

HIGHWAY RESEARCH RECORD

Number 217

Land Acquisition
and
Freeway Land
Development

4 Reports

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Foreword

The four papers in this RECORD deal with land development near limited-access highways. The papers support the common idea that coordinated planning of highways and land use can result in compatibility that will be advantageous to the highway and to the uses nearby. Some of these uses may have only an indirect connection with the highway—for example, parks or playgrounds in excess land near the roadway or above or below the roadway. Other uses discussed, such as trucking terminals, may be directly related to the highway. The papers all suggest that nearby land-use patterns can be improved by making use of the opportunity for change that is offered by the impetus of highway construction.

These papers illustrate what has been happening in highway-impact research. Impact researchers are no longer satisfied to identify and measure highway effects. Highway-impact research now emphasizes ways of using highway improvements to achieve broad community goals.

Darwin G. Stuart calls attention to some of the advantages of coordinating highways and land use nearby and some of the problems in achieving this coordination. Air rights developments can minimize barrier effects of freeways. Land uses needing good access can be located within interchange areas, including space over ramps and on excess land within ramp interiors. Problems of acquiring enough land for development can be solved by a separate public agency that can assemble highway bordering land into usable parcels.

Harvey R. Joyner calls attention to some of the uses (e.g., parking, playgrounds, etc.) that can be made of excess right-of-way land. He emphasizes that these land uses must not adversely affect freeway traffic, and must not be adversely affected by freeway traffic. The uses must be compatible with adjacent development and must not require direct access to freeway lanes. They can be combined with adjacent non-highway land to form developable parcels. The greatest potential lies in coordinated development. Since Joyner's paper is part of an NCHRP project, only the abstract is included in this Record and the readers are referred to the complete NCHRP published report.

Julia A. Connally and C. O. Meiburg describe and analyze some of the land-use patterns along the Washington Capital Beltway, particularly industrial and apartment development. The authors suggest that more apartment developers may have located along the Beltway than is desirable for the apartment dwellers or for the uncongested operation of the Beltway. Connally and Meiburg also describe an approach for controlling land development in interchange areas; this approach involves development sectors which would have the land use designated by large areas rather than on a parcel-by-parcel basis.

Joseph T. Whalen and Thomas M. Flynn call attention to the effect that the Interstate Highway System in Arizona has had on the service facilities for truck drivers. Truck drivers and other highway consumers are demanding better and more complete service facilities, including restaurant and motel facilities. The authors believe that truck stops will evolve into complete service facilities for all highway users, cars as well as trucks.

—Floyd I. Thiel

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Multiple-Purpose Freeway Land Development

DARWIN G. STUART, Barton-Aschman Associates, Chicago

•MULTIPLE uses of highway rights-of-way, beginning with the simple roadside picnic table, have become increasingly important in the building of today's controlled-access highways. The Interstate Highway System will be supplemented by more than 1000 pairs of safety rest areas; the nation's major toll roads have constructed more than 100 service plaza pairs. Approximately 12 acres of additional right-of-way is required for the development of either a single safety rest area or a service plaza. Smaller-scale scenic overlooks have also been developed along the freeways of at least 20 states. Other multiple uses oriented toward the needs of freeway users include truck weight stations (in at least 13 states) and tandem trailer parking areas (facilitating "double-bottom" trucking operations along four toll roads).

Each of these multiple uses has been discussed in detail in a report recently completed for the National Cooperative Highway Research Program (1). The study also identifies a second broad category of multiple use, oriented principally toward the surrounding local area. These uses are of particular importance within urban areas, where the enormous land requirements of freeways suggest that multiple-purpose freeway land development may greatly increase the return on freeway investments to local areas. Urban freeways have frequently been criticized for their disruption of established neighborhoods, for the removal of valuable land from municipal tax rolls, and for the creation of substantial relocation problems for displaced businesses and households. Three other recent reports have also examined this problem of integrating urban freeways with their surrounding urban environment. Two of the studies propose air rights developments over specific freeway sections in Philadelphia and Washington (2, 3), while the third explores the notion of coordinating urban freeway development with the development of other important urban facilities (4).

