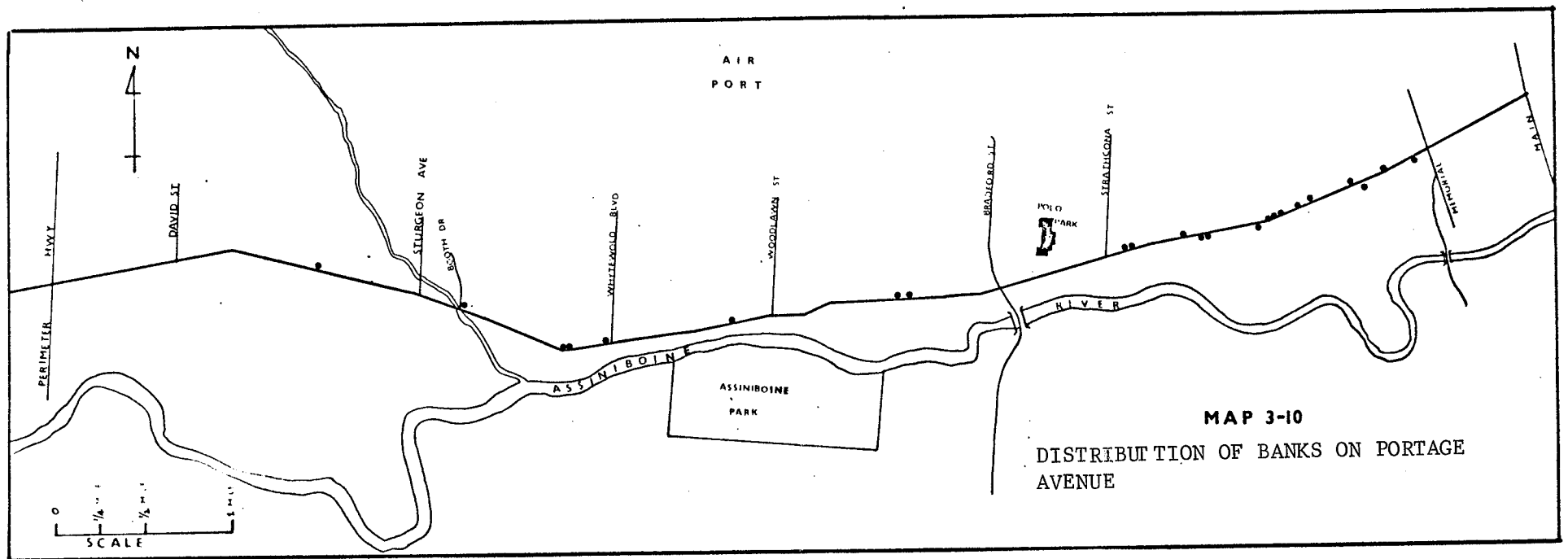


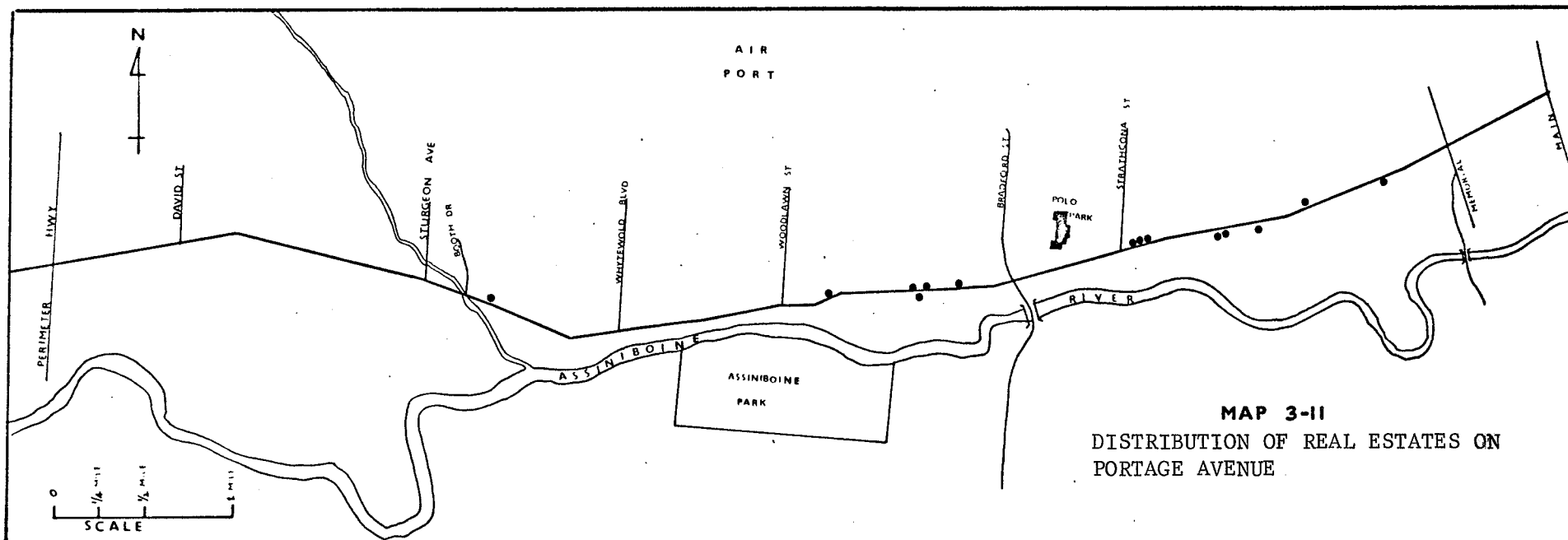


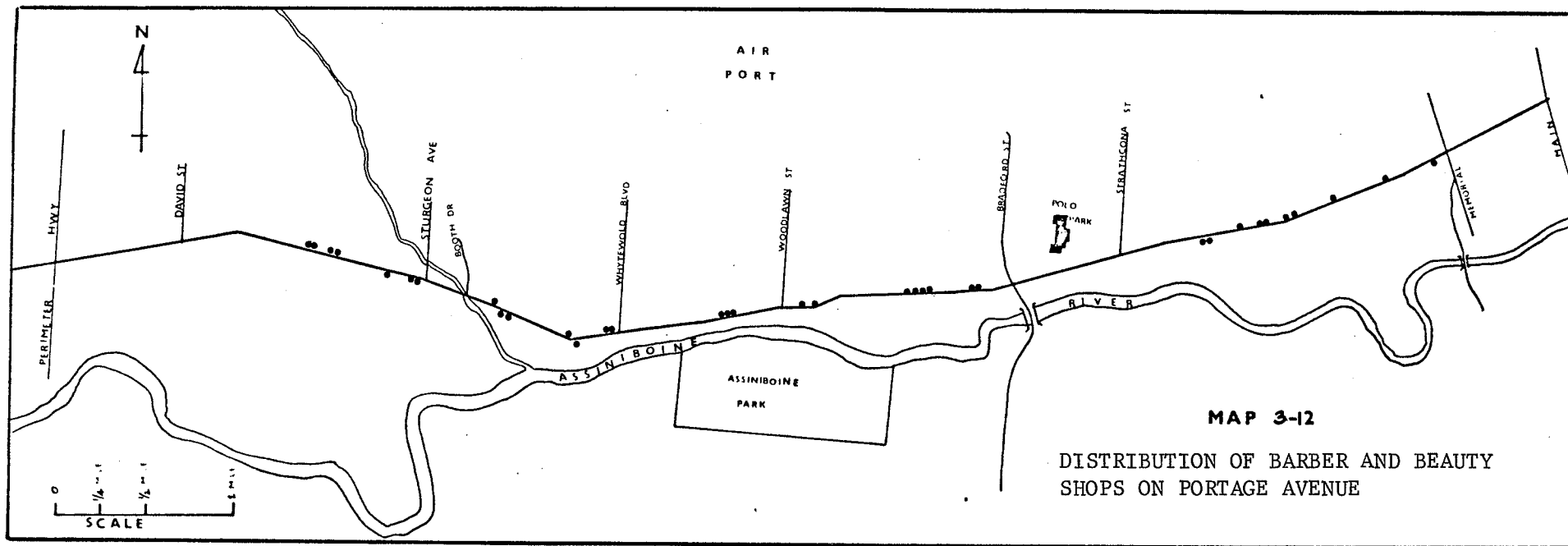


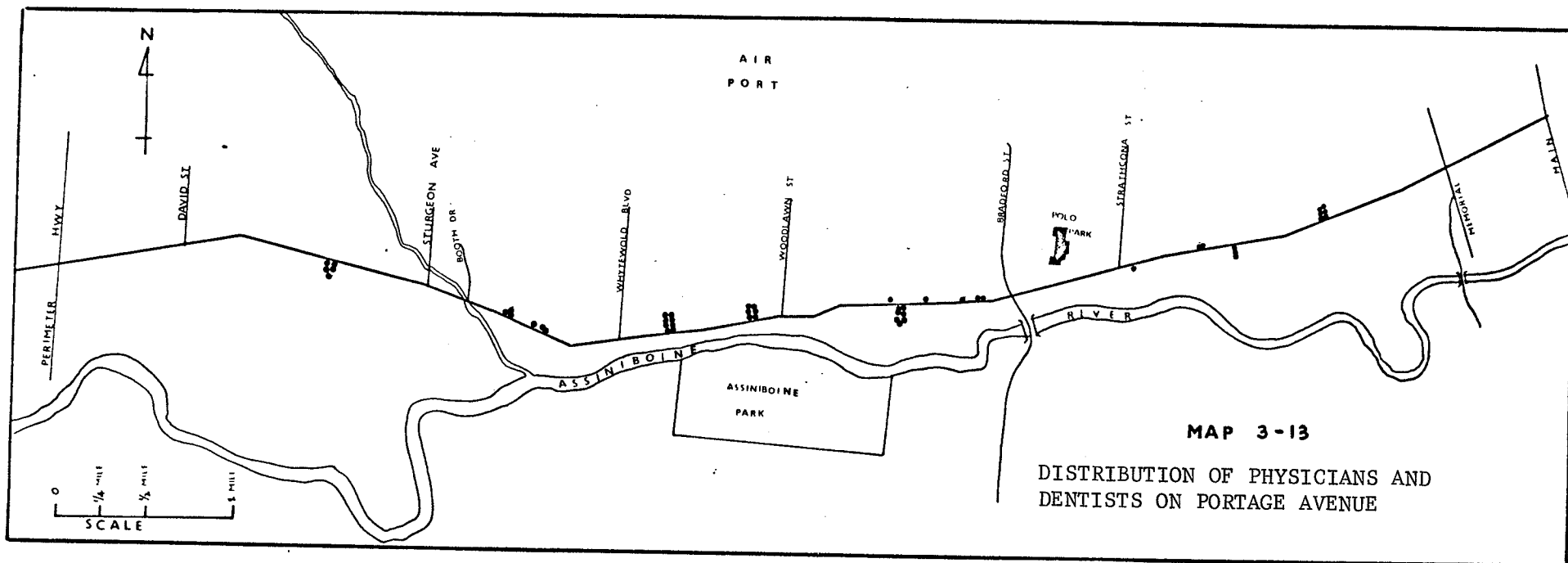


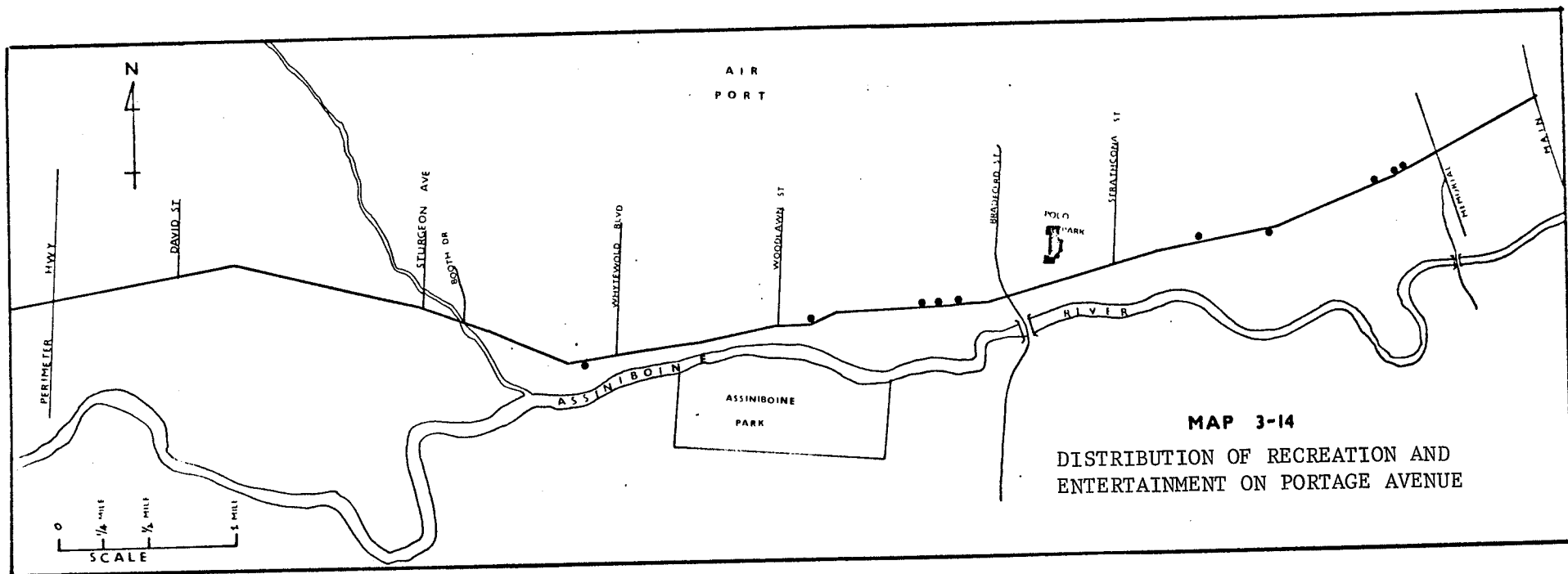


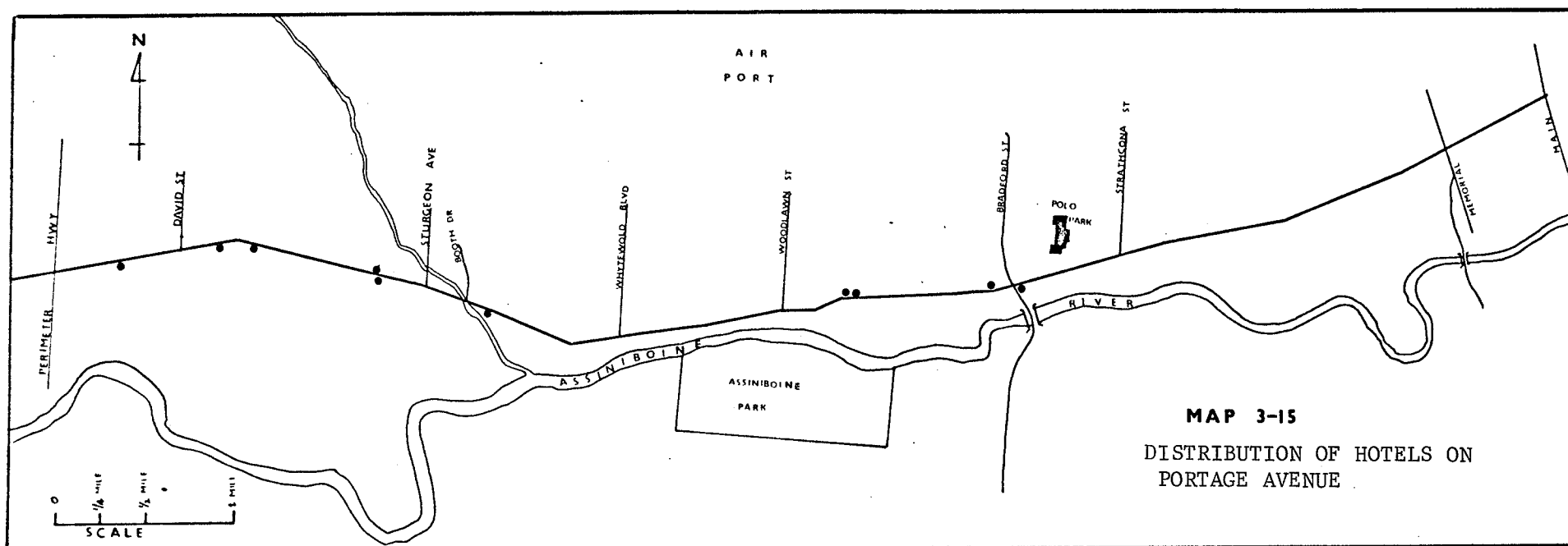












3 - 5 Spatial Association Among Different Business Types

In the previous section, the spatial patterns of twelve selected business classes were examined. Each class was studied independently and hence, the results do not reveal the spatial relationship that might exist between members of different classes. As well, these aspects of commercial structure have been long neglected by previous students in commercial ribbon studies. The author feels that it is essential to understand how different classes are associated while they are located along an urban artery. Spatially, are they closely associated or repulsive to each other? Are members from a particular business class more closely associated among themselves or do they have a tendency to locate near establishments of other class? This section of the thesis attempts to answer some of these problems.

