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The Dynamics of Micro-Location: The Potentials of Airspace in Urban Design

Ira A. Chilton

THE DYNAMICS OF MICRO-LOCATION:

THE POTENTIALS OF AIRSPACE IN URBAN DESIGN

by

IRA A. CHILTON

B.Arch., Virginia Polytechnic Institute and State University, 1975

ABSTRACT OF THESIS

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THESIS ABSTRACT

This thesis is an investigation into the analeptic potentials of airspace utilization in urban areas. The study emphasizes airspace utilization as a dynamic locational catalyst for urban revitalization, and has two fundamental purposes. The first is to attempt to clarify the relevance of using airspace as a tool for pursuing efficient and effective use of the limited and valuable supply of central city land. And the second is to pursue a catalytic process for obtaining socio-economic goals through the multiple use of transportation rights-of-way. In the final phase, these concepts will be briefly elaborated in a case study applied to the Pleasant View village, Pawtucket, Rhode Island.

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PREFACE

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My sincere gratitude goes to Professor Kermit Lee, Jr., for his useful criticism and guidance; to Professor John Agnew, for supporting my work through his interest and encouragement; to Assistant Dean Julio San Jose, for exposing the political implications of my research to me; and to Mr. Dave Kohr and ORL for a rewarding experience which gave me a social perspective for viewing various issues within this study.

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SECTION I

INTRODUCTION

> More and more people are crowding into less and less land. The competition for land in our great urban belts is increasing at startling rates.[1]

This quotation appeared as the opening lines of an author's forward to an intriguing book entitled Land, People and Policy. In it, the author, Gordon Edwards, explains the crucial problem of limited land resources in urban America:

> The issue today is not merely land, but rather urban land: land strategically located to meet the needs of the people, land for homes, for recreation, for cultural and economic development. Land is a basic ingredient in the growth of our nation and in the happiness and welfare of its people. Urban development must be planned and regulated to insure the most efficient use of our urban land resources. One of the crucial elements in effective land use planning is the assembly of land for both public and private large scale development.[2]

In addition to this, Edwards goes on to suggest a method of using eminent domain to agglomerate land which can be managed and dispersed 'properly' to the public and private interests.

As a point of departure for investigating rights in airspace and urban development through airspace realty, it is necessary to examine the perception of the urban land problem as viewed by Gordon Edwards and explore the difficulties involved with the policy he advocates.

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[1]Gordon Edwards, Land, People and Policy (West Trenton: Chandler Davis, 1969), Author's forward.

[2]Ibid., p. 4.

For most cities, parabolic increases in land value continued into the early Twentieth Century. This phenomenon still leads to three basic factors which effect land assembly in urban areas today. First, since land values rose so quickly, it was economical to demolish fairly new structures in order to develop the highest and best use of the land.[3] On the other hand, the American consumer attitude toward building construction became more speculative, hence, when land values in urban areas began to stabilize and/or decline, the obsolete structures were abandoned for suburban development, simply because demolition could no longer pay for itself. A second factor influencing urban land assembly is fractionalization of land and titles in urban areas. This is a natural occurence resulting from high land costs.[4] Of course, the more clients one encounters, the more problems one is apt to discover. Such is the case here, often resulting in increased legal and apprasial fees, as well as frequent 'hold outs' who demand higher prices for individual parcels of land.

The third factor is somewhat historical, in that it originated from the air and light zoning of New York City during the early part of the Twentieth Century.[5] "The striving for openness and open space, for more parks, green belts, and vegetation in urban areas is something of an attempt to 'countrify' the cities, at least to the extent that urban man will not be divested entirely of the natural beauty of the

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[3]Richard L. Nelson, "Appraisal of Air Rights, " Appraisal Journal, Oct. 1955, p. 495.

[4]Ibid., p. 496.

[5]Ibid., p. 496.

country and may receive some of the light and air that goes along with it."[6] Of course to place such zoning limitations on the urban land inventory, with out limiting population growth and mobility, will eventually have negative effects on ultimate land assembly.

By proxy, much of the energy expended to assemble a large parcel of urban land will undoubtedly be allocated to fulfilling planning regulations (e.g., floor-area ratios, public provisions, set backs, and other easements).

Though Gordon Edwards only acknowledges the importance of the first two factors (increasing urban land value and fractionalization) in relation to land assembly, he has, however, addressed the problem of land assemblage.[7] Consider the fact that traditional cost and demand factors stressed by location theorists can no longer explain plant (retail or housing) location, because there is sufficient evidence to indicate that other factors, such as land assembly, are at least as influential.[8] Surveys conducted in 1964 by the San Francisco Chamber of Commerce and the Arthur D. Little Company, indicate that the "need for space per se is a paramount locational consideration" for industrial location in the San Francisco Bay area.[9]

The major drawback with Gordon Edward's attack on the problems of

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[6]Robert R. Wright, The Law of Airspace (New York: Bobbs-Merill, 1968), pp. 383-84.

[7]Edwards, pp. 94-96.

[8]Lewis K. Loewenstein and David Bradwell, "What Makes Desirable Industrial Property?" Appraisal Journal, April 1966, p. 263.

[9]Ibid., pp. 264-65 & 267.

land assembly rests on the fact that he merely recognized 'land' as a two-dimensional, surface phenomenon (i.e., ground). Clearly this is not the case in American society today, but this point will be elaborated in the next section of this thesis. Because of his failure to consider the three-dimensionality of 'land', Edwards submits to extensive use of eminent domain to achieve governmental control over vast amounts of surface area. When sufficient land surface is governmentally controlled, he proposes that the government participate in programs aimed at 'proper' use of the assembled land. Unfortunately, defining 'proper' is a matter of personal perception of various circumstances and is very difficult, if not impossible, to accomplish. While submitting this approach, Edwards fails to fully divulge the problems associated with extensive use of eminent domain.[10] For example, he fails to mention the immense bureaucracy required to attempt to answer burdensome problems, such as: "what to buy, how to pay, and what to do with whate is acquired." He circumvents the issue of relocation of the inhabitants of the land taken through eminent domain. Problems involving the remaining segments of neighborhoods are not mentioned. And finally, he fails to disclose the problems associated with a dwindling tax base for urban governments, as land falls under government ownership.

Admittedly, it seems government assembly of large parcels of 'land' could be used as a tool for attacking various urban problems. As a case in point, consider the fiscal disparities reflected in education

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[10]For example, in 154 pages of the book, 'relocation' is only mentioned briefly on pages 99 and 122. (See Edwards pp. 99 and 122).

within metropolitan areas. "Detroit (Michigan), for example, paid over $100,000 per acre for school sites purchased in 1967, while in surrounding suburban districts the price was about $6,000."[11] This is certainly a disadvantageous factor influential in "increasing the demand for per pupil investment in education in central-city locations."[12] Yet, when viewed in a generally accepted liberal manner, large amounts of 'land' are presently under government ownership, or are available to the government. Peculiar to this perception of land is the concept of rights of airspace ('air rights'). Obviously, the history and feasibility of using airspace should be investigated before governmental agencies are reprimanded for neglecting such a valuable urban resource. The remaining sections of this thesis will be aimed at surveying: 1) the theoretical concepts underlying urban development through airspace realty and the social benefits associated with airspace utilization, 2) the history, feasibility and problems involved with utilizing airspace, 3) the potentials of using airspace development as a tool for achieving socio-economic and physical urban design goals, and 4) potential adaptive measures for Pleasant View, Pawtucket, Rhode Island.

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[11] Kevin R. Cox, Conflict, Power and Politics in the City (New York: McGraw-Hill, 1975), p. 32.

[12] Ibid., p. 32.

SECTION II

THE CONCEPTUAL PERSPECTIVE

When considering the use of airspace as a tool for urban development, the theoretical foundations, as well as the nature of airspace, must be investigated. The concepts underlying urban development through airspace realty are as complicated as the city itself. In an attempt to clarify the potentials of airspace for urban development, the contextual concepts of urbanization, catalytic functions, and micro-location, will be introduced and briefly described. Before concluding this section, the relationships between airspace realty and these contextual concepts will be established.

Urbanization

Basically, urbanization is the process by which a civilization transforms from a rural character to an urban character. Urbanization, an ancient phenomenon, initially occured when early civilizations released surplus populations from labor intensive rural pursuits (e.g., gathering, hunting, fishing) through improved agricultural methods and animal husbandry. This excess population became the forebears of the early preindustrial urban settlements. These settlements were social constructs which began to take advantage of the benefits of agglomeration. However, it is uncertain whether most of these settlements originated as market places, religious hearths, fortresses, or communal associations.[1] Migration and primitive transportation methods

[1]Jack Tager and Park Dixon Goist, ed., The Urban Vision (Homewood, Ill.: Dorsey Press, 1970), p. 1.

contributed heavily to the high density preindustrial urban development. However, high density urban growth was not exclusively a preindustrial phenomenon, since densities have continued to increase well into post industrial city development.

The 'Industrial City' was a social institution which came into existence in the early Nineteenth Century during the Industrial Revolution. "The crucial factor which determined the transition of the preindustrial" settlement "to an industrial city was technology."[2] While the preindustrial settlements were service centers for rural folk structures, the industrial city had technology as a stimulant for urban growth. The factory, the national railroad complex and the intraurban transit systems were products of technological progress. Theses three technological features contributed to the nucleation and enlargement of the urban environs. Factories drew an industrial labor force into the cities and built a legend of urban employment, which stimulated continued migration to urban areas. The centralized services of railroads and transit systems brought a greater volume of business to central commercial areas and concentrated the urban population near these various 'urban' amenities. Specialized production, division of labor, commitment to machinery, and trade reinforced the forces of agglomeration within the industrial city.[3]

The city remained the major non-rural alternative in the United States until after World War II. At that time three major elements

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[2]Ibid., p. 1.

[3]R.U. Ratcliff, Urban Land Economics (New York: McGraw-Hill, 1949), p. 23,

coincided to produce what appeared to be public and private affirmation of a suburbanization policy. These major elements were:

> -The rise of dominance of the automobile as a form of independent individual transport on a nationwide basis;
> -A national program of highway systems, culminating in a federally supported interstate highway system now being completed;
> -The single-owner home bias of the tax tructure and of federally insured mortgages through FHA and VA programs, fostering the notion of "one man, one home."[4]

Initially, the development of suburbia was considered largely beneficial. However, in recent years the real cost of suburbanization has surfaced.

There are several fairly blatant problems which display the costs of suburbanization. First, suburban growth causes additional energy units to be expended for each person per day.[5] These additional energy units are consumed in the form of transportation, residential heating and cooling, utility services, extensive sewer systems, and other public infrastructure services which must be mobilized (e.g., library, police, rescue). Available energy is presently a limited commodity and should not be floundered by this haphazard method of urban growth. Second, suburbanization is attracting the revenue producing residents from the urban centers and leaving the needy and low-income people behind. As a result of this phenomenon, physical decay, segregation, and social demoralization have become characteristics of central city areas. Cities are having to expend more capital on welfare programs than they are able to generate in revenue.[6] Finally, "we can not afford to write

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[4]Randolph R. Croxton, "Urban Center Development and Mass Transportation," Real Estate Review, Summer 1974, p. 88

[5]Ibid., p. 88.

[6]Kevin Cox, Conflict, Power and Politics in the City, (New York: McGraw-Hill, 1975), p. 27.

off the existing investments, social, financial and cultural, that make up the fabric of our cities."[7] Central cities should make an attempt to attack 'physical environmental lag' by trying to activate new urban elements that reinforce existing accommodating systems.[8]

Catalytic Functions[9]

The urban system consists of interrelated components (physical, socio-economic, political, technical). Throughout the past, deficiencies within various components and development of other components have generated disparities within the urban system. For example, two technical components which have had far reaching implications for modern urban development have been the motor truck and the airplane. Both have had reinforcing catalytic effects on dispersion within the modern urban

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[7]Jonathan Barnett, Urban Design as Public Policy (New York: McGraw-Hill, 1974), p. 3.

[8]M.M. Weber, et. al., Explorations into Urban Structure (Philadelphia: University of Pa. Press, 1968), pp. 39-42.

[9]Catalytic functions are the effects which are generated when one agent of a system changes and in so doing, alters another part of the system. For the purposes of this research, the catalytic functions within the urban system include:

a.) the effects population density has on land use
b.) the effects one use of land has on an adjacent use of land (e.g., a positive effect would be a university generating a university town).
c.) the effect the location of transportation terminals, nodes and facilities has on traffic congestion
d.) the effects of traffic congestion on central decline
e.) the effect of new industry or business on the economic health of a neighborhood
f.) the effect residential provisions have on economic vitality
g.) the effect an urban project can have on the various components of the urban systems (positive and negative)

As an urban designer, the effect an urban project can have on other components of the urban system is essential. He/she must attempt to evaluate this phenomenon and to generate a product which not only will evolve with society, but remedy immediate problems as well.

system.[10] These elements are tied to the urban environment by nature because they both need centralized departure/arrival points, and are reinforced through political commitments and supportive economic programs. Because this reinforcement is received and the dispersive catalytic effects continue to exist unanswered, sprawl remains a characteristic of the modern urban system. To accomplish equilibrium within the urban system, existing disruptive catalytic effects must be countered with equal and opposite catalytic effects.

Urban catalysts are difficult to define and hard to manipulate. Urban design project studies should be made on 'situs' (the effects of environment), legal feasibility, economic feasibility, social implications, as well as market potentials and physical feasiblity. Such studies would help to identify the catalytic potentials of the project. Understanding the implications of catalytic functions should help to make urban design "a directing force in the life of the city" rather than an adjustive mechanism.[11]

Micro-Location

Catalytic development should initiate and sustain both public and private activities in support of local goals, while utilizing scale

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[10] Kingsley Davis, "Introduction to Urban Transport and City Planning," Cities: Their Origin, Growth and Human Impact (San Francisco: W.H. Freeman and Co., 1973), p. 183.

[11] Ibid., p. 184.

economies and other advantages of concentration.[12] However, models of human behavior and mass statistical demography display aggregate behavioral patterns which often disavow the importance of scale economies and micro-environmental factors of the city.[13] "These models of large aggregates are often presented without explicit statements about the assumed social organization and technology that exist at the micro-level from which the individual tries to handle his situation."[14] Yet, urban deterioration is probably the product of the neglect of micro-environmental factors and scale economies. As such, local goals using aggregate behavioral patterns as guidelines will be insufficient. If

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[12]Among the advantages of concentration is the effect of agglomeration economies. Agglomeration economies are the efficiencies and benefits accrued when activities cluster together spatially. Agglomeration economies include:

a.) scale economies, which are the benefits derived by firms and agencies in a concentrated region, such as division of labor

b.) external economies, which are benefits received from the by-products of concentration, such as personal contacts, cultural events, market population, or business services.

See: Harry W. Richardson, Urban Economics (Baltimore: Penguin, 2nd edtion, 1973), pp. 15-44.
and, Chicago 21, A Plan for the Central Area Communities (Chicago: City of Chicago, 1973), pp. 1-5.

[13]In this context, 'human behavior' is viewed as a sociological rather than a psychological term. Hence, 'models of human behavior' would be considered patterns established through group reaction, which are usually displayed in research by stochastic processes. 'Aggregate behavioral patterns' are the prototypical reactions which are deciphered out of the stochastic data. For examples see:
Michael R. Green Berg, ed., Readings in Urban Economics and Spatial Patterns (New Brunswick: Center for Urban Policy Research, 1974), Chapter 7, Brian L. Berry, "The Blight of Retail Nucleations," pp. 95-122, and Chapter 14, Franklin James and James W. Hughs, "Modeling Regional Growth," pp. 227-242.

[14]Torsten Hagerstrand, "What About People in a Regional Science," Papers and Proceedings, Regional Science Association, Vol. 24 (1970), p. 8.

an individual is lacking environmental satisfaction at the micro-level, he/she will seek satisfaction by adjustment. It is adjustment which generates aggregate behavioral patterns, and both micro-environmental factors and scale economies, which become determinants of adjustment.[15] (see figure 2-1). Hence, local goals should respond to scale economies and micro-environmental factors in some coherent manner.

The "problem remains to design cities to take advantage of scale economies and other advantages of concentration, and at the same time to provide optimum livabilitiy."[16] To provide optimum livability, micro-environmental factors must be considered. In considering them, the circumstances surrounding a given situation become extremely important, because responses to each situation must be fabricated individually in order to obtain qualitative goals. (Pursuing a program directed toward quantitative goals, is again addressing mass statistical behavior and ignoring the micro-environmental factors which determine such behavior). This means that the circumstances surrounding a given situation must be systematically and thoroughly investigated, in order to produce a resultant which can stimulate revitalization of that situation.

When a particular situation is concurrent with a given location, then the concept of 'micro-location' may be applied. The concept of micro-location is a combination of Hagerstrands' micro-environmental

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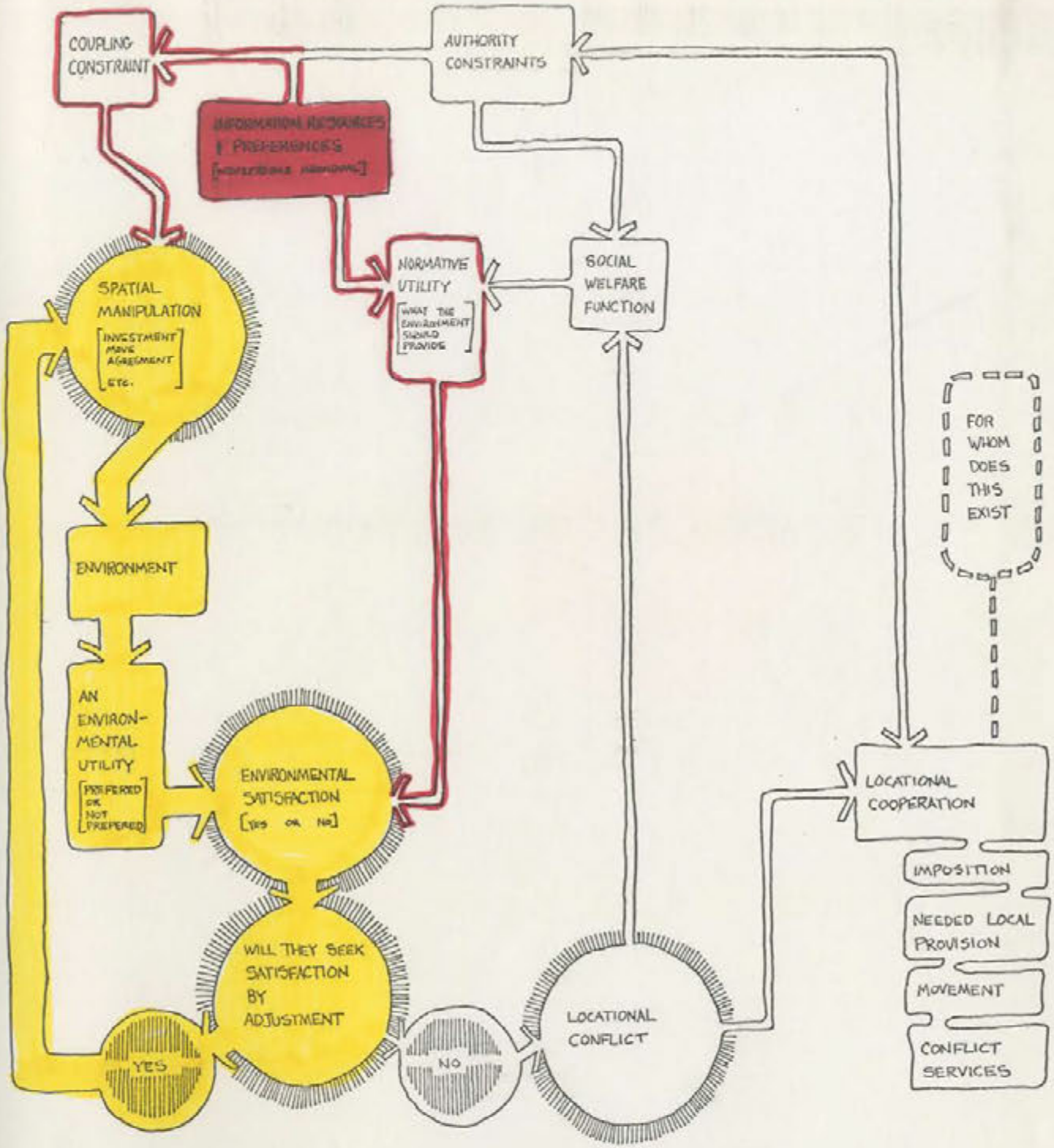
[15] Ibid., pp. 7-21.

[16] E.L. Ullman, "The Nature of Cities Reconsidered," Papers and Proceedings, Regional Science Association, Vol. 9 (1962), pp. 22-23.



The thicker arrows designate a requisite path.	FIGURE 2-1	A DIAGRAMATIC INTERPRETATION OF HAGERSTRAND'S LOCATIONAL DYNAMICS SOURCE: lecture notes taken from Prof. John Agnew, Syracuse Univ., Dept. of Geography.

factors, Pred's multiplier effect, and the Markov chains.[17] In any given location a variety of circumstances will influence the highest and best use of that location. Proper response to these circumstances should produce a product, which is not only compatible at the micro-level, but is also supportive of the infra-structure needed to maintain agglomeration economies. In other words, the response should have a 'multiplier effect' on the adjacent areas. (see figure 2-2). If a response at a given location does become a multiplier, then one can expect either new local or regional commercial thresholds, or enhanced possibilities of innovation.[18] Once this initial step is accomplished, it is reasonable to hypothesize that a first order Markov chain effect

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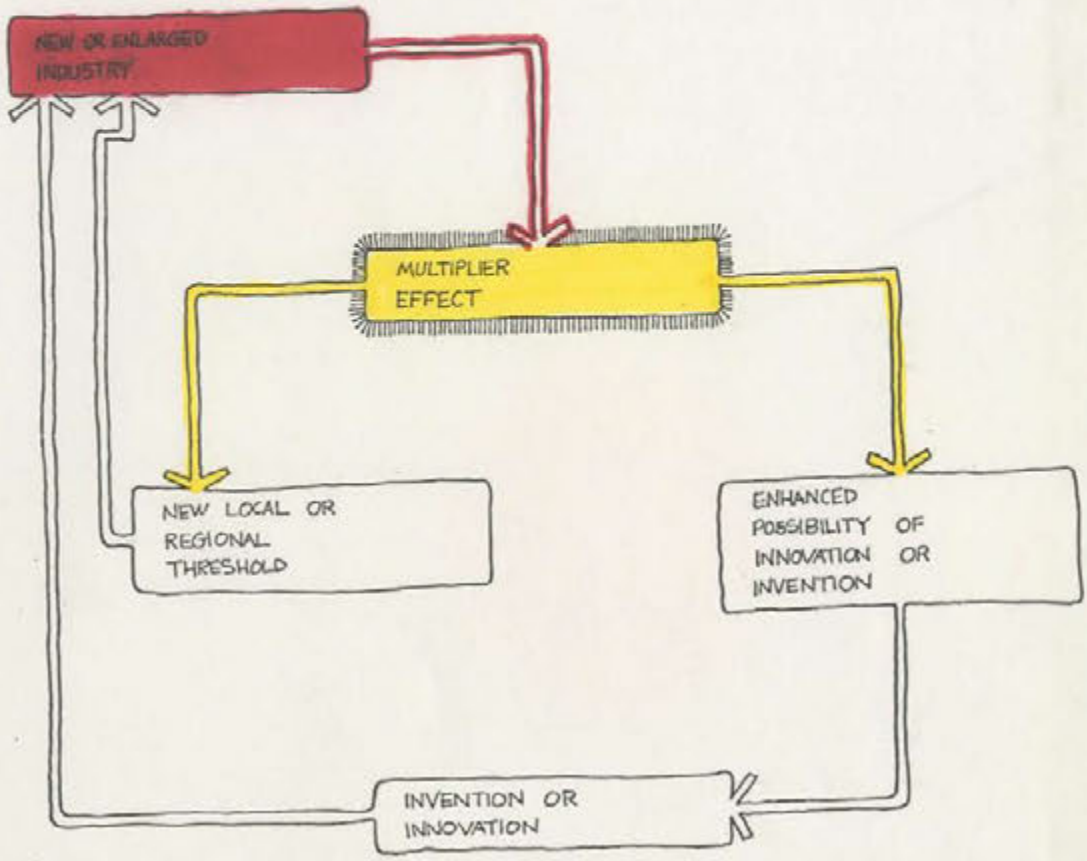
[17]Hagerstrand's 'micro-environmental factors' are immediate urban environmental components which substantiate environmental utility and satisfaction, or promote adjustive measures by the individual. If the immediate localized environment is utilitarian and satisfying to the given individual, then the individual will remain and enjoy the environment. If the environment is not satisfactory, then the individual will attempt to adjust by moving, psychological alterations, or political-economic activism. See: Hagerstrand, pp. 7-21.

Pred's multiplier effect is the concept that new business or industry increases agglomeration, which causes new local commercial thresholds and opprotunity for more growth, or enhances the possibility for innovation and invention, causing additional businesses and industry to agglomerate. Conversely, a stagnating locality will find it more difficult to maintain an infra-structure and experience negative multiplier effects. See: A.R. Pred, The Spatial Dynamics of U.S. Urban Industrial Growth, 1800-1918 (Cambridge: MIT Press, 1966), p. 25.

In a Markov Chain, a system of situations change according to a probability with time. A situation at the starting time plus one is dependent on the situation at the starting time, but is independent of situations which occurred prior to starting time. This is referred to as a first order Markov Chain if some independent random component is considered for comparison. It is possible to create extended order Markov Chains by extending time. See: Lyndhurst Collins and David F. Walker, editors, Locational Dynamics of Manufacturing Activity, (London: John Wiley and Sons, 1975), p. 229.

[18]A.R. Pred, The Spatial Dynamics of U.S. Urban Industrial Growth, 1800-1918 (Cambridge: MIT Press, 1966), p. 25.



In any given location a variety of circumstances will influence the highest and best use of that location. Proper response produce a product supportive of the infra-structure needed to maintain agglomeration economies. (A multiplier effect).	FIGURE 2-2	A DIAGRAMATIC INTERPRETATION OF FRED'S MULTIPLIER EFFECT SOURCE: A.R. Fred, The Spatial Dynamics of U.S. Urban Industrial Growth.(1966), Cambridge: MIT, p. 25.

should initiate revitalization. Hence, responses at time (T_{0+1}) will be generated from the initial product at time (T_0) and stimulate a product keyed to the micro-environment at the micro-location and agglomeration economies.[19]

Metropolitan centers are land poor in terms of large tracts of land available for development.[20] The available large tracts should be used with discretion. The concept of micro-location can act as a guideline for intensive project development, which can stimulate social, economic and physical revitalization. Urban architectural projects should fail if they are inadequate enough to upgrade their surroundings.[21] Such projects can not afford to be framed wholly within the confines of their locations, displaying themselves to the world; these urban projects must be interactive, utilize the location to the fullest, and actively promote urban diversity. (see figure 2-3).

The Conceptual Foundations of Airspace Realty

In these times of inflationary land prices and large populations, 'space' has become a precious commodity because of the pressures of particularly crowded urban situations. When one speaks of space for physical development, it is usually recognized as merely a surface phenomenon (developing land). However, airspace, the cubic volume of

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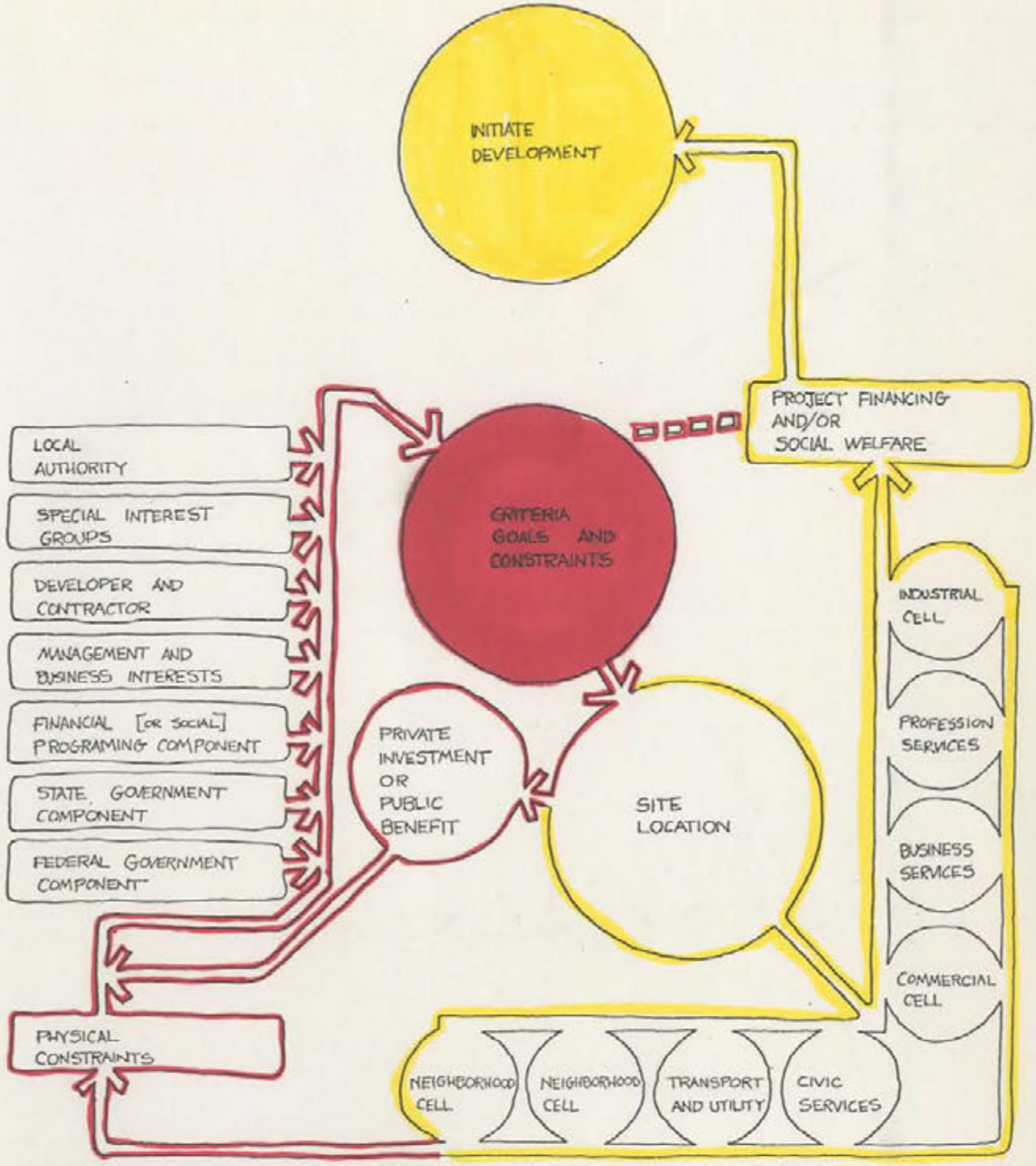
[19] Lyndhurst Collins and David F. Walker, ed., Locational Dynamics of Manufacturing Activity (London: John Wiley and Sons, 1975), p. 229.

[20] Robert R. Wright, The Law of Airspace (New York: Bobbs-Merrill, 1968), p. 4.

[21] "A New Force for Rebuilding Cities," Business Week, No. 2267 (Feb. 17, 1973), p. 61.



Such projects can not afford to be framed wholly within the confines of their locations, displaying themselves to the world: these projects must be interactive, utilize the location to the fullest extent, and promote urban diversity.	FIGURE 2-3	SITE, SITUS AND ENVIRONMENT INTERACTION

space above the ground plane, can be developed. This volume can be accurately measured and subdivided (horizontally and vertically), and except for structural purposes, does not have to be surface bound. Physical projects which use airspace are commonly classified as air rights projects or airspace developments.[22]

"The nature of air rights projects, which involve government and private interests, adds a new parameter to the role of the [urban designer] in executing his professional responsibilities. Such an assignment projects him into a more hectic milieu where interplay of political, social and economic factors have full scope."[23] The previous discussion on urbanization, catalytic functions, and micro-location accentuates the forces effecting airspace realty. If airspace utilization continues to increase, as the current trends indicate, then the urban designer will have to become better acquainted with the forces effecting airspace realty, in order to augment intelligent planning and project decisions.[24] Some knowledge of contextual concepts, such as urbanization, catalytic functions, and micro-location, will aid in fabricating a framework for airspace development as a tool for revitalization.

Airspace utilization is not a patented universal panacea for urban problems. It is not even a comprehensive tool for eliminating wasted

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[22]In surveying the literature on the topic of airspace development, the terms 'air rights' and 'airspace' were interchangeable. However, 'airspace' remained the preferred term, and, except within quotations, is the term used in this thesis.

[23]Thomas F. Galvin, AIA, "New Dimensions in Air Rights," American Institute of Architects Journal, Vol. 50, no. 1 (July 1968), p. 40.

[24]Michael M. Bernard, "Air Rights and Highways," Urban Land Institute. Technical Bulletin #64 (Washington D.C.: Bureau of Public Roads, 1969).

urban space, or promoting more efficient use of the limited urban resource, land. Moreover, if airspace utilization were to increase substantially (as is expected), it would seem to conflict with the planning goals to alleviate and prevent congestion and overcrowding, and to provide adequate open space, light and air for high population areas. However, these goals, when strictly interpreted, are concurrent with the Jeffersonian ideals of bringing the goodness of the country to the "evil city".[25] It is highly questionable whether the assumptions or actions corresponding with this attitude are correct or desirable. It is equally questionable whether minaturization (an opposite attitude from the Jeffersonian ideas) should govern future planning decisions.[26] The probable course of action lies somewhere between these extremes.

Neverthless, certain benefits are accrued with airspace utilization. First, since utilized airspace could be put into the taxable private sector, and public utilization of airspace could free other lands that would have come under the public domain, additional tax revenues would be made available. This is economically and socially beneficial for the city, because it generates additional income, which can be funneled into social service programs for the community (e.g., educational improvements). It also generates agglomeration economies, which can influence growth and development for the locality.

Secondly, the possibility of low-middle-income housing or various

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[25] Wright, pp. 382-384.

[26] The concept of miniturization is espoused by Paolo Soleri who contends that people enjoy organized densities which display diversity. He assumes that organization and well developed transit systems will counter congestion, and will free more land for open space. See: Paolo Soleri, Arcology: The City in the Image of Man (Cambridge: MIT Press, 2nd edition, 1970), pp. 1-30.

civic services abound in the airspace neighborhood, particularly in large tracts of airspace presently under government control. Using airspace in this fashion would promote savings, since the government would not have to deal with acquiring fractionalized urban lands. The capital saved could be used toward creating beneficial amenities for the community in the airspace projects.

Thirdly, airspace is normally unoccupied and can be developed without clearance procedures. In renewal situations this is desirable, because relocation can be strictly controlled so that people will not be forced into other housing conditions.

Finally, in relation to this, the airspace above freeways (and railroad rights-of-way) in most cases, is free from obstructions. This is beneficial since condemnation proceedings are an extremely costly and lengthy process. They cause incredible increases in development costs, and because of this, discourage development.[27]

These examples do not represent all of the benefits to be gained through airspace realty and not all of these items would necessarily be characteristic in any particular airspace development. In essence, the benefits accrued by any airspace project are dependent on the particular situation or situs of the given project.

Situs, location and economic feasibility (or social benefit) are primary considerations when developing an airspace project, because they establish the foundations of airspace development within the

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[27] William J.D. Boyd, ed., "Air Rights Housing to Be Built," National Civic Review, Vol. 51, no. 3, p. 161.

operating systems (social, economic or physical) already existing in the community.[28] Determination of situs criteria is necessary for establishing a functional web of interrelationships between the existing urban fabric and the new urban element. Locational criteria are important because some land (space) uses are more compatible together than others. Higher development costs and restrictions on airspace usage place critical economic constraints on airspace development. Finally, the social benefit of added revenue or civic services for the community must be measured against the physical problems of airspace development to both the motorist and the airspace occupant.[29]

In the final analysis:

> All metropolitan areas will feel the rising interest in air rights development because it minimizes or eliminates the perplexing and often costly problem of obtaining possession. It will allow for essential urban construction in core areas that otherwise might have deserted the city itself in favor of the relatively inexpensive outlying land. Certainly, when pulbic improvements on air rights are contemplated, it reduces the tendency for government to compete with private enterprise for the admittedly scarce supply of well located central city land.[30]

The vanguard of our urban environment will want to make use "of what would otherwise be a great deal of wasted space resulting from the swath that freeways and interstate highways cut through our cities."[31]

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[28]Bernard, pp. 17-18.

[29]Ibid., pp. 17-18.

[30]Donald H. Siskind, ed., Air Rights (New York: Practicing Law Institute, 1974), p. 437.

[31]Robert R. Wright, "Model Airspace Act: Old and New Law for contemporary Land Use Problems," Arizona State Law Journal, Vol. 1972, no. 4, p. 553.