This paper attempts to identify important principles and problems in multiple-purpose freeway land development within urban areas. Several additional articles and reports provide guidance for this task. For instance, "simultaneous linear redevelopment" has been suggested as a means of carrying air rights development to full potential (5). The coordination of freeways with major parks can achieve a multiple use of open space while increasing the accessibility of important recreation facilities (6). The "high-accessibility corridor" offers a useful concept for coordinating land-use planning (and urban renewal) with urban freeway route location (7). Linear rights-of-way can be effectively used for the development of both private and public transportation routes (8). Another report has studied the development of coordinated freeway-parking facilities, with principal focus on air rights both above and below urban freeways (9). The Bureau of Public Roads has recently advanced a concept of joint development of housing and freeway projects based on the public acquisition of entire blocks along the route of a planned freeway (10, 11).

AIR RIGHTS DEVELOPMENTS

A key feature of air rights developments, and a requirement for projects developed over interstate highways, is that direct access from the freeway is not permitted. Except for multiple uses that are heavy traffic generators (such as Detroit's Cobo Hall, developed over the John C. Lodge Expressway and provided with direct ramp access),

immediate freeway connections are not particularly important or even desirable. For most air rights developments, the emphasis of project design is toward a continuity with surrounding land uses—toward eliminating the barrier-like character of freeways. In this respect it is only incidental that the land under an air rights project happens to be used for a freeway. The important point is that established urban patterns are maintained and, especially in urban renewal areas, often improved. From the point of view of freeway design, it is, of course, essential that air rights projects do not infringe on basic safety and traffic considerations.

Though the design possibilities of extensive linear air rights projects over freeways excite the imagination, actual experience to date has involved only one or two local projects in a number of cities. Subject to basic engineering requirements for straddling the freeway, the range in appropriate types of land use is broad. Actual examples include a municipal library in Hartford, a three-building City Hall complex in Fall River, Massachusetts, a four-building high-rise apartment project in New York City, a Federal Post Office building in Chicago, a proposed elementary school-park facility in Minneapolis, a trade and exhibition center in New Orleans, a medical center in St. Paul, a proposed hotel in Washington, a proposed office building in Cincinnati, and a convention center (Cobo Hall) in Detroit. In Philadelphia, it has been recommended that the Delaware Expressway be covered and landscaped over a four-block stretch, so that the continuity of related historic areas may be preserved (2). In Washington, a two-block housing project has been proposed over the Inner Loop Freeway, involving three 10-story apartment buildings, three low-rise townhouse structures, and an existing church (3). Other examples may also be found, and, in general, interest in air rights development appears to be growing. Air space under elevated freeways also offers multiple-use potential, but existing projects have usually been limited to under-structure parking lots (with examples to be found in at least 26 states) or other storage uses. Understructure playgrounds have been developed in Chicago, Jersey City, and Bayonne (1).

Some of the problems of air rights development have been explored in a recent California study (12). These include the added costs of decking over the freeway, which are likely to increase total construction costs by 5 or 6 percent when building over an operating freeway and 3 percent when integrated with original freeway construction. These costs are for a typical 10-story structure, the scale of building generally called for in spanning eight lanes of traffic, an overall dimension of about 170 feet. Building over a completed freeway may also lead to problems in avoiding interference with traffic during construction. Air rights projects more than 300 feet in length will probably require tunnel ventilation equipment for the freeway, and consideration should also be given to the possible effects of highway fumes and traffic noise on occupants of air rights structures. The Washington housing project would result in a 1230-foot tunnel, and a combination of fresh air ducts for the freeway and vertical ducts to dissipate exhaust fumes at the 10-story roof level (through the apartment buildings) is recommended (3).

In some cases the open space provided by freeways may be more valuable to the community than possible air rights structures, while in other instances an air rights building might represent a major regional landmark and orientation point. In general, the average costs of freeway platform construction, around \$15 to \$20 per square foot, provide a useful guide in determining the feasibility of potential air rights developments. The land values of alternative sites should be competitive with this \$15 to \$20 figure, increased by the additional costs of leasing or acquiring the freeway airspace itself (12). Finally, one of the most important features of air rights developments is that much of our urban freeway mileage is not especially suitable for this kind of multiple use (13). The exigencies of route location place freeways next to rivers, harbors, swamps, parks, undevelopable areas, and as boundary lines between major shifts in land use. These situations are not particularly amenable to further right-of-way development. In addition, most of the developed areas through which freeways pass are of insufficient density to support higher-cost air rights projects. It is likely that air rights developments will be appropriate and feasible only at selected locations where surrounding land values are high or that exhibit special site advantages in relation to surrounding development.