The method used for detecting the spatial association, as expressed in their locational patterns, among different business types was a fairly simple one derived by the author. The prime parameter used is the nearest neighbor distances. Nearest neighbor distances among members of each different business types were measured. The measurements were made on the base map of scale 1" to 200'. For any business type i ($i = 1, 2, \dots, 12$), the distance between all the establishments in business type i to its nearest neighbor that belongs to all other business types were measured. Thus, there are all together 11 sets of nearest neighbor distances for each business type i . These nearest neighbor distances will then be used in studying the spatial association among business types.

Suppose we want to find the spatial relationship between Food stores and all other types of business functions, i.e. to find out the locational behavior of Food stores with respect to all other business types. The aim here is to know what other type of functions are closely associated with Food stores while located along an urban artery as well as what type of functions are locationally repelled by food stores. The first step is to compute the means and variances for all sets of nearest neighbor distances with respect to food stores. Then, these values of means and variances are ranked, such that

$$\bar{X}_1 \leq \bar{X}_2 \leq \dots \leq \bar{X}_{11} \text{ and}$$

$$S_1^2 \leq S_2^2 \leq \dots \leq S_{11}^2.$$

The business type which has the smallest mean value \bar{X}_1 , denoted as business type(Y), is then said to have the smallest mean nearest neighbor distances to Food stores. Business type (Y) can be interpreted as the one most closely associated to Food stores among all other business types. In other words, within the shortest average distance away from each member in Food stores class we would find an establishment belongs to business type (Y).

In a relative sense, business type (Y) is observed to be more spatially compatible to Food stores than all other business types under investigation. On the other hand, a business type that has the largest mean nearest neighbor distances is said to have a spatially repulsive locational tendency towards members of the Food stores class.

Yet the mean nearest neighbor distance alone will not serve as the best indicator of spatial association, especially, when we are trying to detect spatial relationship of different business types which are not of the same size, i.e. the number of establishments within each class are not the same. The other characteristic of the distribution of nearest neighbor distances that would help in detecting the relationship is the variance of the distribution. Variance of the nearest neighbor distances indicates the variability of the distribution. If the nearest neighbor distances of Food stores to business type (Y) have both the smallest variance (S_1^2) and mean (\bar{X}_1) would suggest that the variability of this particular nearest neighbor distances distribution is the smallest among all the other distributions and they are closely distributed about its mean (\bar{X}_1), which is also the smallest among all other means. This would give us sufficient confidence to say that business type (Y) is most closely associated with Food stores. Similar reasoning can be applied to spatial repulsiveness among business types.

The spatial relationships among each business type to all other business types, based on the means and variances of nearest neighbor distances, are shown in Table 3-21(A) to Table 3-21(L). In these tables, the relation to members of the same class are also included. The inclusion would help to identify whether members of the same business type are more closely associated among themselves or with members of different class. The following observations emerged from studying the relationships as shown in Table 3-21(A) to 3-21(L):

(i) Business establishments from four business types were found more closely associated with members of the same class. These four types of business functions are:

- (a) Eating places (both mean and variance have the smallest value)
- (b) Physicians and Dentists (both mean and variance have the smallest value)
- (c) Auto dealers (only the mean has the smallest value) and
- (d) Barber and Beauty (only the mean has the smallest value).

Among the four, Physicians and Dentists class was the most representative as establishments of this class are usually located in clustering (Map 3-13).

(ii) Food stores ^{were} found to be the nearest neighbor to five other business types. They were Furniture, Drug stores, Banks, Real estates, and Recreation. As well, Food stores were also found to be closely associated with Barber & Beauty shops, based on the criterion that its mean nearest neighbor distance value is within one city block²¹ of establishments from Barber & Beauty Class (Table 3-22).

The varied functional characteristics of business types that the Food stores were found closely associated with reveal the fact that Food stores are spatially compatable to many types of business functions. Due to their nature as a convenience-type good, their locational decision is more responsible to the surrounding residential market area rather

21. See Table 3-21(A) for the definition of a city block.

than its proximity to a certain type of functions. The type of business located nearby would not necessarily hamper the successful operation of food stores.

(III) Eating places, besides being the nearest neighbor to itself, were found to be most closely associated with Food stores, Gas & service stations and Hotels. In addition, they were found to have the mean nearest neighbor distance within a city block to five other business types, namely, Drug stores, Furniture, Real estates, Recreation and Barber & Beauty shops (Table 3-22). In total, Eating places were found closely located to 8 out of the 12 classes being analysed here. This phenomena could be attributed to the fact that their locational nature as being highway-oriented, as was observed in Berry's studies (1958, 1963), therefore, can be located anywhere along the artery or nearby any type of function. This is not the proximity to a certain functional types that would affect their locational decision, rather, the flow of traffic would seem to be the major factor. Generally, the present finding supports Berry's previous findings that the eating places are highway or urban arterial type of function and thus, seek out ribbon locations.

(iv) Drug stores were not found to be the nearest neighbor of Physicians and Dentists class. The reverse relationship did not hold either. As one would expect, drug stores would usually locate close to medical services. However, their locational pattern on Portage Avenue exhibits the negative result. Rather, Food stores were found

to be most closely associated with Drug stores. The close proximity of these two business types could be attributed to their nature as both are convenience-type goods and visits to both of them on a single shopping trip seems to be most reasonable. Hence, close proximity to each other would certainly be beneficial to both stores.

(v) The reflexive nearest neighbor relationship does not exist between any two particular business types. That is, no two business types were found to be the nearest neighbor to each other. This result suggests the existence of an inconsistent nature in the nearest neighbor relationship among different classes. Due to the complexity in locational decision-making process it is, therefore, difficult to find any two particular types of business functions always located closest to each other.