SECTION III

THE FREEWAY AND JOINT DEVELOPMENT

Transportation has always been an integral part of the urban system, and has had considerable effect on the development of the city. Historically, transportation has been a prominent key to urban growth and the built environment.[1] Community development was accelerated around transportation junctions or break-of-bulk terminals, and became the seeds of our modern metropolis. The industrial revolution brought new and stronger relationships between the city and transportation. Among these new relationships were the development of more urban space for transportation functions and the need for hierarchical movement patterns, which led to large urban transportation corridors.[2] One problem, largely overlooked until late in the railroad era, was the need to reassemble the urban fabric dismembered by such transportation corridors.[3]

Concern over the enormous railroad corridors, that penetrated deep into the heart of the city, ultimately led to tunneling. Eventually, the railroad terminus "became a multi-level structure separating trains from pedestrians, establishing gathering places for people, separating

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[1]For elaboration on the effects of transportation on urban growth and building, check the current history of the development of Toronto's transit system. See:
G. Warren Heenan, "The Effect of Rapid Transit on Real Estate Development," Appraisal Journal, Vol. 36, no. 2, (April 1968), pp. 212-224.

[2]Lawrence Halprin, Freeways (New York: Reinhold Publishing Co., 1966), p. 112.

[3]Ibid., p. 113.

people from marshalling yards, and integrating finally, shops and restaurants and places for amusement with the functioning of the transportation mechanism."[4] At the most successful level of development, railroad corridors integrated pedestrian, motor car, and various structural environments as to become indistinguishable from the surrounding cityscape (e.g., the Park Avenue corridor in Manhattan). Unfortunately, it is only recently that action has been taken to understand the importance of developing the freeway corridors.

Characteristics of the Freeway

The recent broad-scale proliferation of urban sprawl has been assisted largely by the development of freeway networks. Yet, the opportunities for using the freeway as a metropolitan structuring device has largely been neglected. Numerous private and governmental agencies continue to exist in a state of 'non-cooperation,' even when given situations apparently indicate coordiantion is needed for decisive action to evolve. Only recently has it been recognized that the freeway environment does not have a singular function to be unilaterally fulfilled. The correlation between the environment through which the freeway passes and the freeway itself has been recognized as a network of relationships important to the development (or destruction)of the region. The densely built-up urban core, the contiguous residential developments, and the less expensive rural lands each have distinct relationships with the freeway.

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[4]Ibid., p. 113.

In effect, the freeway should be similar to that of the trolley car line of the early Twentieth Century, where the movement of the transportation mechanism is enveloped and integrated with the vitality of the cityscape. The freeway should be a functional component of the environment, rather than an imposing foreign element with obnoxious by-products. New interurban freeways should not only link different cities together, but should become structuring devices for new communities, "linkages about which the new cities will emerge."[5] The residential freeway must integrate housing with the needed amenities of residential development. The social and economic implications of residential freeway development should be addressed by considering alternative planning directions and integrated physical results.[6] The freeway of the urban core must recognize the constraints put upon it. It must unify itself with the architectural environment, attempt to eliminate urban dismemberment, establish a dense, efficient concentration, and become enveloped by the cityscape.[7] Additionally, the urban core freeway should attempt to address various political-economic problems of the central city (e.g., educational disparities due to high land and development costs). Both the residential freeway and the urban core freeway are urban components and must be viewed as integral elements of the urban system.

The character of the urban freeway (e.g., the residential freeway

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[5]Department of Transportation, The Freeway in the City (Washington, D.C.: U.S. Government Printing Office, 1968), p. 13.

[6]Halprin, pp. 104 and 105.

[7]Department of Transportation, p. 13.

and the urban core freeway) should be substantially different from the rural freeway (e.g., the interurban freeway). Yet, the similarity between them is remarkable. The urban freeway is fundamentally a rural freeway, slightly adjusted and crammed into the urban environment. However, the basic urban situation is so complex and diverse that the urban highway should inevitably entail:

> wholly new types of freeways--new forms and sections, and new concepts of vehicular movement and of vehicles themselves. The urban freeway must be designed as a scientifically contrived space through which the motorist or truck driver may move speedily, safely, and freely, enjoying a landscape designed to keep him relaxed and at the same time alert. This calls for new ways to integrate highways with other facilities and with the three dimensional structure of the city.[8]

The sheer mass and area of the urban freeway should be reduced to a more human scale. The overwhelming size of freeways may be acceptable in a rural setting, but is at best objectionable in a localized community framework. Freeway size can be concentrated through the use of multi-level cross sections, which would yield more acceptable community connections to and from each side of the freeway. Speed reductions in urban core areas would permit further freeway concentration, because it would allow decreasd curve radii, greater conformity to the typical grid pattern of the community, miniaturize the size of interchanges and allow flexibility in design and location.[9] In the case of interchanges, the reduction in size would amount to considerable savings, since it would greatly reduce land acquisition. Of course, multi-level arterial

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[8]Ibid., p. 55.

[9]Ibid., p. 61.

construction can produce similar savings through lower acquisition and construction costs, and multiple-use/multi-level construction can have social benefits for the community. Annoyingly, most of these suggestions for urbanizing the freeway are largely overlooked, and the freeway remains a foreign element imposing itself upon the urban system. (For typical types of urban freeway solutions, see figure 3-1).

The Functions of the Urban Freeway

Although the freeway is often considered an imposing element on the urban system (e.g., noise, aesthetics, safety...), transportation in this form serves a variety of necessary functions. One function can be to by-pass urban congestion. This function is addressed by the by-pass freeway. The by-pass freeway services the people and goods which are passing through the region and do not need to enter the urban agglomeration. It supposedly provides rapid, congestion-free passage around the urban complex. Often the urban complex has tap routes connecting the by-pass freeway to the urbanized area. Normally, a small minority of the travelers in a region intend to by-pass the urban complex, so the traffic loads sould be considerably lighter than the loads on other urban freeways.[10] (see figure 3-2).

The second urban freeway function serves the suburban/urban commuter, who wishes to use the automobile to travel from home to core area jobs and services. A major problem with commuter routes is the lack of adaptation by the freeway to the environment through which it passes. This problem is complicated by the fact that commuter routes

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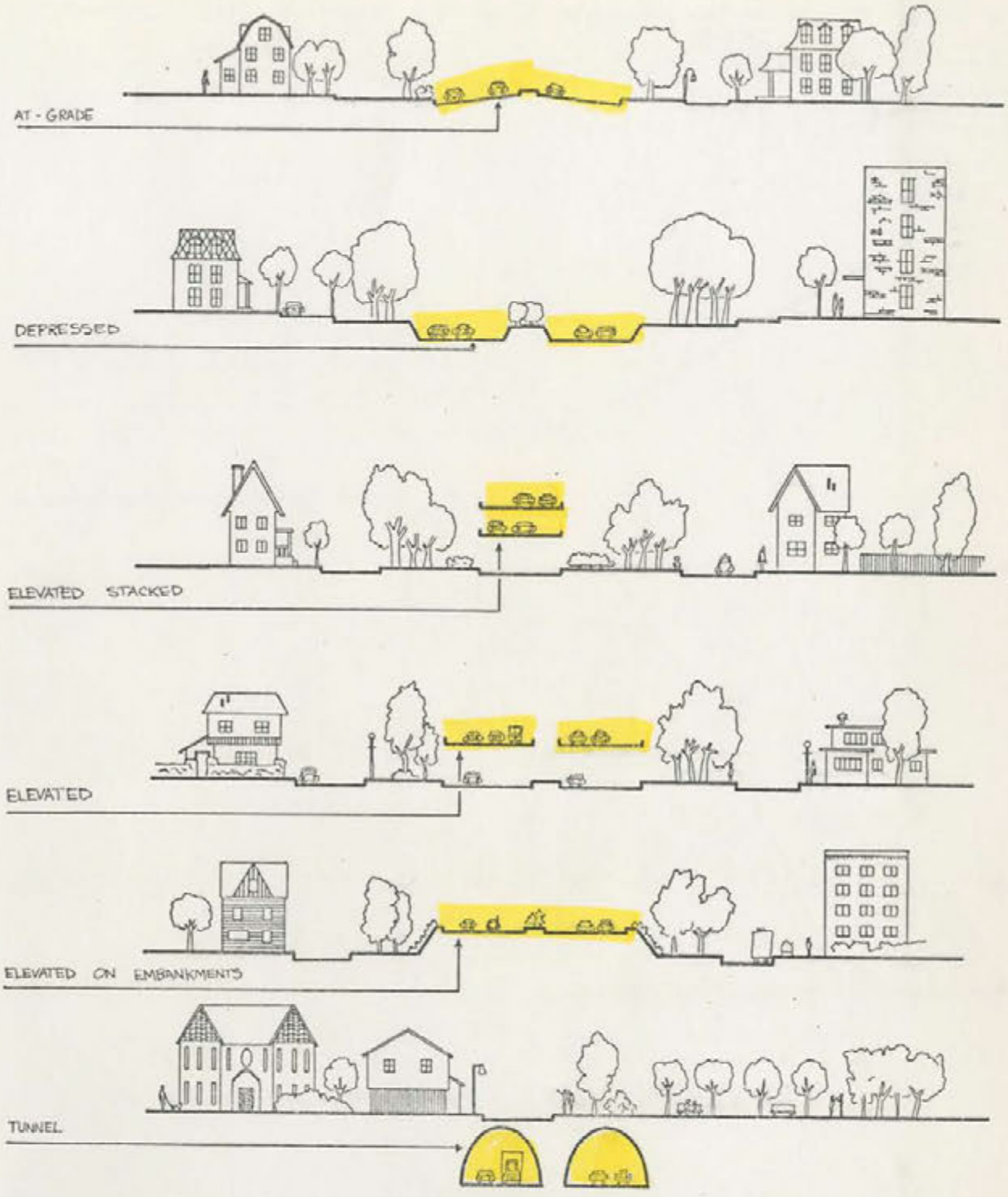
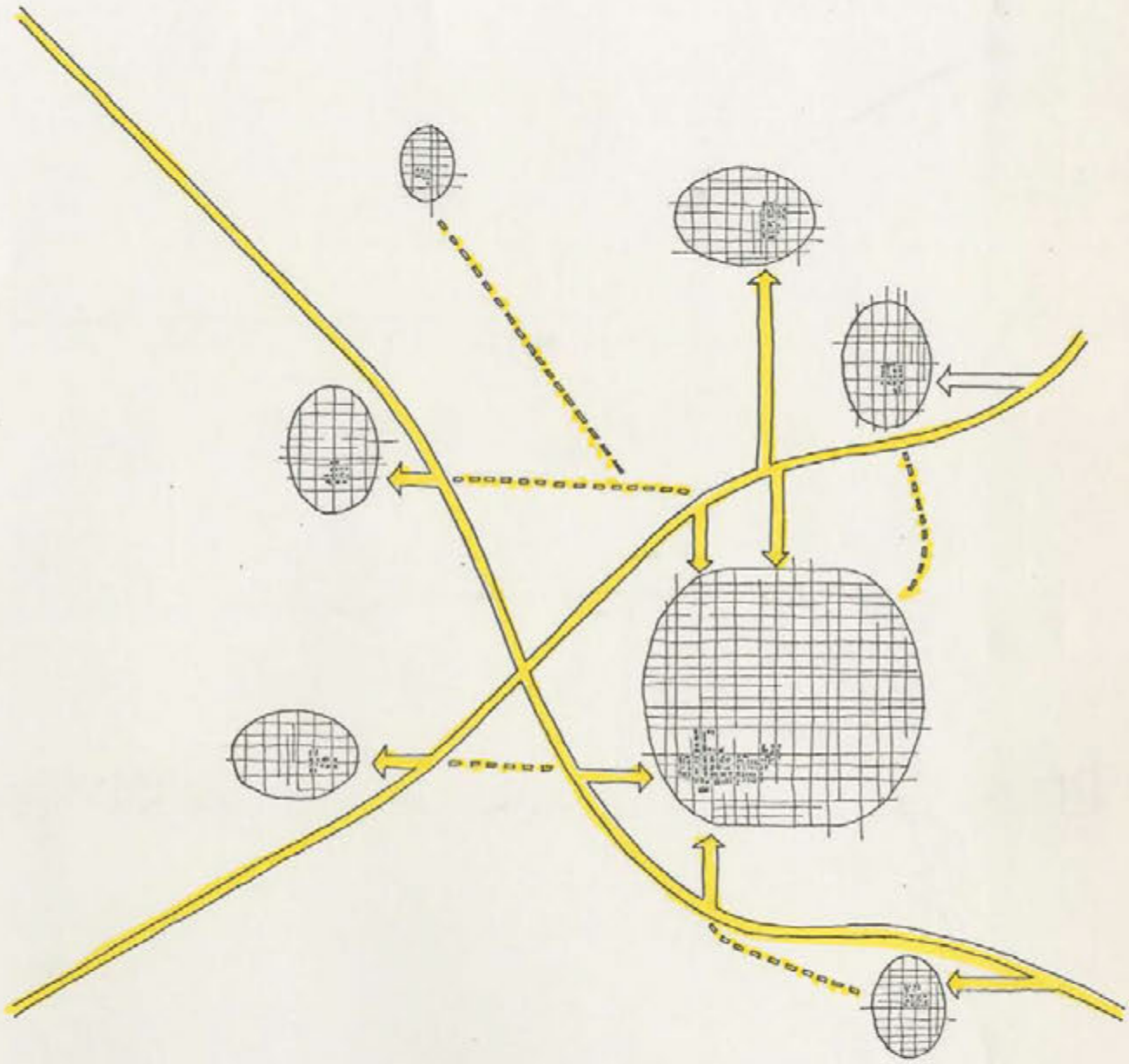
[10]Halprin, p. 58.



The freeway can be an imposing element on the urban system. Every attempt should be made for integration and/or joint development. The whole range of possibilities should be investigated.	FIGURE 3-1	TYPES OF FREEWAYS



by-pass freeway .....

commuter freeway ....

C.B.D. .....

FIGURE 3-2

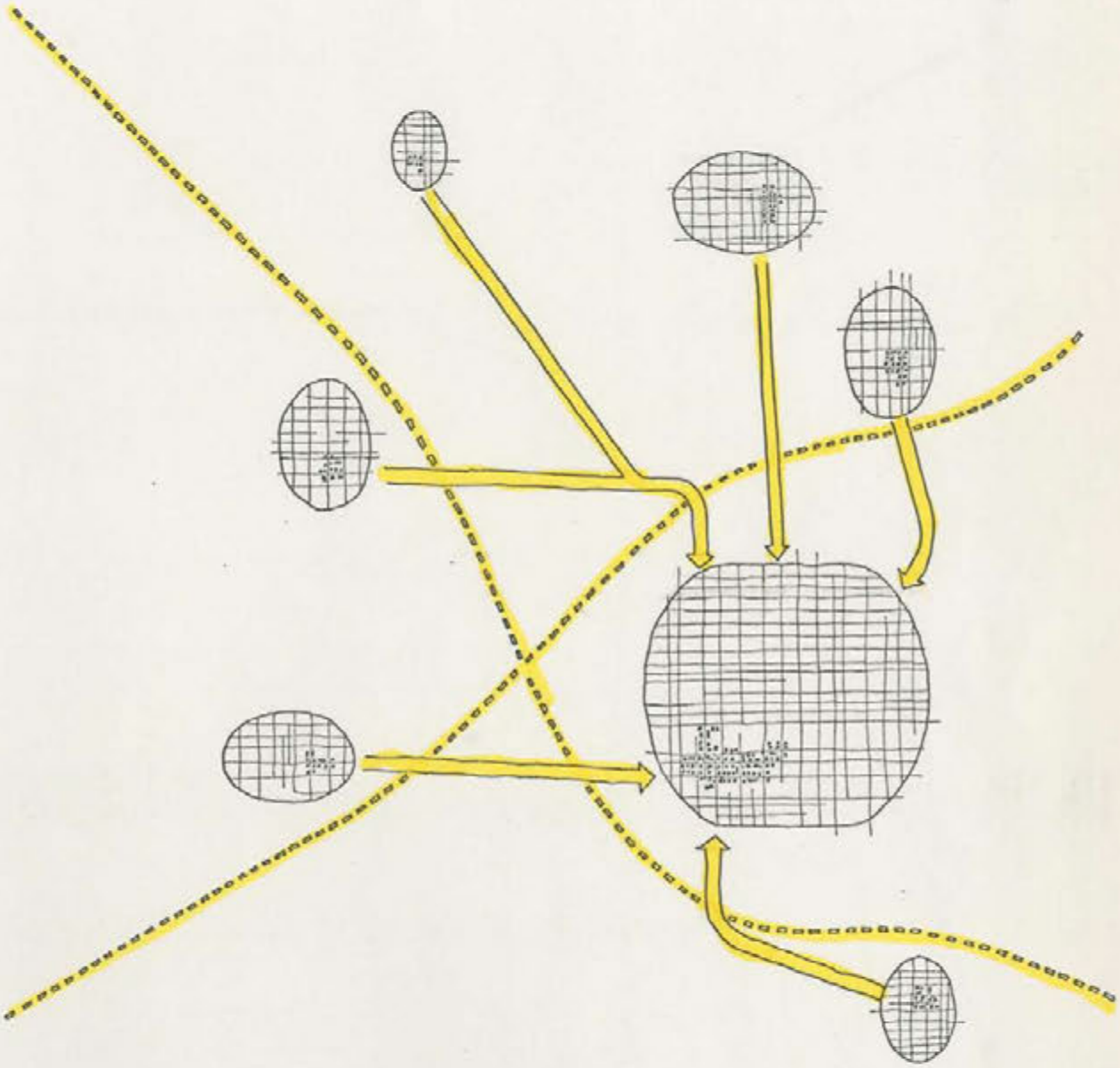
THE BY-PASS FREEWAY FUNCTION
A DIAGRAMATIC INTERPRETATION

pass from rural areas through suburbia and into urban core areas. Additionally, the commuter freeway fails to properly service the needs of the reverse commuter dwelling in the urban core. This is a growing concern, since increasing numbers of jobs suburbanize annually. (see figure 3-3).

The final most demanding function of the urban freeway is internal transportation. Within the city an extremely large number of destinations must be reached by vast numbers of vehicles. The scale of this function, coupled with the attempt to maintain high speed service, has often produced elephantine structures, which are highly disruptive in the urban environment. However, if planned and designed carefully, the internal freeway can lighten the load on urban streets (not designed for heavy loads) and promote accommodating local environments. The local residents can benefit from quieted urban streets and pedestrian amenities become achievable goals. Nevertheless, it is the internal freeway which remains the most difficult to coordinate, and the type needing the most additional research. (For a diagrammatic representation of an internal freeway, see figure 3-4).

The Location of the Freeway

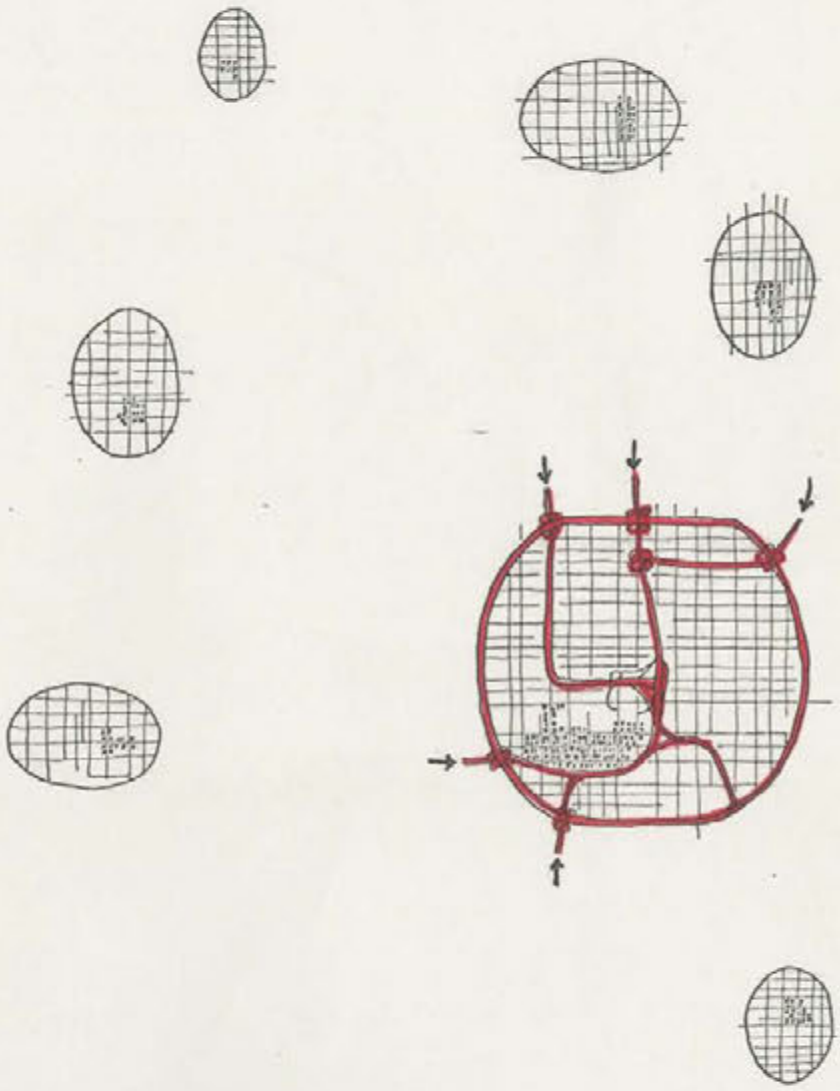
The location of the freeway is a major concern, because of consequent effects on the community through which it passes. Unfortunately, freeway location is largely determined by economic factors. Certainly, the economic concern for moving the greatest number of vehicles at the least cost should be a priority, but it should not be the governing concern, particularly in an urban setting.



commuter freeway ....
by-pass freeway .....
C.B.D. .....

FIGURE 3-3

COMMUTER FREEWAY FUNCTION
A DIAGRAMATIC INTERPRETATION



internal freeway .....
interchange .....
C.B.D. .....

FIGURE 3-4

INTERNAL FREEWAY FUNCTION
A DIAGRAMATIC INTERPRETATION

The social and aesthetic criteria should be evaluated and used for locating urban freeways. The problem of using these types of criteria for locating urban freeways is compounded by the fact that social and aesthetic criteria are difficult to quantify. Yet, social and aesthetic criteria can not be overlooked.

Coordination and Joint Development

The suburban lifestyle now dominates our culture. Recent land use patterns are marked by the dispersal of jobs, residences, and recreation, which have generated traffic patterns "that can only be handled by the automobile."[11] Vast numbers of people live, shop, work and play "within the physical confines of the freeway culture."[12] However, all is not well; a great discrepancy has been created by satisfying the demands of the driver (i.e., traveler), rather than those of the pedestrian (e.g., shopper, resident...). The elephantine scale of the freeways is not compatible with the fine-grained texture of the pedestrian environment.[13] In a recent New Jersey legal suit, Norwalk CORE v. Norwalk Redevelopment Agency, the point was made that land around freeways became blighted because of the abrupt scale change from the residential uses to the freeway corridor.[14] This point augmented the argument that large numbers

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[11] J. W. Hughes, Suburbanization Dynamics and the Future of the City Camden: U.S. Center for Urban policy Research, 1974), p. 3.

[12] Ibid., p. 5.

[13] Halprin, p. 52.

[14] Norwalk CORE v. Norwalk Redevelopment Agency, 395 F 2d @ 920 (2ed CIV. 1968).

of low-income families were forced either to relocate or to adjust to the blighted conditions. It is this type of case which has triggered recent Federal Government attention to the implementation and institutional tools for coordinated 'joint development' between transportation facilities and land development.[15] (See figures 3-5 to 3-7A). The concept of 'joint development' encompasses a special use of airspace utilization in which airspace development is integrated with surface land development around a transportation right-of-way.

Little has been done to utilize the important functional and urban design opportunities inherent in transportation development. Historically, transportation and land use planning authorities have operated in isolation, and as a result single-use transportation corridors have been created. Normally, these corridors are poorly integrated into the urban environment, and "are frequently located without regard to whether or not they can generate or permit joint development."[16] Yet, "the concept of joint development is one way in which cities can provide housing, parks and other facilities simultaneously with the construction of future urban freeways and other transportation links in less space and with less cost."[17]

Attempts at urban revitalization and reconstruction are burdened by constraints of space, time, and capital. Capital should be used

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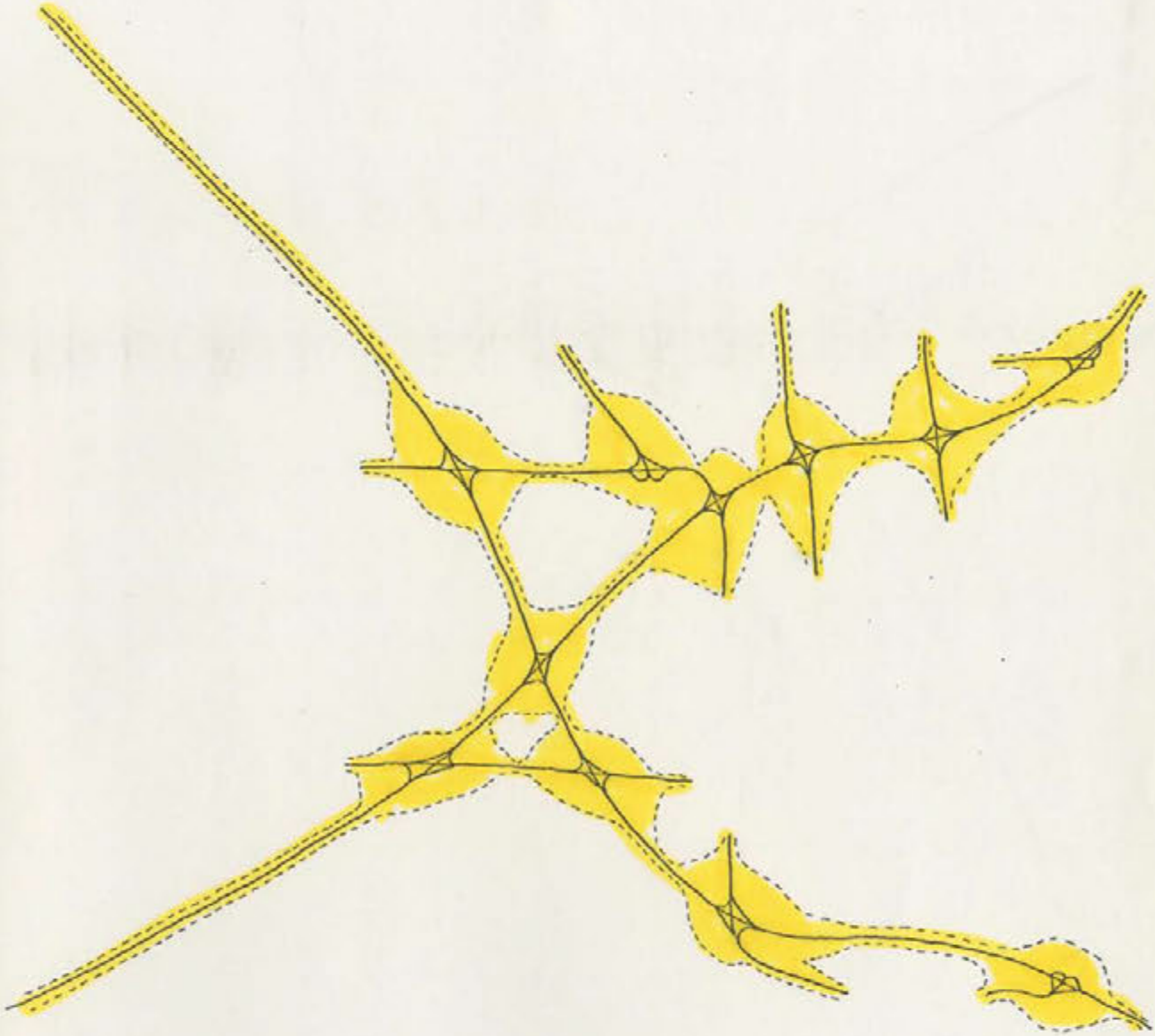
[15]Rodney E. Engelen, "New Institutions for Joint Development," ASCE Urban Planning and Development Division Journal, Vol. 101, no. UP1 (May 1975), pp. 11-12.

[16]Ibid., p. 12.
Joint development is airspace development which is coordinated with land development around the transportation right-of-way.

[17]Dwight M. Baumann (Chairperson), Interdisiplinary Research Topics in Urban Engineering (Washington, D.C.: American Society for Engineering Education,1969), p. 75.



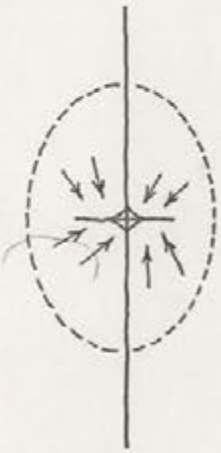
area influenced by the freeway .....

freeway .....

interchange .....

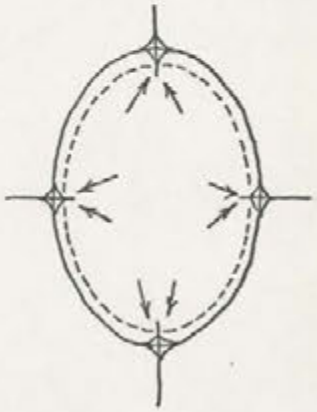
FIGURE 3-5

AREA OF INFLUENCE AROUND THE FREEWAY



An interchange within an urban center requires that people drive inward in order to get out.

Where interchanges are located outside the urban center, and where local streets are adequate traffic ingress and egress moves more efficiently and logically.



A circumferential expressway of six lanes (three lanes in each direction) saves land in the center of the city, and preserves local streets for local traffic.

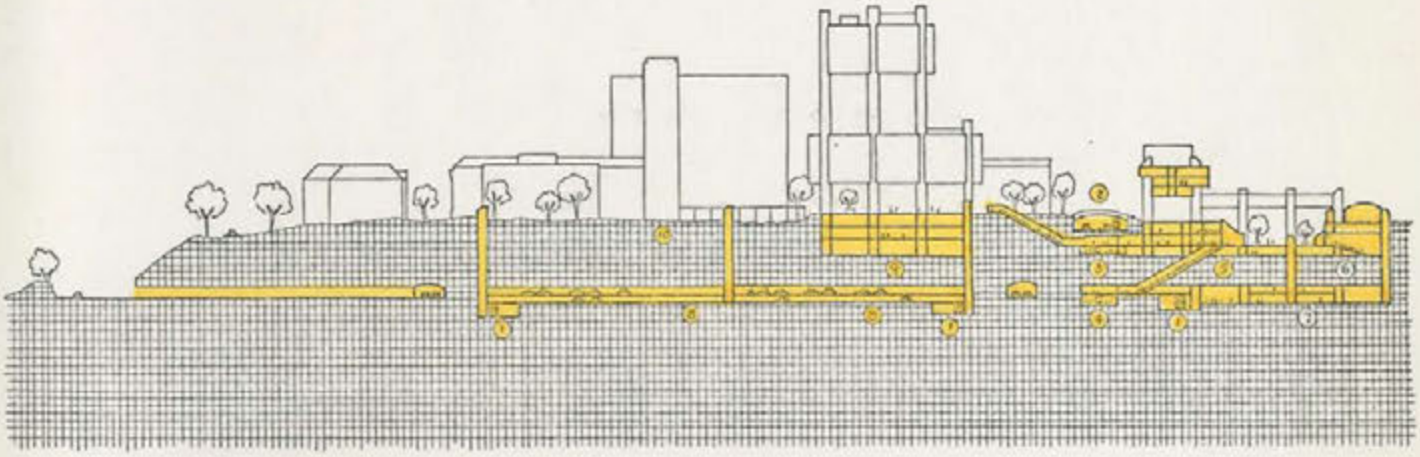
C.B.D. .....

traffic flow ..... →

FIGURE 3-6

THE EFFECT OF INTERCHANGE LOCATION ON THE CENTRAL CITY

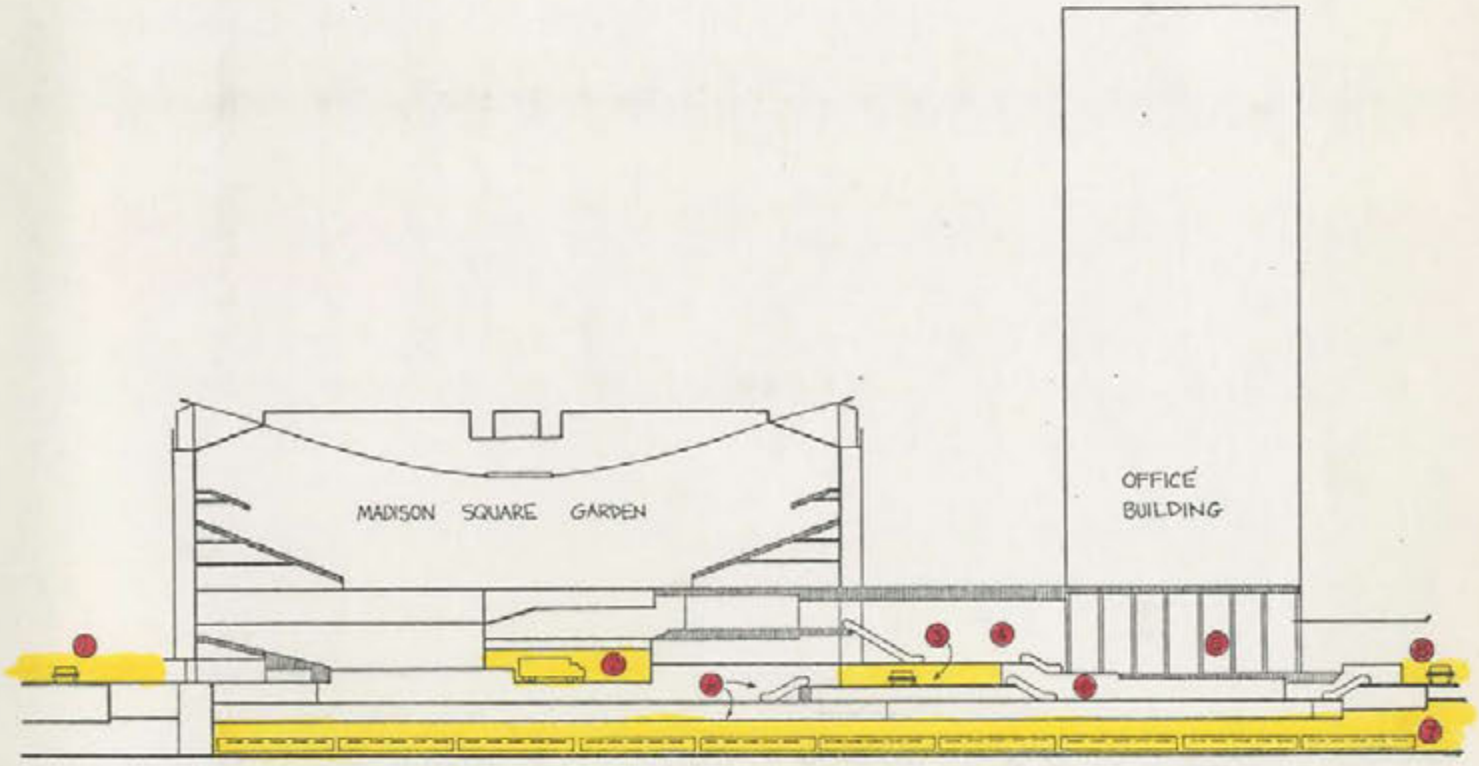
SOURCE: Bureau of Public Roads, The Freeway in the City, (1968), Washington D.C.: U.S. Government Press, p.49.



1. services and utilities
2. Washington Ave.
3. campus transit
4. regional transit
5. commercial
6. lecture space
7. laboratory space
8. parking
9. health sciences
10. university hospital

FIGURE 3-7

UNIV. OF MINNESOTA CAMPUS COMPLEX



1. Eighth Ave.
2. truck unloading area
3. taxi drive
4. enclosed mall
5. entrance to office building
6. railroad concourse
7. track right-of-way
8. Seventh Ave.

FIGURE 3-71

MADISON SQUARE GARDEN COMPLEX
a multi-level, multi-use airspace development.

effectively for multiple purposes, so that a wider range of return can be realized. Central city urban land should be more efficiently used, because the cost is high and the space is needed.

Studies made by the Bureau of Public Roads show that in urban areas where space is a desired commodity, land purchases for multiple-use joint development projects would be only slightly more expensive than the cost of purchasing land solely for the freeway right-of-way.[18] "A city could acquire entire blocks on the route of a planned freeway, sell to the highway department the space needed for the freeway and still have valuable land available for other development at a fraction of the cost of acquiring it alone."[19] (See figures 3-8 and 3-9).