HIGH-ACCESSIBILITY CORRIDORS

Land in the vicinity of freeway interchanges, including the freeway land itself, is highly desirable for land-use developments requiring a good degree of exposure and accessibility. Many public and quasi-public facilities—such as libraries, cultural centers, museums, government centers, and major institutional buildings—are major traffic generators, and are particularly well-suited for multiple-purpose development in association with interchange rights-of-way. Where satisfactory lease arrangements can be worked out, private developments that require high accessibility (for instance, office centers and hotel-convention facilities) might also be appropriate. Multiple use of freeway land might involve air rights structures spanning the freeway and/or its ramp arrangements or located within the ramp interiors of cloverleaf or directional interchanges.

Examples here include the Prudential Center complex over Boston's Massachusetts Turnpike, a private redevelopment project involving residential, commercial, office, hotel, and cultural facilities; proposed air rights developments over the adjacent five-acre ramp area; administrative offices of the Richmond-Petersburg Turnpike (ramp interior); and a suggested cultural center development within the O'Hare directional interchange in Chicago (1, 6). In some instances it might be desirable to provide direct ramp access to high-accessibility multiple uses, provided there are no conflicts with basic freeway design and interchange spacing. This has occurred with both the Garden State Arts Center (Garden State Parkway) in New Jersey and the Anthony Wayne Recreation Area (Palisades Interstate Parkway) in New York (6).

The broad concept of high-accessibility corridors and corridor systems within urban areas offers an important guide in developing multiple uses of this type (7). Both freeway rights-of-way and other lands within perhaps one-half mile of interchanges should be considered as potential locations for all types of land use requiring metropolitan accessibility, including industrial districts, regional shopping centers, special commercial areas, university and college campuses, medical districts, major recreation attractions, and high-density housing. Portions of these kinds of projects, as well as the land uses mentioned above, might well be considered for development within or over freeway lands, and all require coordination with respect to overall traffic generation and interchange capacity, alternative opportunities for development, urban renewal programs, and possible rezoning actions. The notion of linear corridors comprised of a series of interchange nodes with high-accessibility project potential, connected by freeway segments more suited for locally oriented air rights or other joint development, provides a useful guideline for multiple-use planning.

Studies currently under way in Baltimore and Chicago are aimed at identifying joint development opportunities within the corridors of pending Interstate freeway projects. Preliminary work in both cities indicates that the framework for these studies will involve the use of thoroughgoing methods for evaluating alternative route locations. For example, comprehensive planning for the Crosstown Expressway in Chicago has been built around achieving a balance between transportation goals and other community impacts and goals (14). Given that the need for an expressway within the crosstown corridor can be established, three different levels of evaluation of alternative alignments are identified: (a) engineering aspects in terms of traffic movement and highway economics; (b) impact on existing communities, including relocation loads, displacement of community facilities, and the disruption of neighborhood social patterns; and (c) potential land-use improvements, including multiple-purpose development opportunities as well as the achievement of such land-use objectives as the elimination of blight and the separation of noncompatible land uses. In Baltimore, a similar approach has been used in evaluating alignments for the Southwest Expressway (15). Two broad types of evaluation criteria are distinguished: (a) accessibility factors dealing with trip desires and traffic volumes, and (b) environmental factors dealing with the impact of the freeway on surrounding neighborhoods. Seven different kinds of environmental factors are considered: neighborhood and social impacts, city and regional impacts, open space and nature, cultural assets, amenities of environs, amenities from the road, and economic factors.

The integration and coordination of freeways with surrounding urban areas, including the investigation of specific multiple-purpose or joint development opportunities, is the subject of continuing research in both cities. The concept of high-accessibility corridors can be used as a means for identifying and evaluating joint development possibilities. The joint project concept, or the idea of planning and developing two or more land uses within a unified project, with consequent gains in land conservation and coordinated design, is also of importance. As applied to major transportation right-of-way, the concept can lead to multiple-purpose freeway projects as well as improved relationships between freeways and adjacent land uses (4). Opportunities for joint project development involving freeways include recreation, public buildings, utilities, transit and parking, housing, and private development. Related concepts useful in joint project planning, in addition to high-accessibility corridors, include linear renewal projects and interchange districts. Freeway and renewal coordination can lead to key redevelopment opportunities associated with new rights-of-way, while the interchange district can ensure that land uses requiring high accessibility are appropriately developed in relation to interchange design and capacity. Other important facets of the joint project concept include basic planning procedures, problems in interagency coordination, financial feasibility, and legal authority and limitations (4).