Table 3-21 (A)

Spatial Relationships Among Business Types Based On
Means and Variances of Nearest Neighbor Distances:
Food Stores With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food stores	5.22	22.18
Eating places	3.98*	14.24
Furniture, Home furnishing	11.34	141.64
Gas & Service Stations	6.31	38.53
Auto dealers	31.88	1532.80
Drug stores	5.88	36.54
Banks	7.94	88.26
Real estates	21.03	603.02
Barber & Beauty	5.23	58.23
Physicians & Dentists	10.18	98.87
Recreation	31.85	1741.39
Hotels	26.89	308.80

* denotes the business types which has its mean(\bar{X}) nearest neighbor distance within one city block of Food stores.

The average length of one city block on Portage Avenue is approximately equal to 4.5 cm on the map of scale 1" to 200' (or 354 ' on the ground)

Table 3-21 (B)

Eating Places With Respect To All Other
Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>s^2</u>
Food stores	7.09	67.42
Eating places	4.25*	14.39
Furniture, Home furnishing	17.77	249.28
Gas & Service stations	6.42	36.39
Auto dealers	38.78	1621.04
Drug stores	10.34	107.23
Banks	9.37	103.72
Real estates	15.35	273.15
Barber & Beauty	10.26	152.47
Physicians and Dentists	12.11	122.04
Recreation	29.18	1386.20
Hotels	23.14	275.61

* denotes the business type which has its mean nearest neighbor distance within one city block of Eating places.

Table 3-21(C)

Furniture, Home Furnishing With Respect to All Other
Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food Stores	2.35*	3.48
Eating Places	2.94*	11.22
Furniture, Home Furnishing	16.08	700.92
Gas and Service Stations	4.64	18.56
Auto Dealers	55.35	2304.89
Drug Stores	5.17	19.27
Banks	7.36	30.92
Real Estates	8.62	239.37
Barber and Beauty	3.52*	9.55
Physicians and Dentists	9.05	105.72
Recreation	11.65	945.43
Hotels	29.88	570.92

* denotes the business type which has its mean nearest neighbor distance within one city block of Furniture, Home Furnishing.

Table 3 - 21 (D)

Gas and Service Stations With Respect To All
Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food Stores	8.53	96.62
Eating Places	4.47	25.75
Furniture, Home Furnishing	18.15	270.22
Gas and Service Stations	8.80	65.53
Auto Dealers	32.78	1527.70
Drug Stores	13.68	157.88
Banks	14.05	196.03
Real Estates	16.79	355.19
Barber and Beauty	10.25	119.94
Physicians and Dentists	10.48	153.22
Recreation	29.44	1372.30
Hotels	22.32	377.76

Table 3 - 21 (E)

Auto Dealers With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food Stores	6.68	26.80
Eating Places	5.18	13.80
Furniture, Home Furnishing	11.32	60.59
Gas and Service Stations	5.14	7.03
Auto Dealers	4.48	20.85
Drug Stores	6.73	33.21
Banks	5.19	40.65
Real Estates	12.19	195.74
Barber and Beauty	4.78	6.84
Physicians and Dentists	9.29	56.31
Recreation	14.42	515.89
Hotels	46.91	998.46

Table 3 - 21 (F)

Drug Stores With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>s^2</u>
Food Stores	2.92*	10.70
Eating Places	3.85*	20.02
Furniture, Home Furnishing	15.65	172.44
Gas and Service Stations	6.94	39.51
Auto Dealers	35.14	1915.77
Drug Stores	25.25	352.12
Banks	6.30	78.95
Real Estates	19.60	383.68
Barber and Beauty	5.84	76.58
Physicians and Dentists	8.08	70.96
Recreation	32.75	1424.81
Hotels	28.05	328.25

* denotes the business type which has its mean nearest neighbor distance within one city block of Drug Stores.

Table 3 - 21 (G)

Banks With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>s^2</u>
Food Stores	3.51*	5.31
Eating Places	4.77	12.93
Furniture, Home Furnishing	12.88	125.14
Gas and Service Stations	4.38*	19.72
Auto Dealers	15.08	891.55
Drug Stores	5.63	31.74
Banks	8.45	227.65
Real Estates	8.97	268.79
Barber and Beauty	5.09	39.47
Physicians and Dentists	6.63	23.06
Recreation	15.35	515.07
Hotels	55.45	587.46

* denotes the business type which has its mean nearest neighbor distance within one city block of Banks.

Table 3 - 21 (H)

Real Estates With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food Stores	2.69*	4.14
Eating Places	3.57*	8.85
Furniture, Home Furnishing	11.08	138.45
Gas and Service Stations	3.92*	4.73
Auto Dealers	42.22	2099.40
Drug Stores	7.08	28.74
Banks	3.14*	18.25
Real Estates	8.39	135.01
Barber and Beauty	6.38	62.78
Physicians and Dentists	6.95	54.19
Recreation	19.08	1056.88
Hotels	36.45	644.70

* denotes the business type which has its mean nearest neighbor distance within one city block of Real Estates.

Table 3 - 21 (I)

Barber and Beauty With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food Stores	2.98*	11.96
Eating Places	3.49*	15.45
Furniture, Home Furnishings	12.56	127.66
Gas and Service Stations	6.38	35.71
Auto Dealers	35.70	1535.11
Drug Stores	7.89	65.22
Banks	8.04	84.31
Real Estates	21.43	517.93
Barber and Beauty	2.83*	20.85
Physicians and Dentists	7.95	59.41
Recreation	28.76	1678.34
Hotels	20.90	362.18

* denotes the business type which has its mean nearest neighbor distance within one city block of Barber and Beauty.