Joint development can stimulate urban revitalization by combining freeway construction with land use development. The land use projects can provide a variety of urban necessities and services (e.g., residences, shops, civic centers, schools...), while being integrated with the most critical of urban life lines, the freeway. However, joint development can also be coordinated around other transit facilities, as was done successfully with the Toronto subway system.[20] In any case, future transportation corridor construction should be coordinated with joint

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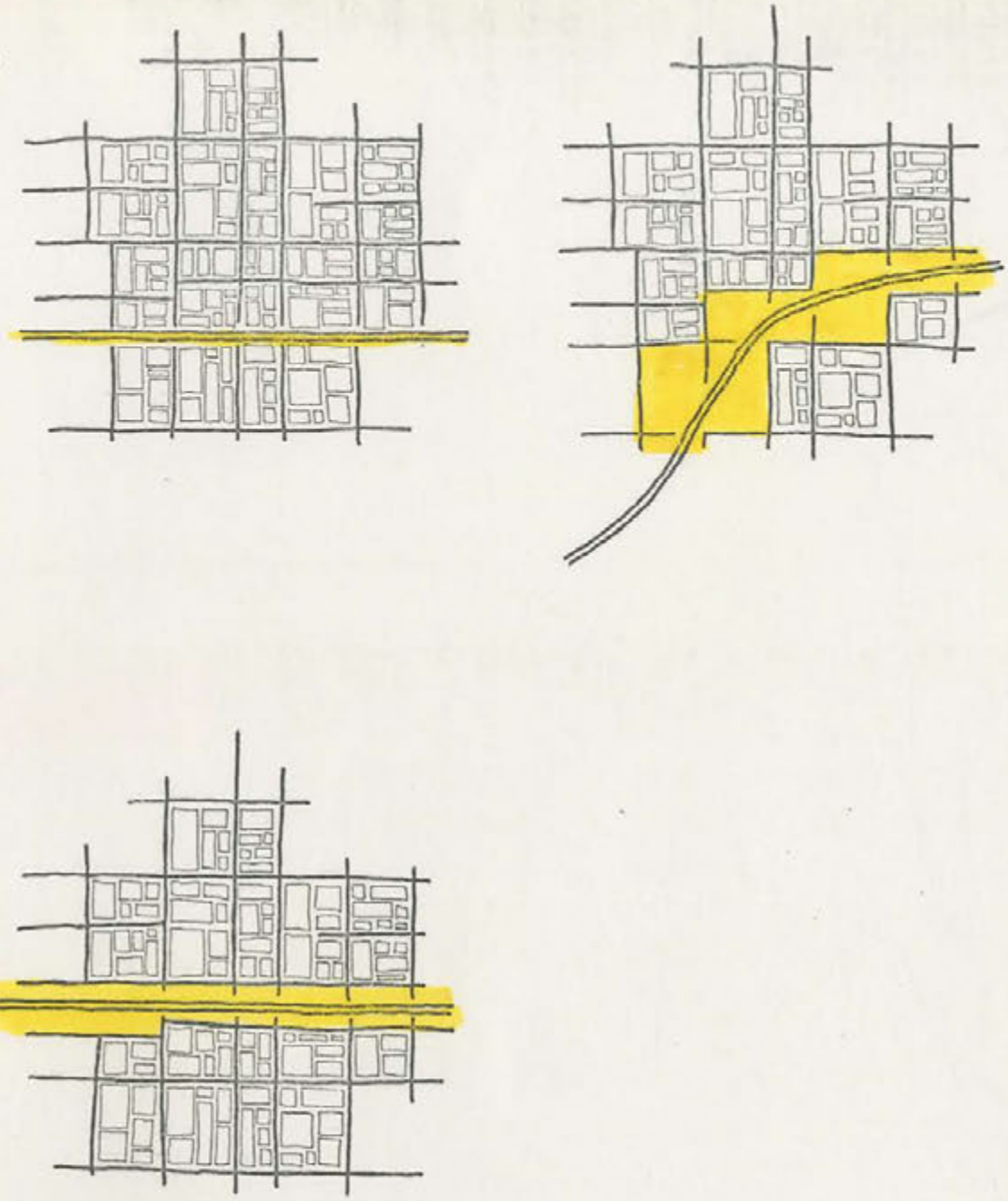
[18] Barton-Aschman Associates, Inc., Joint Project Concept - Integrated Transportation Corridors (Washington, D.C.: HUD Publication, 1968), see full report.

[19] Bauman, p. 26.

[20] A total investment of $67 million for the Yonge Street Subway ignited a $10 billion development explosion; so, when developing the new extensions, new zoning codes, and vertical development zones were established near subway stations. See:
G. Warren Heenan, "The Effect of Rapid Transit on Real Estate Development," Appraisal Journal, Vol. 36, no. 2, (April 1968), pp. 212-224.

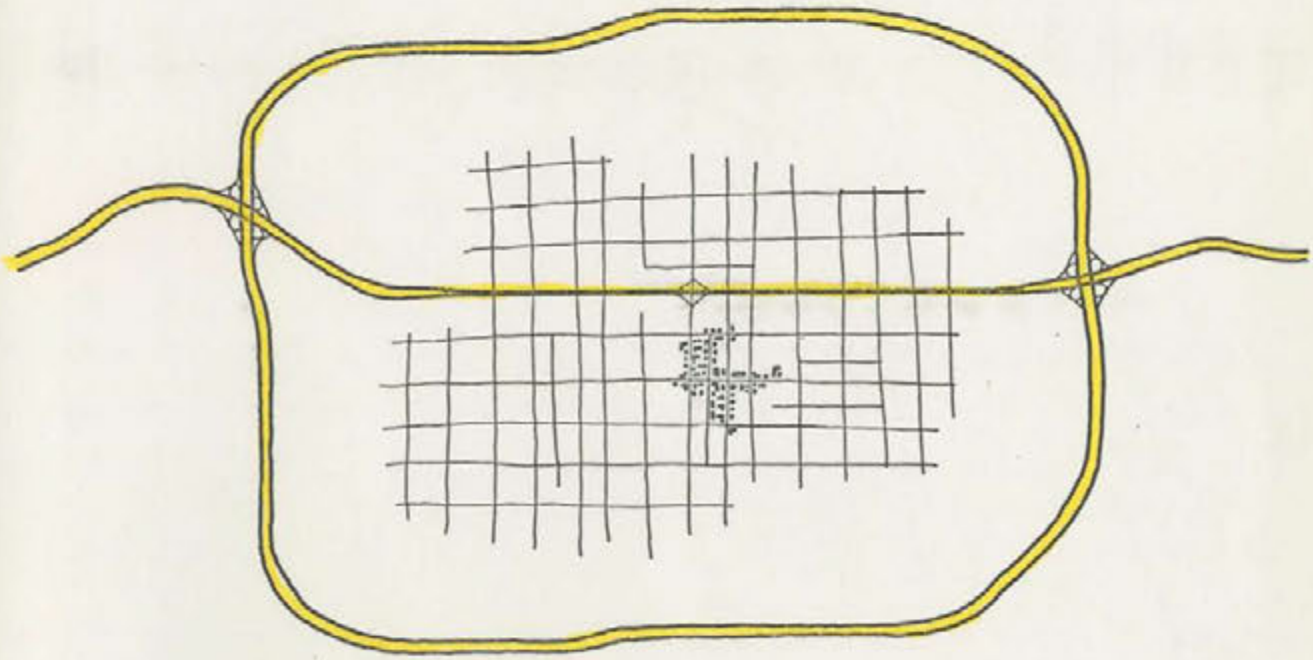


Whenever the existing street pattern is regular and dense the freeway must either be constructed parallel to the established streets or it must bear the cost of increased property-taking, damages and redevelopment. Freeway alignment, at best, should respond to the city grid patterns.

FIGURE 3-8

LOCATING URBAN FREEWAYS

SOURCE: Bureau of Public Roads, The Freeway in the City. (1968), Washington D.C.: U.S. Government Press, p. 50.



In this situation the freeway is integrated with the city grid. It is not extensively disruptive, but joint development would be even more desirable, because the urban fabric could remain united.	FIGURE 3-9	FREEWAY LOCATION ALONG A CITY GRID

development planning.

Adaptive Measures

For the thousands of miles of additional or expanded highways being constructed, coordination with joint development is a necessary objective. However, for the extensive miles of highways and streets already in existence, adaptive measures must be developed to utilize the valuable airspace which is presently dormant. Extensive study indicates that the adaptive approach is technically more difficult to optimize and develop than joint development. A rigorous method for handling this complex planning problem is greatly needed. In an attempt to establish a systematic approach to utilizing adaptive airspace, the strategy, forces, equipment, and project interrelationships must be clearly defined within the framework of an effective presentation. Moreover, an organization, schedule and an evaluative feedback mechanism must be established.[21] (See figure 3-10).

Like joint development, the utilization of adaptive airspace is affected by environmental factors:

1) the state of technology
2) the natural environment (i.e., ecology)
3) organizational policies
4) the economic conditions for new systems
5) human factors[22]

However, one important additional feature must be considered before attempting to utilize adaptive airspace. Unlike joint development,

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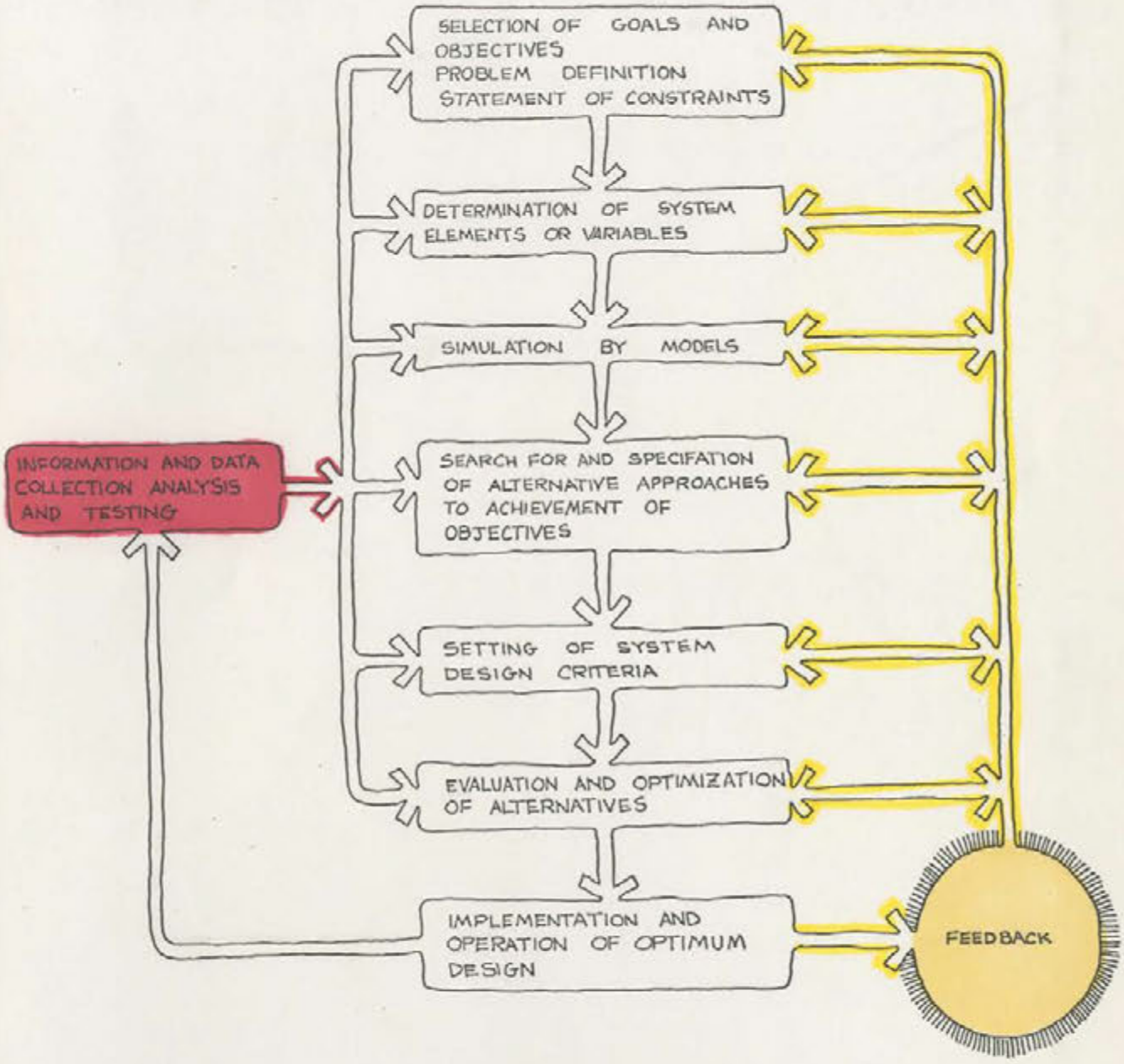
[21]Department of Transportation, pp. 111-113.

[22]Ibid., p. 112.



A block diagram of the typical steps in the general systems approach to a planning problem. Feedback is the continual procedure of reviewing and modifying prior steps in light of decisions made at earlier stages in the process.	FIGURE 3-10	DESIGN FEEDBACK FUNCTION

adaptive airspace must be integrated with a preexisting, man-made transprotation system, which in many cases has disrupted the environmental context of the area. Repairing the disrupted urban fabric is a noble, but challenging, objective for the urban designer.

It is my contention that an understanding of both joint development and adaptive airspace development is a vital concern for the urban designer. Without such an understanding, the value of airspace utilization as a tool for urban revitalization may not be fully recognized. The legal development of 'air rights' and the economic constraints on airspace development are of foremost importance to the understanding of both types of airspace utilization, and warrant serious consideration by the urban designer.

SECTION IV

THE LEGAL AND ECONOMIC HISTORY OF 'AIR RIGHTS'

Recognizing Legal Rights in Airspace

"Since space per se is an ubiquitous commodity, it is seldom considered by locational theorists."[1] Yet historically, legal precedent establishes the notion that space is not ubiquitous, because it is both subject to ownership and limited by feasibility of usage. This point can be sufficiently exemplified by momentarily reviewing the history of airspace law.

The foundations of Anglo-American airspace law are established in the maxim "cujus est solum ejus est usque ad coelum," attributed to Sir Edward Coke.[2] Coke gave life to this maxim with a classic statement in Coke on Littleton: "the earth hath in law a great extent upwards, not only of water, as hath been said, but of ayre and all other things even up to heaven; for cujus est solum ejus est usque ad coelum, as is holden..."[3] This maxim lead to a common law recognition of a landowner's right to possess and utilize superjacent airspace. The American landmark case upholding this maxim was Butler v. Frontier Telephone Company, in which the court found that a telephone wire suspended over the

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[1]Lewis K. Loewenstein and David Bradwell, "What Makes Desirable Industrial Property?" Appraisal Journal, April 1966, p. 267.

[2]Blackstone, Commentaries on the Laws of England, Chapter 2 at p. 19 (in Wright, p. 13).

[3]Laird Bell, "Air Rights," Illinois Law Review, Vol. 23 (1928-1929), p. 250.

plaintiff's land was a sufficient taking of airspace as to necessitate compensation.[4]

Another historical basis for possession and utilization of airspace is the right of separate ownership of an 'upper chamber.' The 'upper chamber' cases, such as, Loring v. Bacon (1808), Mills v. Pierce (1819), McConnelly v. Kibbe (1867), and Madison v. Madison (1903),[5] establish airspace ownership as not merely attached to surface land parcels, but rather, as distinct spatial rights in the upper stories of dwelling structures. These early cases favored the argument of horizontal separability of land. They did not, however, resolve the problem of what happened to conveyed rights in upper story space once the structure that measured the space no longer existed (e.g., when a building burned down leaving no way to measure one's upper chamber rights).[6] This problem was not resolved until precedence was set by Weaver v. Osborne (1912) and Pearson v. Matheson (1915).[7] These cases defined the rights to reserve airspace as equal to the power to convey airspace, if the airspace was properly defined and measured. Thus it is not only legal to claim ownership of airspace, but if properly defined and measured, one can lease, divide, reserve and convey airspace.

With the development of aviation, the vertical extent of airspace

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[4]Butler v. Frontier Telephone Co.; 79 N.E. 716 (1906).

[5]Loring v. Bacon; 4 Mass. @ 575 (1808).
Mills v. Pierce; 2 N.H. @ 9 (1819).
McConnelly v. Kibbe; 43 Ill. @ 12 (1867).
Madison v. Madison; 206 Ill. @ 534, 537 (1903).

[6]Hahn v. Baker Lodge; 21 Ore. @ 30 (1891).

[7]Weaver v. Osborne; 154 Iowa @ 10 (1912).
Pearson v. Matheson; 86 S.E. @ 1063 (1915).

became legally limited. The United States Supreme Court set legal precedence for this fact in the case of United States v. Causby (1945). In the Supreme Court opinion, Justice William O. Douglas reviews the extent of the ad coelum maxim. He concludes: "air is a public highway," but "it is ovious that if the landowner is to have full enjoyment of the land, he must have exclusive control of the immediate reaches of the enveloping atmosphere."[8]

As the world population continues to increase, the value of space becomes more apparent. As the United States continues to urbanize, space becomes a more desired commodity. It is not unusual to find airspace in some areas more valuable than surface land in other areas. To claim ownership of airspace and to consider such space an economic resource is legally recognized today, as it was in the times of Sir Edward Coke. Additionally, it is relevant to perceive space as a commodity limited by the extent of mankind's ability to utilize and control technology.[9] To sustain the notion of ubiquitous space is presently unrealistic.

The History and Feasibility of Airspace Utilization for Urban Development

During the Nineteenth Century, railroads developed throughout the United States. In an attempt to service urban markets and manufacturers, railroads utilized large amounts of land in the heart of many major

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[8] United States v. Causby; 328 U.S. @ 260-261, 264 (1945).

[9] As an example, technology is controlled by the recognition of the public right of flight and has limited utility because of present construction methods.

cities. As open land dwindled and land prices continued to increase, the land occupied by the railroads became more valuable. New York City became the first metropolis to expose its needs for both expanded railroad facilities, and more central city space. As a result the Grand Central Station plan evolved.[10] "Today the railroad tracks running into the heart of Manhattan have been covered by streets and buildings. The Park Avenue area and other areas as well, contain numerous buildings built in airspace."[11] Except for supporting columns, these buildings terminate at a level some twenty to forth feet above the floor of the railroad right-of-way.

In the late 1920's, Chicago began to utilize airspace. Because of the large amount of railroad acreage around Chicago, it was speculated that Chicago would surpass New York in airspace development.[12] However, this speculation never fully materialized. It is particularly interesting to note that the Chicago Daily News Building and the Merchandise Mart utilized airspace over railroads, though each had a significant difference in the structure of their deeds. Because of the general terms governing the mortgages held by the respective railroads, each deed had to provide a free and clear title for the airspace being purchased. The general terms of the railroad mortgages prohibited release of lines of tracks, structures and rights-of-way.[13] In the

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[10]Robert R. Wright, "The Model Airspace Act: Old and New Law for Contemporary Land Use Problems," Law and the Social Order, 1972, no. 4 (1972), pp. 539-540.

[11]Ibid., p. 540.

[12]Bell, p. 260-261.

[13]Ibid., p. 261.

Union Station/Chicago Daily News transaction, the entire interest to the airspace above a designated horizontal plane was deeded to the purchaser, except for foundation 'easements,' which extended below the designated horizontal plane.[14] In the Northwestern/Marshall Field (Merchandise Mart) transaction, the deed was more explicit and complicated. It called for the total purchase of three lots. First, an 'air lot' comprised of all the space above a designated horizontal plane. Second, 'column lots' comprised of three-hundred cylindrical lots extending from the base of the 'air lot' to the ground. Finally, the 'casement lots' extended from the base of the 'column lots' below the surface of the ground.[15] It is also interesting to note that the Merchandise Mart cost about $18 million and $2.5 million went to airspace alone.[16]

Development of railroad airspace spread beyond Chicago and New York (e.g., Boston's Prudential Center). This is an indication that positive factors do exist to offset the costs involved with airspace development. Railroad rights-of-way remain one of the most fertile areas for future airspace development. One major reason is the problem of obtaining large tracts of urban land for development (land assembly).

Land assembly is difficult in urban areas for a number of reasons. One significant factor is urban land value. As the automobile increased mobility, the central city lost its transportation convenience. Moreover, increased industrialization brought standardization of many products and wide distribution of goods. Both of these phenomena

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[14]Ibid., pp 261-263.

[15]Ibid., pp. 261-263.

[16]Wright, p. 541.

combined to bring about a substantial decrease in the agglomeration economies of the central city. This decrease in agglomeration economies decreased the value of urban land.[17] With a decline in land value the feasibility of demolishing the old structure and replacing it becomes greatly diminished.[18] The major reason for this fact is that the highest and best use of the land has declined, so to demolish an old structure and reconstruct a new one, often liquidates capital.

A second major factor affecting land assembly is "fractionalization." Fractionalization is a natural by-product of both increased land values and increased population. The parabolic increases in land values, experienced earlier in United States history, contributed to the relative increases in land prices. As a result, land and titles were divided for easy sale and profits. Dramatic acceleration in the 'percentage of population increase' before the first quarter of the Twentieth Century, led to an upsurge in the demand for land.[19] Because the demand for land increased, values were subsequently affected. This not only catalytically affected fractionalization, but also enhanced superce-dure in urban areas. Later in the Twentieth Century, cities experienced a decrease in land values and population. Additionally, developments in technology affected production operations in a way which warranted a need for large parcels of land. All these factors combined to make

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[17] Richard L. Nelson, "Appraisal of Air Rights," Appraisal Journal, Oct. 1955, p. 495.

[18] Ibid., p. 496.

[19] Ibid., p. 496.

small segmented parcels of urban land still occupied by "thin, tall buildings"[20] an undesirable commodity.

A final factor affecting land assembly is planning regulation. A need for light, air, open space and a variety of 'natural aesthetics' has decreased the land resources in urban areas.[21] Although these items may be of basic necessity in urban areas today, planners should seek to promote the utilization of wasted space. The air and light over railroads and highways clearly does not benefit the urban resident.

The previously mentioned factors affecting land assembly in urban areas (declining land values, fractionalization and planning regulation) are still influential, despite inflation. Land assembly remains a problem. The construction of needed modern structures in urban areas requires large, clear land parcels. The most extensive urban parcels meeting the requirements are not only the airspaces associated with railroads, but also the airspace above highways, streets,and parking lots.

As more and more land is designated to automobile transportation, the probability of such land being a recipient of airspace development increases. It is possible that highway airspace development could surpass railroad airspace development, because it not only attacks the problem of land assembly, but is becoming publicly recognized by governmental and private institutions.[22] The importance of this recognition

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[20] Ibid., p. 496.

[21] Robert R. Wright, The Law of Airspace (New York: Bobbs-Merrill, 1968), pp. 384-386.

[22] Wright, "The Model Airspace Act," pp. 542 and 544.

lies in the fact that, unlike railroad airspace, highway airspace is to a large extent under public ownership. Because of this public ownership, problems associated with title to airspace are minimized, financing is more easily assured, and the nature of liens and encumbrances are more acutely defined.[23]

Airspace development has been generally credited with two additional 'pluses'. First, the problems associated with relocation are much less severe with airspace development than would be the case with expanded use of eminent domain. The areas associated with airspace development are neither inhabited, nor in such proximity to residences, as to necessitate displacement.[24] Second, the value of blighted land adjacent to railroad and highway rights-of-way would increase and spur new development, if airspace development was initiated.

Basically, the feasibility of using airspace for urban development is reflected in the remarks of John Robert White, appraiser:

> All metropolitan areas will feel the rising interest in air rights development because it minimizes or eliminates the perplexing and often costly problem of obtaining possession. It will allow for essential urban construction in core areas that otherwise might have deserted the city itself in favor of relatively inexpensive outlying land. Certainly, when public improvements on air rights are contemplated, it reduces the tendency for government to compete with private enterprise for the admittedly scarce supply of well-located central city land.[25]

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[23] J.M. Pedowitz, "Air and Development Rights," Real Property, Probate and Trust Journal, Vol. 9 (1974), pp. 192, 193 and 196.

[24] Wright, "The Model Airspace Act," p. 543.

[25] John R. White, "George Washington Bridge Approach: A Case Study," in Air Rights, ed. Donald H. Siskind (New York: Practicing Law Institute, 1974), p. 438.

The Importance of Well-Located Central City Land (Space)

Location theorists stress the fact that cost and demand factors explain industrial plant location. Strong empirical evidence indicates, however, that such factors can not fully account for this phenomenon. Traditionally, the locational factors were considered to be:

1) Relatively inexpensive land
2) Accessibility to markets, to raw materials, and to sources of labor
3) A site grade of less than 10%
4) Access to utilities
5) Access to storm and sanitary sewers and treatment facilities
6) Soil with satisfactory land bearing and land drainage
7) Stable industrial zoning
8) A healthy tax climate
9) A community receptive to industry
10) Nearby shopping and recreation facilities[26]

Though these factors may be important in theory, in reality, surveys indicate that lack of land, labor problems, and urban tax problems are of overriding concern. For example, one survey conducted in 1964 for the San Francisco Chamber of Commerce by the Arthur D. Little Company, pursued the question of 'What does industry want?' In this survey nine major factors were apparently unimportant, while fourteen others were considered important by more than 50% of the four hundred firms contacted.[27] (See figure 4-1). Of additional significance was the discovery that seven particular disadvantages were associated with remaining in the city. These drawbacks included:

1) inventory taxes
2) property taxes

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[26]Loewenstein, p. 264.

[27]Ibid., p. 264.

WHAT DOES INDUSTRY WANT ?

9 major factors of little importance:

1- availability of capital risk
2- local zoning codes
3- local recreational amenities
4- attitudes of communities education and welfare benefits
5- availability of unskilled labor
6- relations with local government
7- local building codes
8- community relations
9- labor turnover

14 major factors important for more than 1/2 of the 400 industries contacted:

1- fire protection
2- frequency control of power supplies
3- climatic conditions
4- natural gas, fuel oil (quality and service)
5- police
6- water pressure and quality
7- public transportation
8- proximity to principal markets
9- ease of access by auto and truck
10- business credit availability
11- proximity to principal suppliers
12- condition of near by streets and highways
13- condition of buildings occupied
14- employee commuting conditions

7 items disadvantageous:

1- inventory taxes
2- property taxes
3- high wages and salaries
4- labor union practices
5- lack of land for expansion
6- parking problems
7- other taxes

Excerpts from Arthur D. Little Survey, which was done for San Francisco Chamber of Commerce	FIGURE 4-1	EXCERPTS FROM A SURVEY INVESTIGATING THE CAUSE OF INDUSTRIAL RELOCATION SOURCE: Louis Loewenstein and David Bradwell, "What Makes Desirable Industrial Property". Appraisal J., Apr. 1966, p.264.

3) other taxes
4) parking problems
5) lack of land for expansion
6) labor union strength in urban areas
7) higher wages and salaries[28]

items 1,2, and 3 = urban tax problems
items 4 and 5 = urban space and congestion problems
items 6 and 7 = urban labor problems [29]

The overall objective of this survey was to indicate why industrial firms were leaving San Francisco. To pursue this task, every firm which moved from San Francisco to one of eight Bay Area counties within the ten year span from 1953 to 1963, were isolated and questioned. During this decade the number of establishments in San Francisco dropped about 10% (from 23,400 to 21,000).[30] The usual procedure for the relocating firms was to "increase the size of their lot by more than 500%, and building by 200%." Storage was usually increased by 150% and office and production by 175%.[31] Even more shocking was the fact that the relocated firms were well established, and older than the average age of thirty-nine years. It seems that these firms became mobile when space became antiquated, redundant, or inadequate. The move to suburban areas was promoted by the fact that land purchase and leasing costs averaged 25% less in suburban areas. There were also savings on insurance rates (down 10%). The only tax which was significantly greater was inventory

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[28] Ibid., p. 264.

[29] These disadvantages display three major urban problem areas; however, with increasing transportation and communication advancement, the labor problem is more myth than fact, the tax problem is critical, but sometimes over-emphasized, and the space problem, which is severe, is rarely considered and seldom researched.

[30] Loewenstein, p. 265.

[31] Ibid., p. 265.

tax, while wages, labor and fuel costs were no different between locations.[32] It seems that the need for a functional supply of space was the most critical factor for the relocating firms, and undoubtedly affects other aspects of the urban environment.

Recent Codes and Agency Relationships

In April of 1957, the Cherry Memorandum #31 of the Bureau of Public Roads stated that parking facilities would be permitted over freeways, if no impediment or additional unapproved egress was constructed.[33] Section 234 of the National Housing Act of 1961 provided FHA mortgage guarantees for individual condominiums (another legal form of airspace).[34] In June, 1961, the Bureau of Public Roads Instructional Manual IM 21-3-62 and U.S. Code, Section III of Title 23 extended the permitted use of airspace over freeways to other areas.[35] These developments led to improved Federal-State relationships with respect to freeway airspace utilization. However, the role of local jurisdictions remained unnecessarily vague.[36]

An important step toward harmonious relationships between local and state agencies concerned with airspace development, is to initiate

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[32]Ibid., p. 266.

[33]Slavis and Pignataro. "Utilization of Air Rights Over Highway Rights-of way," Traffic Quarterly, Jan. 1969, p. 31.

[34]Wright, The Law of Airspace, p. 89.

[35]Slavis and Pignataro, p. 31.

[36]Michael M. Bernard, "Air Rights and Highways," Urban Land Institute Technical Bulletin # 64, pp. 50-51.

a general rule that development can not be pursued without complete local approval. This arrangement would minimize jurisdictional jealousy and conserve time needed for bureaucratic functions. However, the state should not relinquish all of its authority, because it more easily coordinates area-wide development plans.[37]

Since local authorities control land use in the immediate urban surroundings through the use of zoning restrictions, it is important that the airspace developer consider the consequences of such restraints. Zoning restrictions introduce the potential devaluation of airspace rights because they may constrain development. Nevertheless, codes delineating land use can be petitioned to allow for 'special use permits,' as long as it is remembered that these codes were generated to service 'local needs.' Unless the community receives localized benefits from development, a 'special use permit' will probably be denied. Local authorities have the first right of refusal in order to protect the welfare of the community at-large.

With this in mind, the state should manage airspace development in a manner which would permit local authorities to capitalize on the benefits of airspace development without jeopardizing the larger regional and state concerns. "The state will have to assist in coordinating and overseeing the separate community efforts and preserving regional or area-wide planning."[38] While the state should inform local agencies about the benefits accrued by using airspace and should direct regional airspace utilization, consideration must be given to state obligations,

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[37]Ibid., p. 51.

[38]Ibid., p. 52.

particularly those made in cooperation with the federal government (e.g., the state is responsible for the uninterrupted and safe traffic conditions on freeways). The state fulfills such obligations by placing supplemental controls on airspace usage in statewide building and highway codes. In many cases the state has additional authority for administering airspace development restrictions because the state will impose the lease arrangements on the airspace it controls. For example, the state will be lessor for interstate and state highways, unless the airspace is sold. In this circumstance, the state can prevent interruption of traffic flow through its lease agreement.

In the meantime, one particular legal question remains unresolved. Does the state have the authority to lease property, taken through eminent domain, to private interests? "There is no question about the state's right to land that is for public use, and the courts have also upheld the state's right to acquire land in excess of highway needs when it is known in advance that the airspace would be leased on a short-term basis for privately operated parking lots."[39] State authority to redistribute land controlled through eminent domain can only be defined through judicial precedent at the state level, since federal courts have largely neglected the issue.

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[39] Ibid., p. 51. (Also see; Slavis, p. 38).

SECTION V

MARKET INFLUENCES ON AIRSPACE DEVELOPMENT

Competition

The economic considerations for airspace development are extremely complex. They range from consideration of land use to tax abatement and construction costs. However, an overriding determinant in justifying airspace utilization is the relationship between land values and income production.[1]

Income production is the dividend between land usage and the basic site requirements combined with land carrying capacity (land values). Because an airspace platform costs $15.00 to $25.00 per spuare foot to construct,[2] the basic site requirements for airspace utilization are high. For airspace development to compete with surrounding sites they must have large land carrying capacities (or a value of at least $15.00 per sqare foot). Airspace development can not compete with raw land in farm or rural areas, because the cost of the platform can not compare with the $5.00 per square foot (and lower) land values.[3] When the values between airspace and land are equalized, competition can resume naturally. Generally, high density development will be more

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[1]Slavis and Pignataro, "Utilization of Air Rights Over Highway Rights-of-way," Traffic Quarterly, Jan. 1969, p. 36.

[2]Michael M. Bernard, "Air Rights and Highways," Urban Land Institute Technical Bulletin #64, p. 18.

[3]Thomas Layden Cook, "The Nature and Use of Airspace, Appraisal Journal, Vol. 39, no. 3, 1971, p. 359.

suitable for airspace. (See figure 5-1).

Financing Problems

Since airspace development is a relatively recent phenomenon, the value of the airspace lease and the proposed structure is considered a high risk security. Until financial institutions gain confidence in the authority of airspace contracts and deeds, private airspace development will be more difficult to finance than raw land development. "A risk premium can be anticipated on an airspace project," but the rate will depend on the record and background of the developer.[4] The additional premium can often be countered by depreciating the entire cost of the improvement and designating the annual lease program as an expense.[5]

A title company will carefully examine the instruments and documentation upon which insurance is based. All instruments and documentation must be sufficient enough to clarify or transfer the estate (or lien) being created.[6] Certain sections of the airspace deed or contract may cause financing problems if they are not carefully prepared. For example, documentation should carefully define adequate means of access (and egress) through superjacent space. This can be obtained by lease, easement or fee simple. If access is obtained by leasehold, provisions should be clearly non-extinguishable. Access rights obtained by ease-

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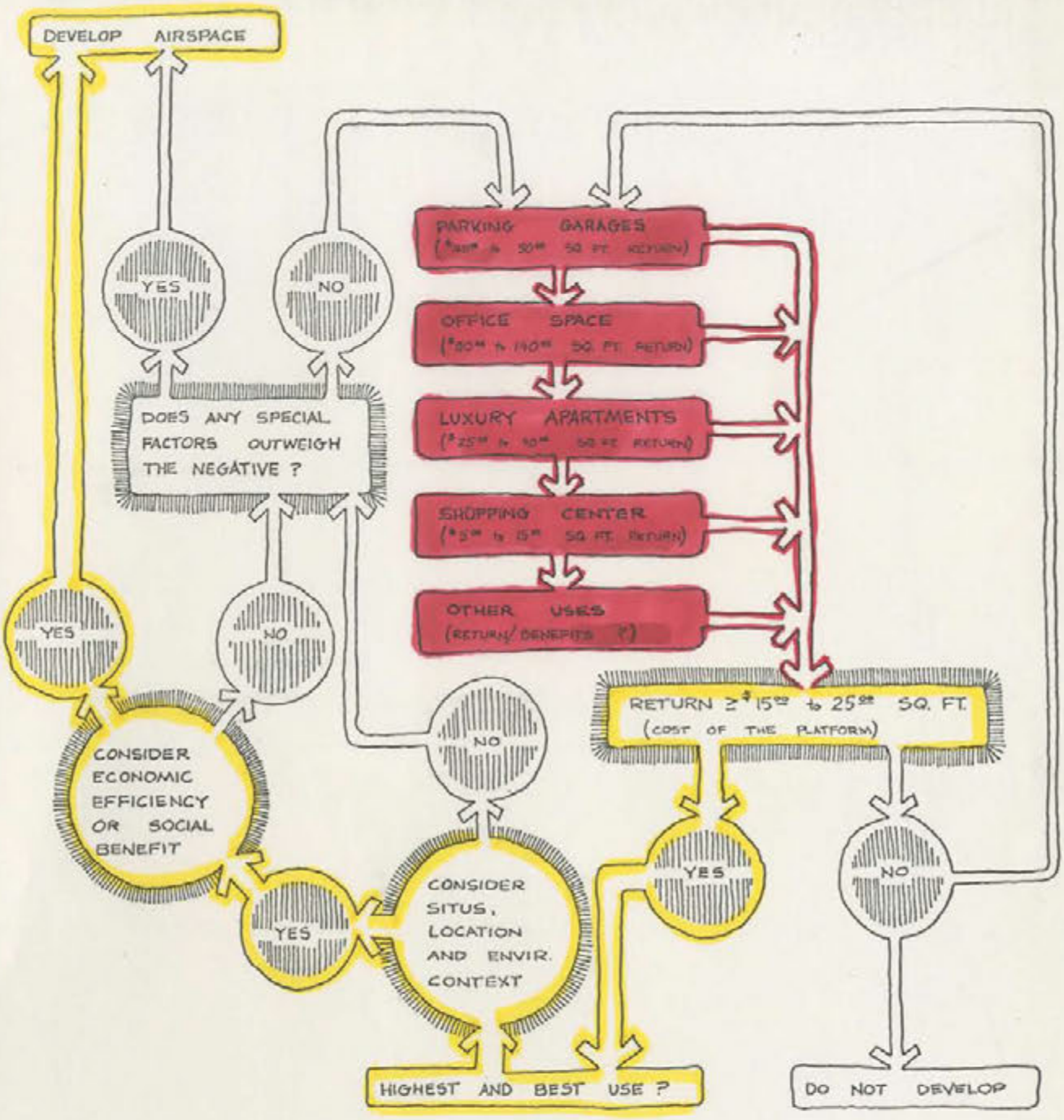
[4]Lawrence E. Williams and Daniel J. McNichol, "Valuation of Airspace," Appraisal Journal, Vol. 41, no. 2, 1973, p. 248.

[5]Ibid., 248.

[6]James M. Pedowitz, "Transfers of Air Rights and Development Rights," Real Property, Probate and Trust Journal, Vol. 9, no. 2, Summer 1974, p. 186.



requisite path .....

FIGURE 5-1

THE DECISION PROCESS FOR AIR-SPACE DEVELOPMENT

SOURCE: M. M. Bernard, "Air Rights and Highways". Urban Land Institute Technical Bulletin #60, (1969).

ment should be perpetual.

The nature and extent of the airspace title is another airspace financing problem. The surface title should be distinct from the airspace title. Existing liens on the original surface property could potentially fall on the airspace title. If repairs are to be made on both properties at a future date, the contracts and deed should clearly define the extent of responsibility of the lien.[7] If the airspace title is not cleared of all former lien responsibility, financing is virtually impossible. Another issue affecting financing, which warrants investigation, is appraisal.