Table 3 - 21 (J)

Physicians and Dentists With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food Stores	6.15	55.26
Eating Places	7.20	70.15
Furniture, Home Furnishing	15.23	231.48
Gas and Service Stations	6.62	70.02
Auto Dealers	42.45	1658.86
Drug Stores	8.74	75.10
Banks	9.07	64.46
Real Estates	24.27	559.90
Barber and Beauty	7.10	69.32
Physicians and Dentists	1.54**	25.90
Recreation	38.04	1518.63
Hotels	33.13	500.54

* denotes the business type which has its mean nearest neighbor distance within one city block of Physicians and Dentists.

** denotes the business type which has its mean nearest neighbor distance within a $\frac{1}{2}$ city block of Physicians and Dentists.

Table 3 - 21 (K)

Recreation With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>S^2</u>
Food Stores	2.54*	1.77
Eating Places	3.19*	21.69
Furniture, Home Furnishings	4.28*	21.37
Gas and Service Stations	4.50*	10.21
Auto Dealers	45.80	2422.65
Drug Stores	5.74	17.46
Banks	7.20	93.66
Real Estates	4.01*	7.09
Barber and Beauty	3.74*	10.11
Physicians and Dentists	10.40	112.49
Recreation	15.90	266.48
Hotels	22.36	341.66

* denotes the business type which has its mean nearest neighbor distance within one city block of Recreation.

Table 3 - 21 (L)

Hotels With Respect To All Other Business Types

<u>Business Types</u>	<u>\bar{X}</u>	<u>s^2</u>
Food Stores	17.55	475.22
Eating Places	5.53	12.46
Furniture, Home Furnishings	23.06	125.23
Gas and Service Stations	7.05	30.94
Auto Dealers	56.62	1606.34
Drug Stores	19.28	175.30
Banks	28.57	107.90
Real Estates	30.64	996.81
Barber and Beauty	17.16	164.76
Physicians and Dentists	18.55	165.30
Recreation	52.64	4641.25
Hotels	11.18	187.08

Table 3 - 22 - A Summary Of Spatial Relations Among Different Business Types As Shown In Tables 3 - 21(A) - (L), Based On Mean Nearest Neighbor Distances Only.

Business Type	Business Type Which Has Its Mean Nearest Neighbor Within A $\frac{1}{2}$ City Block	Business Type Which Has Its Mean Nearest Neighbor Within One City Block
I) Food Stores	-	Eating Places(3.98)
II) Eating Places	-	Eating Places(4.25)
III) Furniture, Home Furnishings	-	Food Stores (2.35) Eating Places (2.95) Barber and Beauty(3.52)
IV) Gas and Service Stations	-	Eating Places (4.47)
V) Auto Dealers	-	Auto Dealers (4.48)
VI) Drug Stores	-	Food Stores (2.92) Eating Places (3.85)
VII) Banks	-	Food Stores (3.51) Gas, Service Stations(4.38)
VIII Real Estates	-	Food Stores (2.69) Banks (3.14) Eating Places (3.57) Gas, Service Stations (3.92)
IX) Barber and Beauty	-	Barber, Beauty (2.83) Food Stores (2.98) Eating Places(3.49)
X) Physicians and Dentists	Physicians and Dentists	-
XI) Recreation	-	Food Stores (2.54) Eating Places (3.19) Barber, Beauty(3.74) Real Estates (4.01) Furniture (4.28) Gas, Service Stations(4.50)
XII) Hotels	-	-

CHAPTER 4

SUMMARY AND CONCLUSION

The purpose of this study was to examine the spatial structure of business establishments located along a commercial ribbon in Winnipeg. In this context the study examined the functional composition, spatial pattern and functional association of business types on Portage Avenue.

The examination of functional composition revealed the highly diversified nature of such business districts. The two main functional categories, retail and service functions, were found quite evenly represented in the overall structure of business composition. A breakdown of individual business classes showed that Automotive, Other retail, Finance, Personal service, and Professional service were the most prominent classes in terms of number of establishments. The five business classes accounting for more than one half of the total establishments in the study area. An uneven distributional pattern was observed as over two thirds of the total establishments were located on the outbound lane of Portage Avenue.

The business land use pattern on Portage Avenue can be divided into four subsections based on the spatial continuity of commercial land use as the criterion for division. Business composition varied within each subsection. In general, Finance, Automotive, and Other retail stores were dominating the subsection which is closest to the CBD. Personal service and Professional service were the major functional classes for the two subsections located at half way of the study area. At the periphery of the city, the Automotive (mainly gas stations) comes into prominence.

Spatial patterns of business establishments were investigated by two means. First, the graphic analysis of percentile values was employed to detect the spatial character of each business class. Four types of patterns can be generalized and the business classes associated with them are: (i) Heavy downtown orientation (Entertainment & Recreation, Household repair, Business service, and Apparel and accessories stores); (ii) Slight downtown orientation (Other retail, Lumber and Hardware, Eating places, Automotive, Drug stores, and Personal service); (iii) No orientation (Professional service, and Food stores); and (iv) Fringe orientation (Hotels).

The second aspect of locational pattern of business establishments was examined by detecting the randomness of the distribution. The results of a series of hypotheses testing showed that generating process of business locational pattern was not random since the patterns were found to be more clustering than random. The results implied that decisions involved in locating establishments were not purely due to random chances but subject to some dominating forces. Yet the identification of such forces was a complicated matter and beyond the scope of this study. The investigation towards identifying these forces and how they affect the spatial process demand future consideration by urban business students.

The spatial association among different business types, a subject that has been long neglected by previous students in commercial ribbon studies, were examined in order to identify the compatibility between

business types. The spatial compatability between different business types were based on means and variances of nearest neighbor values. The analysis showed that business establishments of Eating places, Physicians and Dentists, Auto dealers, and Barber and Beauty shops were most closely associated with members of the same class. Food stores and Eating places were found to be spatially compatable to most of the other functional types. The inconsistent nature in the nearest neighbor relationship among different business types were clearly revealed as no reflexive relationship exists between any two particular business types.