Appraisal

In 1955, Richard Lawrence Nelson proposed a revolutionary method (a market approach) for appraising airspace by setting the airspace decking equal to the raw land.[8] In this approach, urban land was considered as pure space, so that coefficients could be derived from surface land and used to assign value to the airspace platform. The airspace area was given a value derived from the value of similar surface land, but adjustments were made downward for the extra costs involved with airspace utilization.

Another appraisal method (an income approach) employs capitalization and a residual technique for determining the separate incomes produced

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[7] Ibid., p. 187.

[8] Richard Lawrence Nelson, "Appraisal of Air Rights," Appraisal Journal, Oct. 1955.

by land and improvements.[9] Using this method, construction costs, operating expenses, and gross income are applied to a hypothetical airspace improvement. Net income is determined by deducting investment, depreciation and maintenance. The balance is presumably the income of the airspace site, and can be capitalized at a suitable rate.[10]

A third method (a cost approach) uses the full value of the land before the airspace encumberances as a guideline for the airspace appraisal. Various costs are subrtacted from the value of the raw land to obtain the airspace value. Walter R. Kuehnle and John R. White have expanded this theory by formulting an equation for the value of airspace. Although the components within the equation differ slightly, they remain basically the same.

KUEHNLE FORMULA:

$$V - (X+Y) - I = A \quad \therefore \quad V - A = R$$

V = value of the land before taking the 3-D interest
X = economic value lost due to functional utility (net income) in modifying the structure for constructing in the airspace interest
Y = additional costs of constructing the building under the terms of the conveyances creating the airspace and remaining surface interests
I = interests on investment
A = value of airspace rights after taking the 3-D interest
R = remaining surface interest[11]

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[9] Paul E. Hanchett, "On the Monopoly Bias in Airspace Development," Appraisal Journal, Vol. 39, no. 3, 1971, p. 366.

[10] "Because capitalization rates will necessarily be low, small errors in estimation can produce substantial differences in the appraisal. Consequently, this method is not recommended as a sole approach." See: Hanchett, p. 366.

[11] Williams, p. 241.

WHITE FORMULA:

$$V^C - [X + (C - D)] - I = A \quad V^C - A = R$$

V^C = land value by comparison in fee simple
X = loss of residual value from functional or economic obsolesence arising from the creation of air rights
C = added capital improvement costs to airspace purchaser or lease in construction of the building
D = saving to airspce purchaser or lessee in excavation and foundation costs, demolition, tenant relocation and income losses during relocation and demolition
I = added interest and carrying charges as a result of added capital improvements in "C"
R = residual value of fee interest
A = airspace value[12]

Still another approach to airspace appraisal (developer's investment pro forma) calculates the lease payment, which can be assumed as being a percentage of the airspace value (so that the airspace value is implied). The following calculation will clarify this method:

PRIVATE AIRSPACE DEVELOPER'S INVESTMENT ANALYSIS PRO FORMA: DETERMINATION OF ANNUAL LEASE PAYMENT FOR AIRSPACE

Estimated construction costs	$20,000,000
Original equity required	5,000,000
Desired after tax return of original equity: 15%	750,000[a]

(See next page for complete calculation)

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[12] John R. White, "George Washington Bridge Approach: A Case Study," in Air Rights, Siskind, ed. (New York: Practicing Law Institute, 1974), p. 440.

Annual

Gross income, net of vacancy		$5,000,000
Less:		
Operating costs	$2,500,000	
Property taxes	500,000	
Interests	1,000,000	
Depreciation	600,000	
Airspace lease payment	x[e]	
	$4,700,000	4,700,000[d]
Net income for tax purposes		300,000[c]
Less income taxes		150,000
Net profit		150,000[b]
Plus depreciation		600,000
Net cash earnings		$ 750,000[a]

a: Net cash must equal desired return on original equity.
b: Net profit plus depreciation equals net cash; i.e., net profit must equal $150,000.
c: Net profit equals 50% of net income for tax purposes; therefore, net income must equal $300,000.
d: Operating expencses can not exceed gross income less required net income.
e: Solving the x, the maximum air space lease payment is $100,000.

As a brief explantation of the calculation of the lease payment and air rights value, note that the net annual cash income required is $750,000 if a 15% return is to be achieved on the original equity of $5 million. Working back from this figure, the $600,000 depreciation indicates a required after-tax net profit of $300,000. Assuming that gross income and all costs other than the lease payment are fixed, the minimum lease payment is $100,000. The implied value of the air rights is therefore, $1 million, if a lease rate of 10% of land value is assumed.[13]

[13] B. Budd Chavooskian and Thomas Norman, "Transfer of Development Rights; A New Concept in Land Use Management," Appraisal Journal, Vol. 43, no. 3, 1975, p. 264.
Also see: Williams, p. 249.

Airspace Conveyance

There are six basic legal arrangements used to convey rights in airspace. These include:

1. Lease
2. Aerial easement
3. Fee of airspace and easement of support and access
4. Fee of airspace and fee of ground with reservation of easement by grantor
5. Fee of airspace and fee of support parcels
6. Fee in condominium[14]

Conveying airspace by lease is least pleasing to financers, but is the simplest to provide with legal instrumentation. It is relatively easy to provide easements during the term of the lease for supporting structures and egress. However, special provisions must be made to deal with insurance, taxes, demolition of airspace structures, subletting and subordination of mortgage.[15] Even with the difficulties of financing, the state should lease, rather than sell airspace because:

1. Leasing gives the state close control over permitted use and specified assurances against abandonment.
2. Leasing provides rental revenues for the state.
3. Leasing provides local possessory tax revenue (however, sale would provide similar or even greater local tax revenue).
4. Leasing makes it possible to reacquire the property at a specified time in the future when highway expansion may be necessary.[16]

Aerial easements must be specifically dimensioned and must have

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[14]Pedowitz, p. 185.

[15]Robert R. Wright, The Law of Airspace (New York: Bobbs-Merrill, 1968), pp. 345-348.

[16]Bernard, p. 53.

provisions for structural support. This conveyance is widely used for providing pedestrian and vehicular access to larger projects. Usually the grantor will specify easement area and placement. Obligations of maintenance should be clearly defined.

Both the fee of airspace with easement of support and access, and the fee of airspace with fee of ground and reservation of easement by grantor are methods commonly used when conveying airspace over railroad rights-of-way. In the first method the railroad maintains ownership of its railroad lines, while in the second method all railroad rights-of-way are converted to easements passing through a property.

The conveyance of fee of airspace and the space and surface needed for supporting structures is a very old method and is still needed today.[17] One example of airspace development which used this method of conveyance was the Prudential Building (1955) in Chicago, Illinois. This building is located over the tracks of the Illinois Central on Chicago's lakefront. A variety of factors contributed to the utilization of this complicated and difficult method of conveyance. The morgage indebtedness of the Illinois Central prompted Prudetial to attempt to acquire fee title to structural parcels as well as the airspace. Without such an arrangement, financing would have been unlikely. Because this type of structure is more legally binding than an easement, it is much easier to obtain financial backing. Nonetheless, other problems arise because a great deal of accuracy is needed in locating and using the structural parcels. If the physical construction penetrates the designated structural space, the contract has been breached and legal action

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[17]See James J. Brennan, "Lots of Air: A Subdivision in the Sky," Real Property, Probate and Trust Journal, 1955.

may result. This method of conveyance normally increases legal and construction costs above that associated with the other methods.[18]

Fee in condominium is a form of airspace conveyance which is becoming increasingly popular and accepted by financiers and lawyers alike. Normally, fee in condominium is ownership of a particular parcel of airspace, containing the fee holder's dwelling unit. All community space and land is held by the cooperative made up of all the condominium fee holders. An example of a common law condominium is the United Nation's Plaza. In the two towers of this structure are 168 apartments, whose tenant owners have equity only in the airspace of the respective apartments.[19] Like all other airspace conveyances, the condominium conveyance looks like a lengthy contract, rather than a traditional deed, because the rights and responsibilities of the condominium (airspace) owner must be clearly defined.

Feasibility

In this section we have deterred financial problems, conveyed airspace and appraised its economic value. Nevertheless, there are areas in every major city of the United States where airspace development is financially feasible, but is not being developed. Neither the private market, nor the public sector has pursued airspace development, despite the benefits each could gain.

"The private market simply is unwilling to undertake air rights

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[18]Wright, p. 252.

[19]William Robbins, "Funding Detailed at the U.N. Plaza," New York Times, Section 8, p. 1.

development... for subjective, non-quantifiable reasons over and above the financial considerations."[20] Inadequate experience, lack of confidence, and inability of estimating realistic risks have stifled private airspace development. However, the market indicates that time will resolve these problems, and airspace will become recognized as an income-producing resource.

The public sector has much to gain by using airspace. When airspace is used for new civic development, taxable land remains on the roster. Civic improvements over airspace would encourage private enterprise to consider airspace development. With proper government coordination and planning, joint development could generate corridor development, which would weld the physical urban fabric back together, while providing the needed transportation thoroughfares. Joint (airspace) development would not depreciate local land values, as is now the case with urban freeway erection. The tax base and tax income would be stablized (or improved) and the additional urban space could be coordinated and developed in such a way as to become an economic stimulant.[21]

American cities can not and should not attempt to solve space problems by continued haphazard outward expansion. Both land and energy are limited resources. Outward expansion consumes vasts amounts of these commodities, consequently, economic problems are compounded. Continued economic pressure and scarcity of these commodities should promote

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[20] Williams, p. 252.

[21] For a discussion on the value of government use and coordination of airspace see: Wright, p. 381-411, and Rodney E. Engelen, "New Institutions for Joint Development," ASCE Urban Planning and Development Division Journal, Vol. 101, no. UP1, 1975, pp. 11-20.

coordinated airspace utilization in the future, if a viable airspace technology continues to evolve.

SECTION VI

TECHNOLOGICAL CONSIDERATIONS

Much concern has been expressed about the noise and fume problems associated with airspace development. Actually, the noise and fumes generated by a freeway are no more severe than those generated by a major urban street (e.g., Park Avenue, New York City).[1] However, concern expressed about resolving the technological and environmental problems of airspace development warrant investigation.

Physical Technology

A variety of systems are being researched and developed to handle assorted problems associated with airspace utilization. These systems range from tunnel ventilation and lighting to construction methods and management. Each new and applied system lessens the cost of airspace development and diminishes the negative impact of transportation corridors, thus making it more competitive with raw urban land, as well as more socially desirable.

It is important, at this point, to keep in mind the impact of airspace development on not only the airspace occupant, but also the urban traveler who must use the transportation corridors adjacent to an airspace project.

Because airspace utilization often requires tunneling of a trans-

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[1]Thomas F. Galvin, AIA, "New Dimensions in Air Rights," American Institute of Architects Journal, Vol. 50, no. 1, 1968, p. 40.

portation corridor, the adjacent airspace project could interfere with traffic efficiency in a variety of ways. For example, ventilation represents an acute problem, particularly in central city areas where traffic flow is heavy. Gaseous fumes can have a hazardous effect on the transportation user, as well as a nauseous effect on the airspace occupant. In a compact, tightly designed freeway tunnel, natural ventilation may be adequate, particularly when the passing vehicle creates a 'piston effect' that removes the fumes. Nevertheless, in many freeway and subway tunnels, mechanical ventilation is required. This type of mechanical system forces fresh air into the tunnel, while fumes are exhausted out of the mouth of the tunnel or, if necessary, fanned up and away from the airspace project.[2] (See figures 6-1 and 6-1A).

Lighting presents another problem associated with tunneling. Tunnel lighting systems must take into account the fact that the human eye labors when light intensity changes abruptly. Contrast in light intensity temporarily impairs vision, creating a potentially hazardous situation. This situation can be avoided by gradually changing the light intensity with a staggered interior lighting lay out. (See figure 6-2). At the same time lighting can be reduced at night because light intensity contrast is not as severe. To increase lighting efficiency, bright tiling should be used to finish interior tunnel walls, and these walls should be washed regularly to increase reflectance.[3] (Tunnels should not be washed unless the temperature is above freezing).

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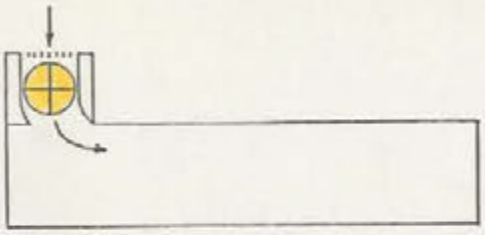
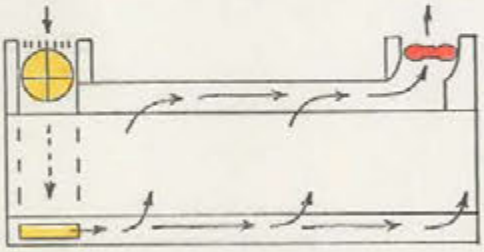
[2]Transportation Research Board, National Research Council, Highway Tunnel Operations (Washington, D.C.: U.S. Government Press, 1975), p.20.

[3]Ibid., pp. 12, 16 and 17.

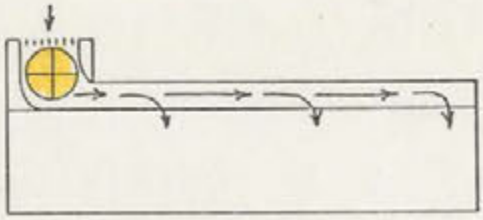
LONGITUDINAL

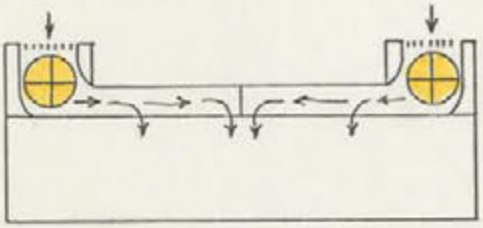


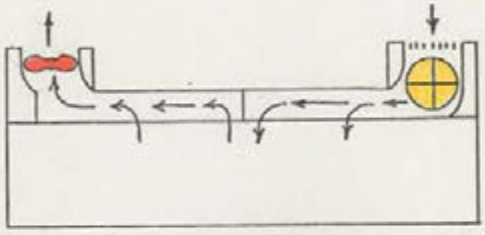
TRANSVERSE



SEMI-
TRANSVERSE







exhaust fan .....

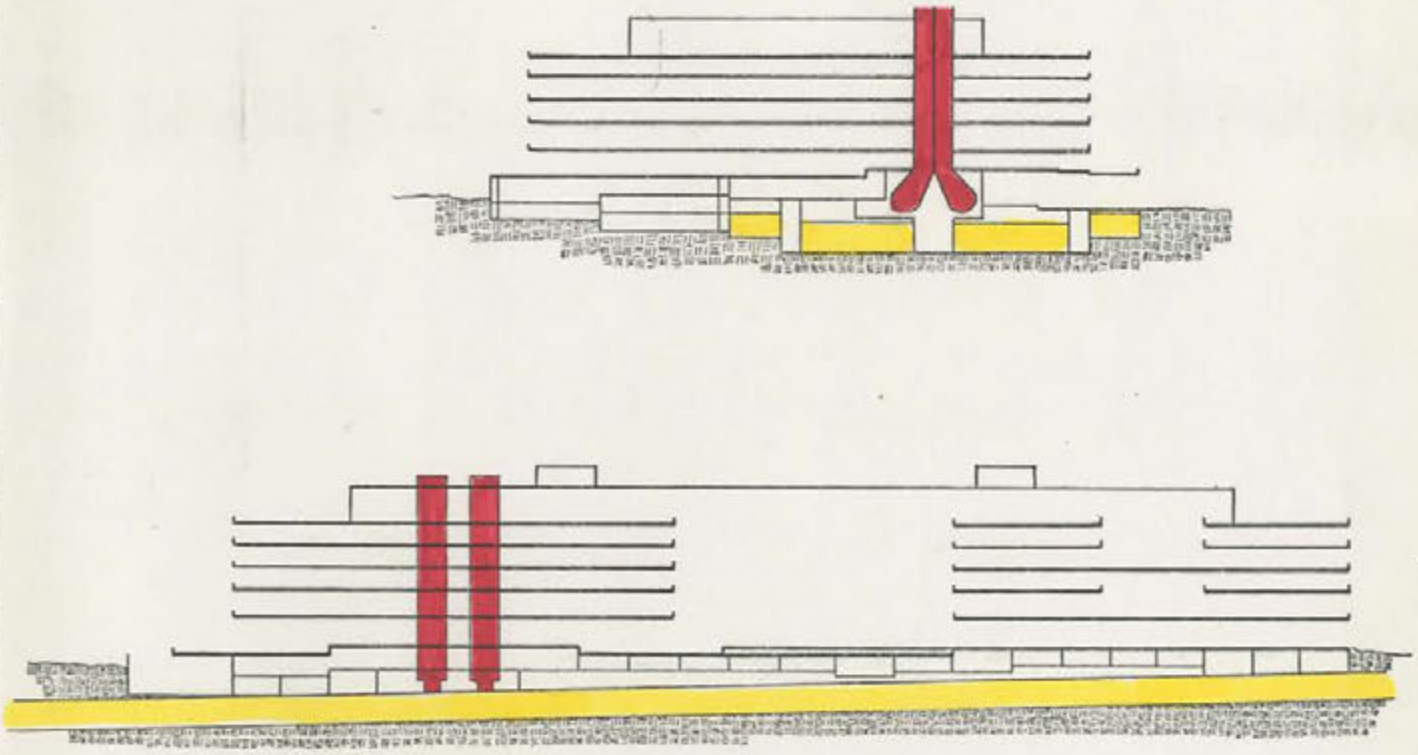
intake fan .....

filter .....

FIGURE 6-1

TUNNEL VENTILATION

SOURCE: Transportation Research Board National Research Council, Highway Tunnel Operations. Washington D.C.: U.S. Government Press, (1975).

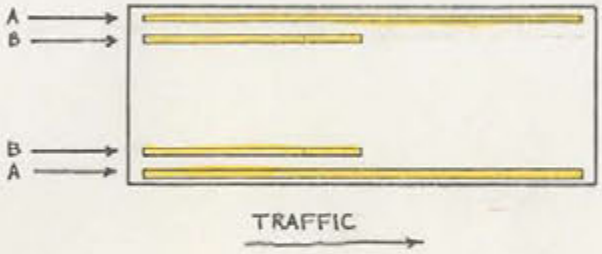


1. cross section-Labor Dept. Building showing blower and air duct system
2. longitudinal section of same building

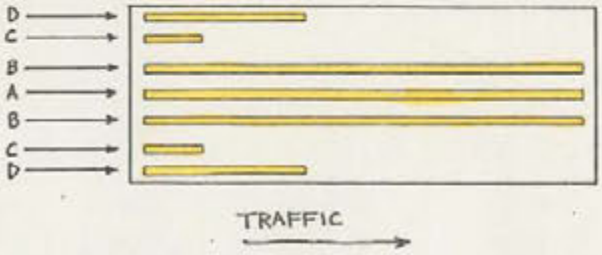
ventilation ....
right-of-way ...

FIGURE 6-1A

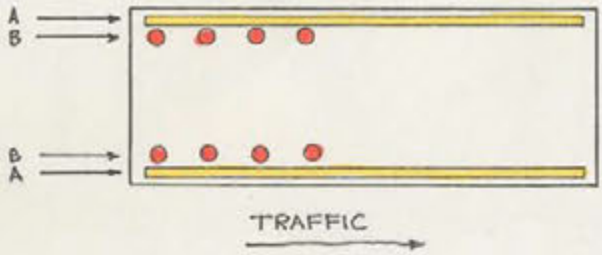
AIRSPACE JOINT USE CONCEPT: LABOR DEPARTMENT BUILDING, WASHINGTON D.C.; VENTILATION AND RIGHTS-OF-WAY HIGHLIGHTED.



DAY	A + B
NIGHT	A



DAY	A + B + C + D
*	A + B + D
*	A + B
NIGHT	A



DAY	A + B
NIGHT	A

fluorescent .....

spot lamp .....

FIGURE 6-2

TUNNEL LIGHTING

TOLEDO: Transportation Research Board National Research Council, Highway Tunnel Operations. Washington D.C.: U.S. Government Press, (1975).

Aside from the problems associated with tunneling, of which ventilation and lighting are only two, there exist very real structural complexities intrinsic to spanning wide transportation rights-of-way. In order to minimize disruption to underlying surfaces, large horizontal decks are needed.[4] These decks must carry substantial loads over very long spans, which can create structural problems. The single and double 'tee' members normally used in garage construction are relatively inadequate for airspace platforms, because without a thick heavy top slab, water and salt will penetrate joints and speed the deterioration of the structure.[5] The weight of the heavy top slab reduces the amount of development which can be created on an airspace platform.

A recently developed π-deck system (used in the Hancock Tower Garage in Boston, Massachusetts; see figure 6-3) overcomes such structural problems by incorporating a structurally sound 'key' joint between abutting units to eliminate cracks. This joint also eliminates the need for a topping slab.[6] If a thin topping slab is desired, a machine which can pave 400 square feet per day, can be used with a chemically shrinkage-compensating cement.[7] (The special cement prevents cracking during the drying process).

Another type of structural problem, which must be considered, is caused by sulphuric acid. This is a distinguishable airspace development problem. The pollution control devices on automobiles emit sulphur

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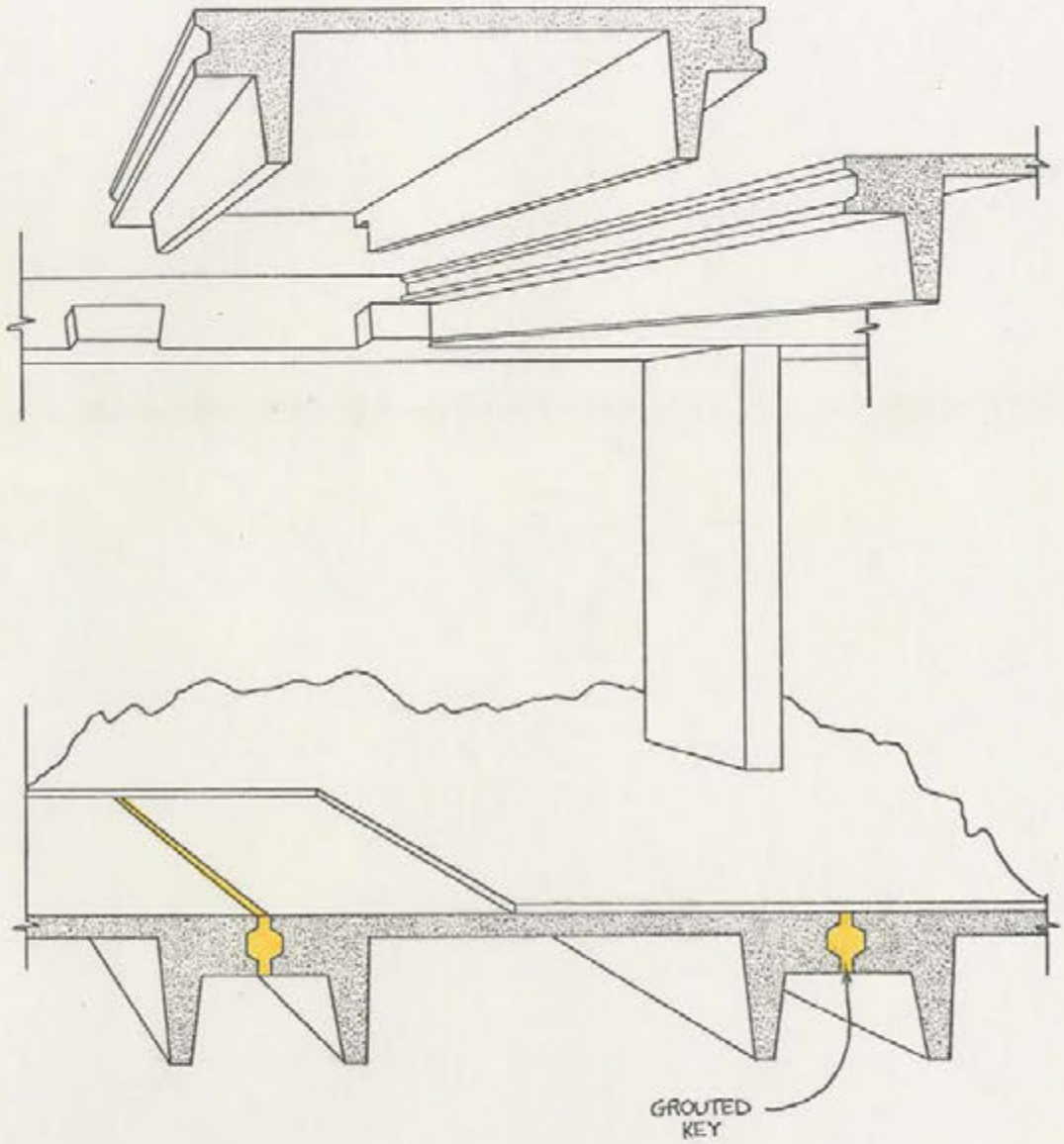
[4]Michael J.A.H. Jolliffe, "Large Precast, Prestressed Concrete Decks Over Air Rights," Prestressed Concrete Institute Journal, March/April 1975, p. 75.

[5]Ibid., p. 80.

[6]Ibid., p. 80.

[7]Ibid., p. 80.



The possibility exists to develop structural systems that are adaptable to highway dimensions. Such a system could substantially lower airspace development costs. Some systems already exist.	FIGURE 6-3	T-DECK SYSTEM SOURCE: Michael Jolliffe, "Large Precast Prestressed Concrete Decks Over Air Rights", Prestressed Concrete Institute Journal, March/April 1975, 74-86.

dioxide (SO_2), which, under normal circumstances, is carried away and oxidized in the atmosphere. Yet, in a tunnel situation, the sulphur dioxide is adsorbed on particulate matter (e.g., dust), becomes oxidized (SO_3), contacts moisture ($H_2O + SO_3$), and reacts to form sulphuric acid (H_2SO_4).[8] Sulphuric acid corrodes metals and limestone, but problems caused by sulphuric acid can be avoided by using reliable ventilation systems, glazed finishes on tunnel walls, and/or moisture control mechanisms.

From a technological viewpoint, no airspace development engineering problem is unresolvable. In many cases technological results not only resolve immediate problems, but also increase construction efficiency. For example, the π-deck system not only countered structural deterioration, but also enhanced the possibility of systematic construction, and the installation of a reliable ventilation system not only promoted a more desirable airspace environment, but also eliminated problems of structural deterioration caused by sulphuric acid. Most engineering problems, particularly those involving utilities, are small in magnitude and are easily resolved through team efforts and systems thinking.

Systemization of airspace design can give rise to organized assemblage through standardized and correlated construction components. Traditional construction mehtods should always be updated, standardized and prefabricated in order to promote quality, economy and speed.

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[8] Eugene P. Odum, Fundamentals of Ecology (Philadelphia: W.B. Saunders Company, 1971), p. 445.

Establishing Airspace Development Criteria

It should be relatively easy to standardize and prefabricate airspace construction components, because of the existing specific design limitations on airspace development (e.g., clearances, fire protection standards, highway width, etc.). These limitations establish the basic criteria which must be fulfilled by the airspace construction system as a physical entity. As such, the components of an airspace construction system must amalgamate into a whole which will fulfill these same criteria.

To promote the orderly execution of any project, a set of criteria must be established to provide guidelines. Airspace development criteria establish guidelines, which help coordinate development, clarify the extent of airspace which can be developed, and protect the safety of the airspce occupant and transportation user. An additional spill-over effect from these guidelines would establish easier financing and more precise legal instrumentation.

The following is a partial listing of the basic airspace development criteria as prepared by Michael M. Bernard (Bureau of Public Roads, 1969) for the Urban Land Institute:

> 1) Clear span requirements over freeways-- These figures probably should be based on the projected ultimate section for the portion of the freeway under consideration; the maximum width is usually four lanes in each direction. Provision must also be made to clear speed change lanes and roadway shoulders. Median strip support usually would be permitted, although not always.
>
> 2) Height clearance over freeway-- This requirement could be fairly uniform, although higher than normal clearances may be specified in such special instances as at sign locations and at sites of possible

future double decking. (Consider 14' absolute minimum)

3) Length of longitudinal cover-- This requirement has roots in architectural, traffic engineering and general engineering design objectives. It also depends on the amount of side confinement, top cover and the total cross sectional clear area of the roadway. Other items affecting this variable are the amount of ventilation (natural or forced), quantity of lighting (natural or artificial), required site distances at ramps, proximity of other airspace projects and aesthetic value of the landscape that is removed from the motorist's view.

4) Building resistance of columns-- Building columns are not usually designed to resist high speed impacts from heavily loaded motor vehicles. Consideration must be given to this possiblity.

5) Fire resistance of structures-- A severe hazard can result from a vehicular accident involving a tank truck carrying flammable liquids. It should be noted here that unprotected structural steel loses strength rapidly at elevated temperatures and must be protected. (An additional point may be interjected. The airspace structure will normally require an emergency fire sprinkler system. The system must be properly drained, so that if accidental triggering were to occur, the highway below would not be flooded).

6) Foundation spacing-- Foundations for separate but adjacent structures must be spaced sufficiently apart to avoid overloading the underlying supporting soils.

7) Combination structures-- Design criteria might be established to permit blending an elevated freeway and a multi-story overhead building into one structure (see figure 6-5, #4). Since commercial and highway structures generally use different design criteria, these differences would have to be resolved.

8) Utilities-- There appear to be no major problems in this area, although it may be wise to require concealment of all utility services so that they are not exposed to view beneath the floor over the freeway. (It must also be remembered that a basement area may not be available, so placement of utilities must be relocated to other floors

within the structure, or to land adjacent to the actual airspace lot).[9]

All official airspace development criteria must be precisely defined, but it should be understood that areas requiring subjective judgments can not be totally eliminated from airspace development. The final resolution will depend upon the quality and necessity of the airspace project, and the integration of the project with the surrounding environment (highway and urban fabric).

Airspace Structure Classification

The measure of feasibility for an airspace project is dependent on the nature of the circumstances and the environment surrounding the airspace, and not on any particular formula. Low density land uses, however, are not typically adaptable to airspace development, because the airspace platform places an initial value of $15.00 to $25.00 per square foot. This value is much too high to be supported by low density land uses. Nonetheless, civic projects are usually measured in terms of social benefit rather than economic returns, so low density land uses in civic airspace projects are potentially feasible. Whether the airspace project is civic-or profit-oriented, the physical structures will display certain classifiable characteristics.

For engineering purposes, there are basically six types of airspace structures, which are classified according to the relationship between the transportation right-of-way and the postion of the airspace structure. In the first classification, the airspace structure is overhead and

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[9]Michael M. Bernard, "Air Rights and Highways," Urban Land Institute Technical Bulletin #64, 1969, pp. 58 and 59.

the right-of-way is at grade. (See figure 6-4), This type of structure is essentially that of a building not in airspace, except that the ground level is omitted and ocupied by the transportation right-of-way. In this ground area space the column spacing would be approximately 90' (for an eight land highway with columns in the median), rather than the usual 20' to 30'. These columns would be larger than usual because they must carry a heavier verticaly load, resist collision, and counter higher bending stresses during seismic loading.[10]

In the second classification, the airspace structure is still overhead, but the right-of-way is depressed. (See figure 6-4 and 6-5). This structure is basically the same as that in the first classification (overhead structure-freeway at-grade), but the ends of the structure rest on grade, which provides seismic resistance, and lowers construction costs.[11]

The third classification consists of an overhead structure over elevated rights-of-way (see figure 6-4). Again this classification is similar to the first classification (overhead structure-freeway at-grade). However, an additional lower floor must be omitted. The columns in the space below the enclosing airspace structure will be thicker, because of the longer unsupported length. If very long distances are required for column structuring, it may be more economical to use a bearing wall construction.[12]

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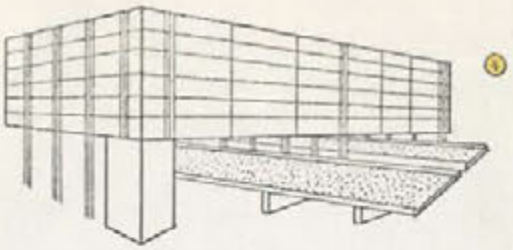
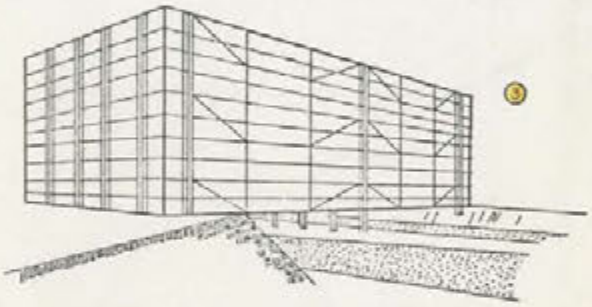
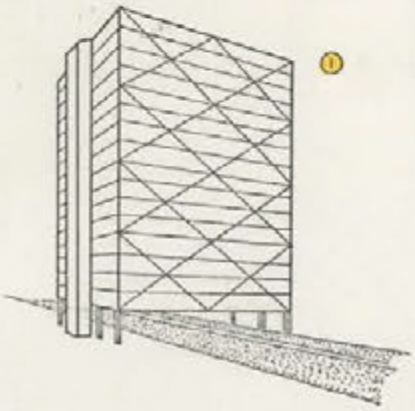
[10]Ibid., p. 60.

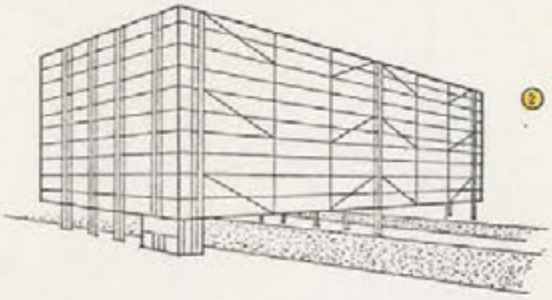
[11]Ibid., p. 60.

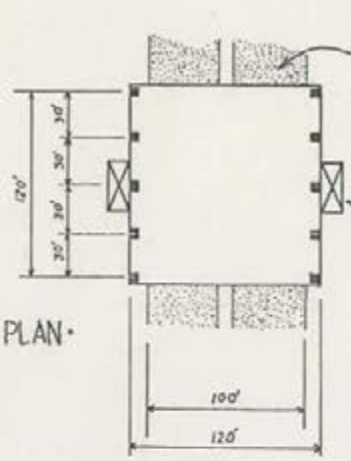
[12]Ibid., p. 60.



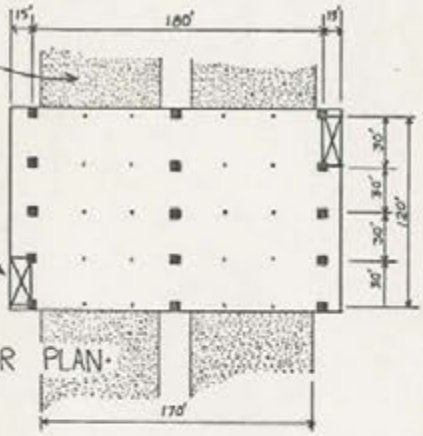






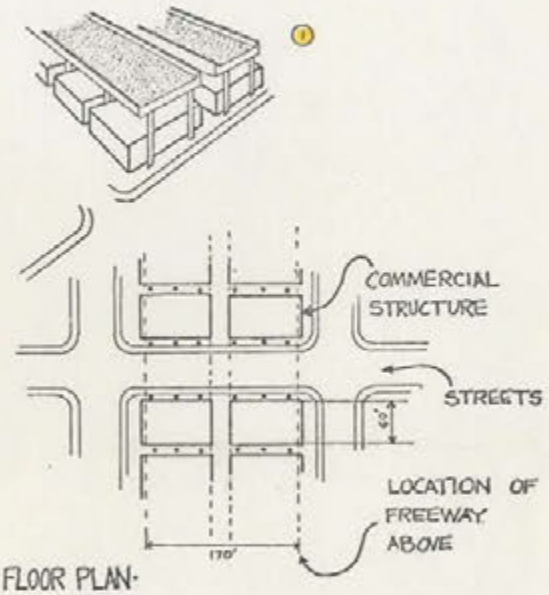


·TYPICAL FLOOR PLAN·

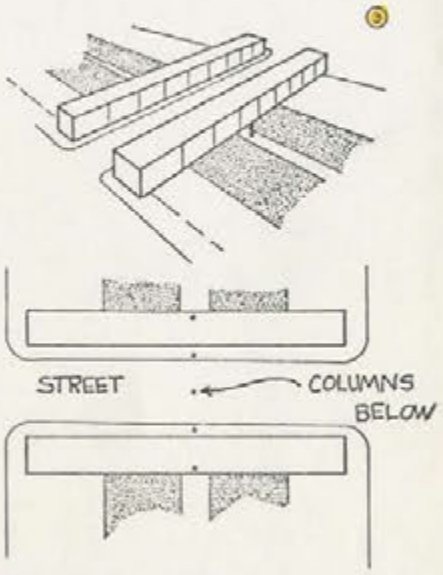


·TYPICAL FLOOR PLAN·

1. overhead structure freeway at grade 2. overhead structure freeway at grade 3. overhead structure freeway depressed 4. overhead structure freeway elevated	FIGURE 6-4 RECONSTRUCTED 2-1-77	TYPES OF AIRSPACE STRUCTURES SOURCE: M. N. Bernard, "Air Rights and Highways". Urban Land Institute Technical Bulletin #58, (1969), pp. 50-62.