This study has sought throughout to rectify certain ambiguities prevalent in ribbon studies. The author feels that former classificatory schemes failed to consider certain elementary geographic distinctions, and has attempted to provide some insight into the nature of entrepreneurial locational behavior. Although it has been recognized throughout that the resources available in this instance are inadequate to deal properly with question concerning attractivity of ribbons and competition between business classes, an attempt has been made to relate spatial patterns to functional correlates. The author strongly believes that merely the application of analytical techniques, regardless of their sophistication, will not lead to much more understanding of ribbon structure. What is required is a conception of the ribbon as a flux, where a pattern at any one time cannot be expected to yield to static analysis.

Appendix I Classification of Business Classes

(1) FOOD STORES

- 5411 Grocery stores, with or without fresh meat
- 5410 Supermarket
- 5422 Meat market
- 5423 Fish markets
- 5431 Fruit stores and vegetable markets
- 5441 Candy, nut and confectionery stores
- 5451 Dairy product stores
- 5462 Retail bakeries manufacturing
- 5471 Egg and poultry dealers
- 5499 Food stores, not elsewhere classified

(2) EATING PLACES

- 5812 Eating places

(3) GENERAL MERCHANDISE STORES

- 5311 Department stores
- 5322 Mail order houses, general merchandise
- 5323 Mail order houses, except general merchandise
- 5331 Limited price variety stores
- 5431 Automatic merchandising
- 5392 Dry goods and general merchandise including
"Army and Navy" stores
- 5393 General stores

(4) APPAREL, ACCESSORIES STORES

- 5612 Men's and Boy's clothing stores
- 5621 Women's ready-to-wear stores
- 5631 Millinery stores
- 5633 Hosiery stores
- 5634 Apparel accessory and other specialty stores
- 5641 Children's and infants' wear stores
- 5651 Family Clothing stores

5662 Men's shoe stores
 5663 Women's shoe stores
 5664 Children's and juveniles' shoe stores
 5665 Family shoe stores
 5671 Custom tailors
 5681 Furriers and fur shops
 5699 Miscellaneous apparel and accessory stores
 5933 Secondhand clothing and shoe stores

(5) FURNITURE, HOME FURNISHING, APPLIANCE DEALERS

5712 Furniture stores
 5713 Floor covering stores
 5714 Drapery, curtain, and upholstery stores
 5715 China, glassware and metalware stores
 5719 Miscellaneous home furnishing stores
 5722 Household appliance stores
 5732 Radio and television stores
 5934 Secondhand furniture stores

(6) LUMBER, BUILDING MATERIALS, HARDWARE GROUP

5211 Lumber yards
 5212 Building materials dealers
 5221 Heating and plumbing equipment dealers
 5231 Paint, glass and wallpaper stores
 5241 Electrical supply stores
 5251 Hardware stores
 5252 Farm equipment dealers
 5299 Miscellaneous

(7) AUTOMOTIVE

5511 Motor vehicle dealers (new & used cars)
 5521 Motor vehicle dealers (used cars only)
 5531 Tire, battery, and accessory dealers
 5541 Gasoline service stations
 5936 Secondhand automotive tire, battery and accessory dealers

(8) DRUG STORES

5912 Drug stores and proprietary stores

(9) OTHER RETAIL STORES

5939 Secondhand stores none elsewhere classified
 5942 Book stores
 5943 Stationery stores
 5952 Sporting goods stores
 5953 Bicycle shops
 5962 Hay, grain, and feed stores
 5969 Farm and garden supply stores, not elsewhere
 classified
 5971 Jewelry stores
 5982 Fuel dealers, except fuel oil dealers
 5983 fuel oil bottled gas dealers
 5984 Ice dealers
 5992 Florists
 5993 Cigar stores and stands
 5994 News dealers and newstands
 5996 Camera and photographic supply stores
 5997 Gift, novelty, and souvenir shops
 5998 Optical goods stores
 5999 Miscellaneous retail stores, not elsewhere classified
 5921 Liquor stores
 5931 Antique stores
 5733 Music stores
 5599 Miscellaneous aircraft, marine, and automotive
 dealers

(10) Finance

60-- Banks
 605- Establishments performing functions closely related
 to banking e.g., currency exchange
 612- Savings and Loan Associations
 614- Personal credit institutions
 6159 Loans
 64-- Insurance agents, brokers, and service
 651- Real estate operators(except developers) and lessors
 653- Agents, brokers and managers
 66-- Combinations of real estate, insurance, loans, law offices

(11) Personal Service

7211 Power laundries, family and commercial
 7212 Laundries, except power
 7213 Linen supply and industrial laundries
 7214 Diaper service
 7215 Self-service laundries
 7216 Cleaning and dyeing plants, except rug cleaning
 7217 Rug cleaning and repairing plant
 7221 Photographic studios, including commercial photography
 7231 Beauty shops
 7241 Barber shops
 7251 Shoe repair shops, shoe shine parlors and hat cleaning shops

- 7261 Funeral service and crematories
- 7271 Pressing, alteration and garment repair
- 7272 Fur repair and storage
- 7511 Automobile rentals, without drivers
- 7299 Miscellaneous personal service (include wedding service,
travel agents, picture framing, and Taxidromes)

(12) BUSINESS SERVICE

- 731- Advertising
- 732- Consumer credit reporting agencies, mercantile reporting
agencies, and adjustment and collection agencies
- 733- Duplicating, addressing, blueprinting, photocopying,
mailing list, and stenographic service
- 734- Services to dwellings and other buildings
- 735- New syndicates
- 736- Private employment agencies
- 739- Business services not elsewhere classified (include
business offices)

(13) PROFESSIONAL SERVICE

- 801- Offices of physicians and surgeons
- 802- Offices of dentists and dental surgeons
- 803- Offices of osteopathic physicians
- 804- Offices of chiropractors
- 807-- Medical and dental laboratories
- 809- Health and allied services, not elsewhere classified
(inc. veterinarian)
- 8099 Optometrist
- 811 Legal service
- 891- Engineering and architectural services
- 893- Accounting, auditing, and bookkeeping services
- 899- Services, not elsewhere classified

(14) HOUSEHOLE REPAIR

- 7621- Electrical repair shops
- 7631 Watch, clock and jewelry repair
- 7641 Reupholstery and furniture repair
- 7692 Bicycle repair shops
- 7693 Leather goods repair shops
- 7694 Armature rewinding shops
- 7695 Locksmith with gunsmith shops
- 7696 Musical instrument repair
- 7699 Repair shops and related services, not elsewhere
classified

(15) ENTERTAINMENT, RECREATION

- 783- Motion picture theaters
- 7911 Dance halls, studios and schools
- 7921 Theatrical producers (except motion pictures),
bands, orchestras and entertainers
- 7931 Bowling, billiards, and pool
- 7949 Sports promoters and commercial operators, and
amusement and recreation services, not elsewhere
classified, includes motor club
- 7999 Miscellaneous recreation & entertainment

(16) HOTELS, MOTELS

- 701- Hotels, tourist courts, and motels
- 702- Rooming and boarding houses
- 704- Organization hotels and lodging houses on member-
ship basis

Appendix II. Derivation of Order Neighbor Statistics For a Class of Random Pattern in One Dimensional Space

The expected distance from a point 1 to the j^{th} nearest neighbor is given by Dacey (1963, p.510) as below,

$$E(r_{kj}) = \frac{\Gamma\left(\frac{kj+1}{k}\right)}{(V_k d)^{1/k} (j-1)!} \quad (1)$$

where j = the order nearest neighbor;

k = dimensional space;

Γ = Gamma function; order neighbor distances belong to the Gamma function;

d = density of points per unit content;

V_k = the mean frequency of points within unit k dimensional content; it is assumed that a random arrangement of points conforms to the Poisson distribution, accordingly, where k even = 2α

$$V_k = \frac{\pi^\alpha}{\alpha!}$$

and k odd = $2\alpha + 1$

$$V_k = \frac{\pi^\alpha \alpha! 2^k}{k!}$$

In the one-dimensional space, where $k=1$, equation (1) becomes,

$$E(r_{1j}) = \frac{\Gamma(j+1)}{(Vd)(j-1)!} \quad (2)$$

since $k=1$ is odd number,

$$\therefore k = 2\alpha + 1$$

$$1 = 2\alpha + 1$$

$$2\alpha = 0$$

$$\therefore \alpha = 0$$

substitutes $=0$ and $k=1$ into

$$v_k = \frac{\pi^{\alpha} \alpha! 2^k}{k!},$$

$$v_1 = \frac{\pi^0(0)! 2}{1!}$$

$$= 2$$

$$E(r_{1j}) = \frac{\Gamma(j+1)}{2d(j-1)!} \quad (3)$$

For $j=1$,

$$E(r_{11}) = \frac{\Gamma(1+1)}{2d(0)!} = \frac{1}{2d}$$

For $j=2$,

$$E(r_{12}) = \frac{\Gamma(2+1)}{2d(1)!} = \frac{2}{2d}$$

For $j=3$,

$$E(r_{13}) = \frac{\Gamma(3+1)}{2d(2)!} = \frac{3}{2d}$$

Assuming a normal distribution of distances, the variances are derived from the following equation (Dacey 1963, p.507),

$$\sigma^2(r_{kj}) = \frac{(j-1)! \left[\Gamma\left(\frac{mj+2}{m}\right) - \left[\Gamma\left(\frac{mj+1}{m}\right) \right]^2 \right]}{\left[(j-1)! \lambda_o^{1/m} \right]^2} \quad (4)$$

when $m=k=1$,

$$\sigma^2(r_{1j}) = \frac{(j-1)! \left[\frac{\Gamma(j+2)}{1} - [\Gamma(j+1)]^2 \right]}{[(j-1)! \lambda_o]^2}$$

For $j = 1$,

$$\sigma^2(r_{11}) = \frac{\Gamma(1+2) - [\Gamma(1+1)]^2}{[0! \lambda_o]^2} = 1/\lambda_o^2$$

For $j = 2$,

$$\sigma^2(r_{12}) = \frac{\Gamma(2+2) - [\Gamma(2+1)]^2}{[1! \lambda_o]^2} = 2/\lambda_o^2$$

For $j = 3$,

$$\sigma^2(r_{13}) = \frac{2! \left[\Gamma(3+2) - [\Gamma(3+1)]^2 \right]}{[2! \lambda_o]^2} = \frac{12}{[2\lambda_o]^2}$$

The observed χ^2 value is given as,

$$\chi_j^2 = k V_{kd} \sum_{i=1}^n (r_{ij})^k \quad (5)$$

where $k = 1$, (5) becomes,

$$\chi_j^2 = 2d \sum_{i=1}^n (r_{ij}) \quad (6)$$

where d.f. $> \chi^2$, then normal approximation to χ^2 is,

$$z = \left\{ (2\chi^2)^{1/2} - (2N-1)^{1/2} \right\} \quad (7)$$

Appendix III. Classification of Business Types

(I) Food Stores

5411
5410
5422
5423
5431
5441
5451
5462
5491
5499

(II) Eating Places

5812

(III) Furniture, Home Furnishing

5712
5713
5714
5719
5934

(IV) Gas and Service Stations

5541
7539

(v) Auto Dealers

5511
5521

(VI) Drug Stores

5912

(VII) Banks

60--
612-
6159

(VIII) Real Estates

651-

(IX) Barber & Beauty Shops

7231
7241

(X) Physicians & Dentists

801-
802-
803-
804-
807-
809-
8099

(XI) Recreation

783-
7911
7921
7931
7949

(XII) Hotels

701-

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