·TYPICAL FLOOR PLAN·



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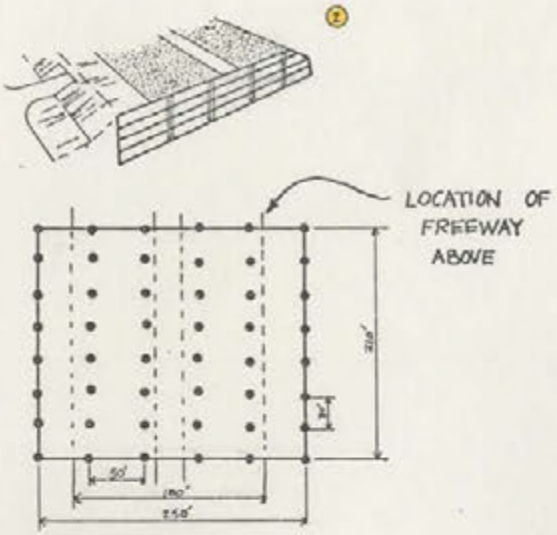

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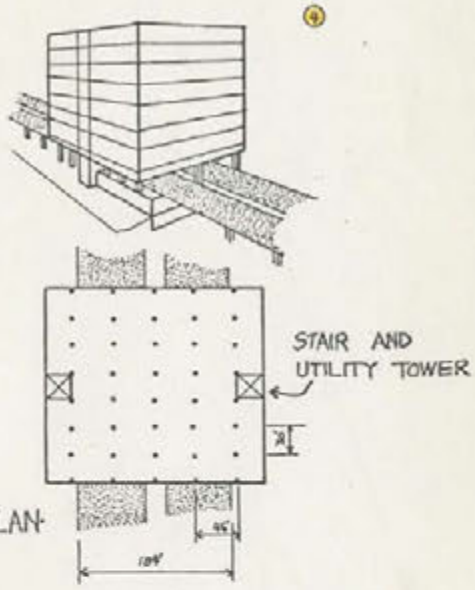

·TYPICAL FLOOR PLAN·

1. structure below freeway elevated 2. structure below freeway at grade 3. overhead structure freeway depressed 4. combined structure freeway elevated	FIGURE 6-5 RECONSTRUCTED 2-1-77	TYPES OF AIRSPACE STRUCTURES SOURCE: M. M. Bernard, "Air Rights and Highways". Urban Land Institute Technical Bulletin #64, (1969), pp. 56-62.

ZR.

In the fourth classification, the airspace structure is below the at-grade right-of-way (see figure 6-5). The right-of-way (above) must be supported by the columns and roofing of the airspace structure (below). When this type of structure is constructed below an existing freeway, a traffic detour is inevitable.[13]

In the fifth classification, the structure is below an elevated right-of-way. If the building in this classification is not attached to freeway construction, then it is no different from similar improvements in non-airspace locations. Most states require the physical separation between the structure and freeway construction. Footings for the structures under this classification must not interfere or weaken the freeway foundations.[14]

The final classification combines several of the previously mentioned strategies into one structure. It is this classification which most nearly represents 'megaform'. Multi-level/multi-use prototypes are now becoming implementable. Though multi-level/multi-use structures of this classification have created problems with zoning, transit and property rights, the potential for activity mix, and profit should stimulate solutions to these problems. Multiple-use schemes, when developed, act as a concentrating phenomenon, which stimulates activity, promotes three-dimensionality, and conserves energy and resources.

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[13] Ibid., p. 60.

[14] Ibid., p. 60.

SECTION VII

POTENTIALS OF AIRSPACE IN URBAN DESIGN

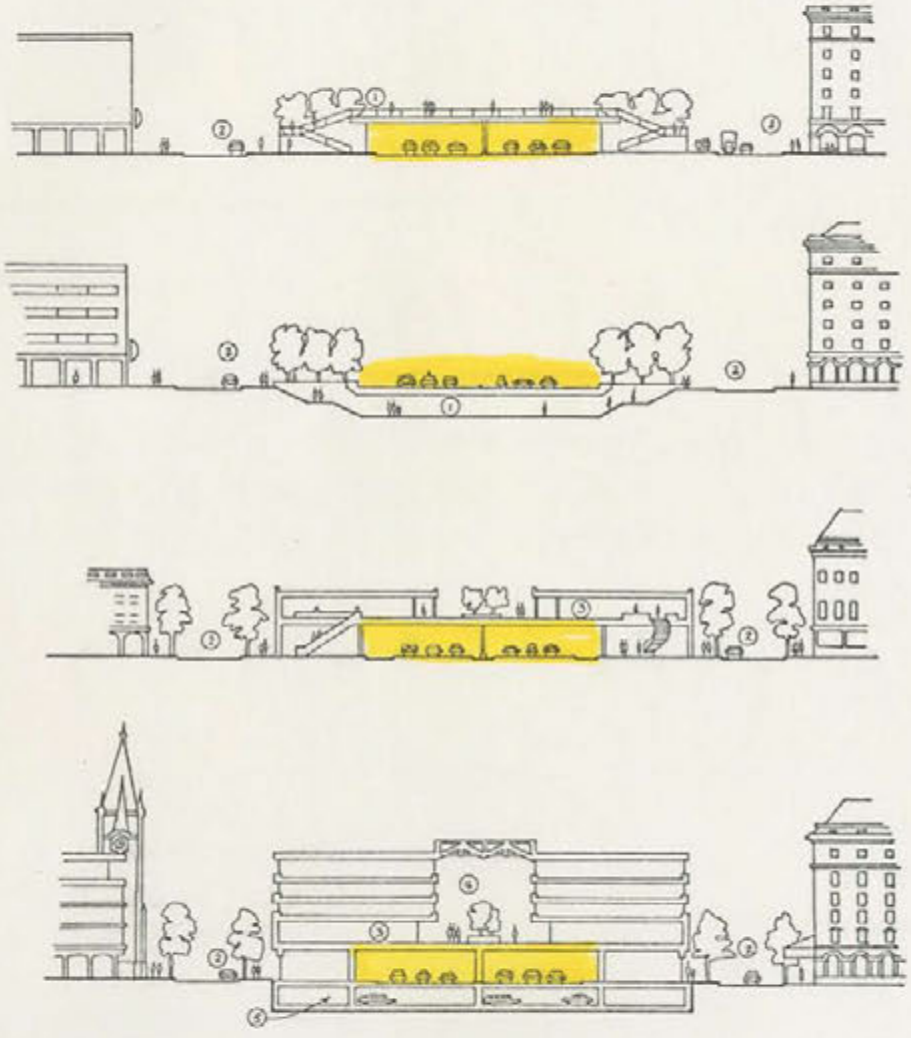
Airspace utilization can be used as an urban design tool to attack certain urban problems, which can help to restore a balance of power between suburbia and core city areas. It can not be over-emphasized that airspace development will have catalytic effects on the city, reinforcing urban agglomeration economies and nodality, and generating socio-economic and physical benefits for the central city residents. However, to pursue such goals would not be advantageious unless the value of revitalizing the central city can be determined.

Much has been written about the deterioration of our central cities. Some assume there is no apparent reason to revitalize these areas, believing the functional use of such areas to have vanished; yet, many factors suggest that central city areas remain viable as concentrated nodal activity centers. The recent energy crisis becomes an extremely influential factor supporting centralized nodality. Professionals from various technical fields agree that dispersion (suburbanization) uses a great deal more energy and resources than would be the case if our society were more nodally concentrated and therefore, more compact. A reordering of energy priorities not only emphasizes energy efficient transportation, but it stimulates nodality.

The importance of central city agglomeration economies and nodality in the modern society is supported by several arguments. It has been successfully argued that only a nodal city can provide certain cultural,

recreational, and educational facilities, because such facilities require extensive services which can only be maintained in nodal concentrations through agglomeration economies (e.g., a theater district needs restaurant facilities, places to acquire talent, stage supplies, etc.). In a similar vein, the cultural importance of the central city prevents total nodal abandonment, simply because the city retains a historical impetus for existence. And, nodalized urban concentration is further supported by the need for the centralization of quartinary functions (e.g., administration, government, and communication functions). It is currently believed that these functions require personalized (face to face) communication, which can only be acheived in a nodal city. These factors indicate that the central city remains a vibrant element of our civilization. Airspace development can be used as a revitalization tool because it capitalizes on the benefits of agglomeration and reinforces the advantages of nodality.

For the urban designer concerned with urban revitalization, airspace development presents the logical alternative to traditional zoning and urban renewal methods. Airspace utilization promotes multiple use of land (which is a concentrating phenomenon), stimulating activity, contributing to three-dimensionality, and conserving energy and resources. Since urban space is such a precious commodity, it should be conserved through effective and efficient utilization. The multi-level/multi-use projects, generated by airspace development, further the cause of efficient and effective utilization of urban space (see figures 7-1 to 7-4). Finally, airspace encompasses a vast amount of space within the urban environment. Much of this space is in the private domain, but a



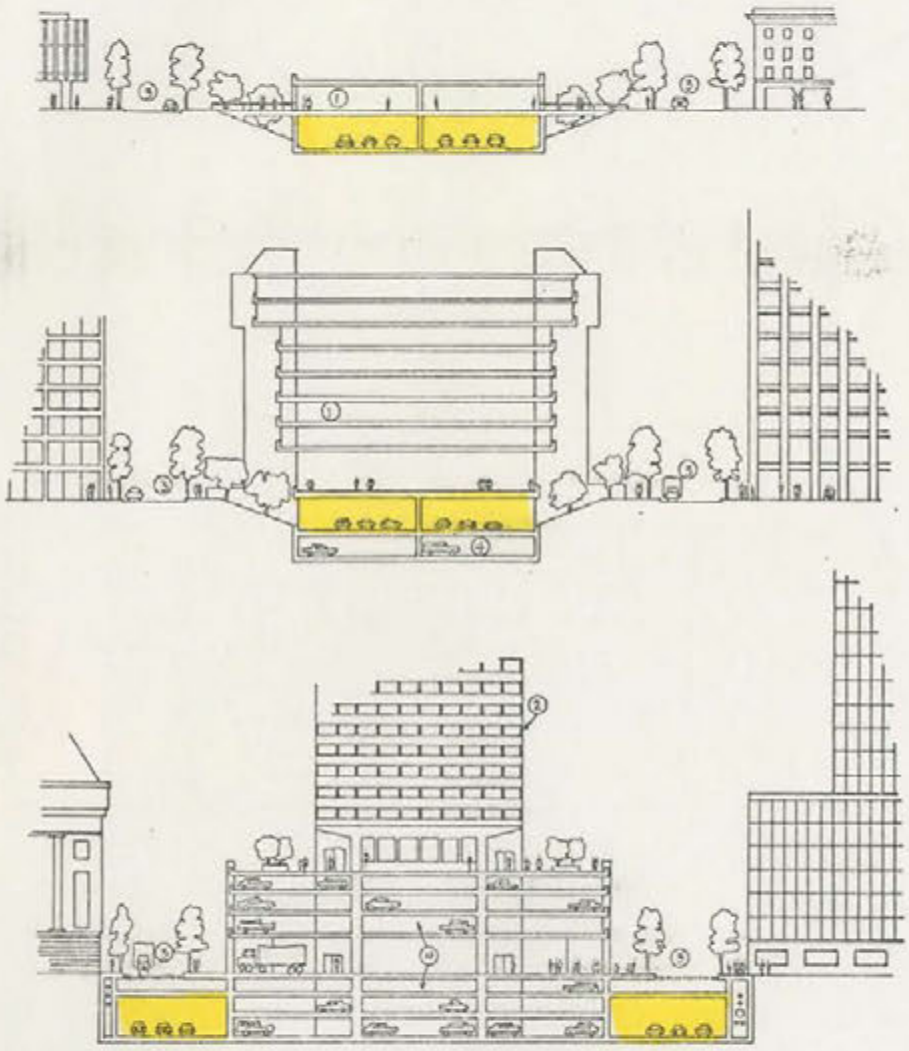
right-of-way .....

1. pedestrian way
2. local street
3. commercial
4. mall
5. parking

FIGURE 7-1

POSSIBILITIES OF ROADWAY PLACEMENT WITHIN THE MULTI-USE CORRIDOR

SOURCE: U.S. Dept. of Trans., The Freeway in the City, Wash. D.C.: U.S. Government Press, 1968.



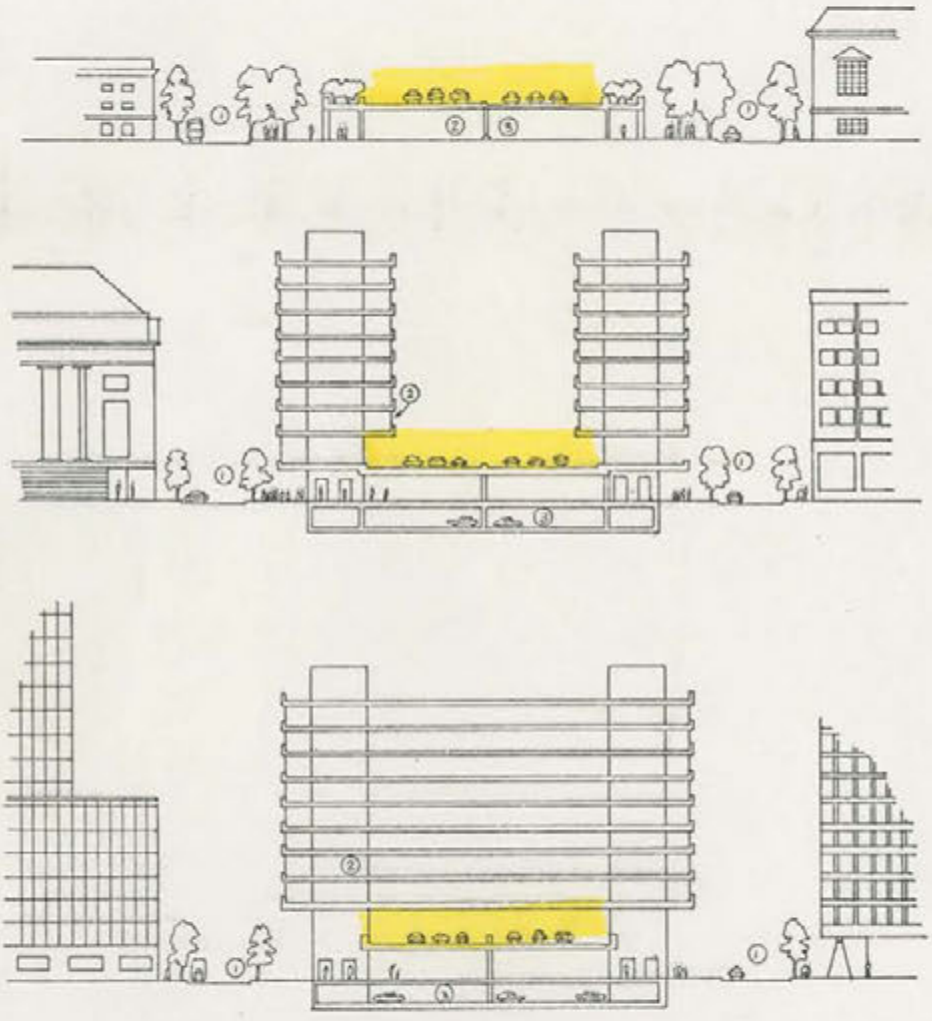
right-of-way

1. commercial
2. residential
3. local street
4. parking

FIGURE 7-2

POSSIBILITIES OF ROADWAY PLACEMENT WITHIN THE MULTI-USE CORRIDOR

SOURCE: U.S. Dept. of Trans., The Freeway in the City, Wash. D.C.: U.S. Government Press, 1968.



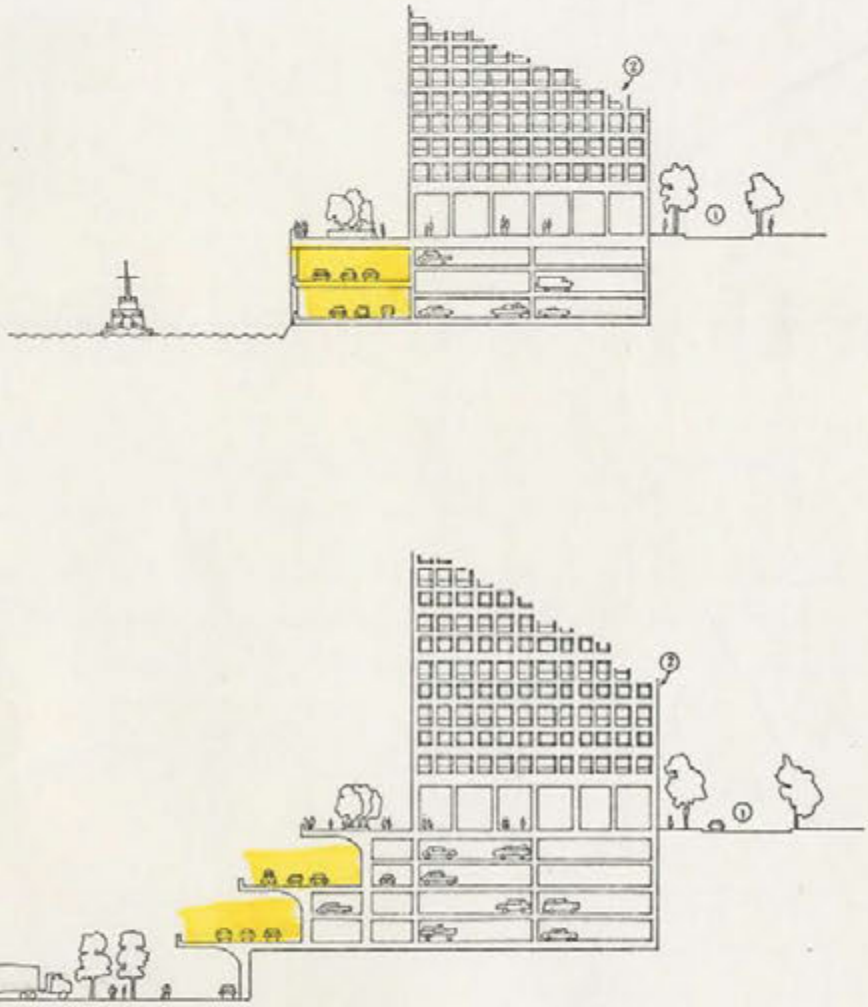
right-of-way.....

1. local street
2. commercial
3. parking

FIGURE 7-3

POSSIBILITIES OF ROADWAY PLACEMENT WITHIN THE MULTI-USE CORRIDOR

SOURCE: U.S. Dept. of Trans., The Freeway in the City, Wash. D.C.:U.S. Government Press, 1968.



right-of-way..... 1. local street 2. residential	FIGURE 7-4	POSSIBILITIES OF ROADWAY PLACEMENT WITHIN THE MULTI-USE CORRIDOR SOURCE: U.S. Dept. of Trans., The Freeway in the City. Wash. D.C.:U.S. Government Press, 1968.

substantial amount is held by public authority. Airspace held by governmental agencies can be coordinated, because market influences can be largely ignored, since the government has direct control over development in its airspace. Preliminary planning and government coordination could result in a reintegrated urban environment, catalytic stimulation of urban development, and refabrication of the physical urban fabric.

For airspace to be jointly developed with transportation corridors, extensive preliminary planning is needed. When studies are done for highway placement, areas should be designated as potential joint development (airspace) sites, so that the infrastructure can be formulated. This procedure will provide the foresight needed to adjust and organize governmental policies affecting joint development, so that construction can occur safely, and without interference or delay. Preliminary planning is needed to facilitate coordination between the various levels and agencies of government.

All aspects of airspace development are affected by governmental coordination. Federal, state and local government agencies should continue to refine the procedure for approving both public and private airspace development. Legislation, procedures and policies for airspace development should continually be updated, and governmental information (technical or regulatory)on airspace development should be made easily available to the private sector.

Airspace will become a marketable item when the private sector realizes that a large amount of airspace is competive with other urban sites. Under such circumstances, expertise in airspace realty and development will increase, and the financial community will have to

consider the risks involved with airspace realty more realistically. As financing becomes more readily available, airspace projects will be more prevalent.

With continued airspace development will come safer and more efficient construction methods. Through systems adaptation, airspace can become more competitive with land on alternative sites, especially when demolition is eliminated. Technological advances in the construction industry should enhance the possibility of multi-level/multi-use structures, particularly those incorporated with transportation rights-of-way.

It is not unreasonable to presume that airspace development, as multi-level/multi-use projects, will become a useful and necessary built form of the future. As an urban designer, the necessary information (legal, financial, governmental, regional, etc.) and engineering techniques are imperative for problem solving within the context of this evolving built form. It is here that this knowledge of airspace utilization comes into the realm of urban design. The result could be the much more rational planning and creative designing of critically located airspace projects.

SECTION VIII

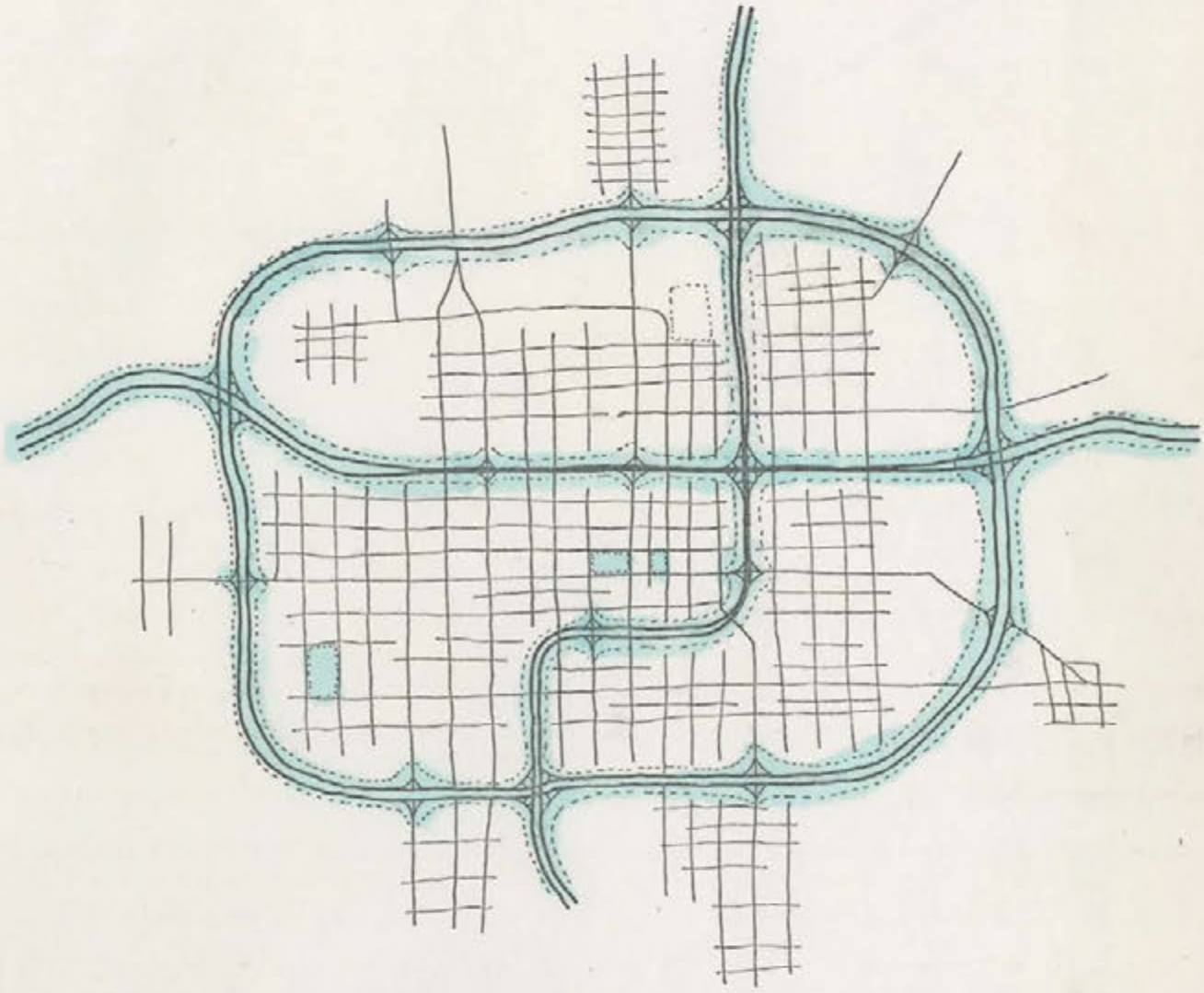
CASE STUDY

Normally growth and development on the urban scale is not planned; it just happens. As such, the urban environment becomes a collection of individual 'solution' (one building, one development, one transportation mode, or one sub-system individually isolated). Consequently, an integrated plan or policy must counter-act the small plans and actions which result from individual, private concerns in a capitalistic society. There is no singular socio-technical tool adequate enough to accomplish this counteracting task. Airspace utilization is only one factor (tool) in an array of socio-technical factors which can be used to generate urban land use policy and/or revitalization.

Section Eight attempts to diagramatically display the alternatives gained by using airspace as an urban design tool. Figures 8-1 through 8-8 display the policy direction which can be endorsed by adapting an airspace zone to current transportation trends. Figures 8-9 through 8-13 investigate theoretical applications of development massing to a linear airspace zone. Figures 8-14 through 8-23 develop and outline adaptive policy measures for Pawtucket, Rhode Island. Finally, figures 8-24 through 8-30 demonstrate a simplified seven step process for airspace development and the implications of each step. It is hoped that a systematic review of the following diagrams will enable the reader to gain a perspective on the adaptiblity of the potentials of airspace within the urban design process, so that it may become a tool which is

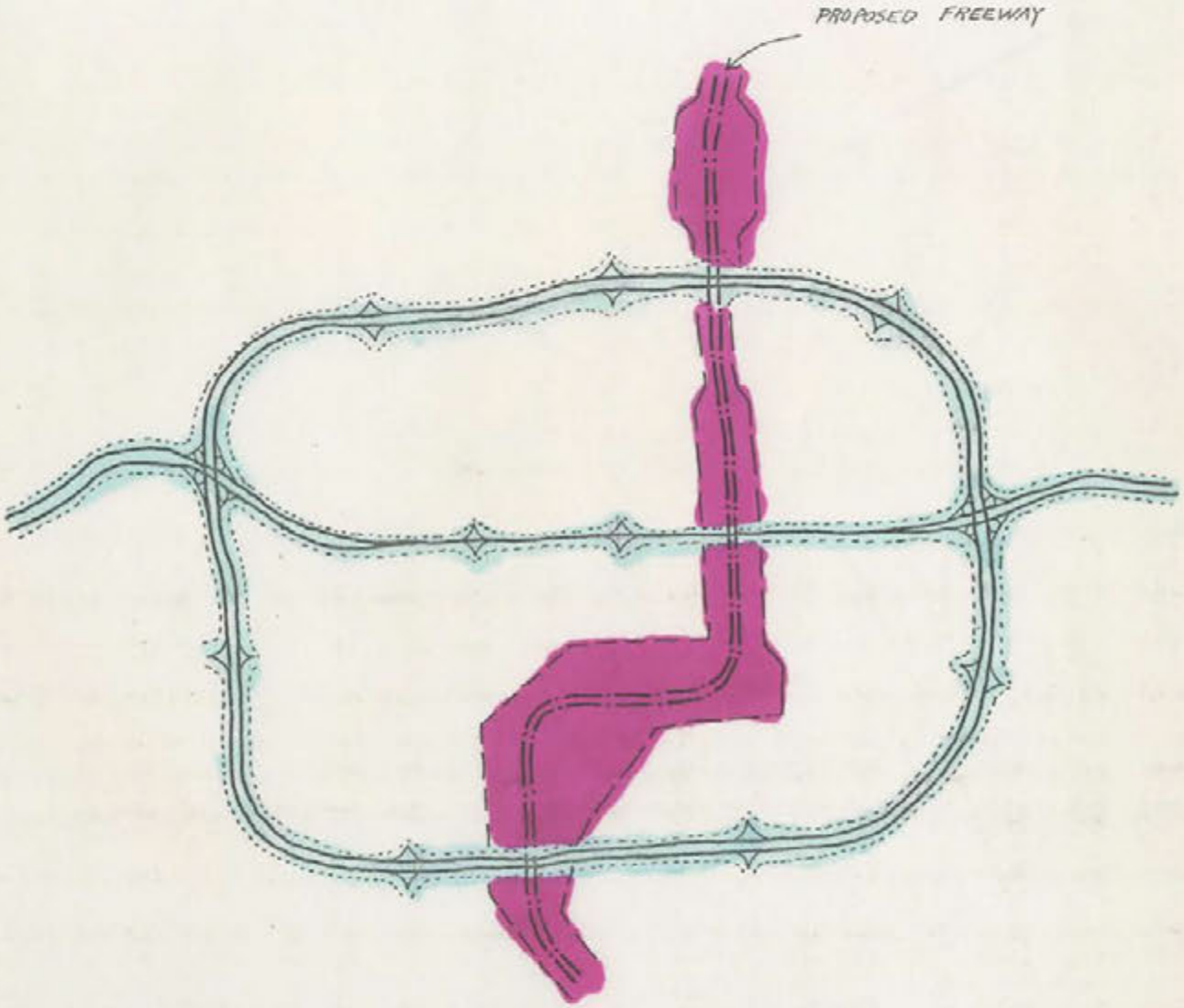
incorporated into future plans and policies governing urban development.

FIGURE 8-1



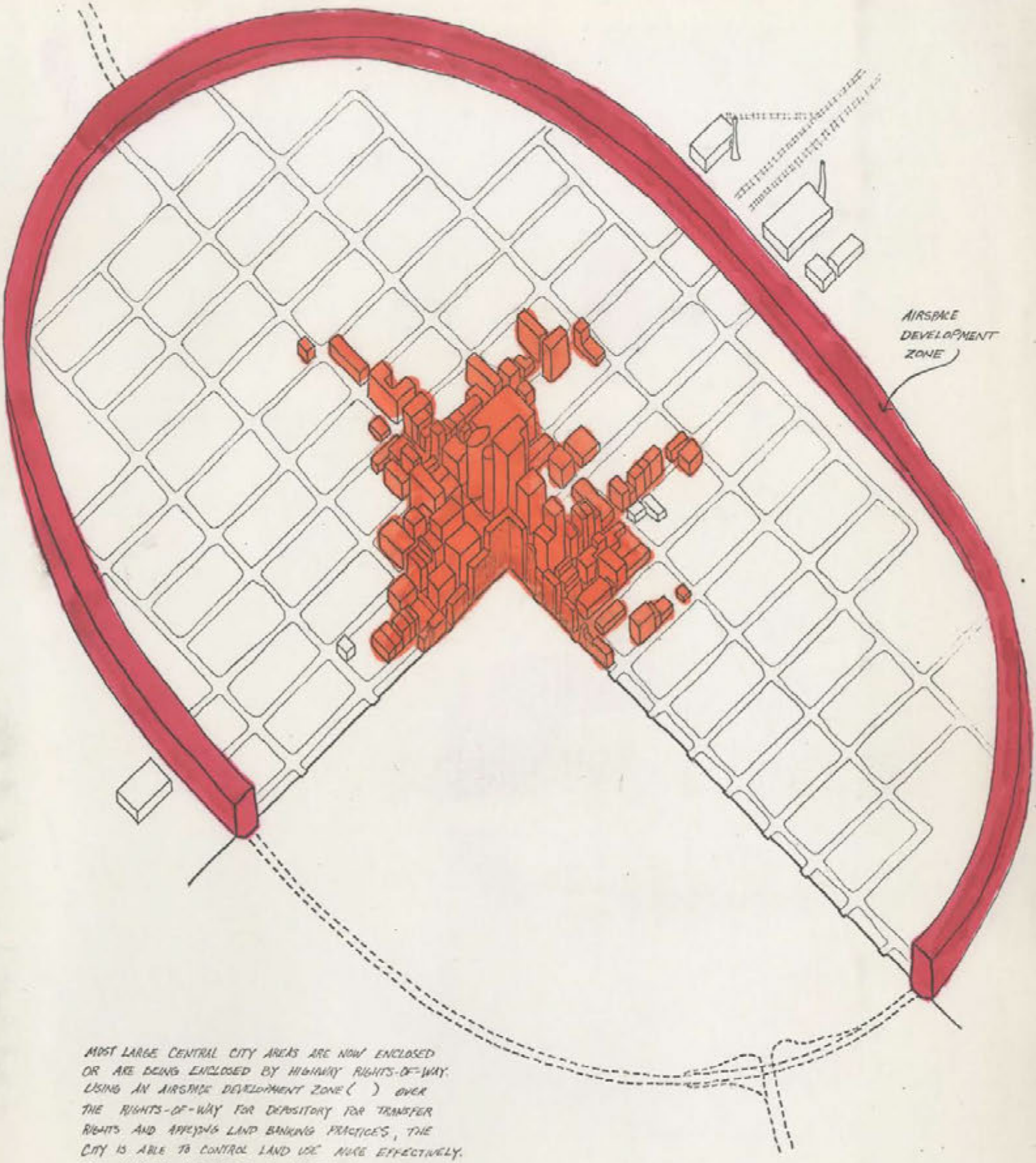
IN A CAPITALISTIC SOCIETY, GOVERNMENT CONTROL OF LAND IS VERY LIMITED ( ). YET IN MOST URBAN SITUATIONS THE FREEWAY (AND LOCAL STREET) RIGHTS-OF-WAY ARE GOVERNMENTALLY CONTROLLED. THOUGH THIS IS A POSITIVE FACTOR, AIRSPACE CONTROL AND USE IS ONLY ONE ASPECT OF THE VERY COMPLEX ISSUE OF EFFICIENT LAND USE. FOR AIRSPACE DEVELOPMENT TO BE MOST SUCCESSFUL, IT MUST BE REINFORCED WITH OTHER BENEFICIAL POLICIES (eg. COMMUNITY LAND ACQUISITION AND REVITALIZATION ORIENTED TAX POLICIES), PARTICULARLY SINCE THE AIRSPACE ZONE IS LIMITED TO A LINEAR NETWORK AND THE EFFECT ON PRIVATE AJACENT AREA CAN NOT BE ABSOLUTELY DETERMINED.

FIGURE 8-2



TRADITIONAL METHODS OF LAND ACQUISITION FOR RIGHTS-OF-WAY EMPHASIZED MINIMAL LAND TAKING OF INEXPENSIVE AND OFTEN BLIGHTED LAND [ ]. USING A 'JOINT DEVELOPMENT' (COORDINATED) CONCEPT MORE LAND IS TAKEN SO THAT THE UPCOMING DEVELOPMENT CAN BE BETTER INTEGRATED INTO THE URBAN FABRIC [ ].

FIGURE 8-3



MOST LARGE CENTRAL CITY AREAS ARE NOW ENCLOSED OR ARE BEING ENCLOSED BY HIGHWAY RIGHTS-OF-WAY. USING AN AIRSPACE DEVELOPMENT ZONE ( ) OVER THE RIGHTS-OF-WAY FOR DEPOSITORY FOR TRANSFER RIGHTS AND APPLYING LAND BANKING PRACTICES, THE CITY IS ABLE TO CONTROL LAND USE MORE EFFECTIVELY. THIS DIAGRAM ILLUSTRATES A WALLED CITY EFFECT CREATED BY AN AIRSPACE DEVELOPMENT ZONE AROUND A CBD ( ).

FIGURE 8-4

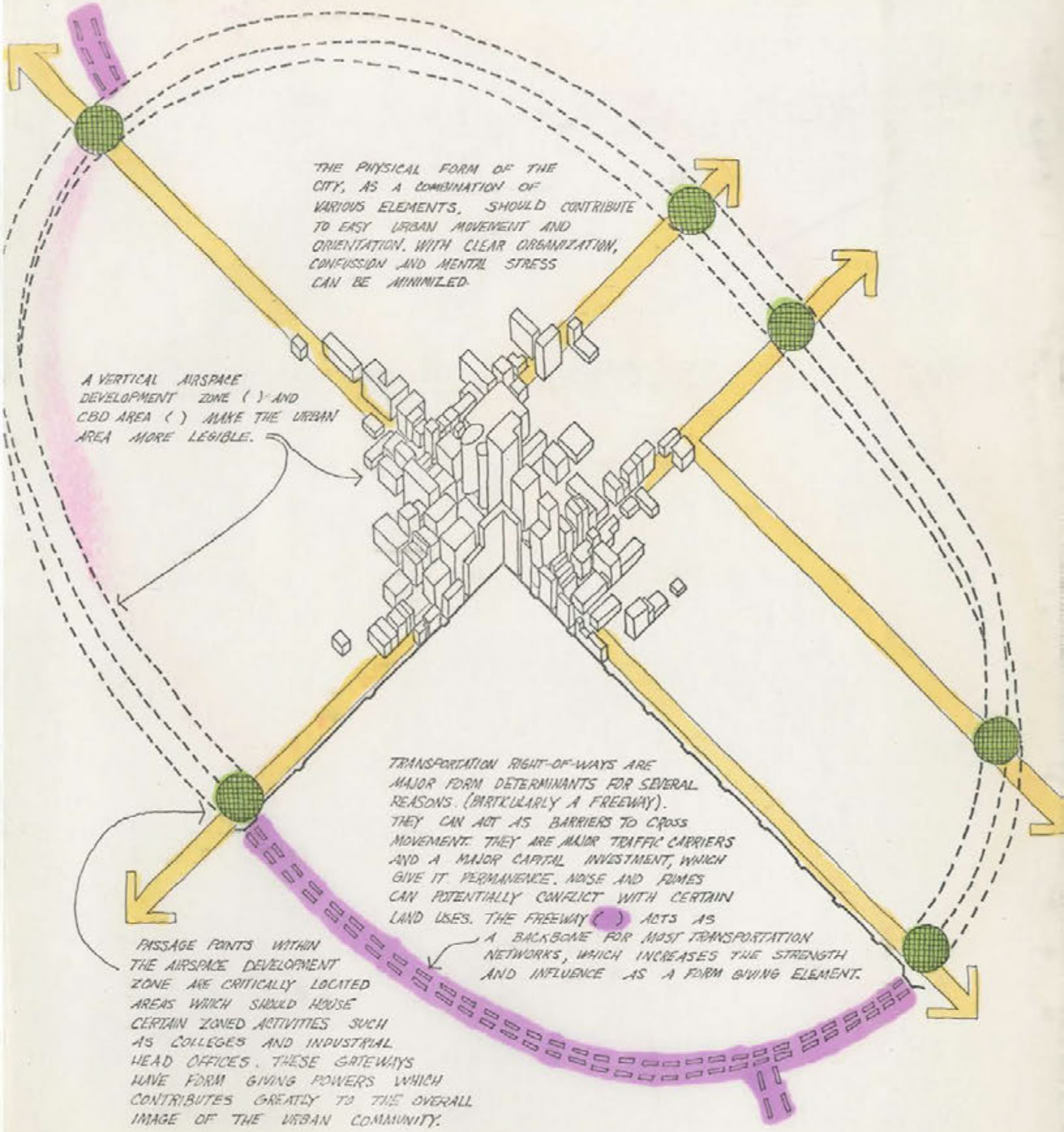

THE PHYSICAL FORM OF THE CITY, AS A COMBINATION OF VARIOUS ELEMENTS, SHOULD CONTRIBUTE TO EASY URBAN MOVEMENT AND ORIENTATION. WITH CLEAR ORGANIZATION, CONFUSSION AND MENTAL STRESS CAN BE MINIMIZED.
A VERTICAL AIRSPACE DEVELOPMENT ZONE ( ) AND CBD AREA ( ) MAKE THE URBAN AREA MORE LEGIBLE.
TRANSPORTATION RIGHT-OF-WAYS ARE MAJOR FORM DETERMINANTS FOR SEVERAL REASONS. (PARTICULARLY A FREEWAY). THEY CAN ACT AS BARRIERS TO CROSS MOVEMENT. THEY ARE MAJOR TRAFFIC CARRIERS AND A MAJOR CAPITAL INVESTMENT, WHICH GIVE IT PERMANENCE. NOISE AND FUMES CAN POTENTIALLY CONFLICT WITH CERTAIN LAND USES. THE FREEWAY ( ) ACTS AS A BACKBONE FOR MOST TRANSPORTATION NETWORKS, WHICH INCREASES THE STRENGTH AND INFLUENCE AS A FORM GIVING ELEMENT.
PASSAGE POINTS WITHIN THE AIRSPACE DEVELOPMENT ZONE ARE CRITICALLY LOCATED AREAS WHICH SHOULD HOUSE CERTAIN ZONED ACTIVITIES SUCH AS COLLEGES AND INDUSTRIAL HEAD OFFICES. THESE GATEWAYS HAVE FORM GIVING POWERS WHICH CONTRIBUTES GREATLY TO THE OVERALL IMAGE OF THE URBAN COMMUNITY.

FIGURE 8-5

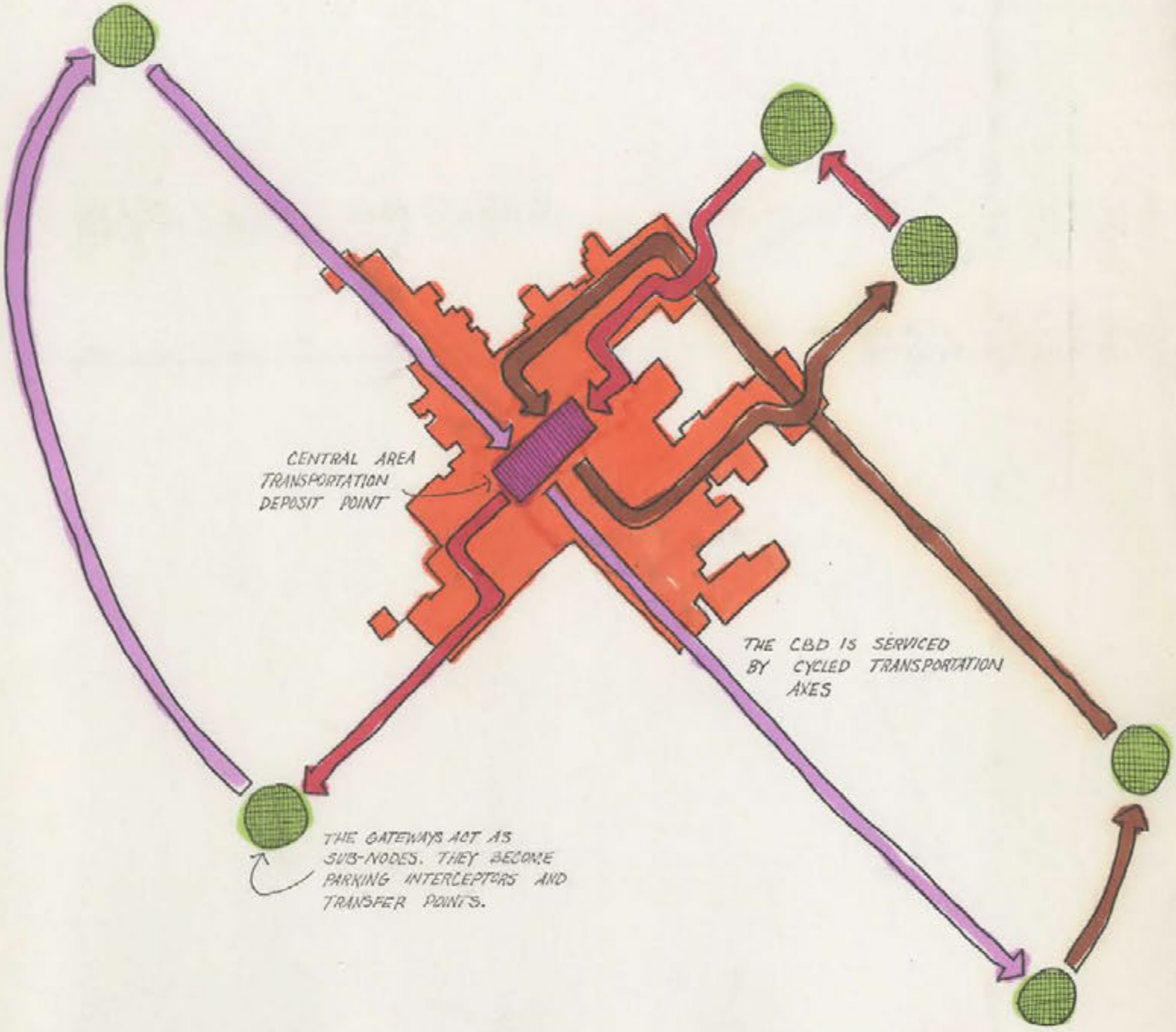

CENTRAL AREA
TRANSPORTATION
DEPOSIT POINT
THE CBD IS SERVICED
BY CYCLED TRANSPORTATION
AXES
THE GATEWAYS ACT AS
SUB-NODES. THEY BECOME
PARKING INTERCEPTORS AND
TRANSFER POINTS.

FIGURE 8-6

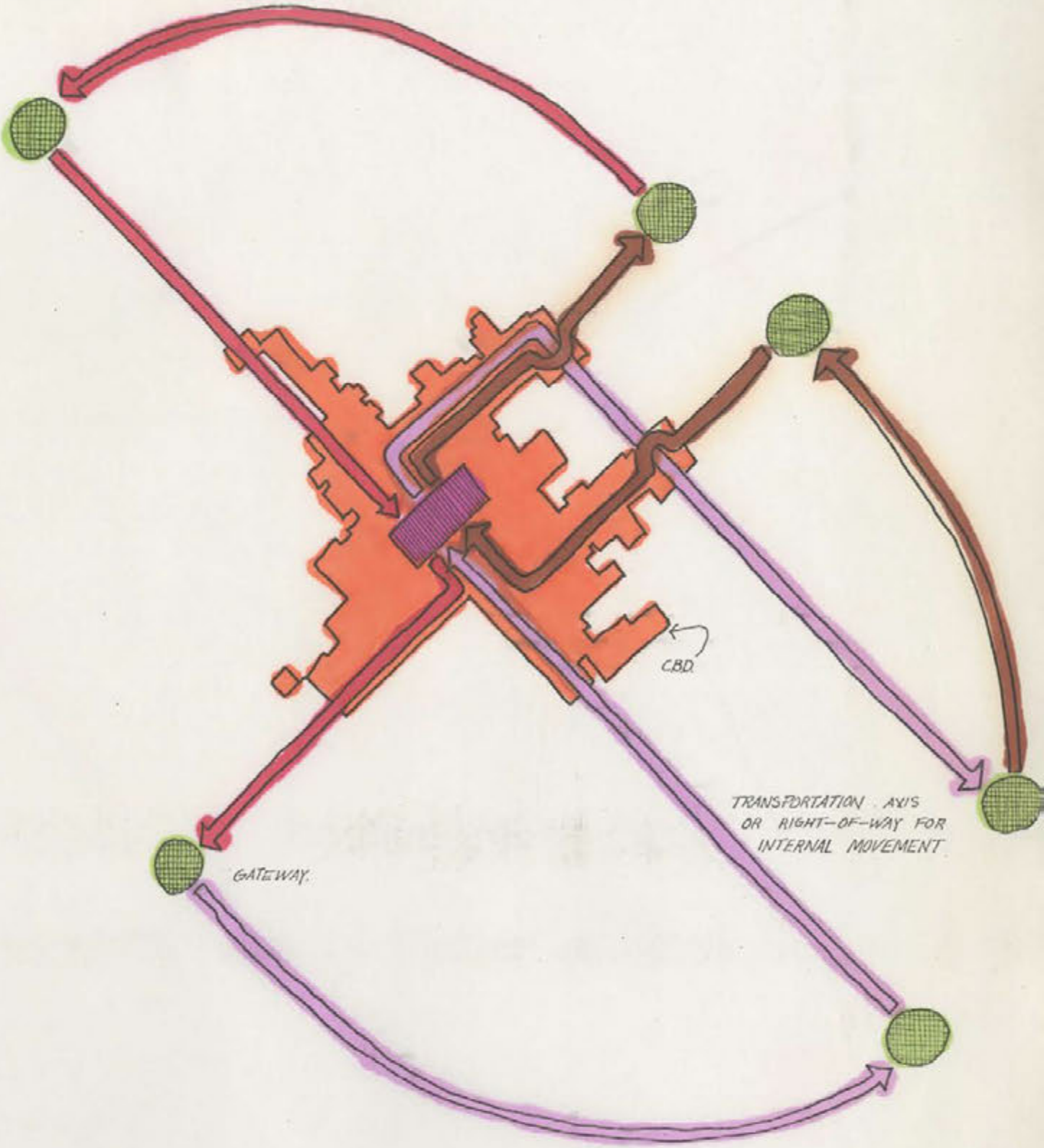
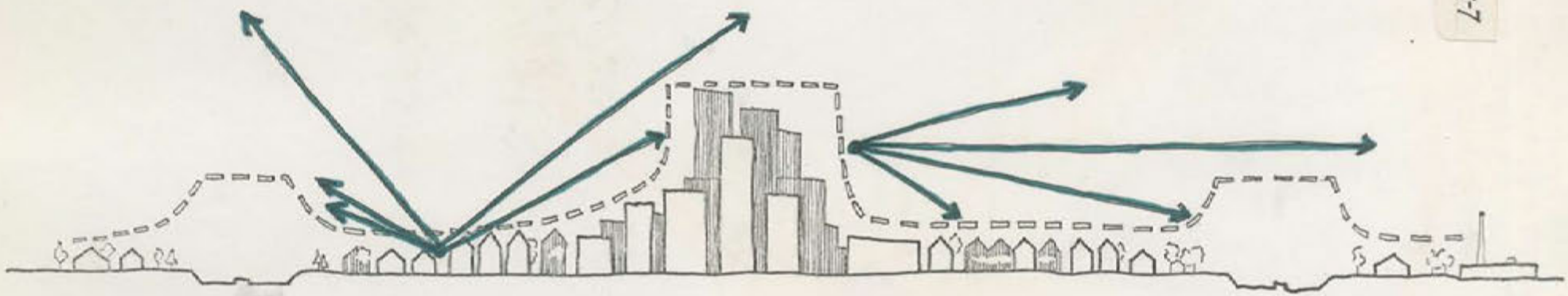
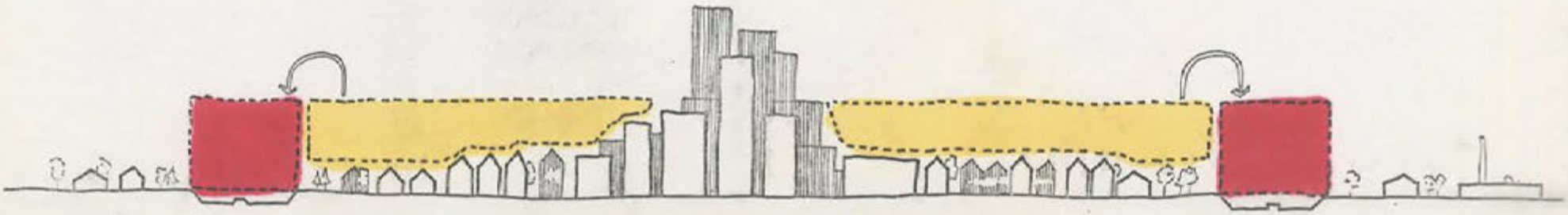

C.B.D.
TRANSPORTATION AXIS OR RIGHT-OF-WAY FOR INTERNAL MOVEMENT
GATEWAY.

FIGURE 8-7





THE AIRSPACE DEVELOPMENT ZONES ( ) ARE CAPABLE OF RECEIVING TRANSFER DEVELOPMENT RIGHTS FROM REGULATED AREAS ( ). THIS PROCEDURE AIDS THE PROCESSES WHICH: KEEPS THE DENSITY IN AND AROUND THE C.B.D., PRESERVES URBAN VISTAS, CONCENTRATES UTILITIES AND SERVICES, AND GIVES IDENTITY AND LEGIBILITY TO THE CENTRAL CITY.

FIGURE 8-8

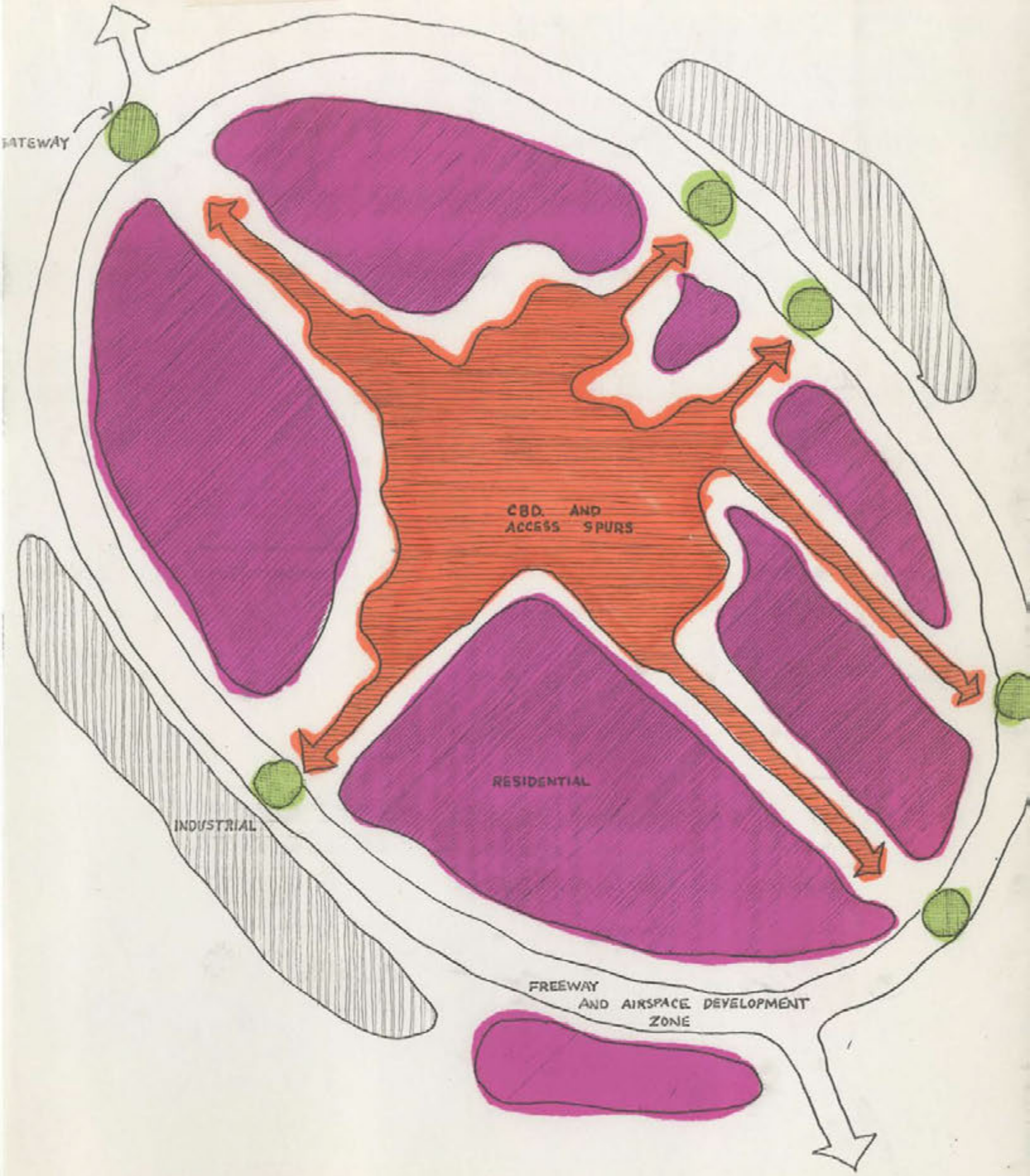

GATEWAY
CBD AND
ACCESS SPURS
RESIDENTIAL
INDUSTRIAL
FREEWAY
AND AIRSPACE DEVELOPMENT
ZONE

FIGURE 8-9 INTERNAL CIRCULATION SYSTEMS

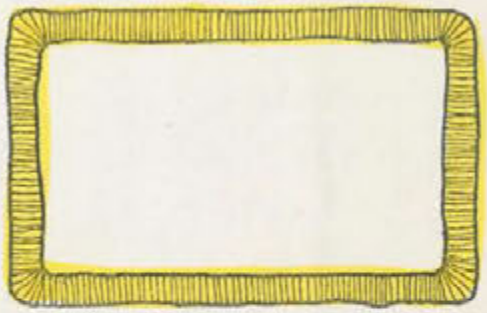
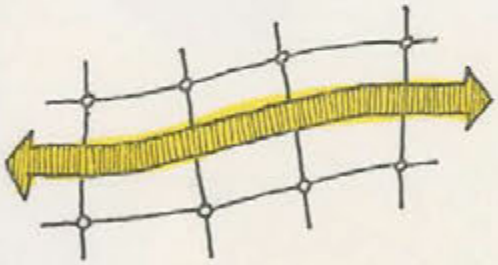
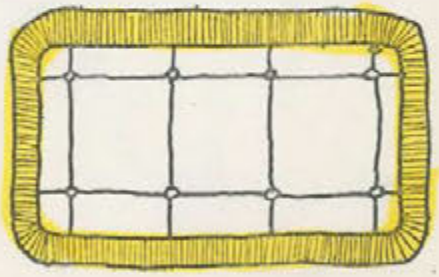
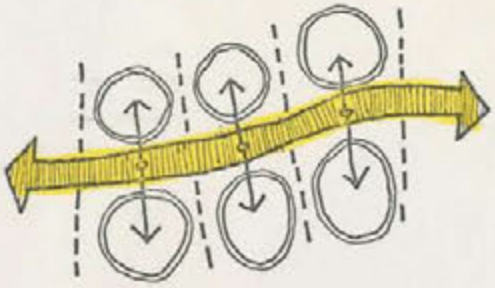
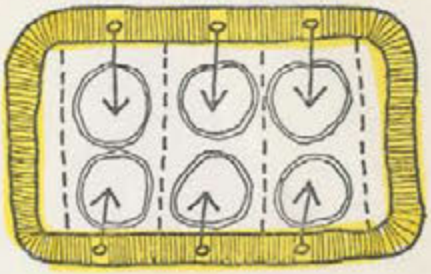
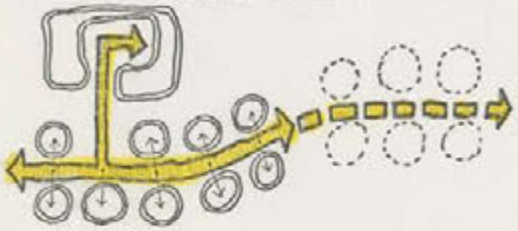
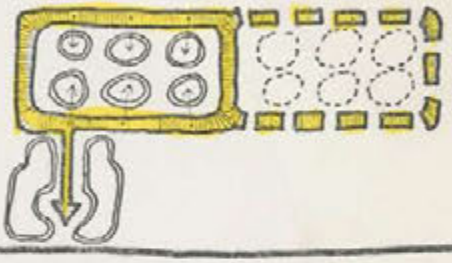
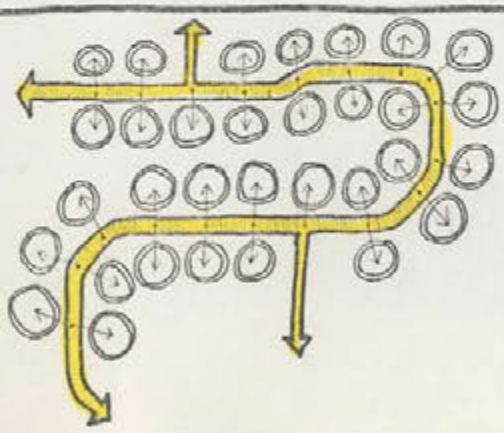
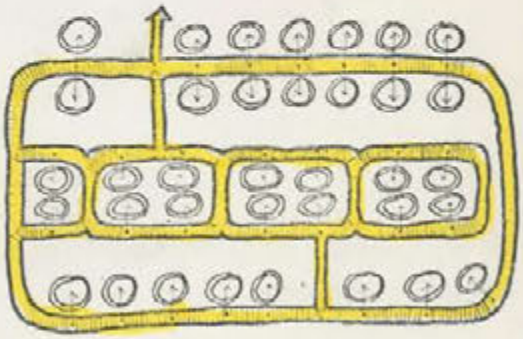
	LINEAL	PERIPHERAL
BASIC FORM		
INFRASTRUCTURE		
SOCIAL SPATIAL UNITS OVERLAID ON INFRASTRUCTURE		
EXTENSION		
GROWTH		

FIGURE 8-10

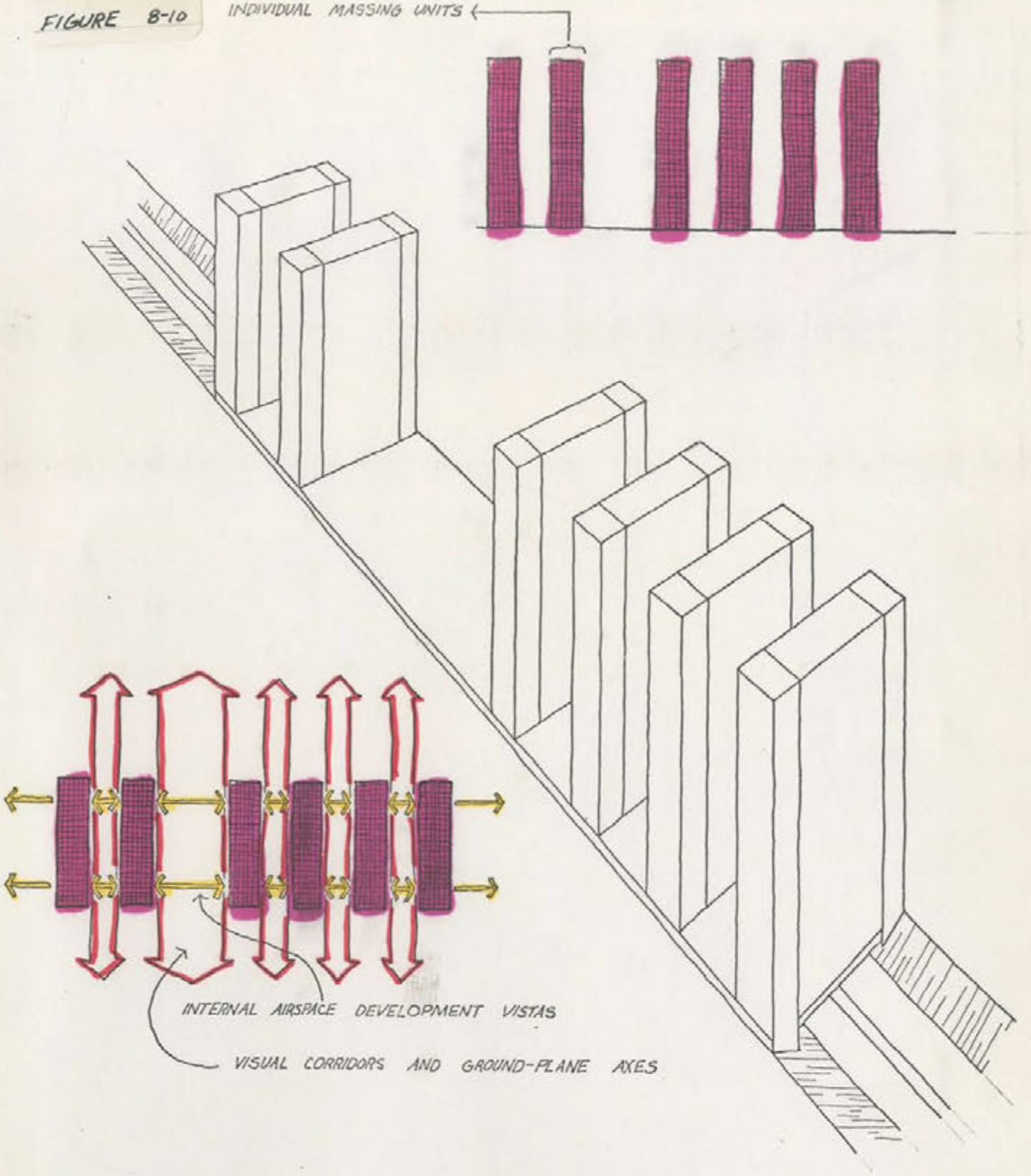

INDIVIDUAL MASSING UNITS
INTERNAL AIRSPACE DEVELOPMENT VISTAS
VISUAL CORRIDORS AND GROUND-PLANE AXES

FIGURE 8-11

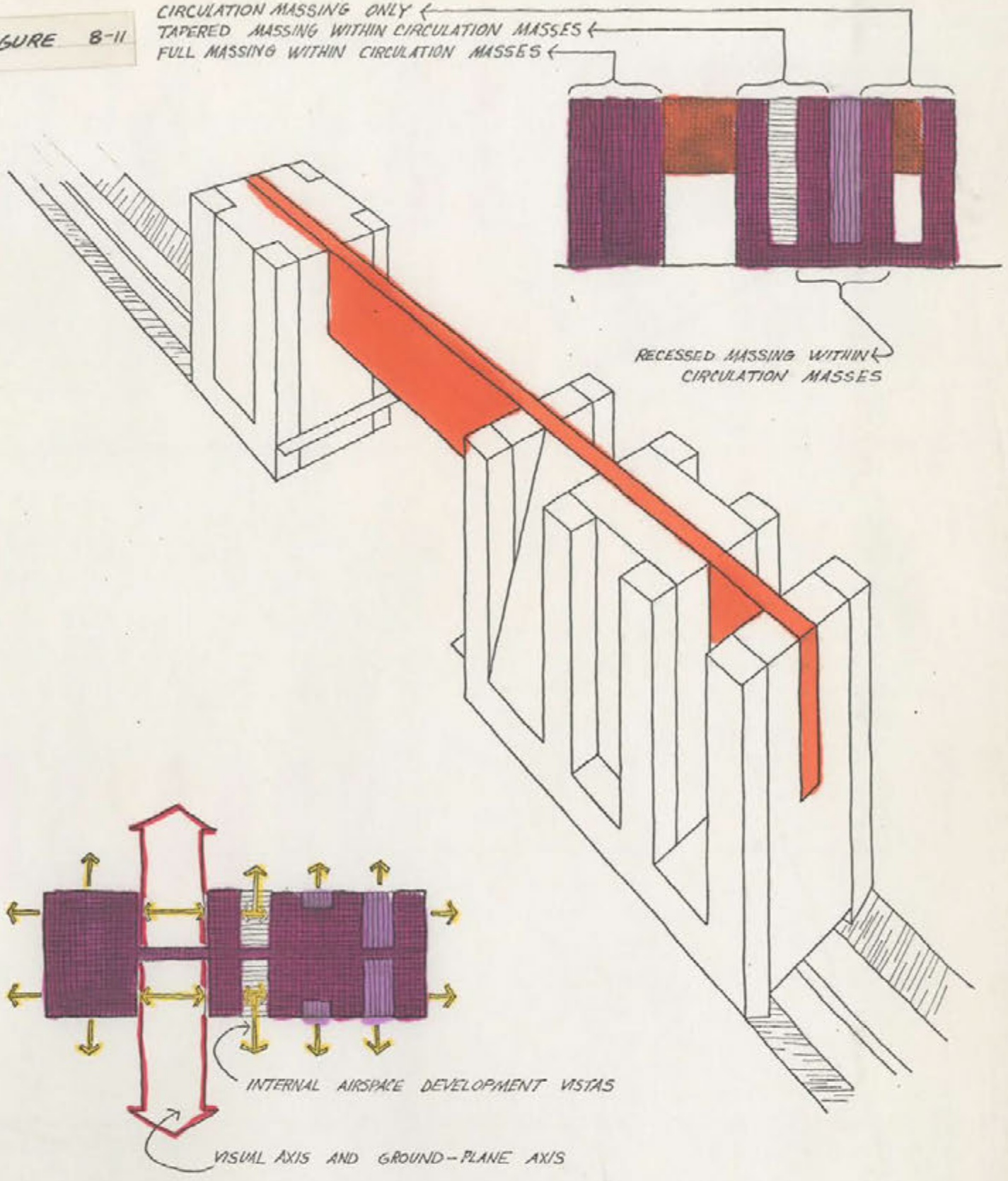
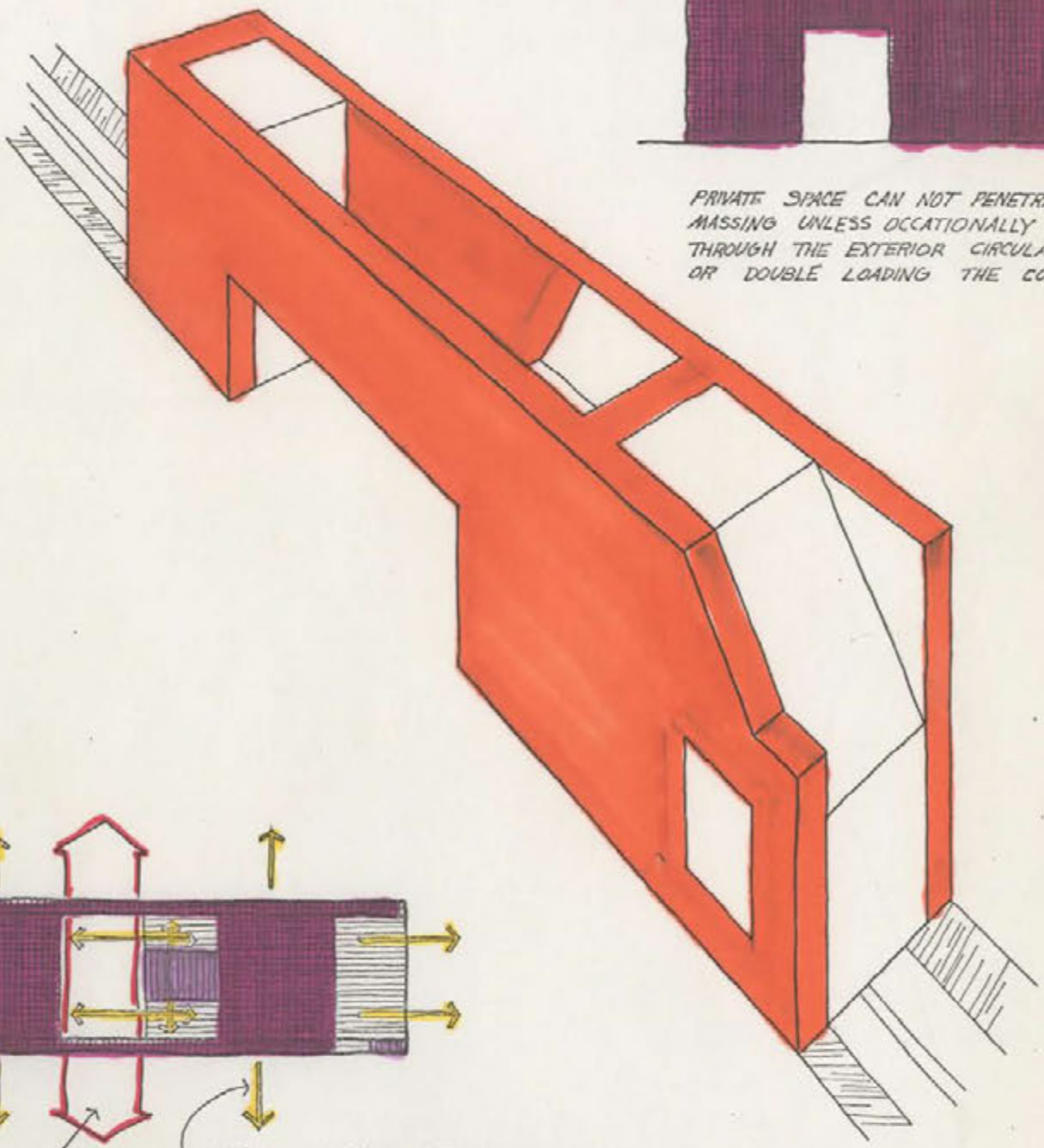

CIRCULATION MASSING ONLY
TAPERED MASSING WITHIN CIRCULATION MASSES
FULL MASSING WITHIN CIRCULATION MASSES
RECESSED MASSING WITHIN CIRCULATION MASSES
INTERNAL AIRSPACE DEVELOPMENT VISTAS
VISUAL AXIS AND GROUND-PLANE AXIS

FIGURE 8-12

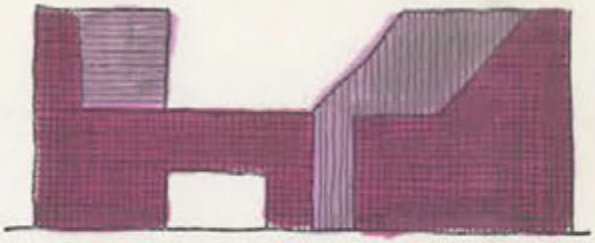
PRIVATE SPACE CAN NOT PENETRATE EXTERIOR MASSING UNLESS OCCATIONALLY PUNCHING THROUGH THE EXTERIOR CIRCULATION ZONE OR DOUBLE LOADING THE CORRIDOR.



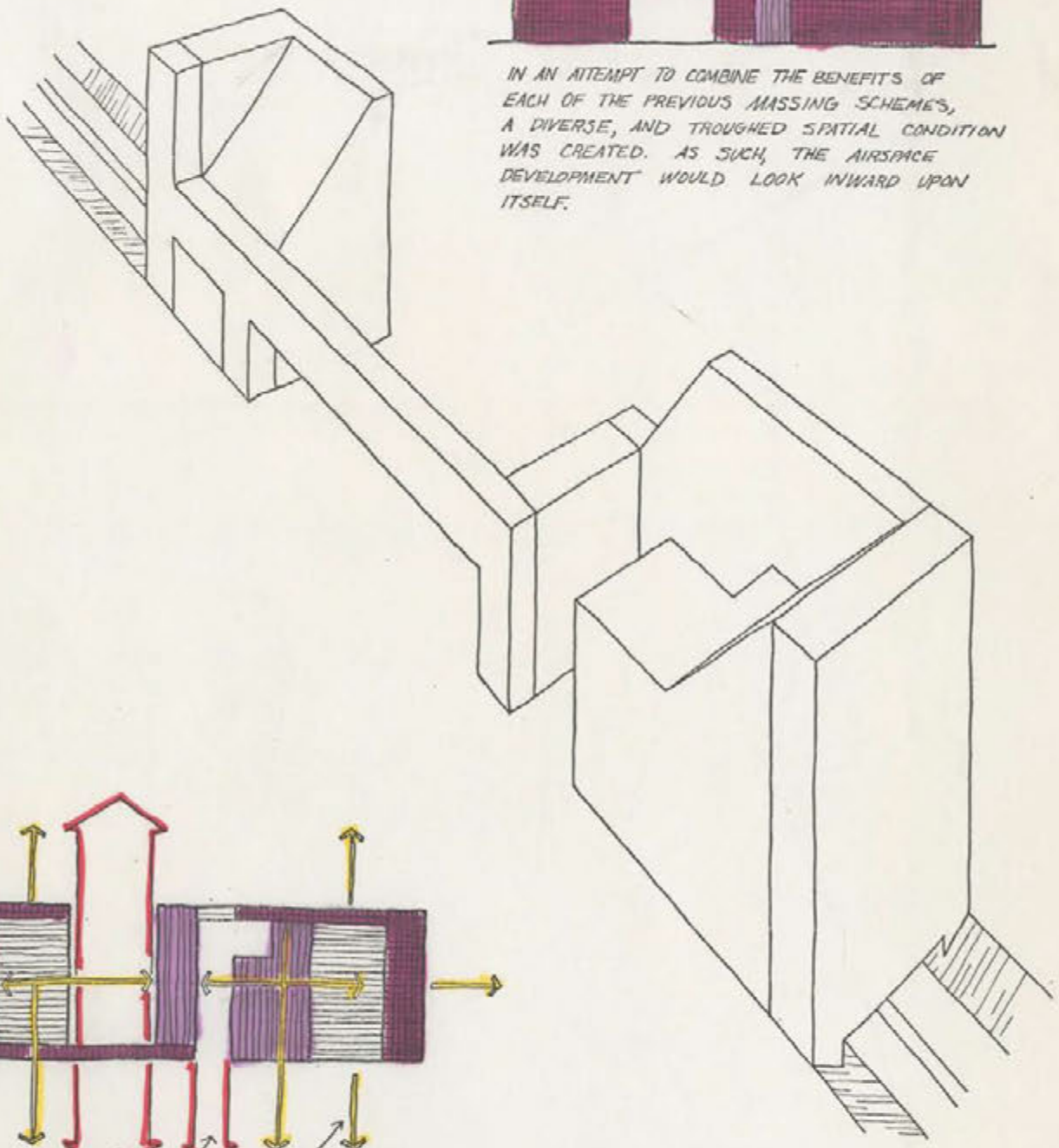
INTERIOR AIRSPACE DEVELOPMENT VISTAS

VISUAL CORRIDOR AND FREE GROUND-PLANE AXIS

FIGURE 8-13

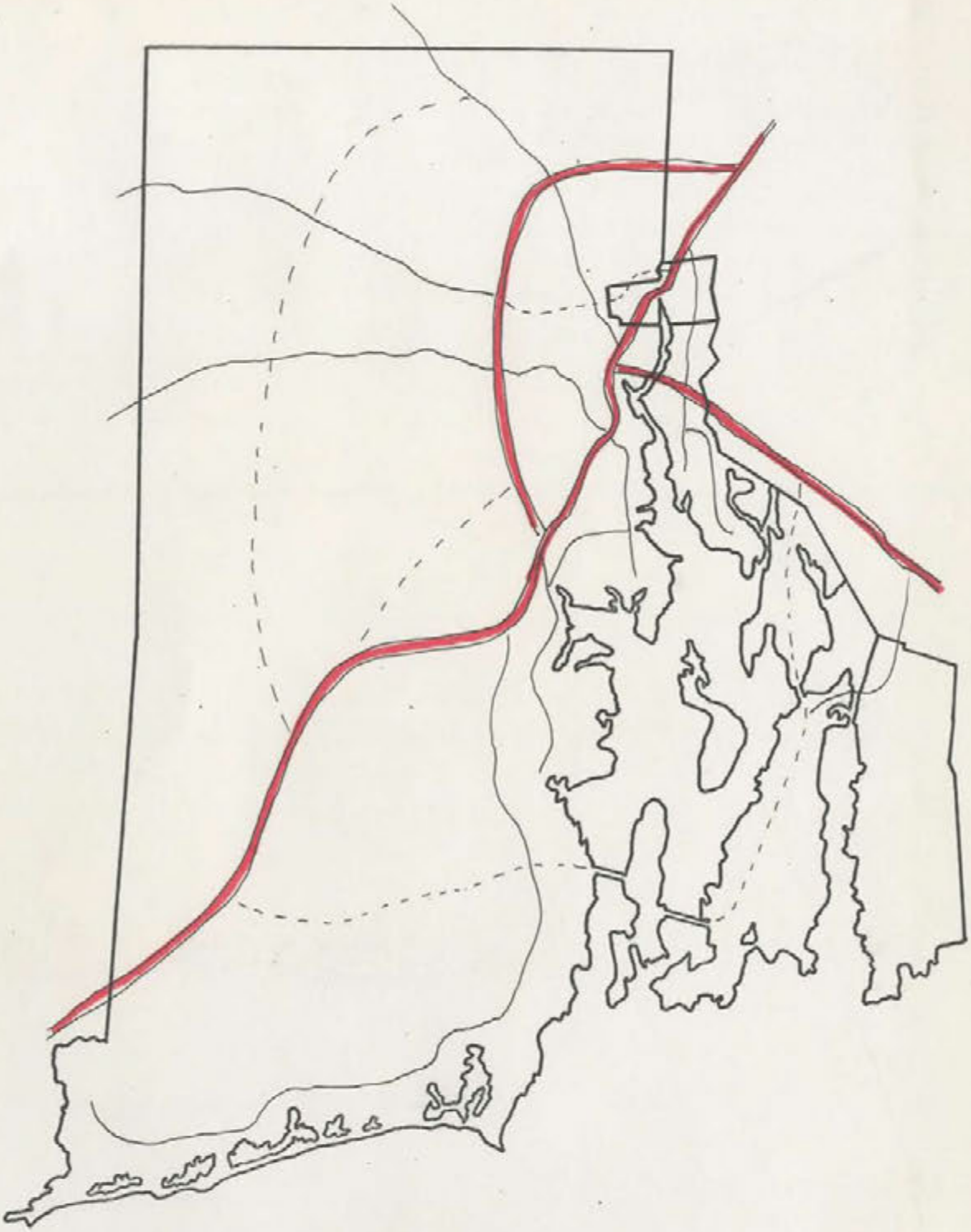


IN AN ATTEMPT TO COMBINE THE BENEFITS OF EACH OF THE PREVIOUS MASSING SCHEMES, A DIVERSE, AND TROUGHED SPATIAL CONDITION WAS CREATED. AS SUCH, THE AIRSPACE DEVELOPMENT WOULD LOOK INWARD UPON ITSELF.



INTERIOR AIRSPACE DEVELOPMENT VISTAS
VISUAL CORRIDOR AND FREE GROUND-PLANE

FIGURE 8-14



FREEWAY .....
MAIN ROAD.....
PROPOSED ROAD... - - -

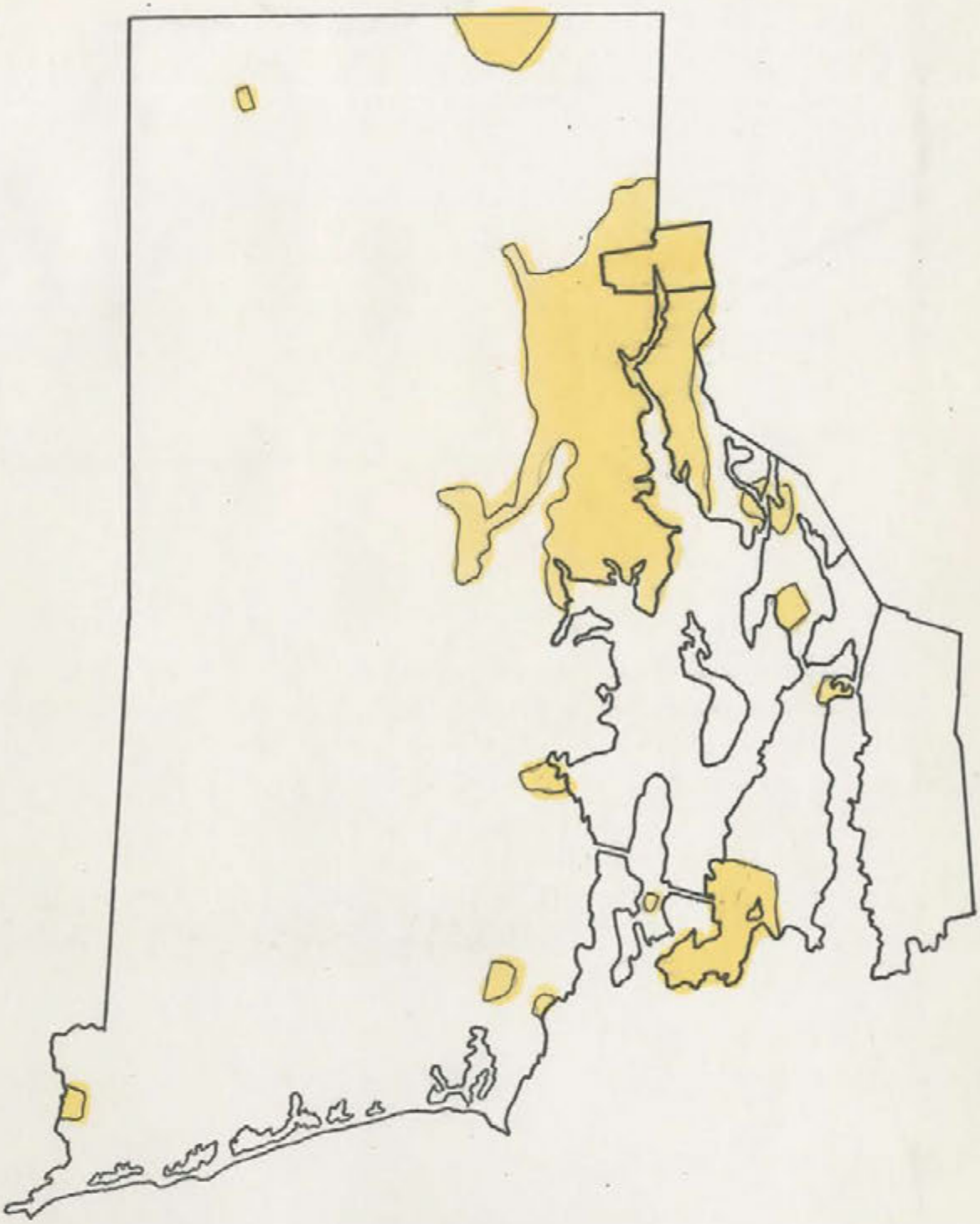
Map B
R.I.

N

0 1 2 3
miles

AUTO SYSTEM

FIGURE 8-15



	Map B R.I.	URBAN AREAS
	N miles	

FIGURE 8-16

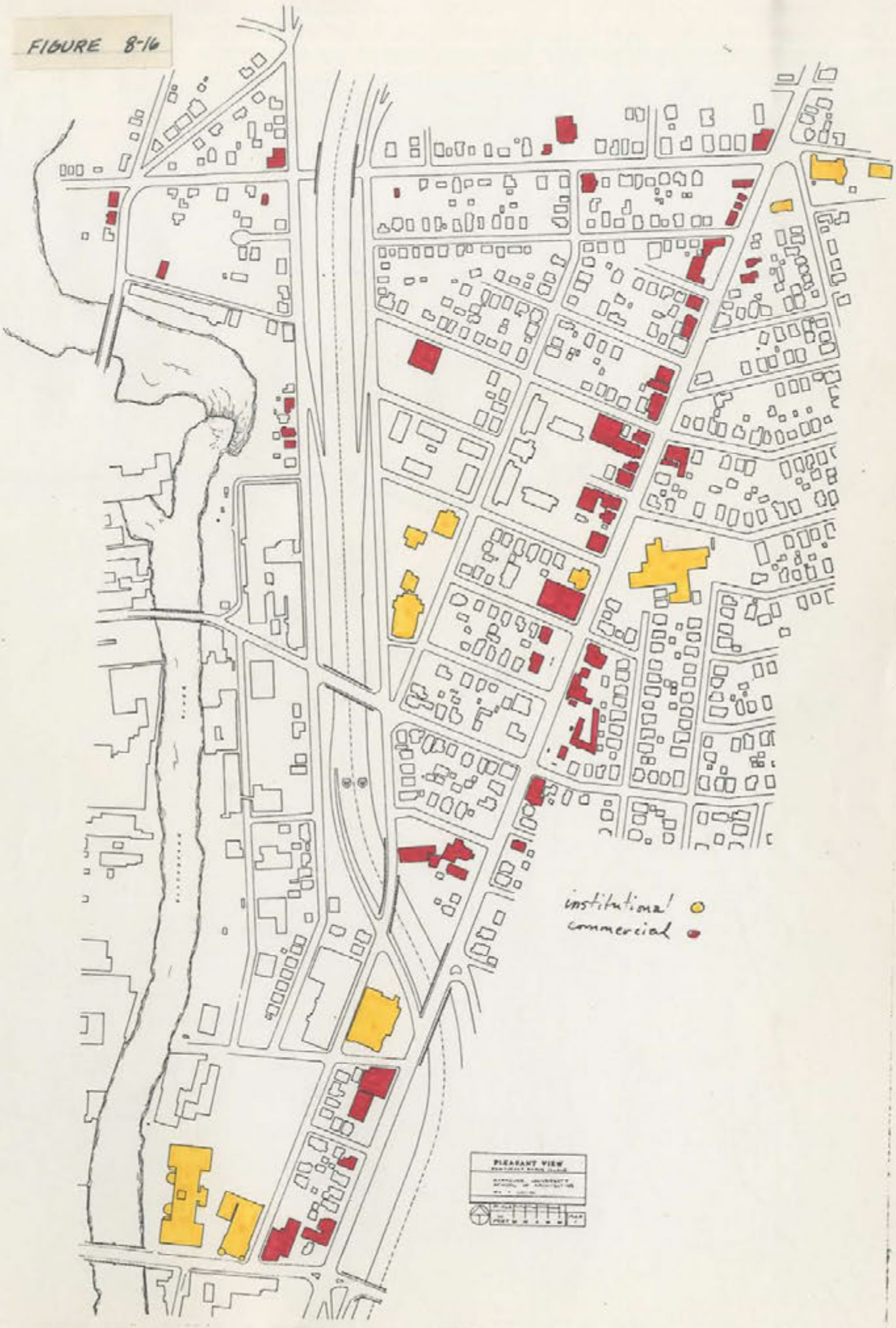


FIGURE 8-17

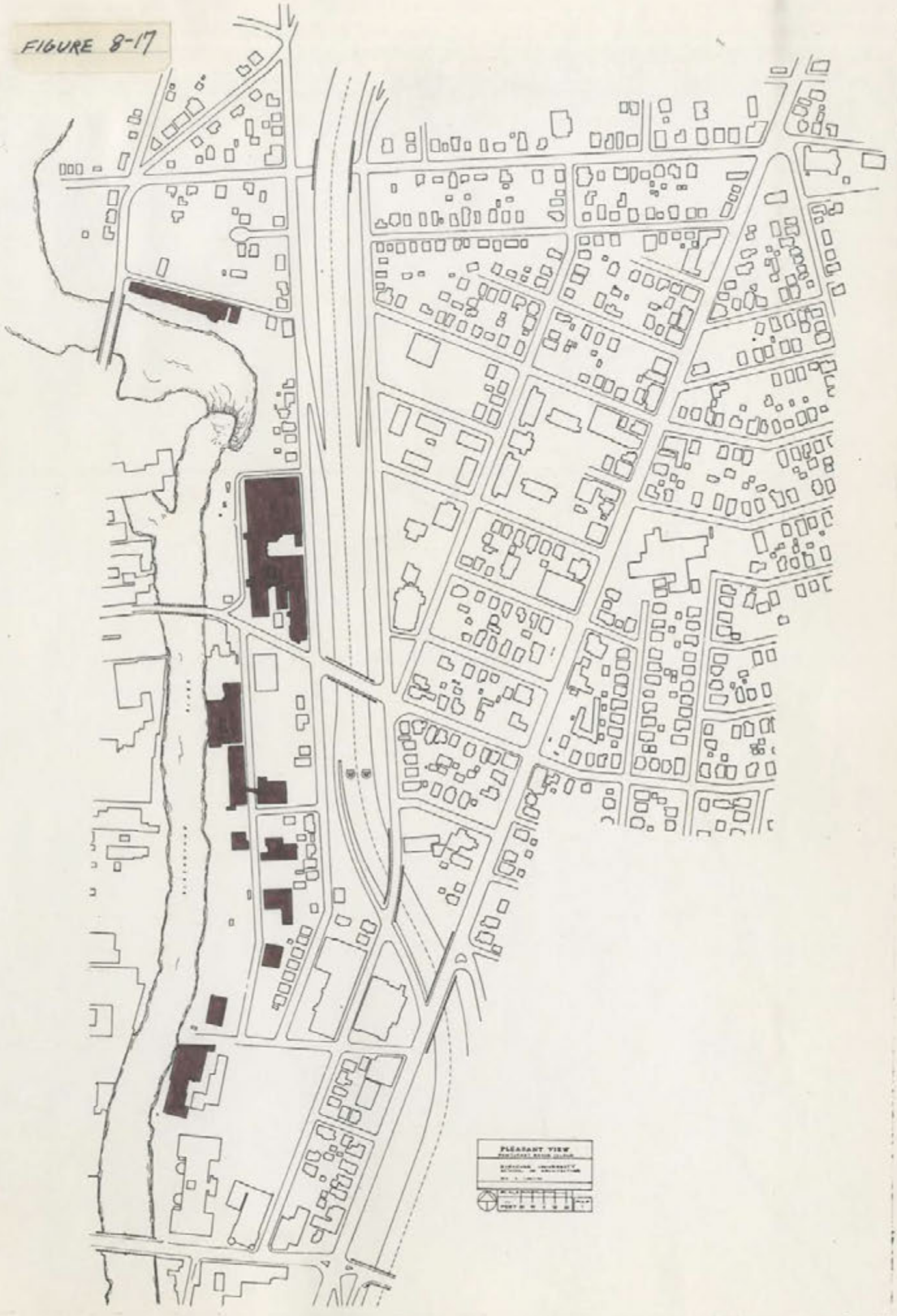
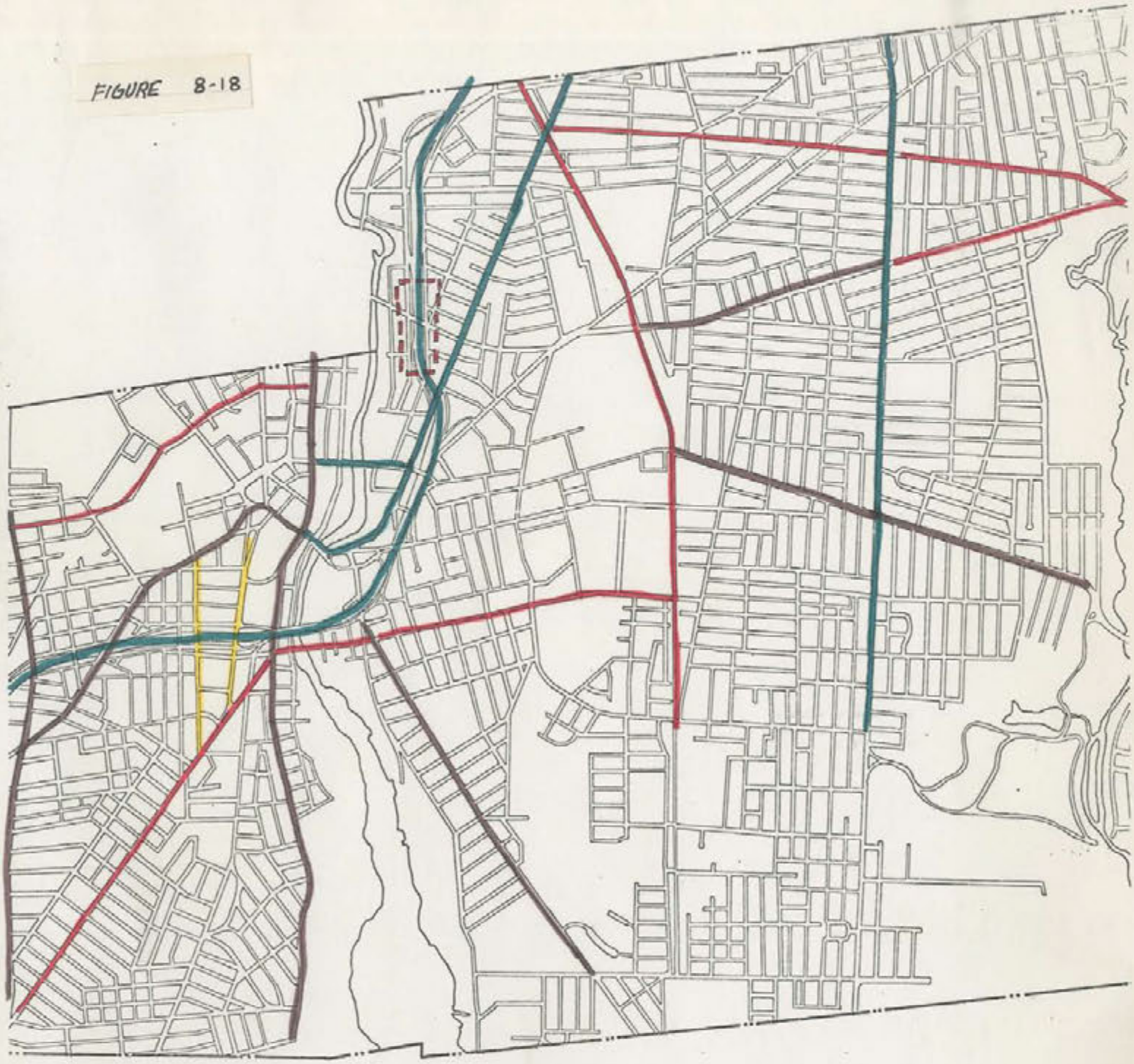


FIGURE 8-18



15,000 and over.....
10,000 to 14,999....
5,000 to 9,999.....
4,999 and under.....

Map A

CENTRAL PAWTUCKET

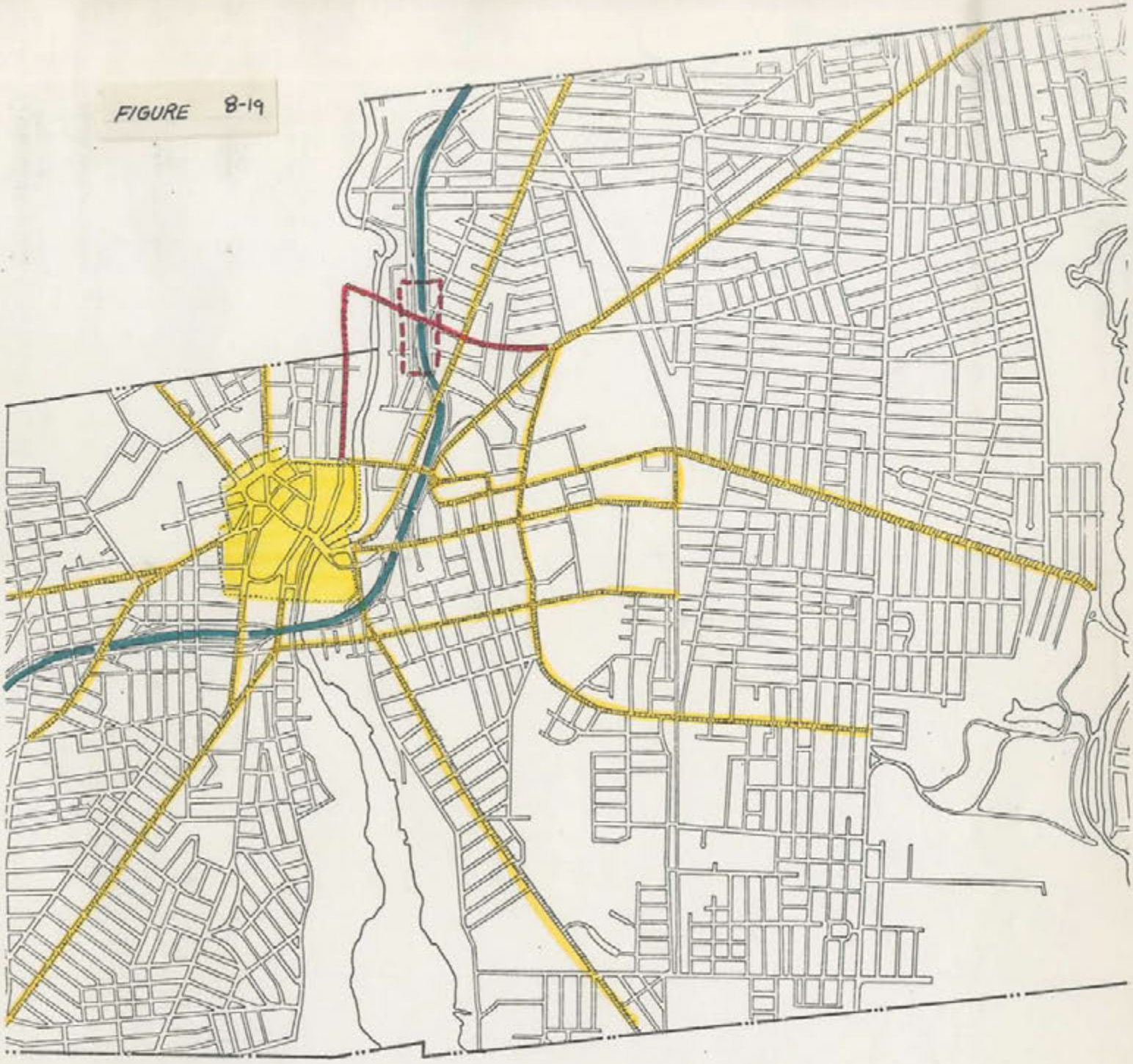
N

feet

AVERAGE DAILY TRAFFIC VOLUMES

site location....

FIGURE 8-19



arterial spoke.....
proposed arterial....
interstate.....
C.B.D. area.....

Map A
CENTRAL PAWTUCKET

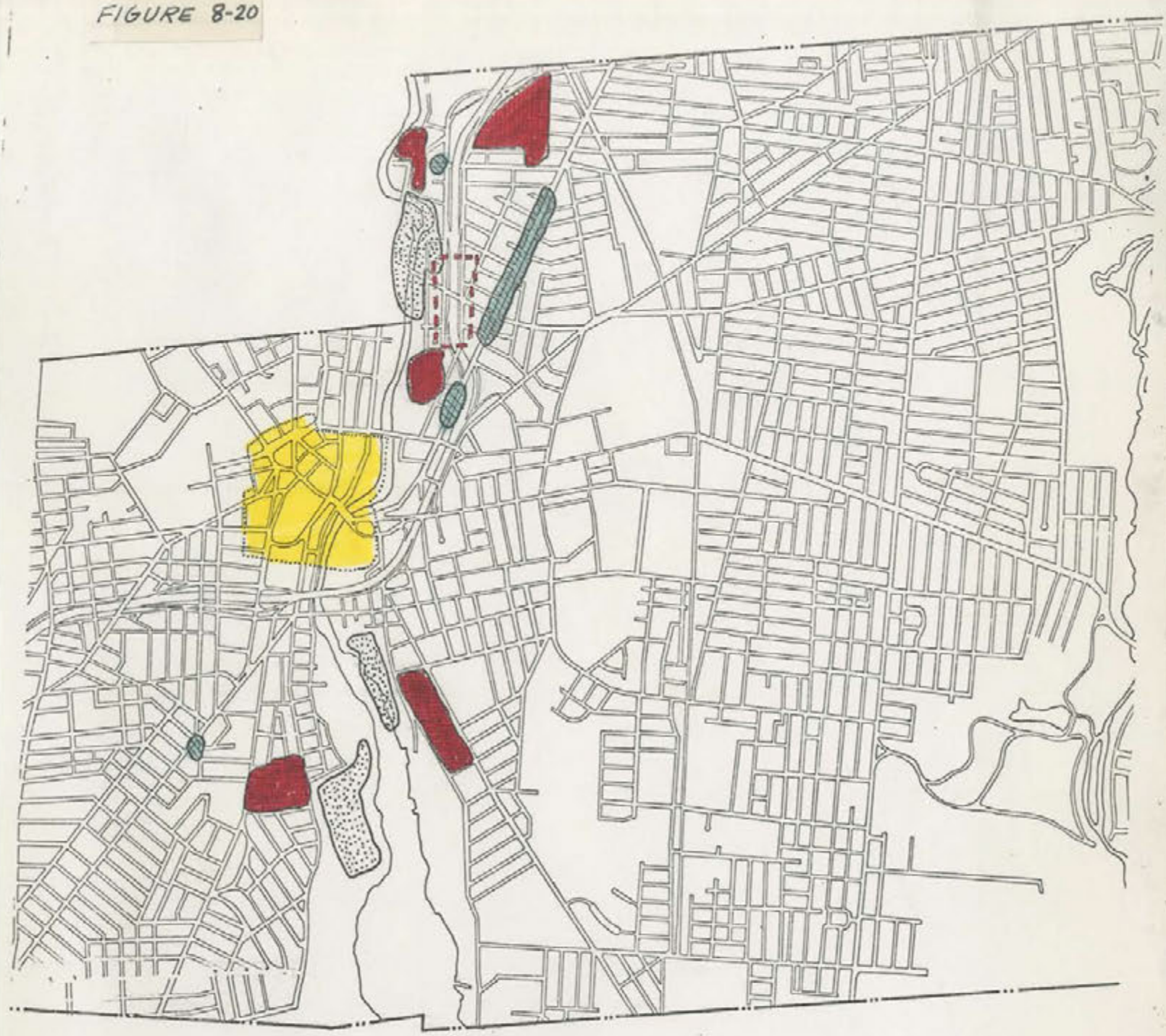
N

feet

ARTERIAL PATTERNS FOR CENTRAL PAWTUCKET

site location.....

FIGURE 8-20



vacant manufacturing..
degenerate commercial.
degenerate housing....
C.B.D. area.....

Map A

CENTRAL PAWTUCKET

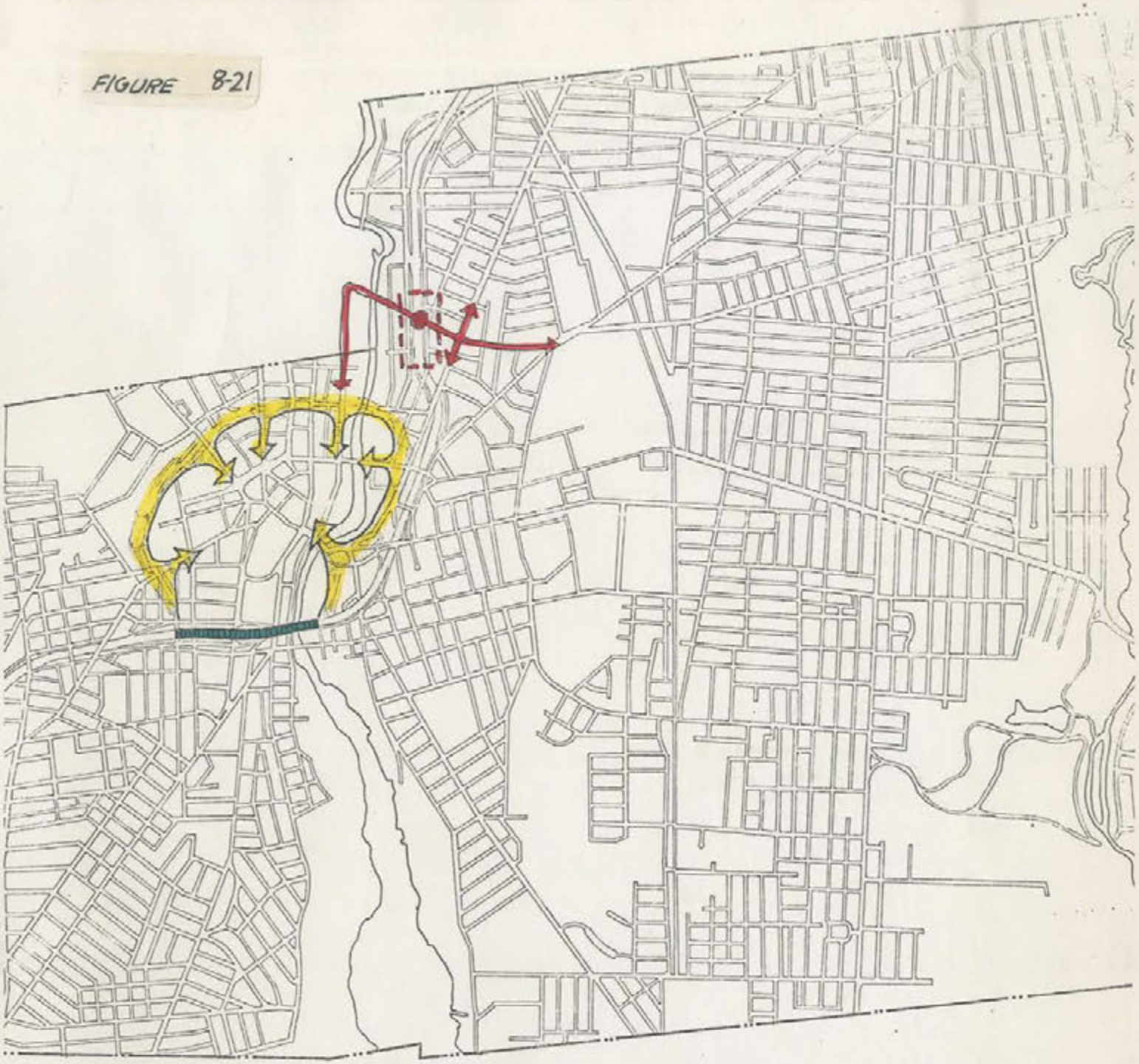
N

feet

DEGENERATE AREAS

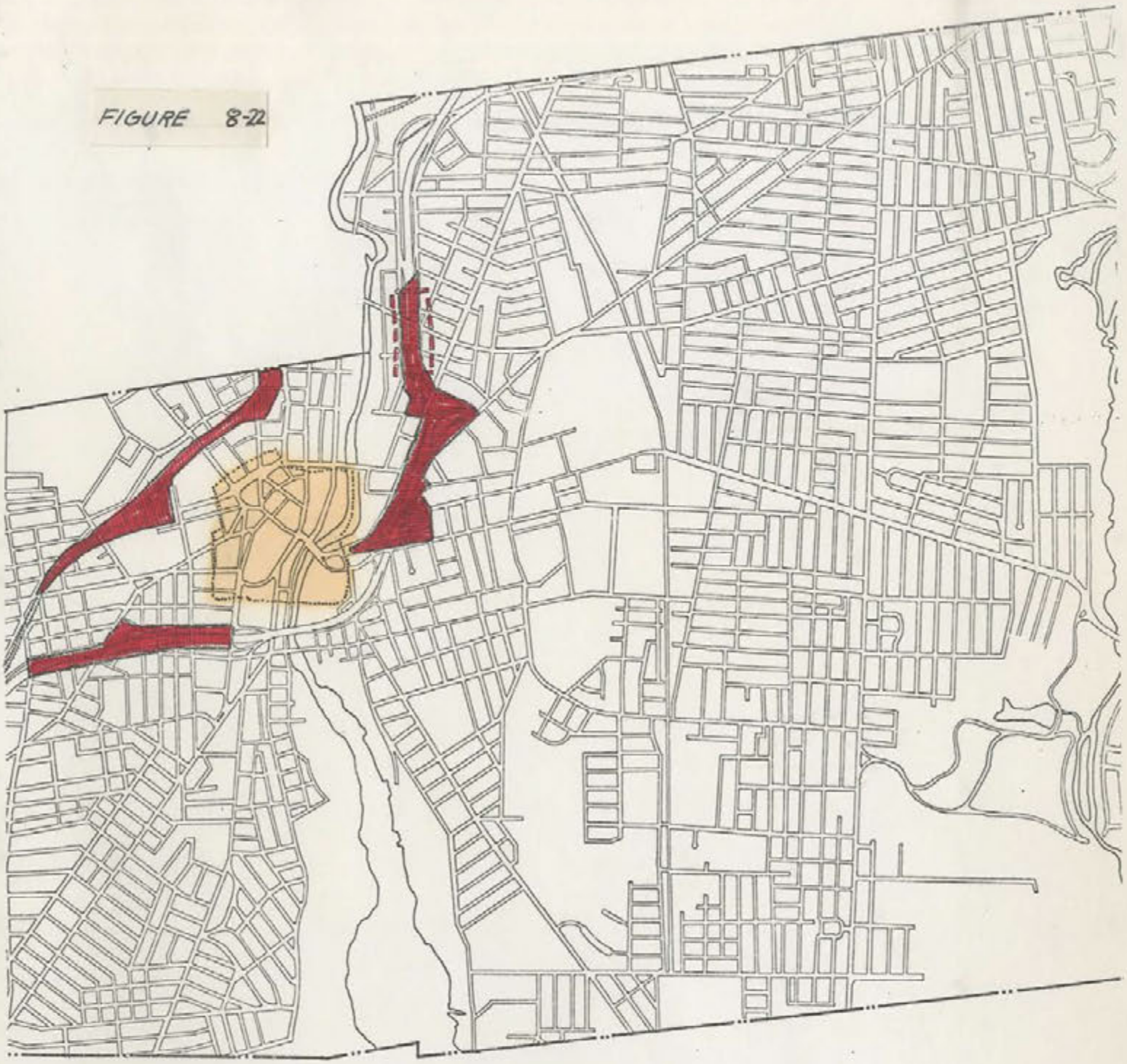
site location

FIGURE 8-21



VIEW TOWARD CBD .... BARRIER ..... NEW MAJOR AXIS	Map A CENTRAL PAWTUCKET N feet	SITE - CBD RELATIONSHIP

FIGURE 8-22



AIRSPACE ZONE....
CBD.....

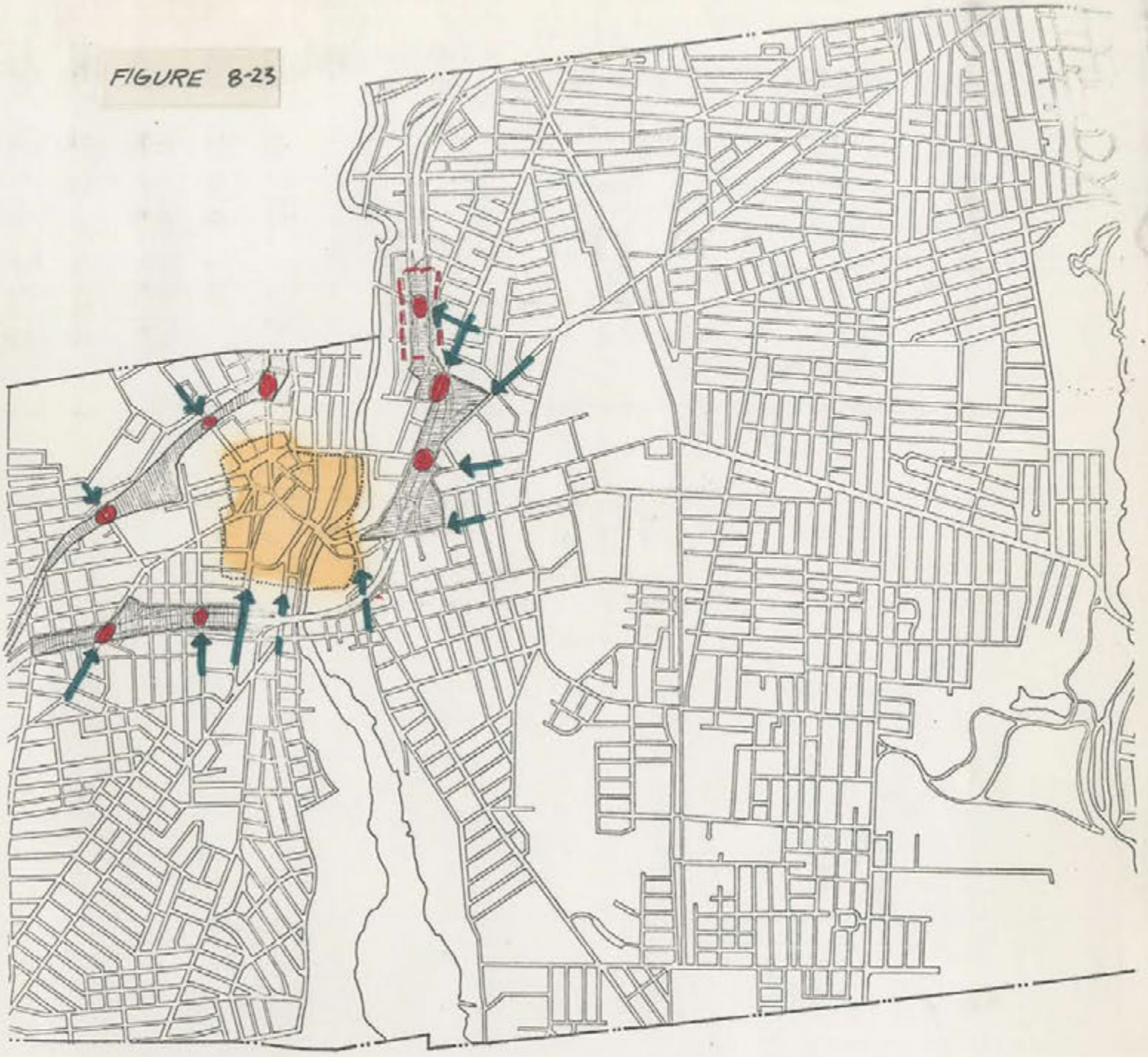
Map A
CENTRAL PAWTUCKET

N

feet

AIRSPACE ZONES

FIGURE 8-23



gateway.....
airspace zone.....
access routes.....
railroad lines.....

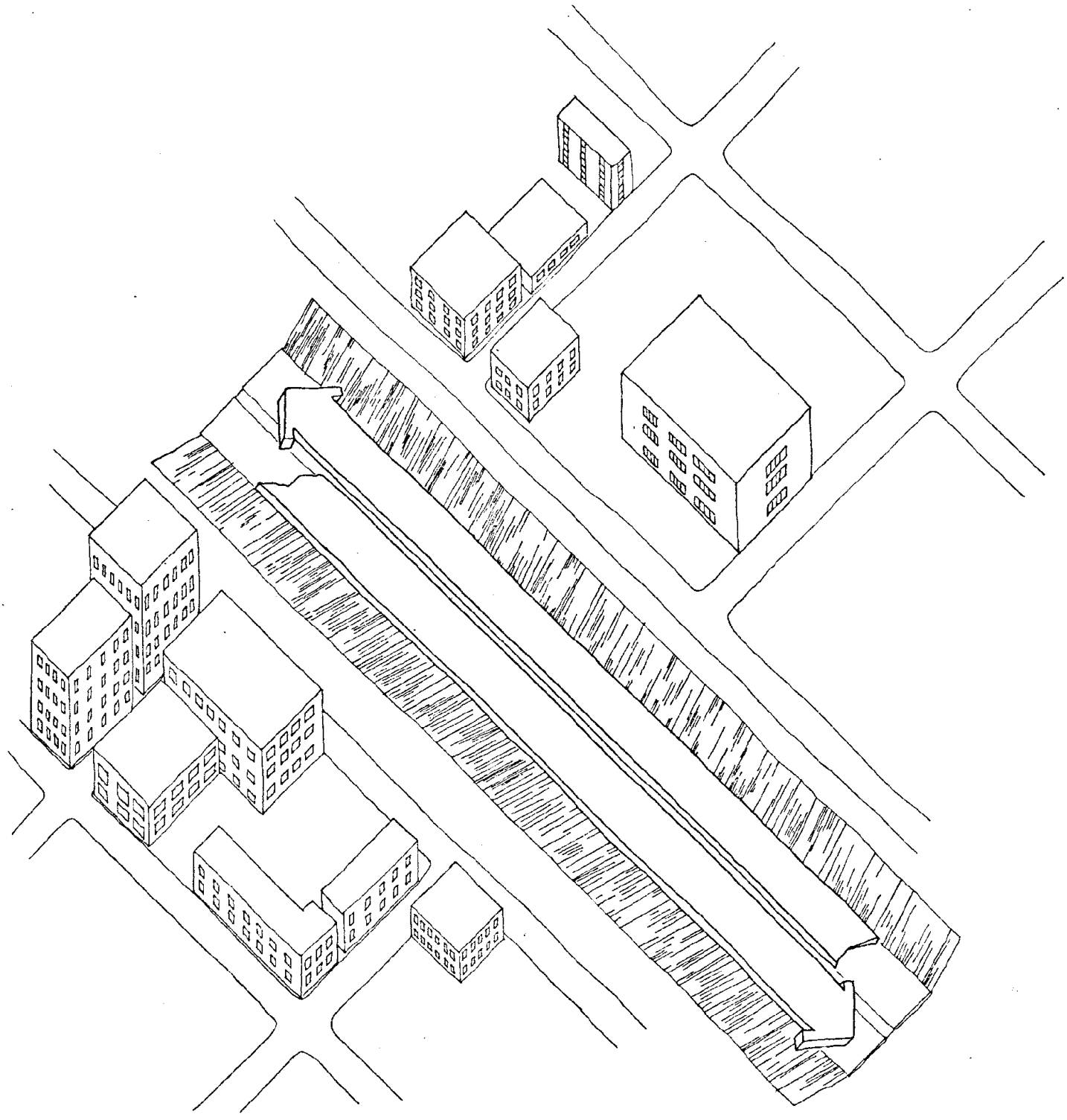
Map A
CENTRAL PAWTUCKET

N

feet

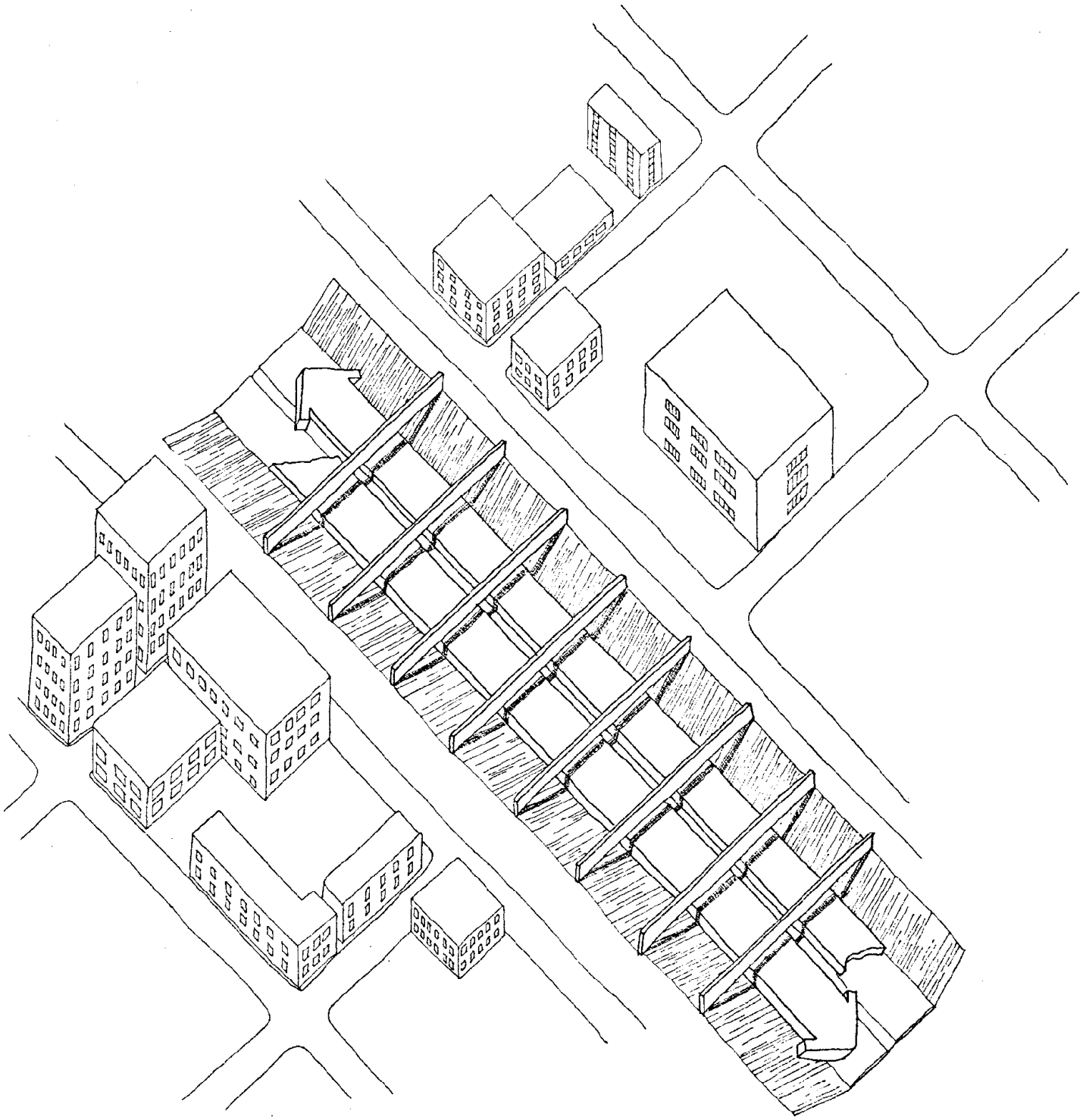
ENCLOSED CBD
site location.....
CBD.....

FIGURE 8-24



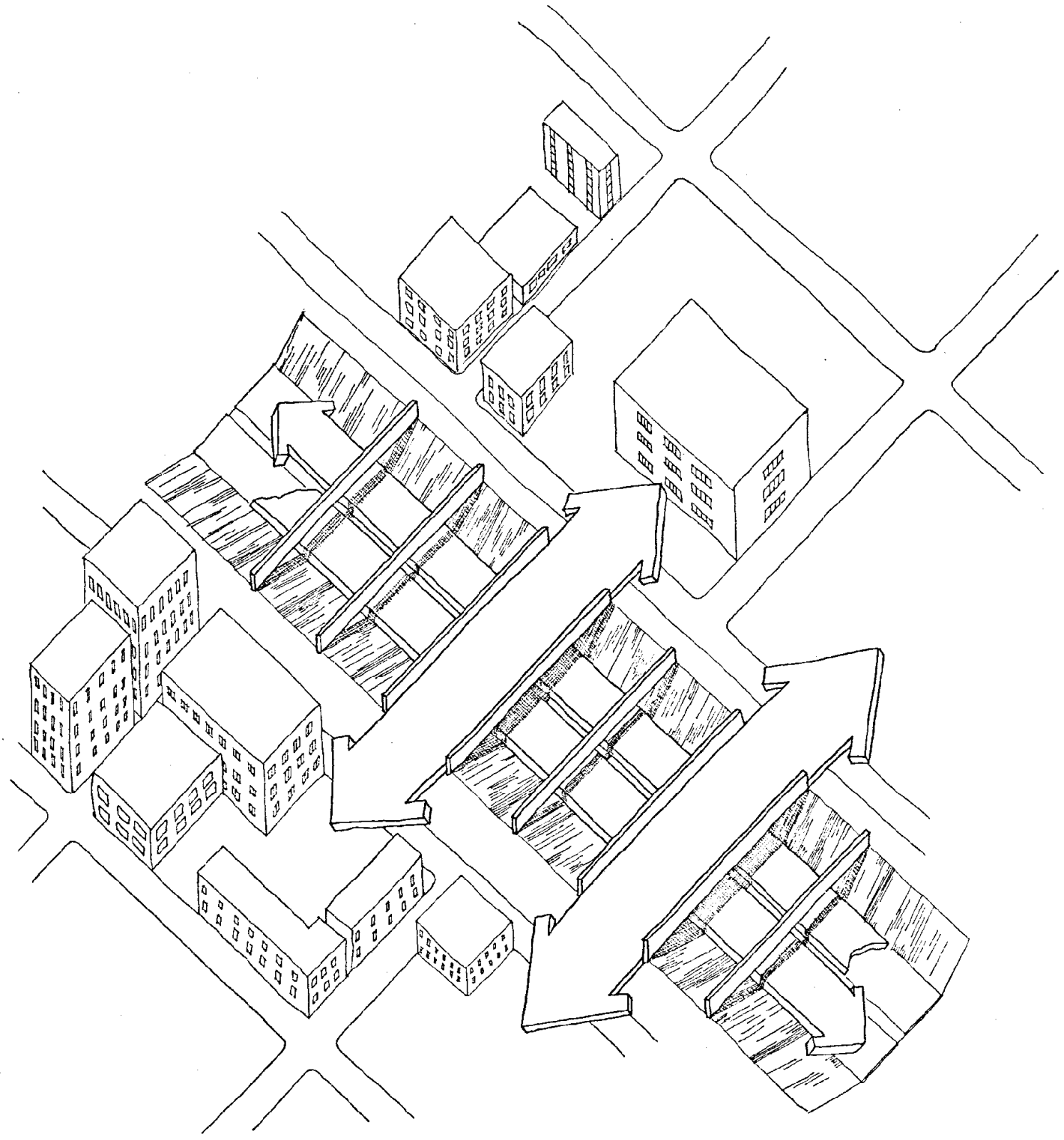
A DEPRESSED FREEWAY RIGHT-OF-WAY ( ) WILL USUALLY ACT AS A BARRIER WITHIN THE URBAN ENVIRONMENT. THIS CONDITION HAS BEEN KNOWN TO GENERATE URBAN BLIGHT, AND DIVIDE NEIGHBORHOODS PSYCHOLOGICALLY, AS WELL AS PHYSICALLY.

FIGURE 8-25



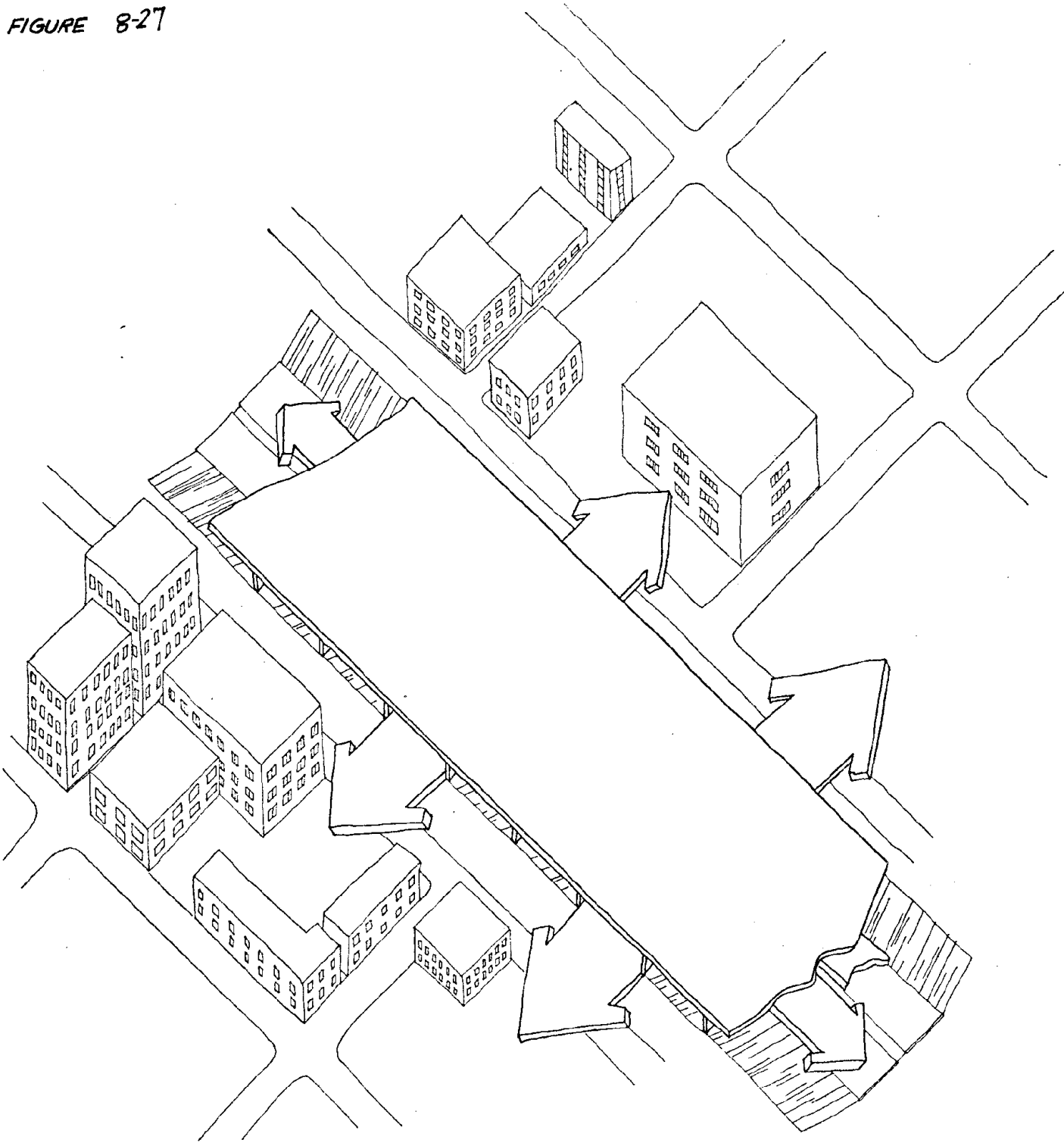
MASSIVE STRUCTURAL MEMBERS ( ) WILL NORMALLY BE USED FOR SPANNING AIRSPACE RIGHTS. USUALLY THE MEMBERS RUN PERPENDICULAR TO THE RIGHT-OF-WAY ( ) AND MUST CARRY HEAVY LOADS.

FIGURE 8-26



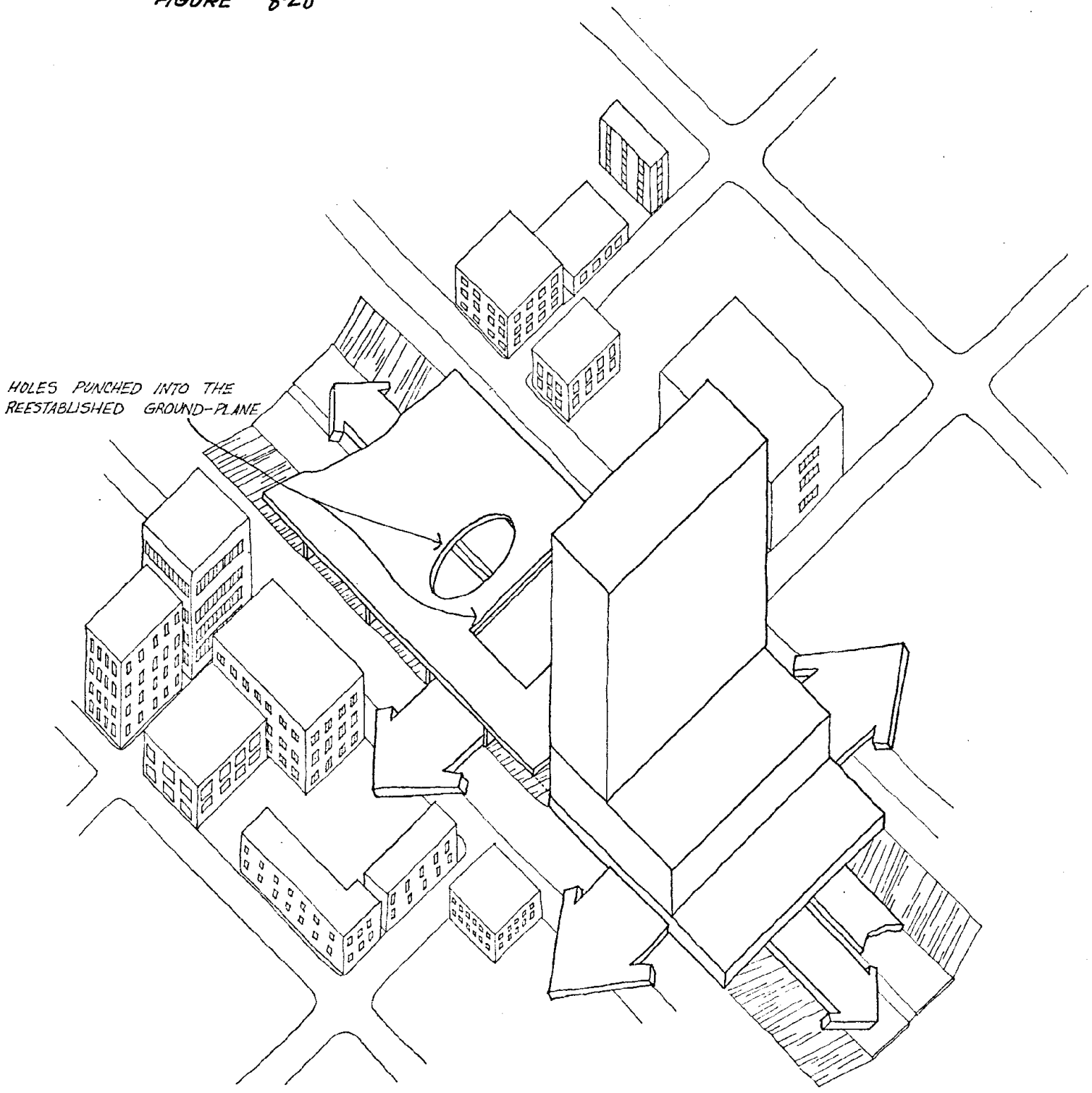
THIS DIAGRAM SHOWS THE RELATIONSHIP OF THE AIRSPACE FOUNDATION FRAMING TO THE IMMEDIATE WEAVE RELATIONSHIPS OF THE URBAN FABRIC. BECAUSE LARGE STRUCTURAL MEMBERS ( ) SPAN THE FREEWAY RIGHTS-OF-WAY ( ) PERPENDICULARLY, THE POTENTIAL FOR A STRONG PERPENDICULAR SPLICE BETWEEN BISECTED URBAN FABRIC EXISTS ( ). IF THE SPLICE IS CRITICALLY LOCATED IT BECOMES A GATEWAY THROUGH A LINEAR MEGAFORM, OR SIMPLY A FUNNEL BETWEEN DIFFERENT UNITS OF URBAN FABRIC.

FIGURE 8-27



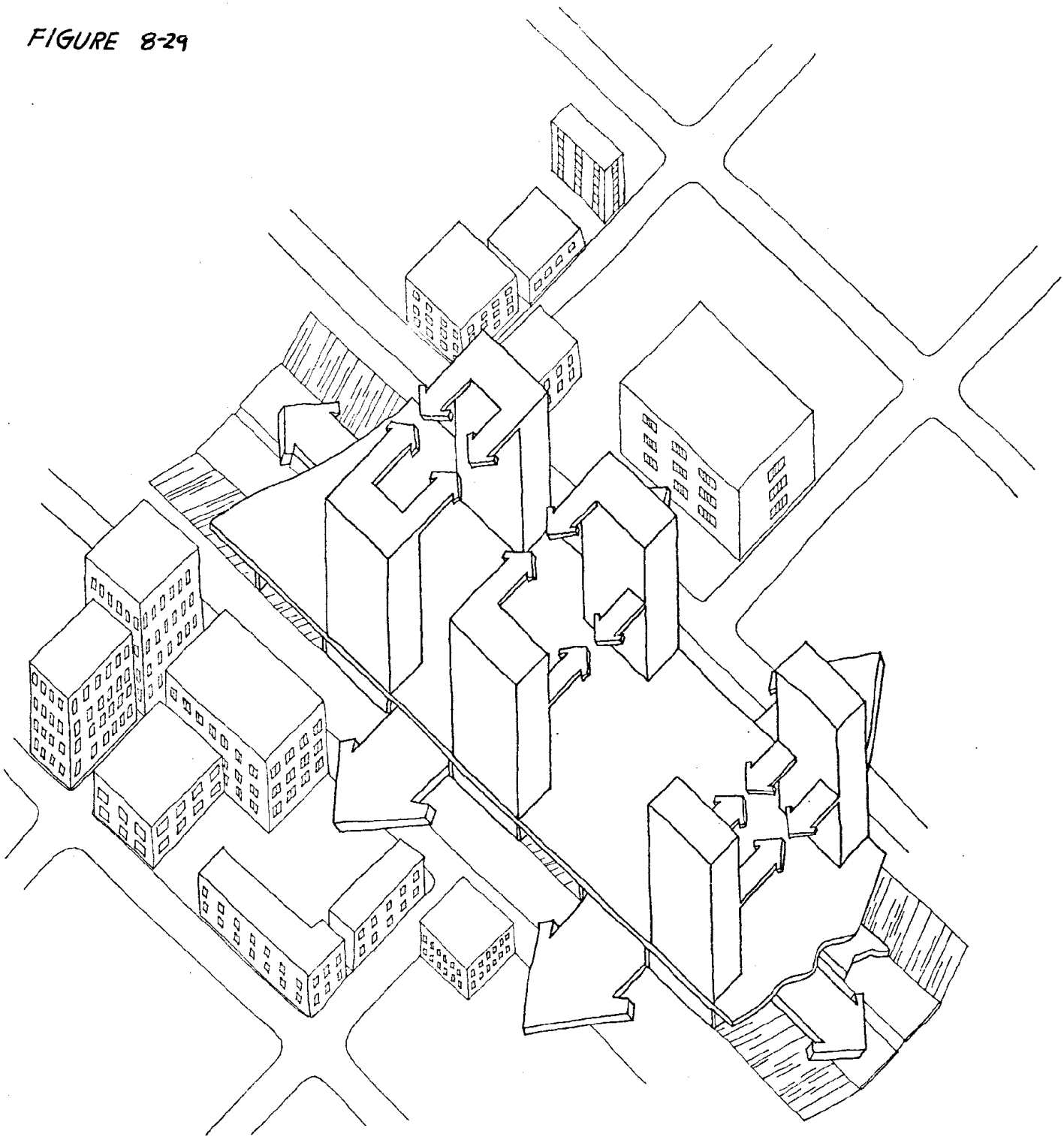
TO UTILIZE AIRSPACE, A GROUND-PLANE MUST BE REESTABLISHED ( ). BECAUSE OF THE COSTS INVOLVED WITH GENERATING A GROUND-PLANE ONLY HIGH INTENSITY USES ARE NORMALLY SUITABLE FOR AIRSPACE DEVELOPMENT. THIS FACTOR SUGGESTS THAT SPECIAL ZONING DISTRICTS SHOULD BE ESTABLISHED FOR AIRSPACE DEVELOPMENT. THESE ZONING DISTRICTS WILL NEED LIBERAL F.A.R.'s INORDER TO LURE DEVELOPMENT.

FIGURE 8-28



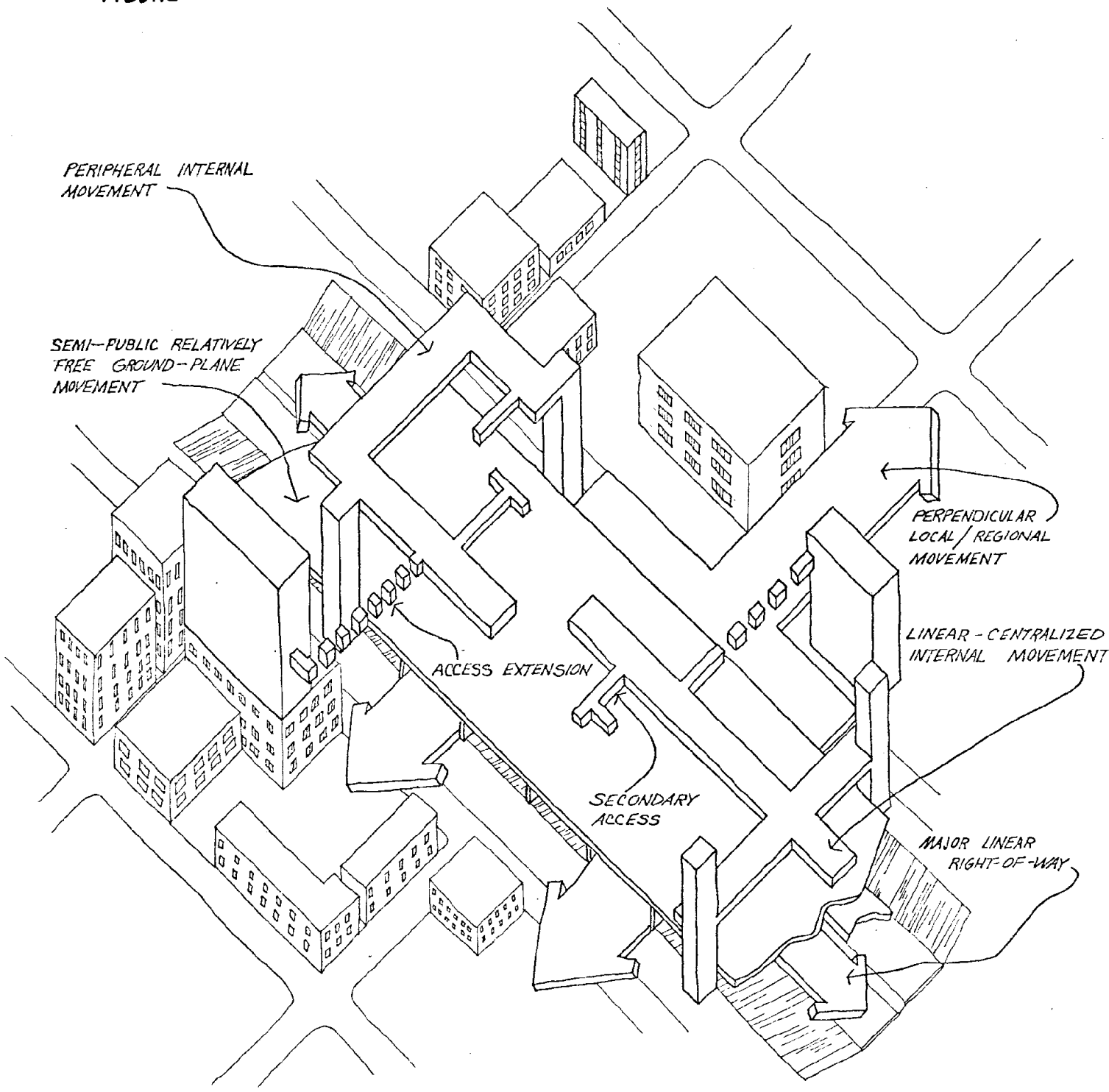
THIS DIAGRAM SHOWS THE MOST PROBABLE VERTICAL ZONES IN AN AIRSPACE DEVELOPMENT. THE LOWEST ZONE IS PUBLIC, ( ), THE CENTRAL ZONE IS SEMI-PUBLIC, ( ), AND THE UPPER ZONE IS PRIVATE, ( ). BECAUSE HOLES CAN BE PUNCHED INTO THE REESTABLISHED GROUND-PLANE, ( ), SOME PUBLIC SPACE WILL BE ABLE TO FLOW INTO THE SEMI-PUBLIC SPACE.

FIGURE 8-29



AN OVERWHELMING FACTOR WHEN DESIGNING IN AIRSPACE IS THE FACT THAT ENVIRONMENTAL SYSTEMS MUST BE SUPPLIED AND RETURNED IN VERTICAL STACKS ( ) WHICH DO NOT INTERFERE WITH RIGHTS-OF-WAY ( ) OR OTHER ACTIVITY AXES ( ). PLACING THE MECHANICAL SYSTEMS AREAS OVER ACTUAL SURFACE AREA WILL CUT CONSTRUCTION COSTS. IN MOST CASES THE MECHANICAL STACKS ARE THE LIFELINE FOR THE REMAINING AIRSPACE AREA. THESE STACKS NORMALLY GENERATE SPECIFIC FORMS WHICH INFLUENCES THE PROJECT AND SHOULD BE INTEGRATED INTO THE DESIGN CONSIDERATIONS.

FIGURE 8-30



ACCESS TO AIRSPACE DEVELOPMENTS WILL NORMALLY START IN VERTICAL STACKS WHICH DO NOT INTERFERE WITH RIGHTS-OF-WAY OR OTHER ACTIVE AXES. MAJOR INTERNAL CIRCULATION SHOULD BE EITHER PERIPHERAL OR LINEAR-CENTRALIZED (OPPORTUNITY TO DOUBLE LOAD). IT IS ALSO POSSIBLE TO EXTEND CIRCULATION CORRIDORS TO ADJACENT AREAS ( ) OR EVEN TO ADJACENT AIRSPACE DEVELOPMENT ( ). AIRSPACE DEVELOPMENTS ARE HIGHLY SUITABLE FOR ACCESS TREE APPLICATION.

GLOSSARY OF TERMS

agglomeration economies: the efficiencies and benefits accrued when activities cluster spatially.

aggregate behavioral patterns: prototypical reactions which are deciphered from stochastic data.

airspace or 'air rights': the cubic volume of space over or under buildings, freeways, railroad rights-of-way, lakes, rivers, etc., which can be owned, transferred, and subject to all the other rights and responsibilities associated with real property.

catalytic functions: the effects generated when one component of a system changes and in so doing, alters another part of the system.

fractionalization: the process of segmenting or separating an arrangment.

Markov Chains: a system of situations which start at a given time and change with a certain probability over time.

micro-environmental factors: environmental components which are immediately perceived by an individual and affect that person's attitude toward environmental utility.

micro-location: a localized area of environmental components directly effecting a person, item or situation (as a sum of constituent parts).

minaturization: the process of condensing a very large and complex environment without sacrificing mobility and efficiency.

multiplier effect: when new business or industry increases agglomeration economies in a given area by establishing new local thresholds or enhancing the possibility of innovation or invention.

urbanization: when a population goes from a rural character to an urban character.

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Other

Agnew, John. Lecture Notes. "Urban Political Geography." Syracuse University, 1975.

BIOGRAPHICAL DATA

Name: Ira Anthony Chilton

Date and Place of Birth: March 5, 1952
N.A.S. Quonset Point, Rhode Island

Elementary School: Jacksonville, Florida
Virginia Beach, Virginia
West Warwick, Rhode Island

High School: West Warwick Senior High School
West Warwick, Rhode Island

College: Virginia Polytechnic Institute and State University
Blacksburg, Virginia
Bachelor of Architecture, 1975

Graduate Work: Syracuse University
Syracuse, New York
Master of Architecture and Urban Design Program

Graduate Appointments: Teaching Assistant, 1975-76
Resident Advisor, 1976-77