COORDINATED TRANSPORTATION FACILITIES

There are three kinds of multiple-purpose freeway land development that involve related transportation facilities: (a) exclusive transit lanes with stations (either bus or rail), (b) passenger stop turnouts for buses operating in the mixed traffic stream, and (c) interchange area parking facilities used both for car pooling and as transit park-and-ride lots. In each instance, the encouragement of these kinds of multiple use is likely to benefit freeway traffic by reducing peak-period volumes and/or increasing the overall capacity of the transportation corridor. This effect, in turn, enhances the accessibility of land uses in the vicinity of interchanges. In general, it appears that exclusive transit lanes are appropriate and feasible within metropolitan areas of more than one million population, while freeway bus operations make sense in areas with populations of roughly 200,000. Interchange parking facilities could be developed in either of these situations (1).

The most widely known examples of exclusive transit lanes are those in Chicago, where median rail transit is in operation along one freeway and programmed for two others, and median express bus lanes are planned for a fourth (8). Median transit facilities are also under construction, programmed, or seriously proposed in Baltimore, Boston, Miami, San Francisco, and Washington. In San Francisco, the Bay Area Rapid Transit District will locate portions of its transit system within freeway medians and sidestrips at four different locations. Los Angeles and St. Louis have each located 10 turnout bus stops along their freeway systems, mostly within interchange areas. Experience with interchange parking facilities has been limited, but single facilities have been established along the Garden State Parkway (35 miles south of Newark), the Massachusetts Turnpike (10 miles from downtown Boston), and in association with the New Jersey approach to New York City's Lincoln Tunnel (1).

LAND ACQUISITION PROBLEMS

Most significant multiple uses (except for coordinated transportation facilities) involve the development of adjacent land parcels in addition to normal freeway rights-of-way. This has represented one of the major stumbling blocks for further application of the multiple-purpose development concept. State highway departments are currently limited to the acquisition of rights-of-way which will serve "highway purposes," with land for very few of the important, urban-oriented multiple uses falling into this category. As a result, though air rights development over Interstate highways is permitted by federal legislation, it is usually difficult for interested public or private agencies to acquire the necessary additional parcels in coordination with highway acquisition. Inadequate parcel size, the possible need for land on both sides of the freeway, timing and legal problems, adjustments to be required in sidestrip width, possible

redesign of interchange areas, and, in general, the need for unusual cooperation from the highway agency have all served to discourage more widespread multiple-use developments. In addition, of course, the increased costs of air rights structures tend to encourage only projects of considerable size, while the joint development concept for lands adjacent to the freeway has only recently been advanced.

One solution to these problems is to turn the acquisition of both highway rights-of-way and required adjacent parcels over to another public agency (10). In the Washington study, this task has been assigned to the local renewal agency (3), which would acquire all the land needed for the joint housing-freeway development project. The highway department would then purchase a permanent three-dimensional easement—an "air tunnel" for the freeway—at a cost equal to its planned right-of-way expenditure. The total cost of this procedure is likely to be about the same as the cost of acquiring freeway rights-of-way (plus severance damage payments) under present practices, so that multiple-purpose sites would, in effect, be nearly cost-free (10). These savings could conceivably be passed on to multiple-use developers, to be applied against the increased expense of possible air rights structures. The concept could be extended to include the acquisition of block-wide strips at several points along planned freeway routes, so that the close coordination of freeway route location with urban renewal planning takes on added significance.

In some cases, the acquisition of rights-of-way might be similarly handled by metropolitan park districts (or state recreation agencies), where a freeway alignment passes through an area proposed for major park development. Early cooperation here might enable land acquisition while such sites (for instance, along river basins) are still suitable for recreation purposes. Several coordinated freeway-park examples illustrate how compatible development might be achieved, particularly within elongated linear park arrangements (6). Major parks and recreation represent a multiple-purpose development where the continuity of freeway sidestrips with adjacent parkland is essential and easily achieved. In some instances, existing parks have been coordinated with new freeways passing through them (as in the Long Island, New York, park and parkway system), whereas in other cases freeway developments themselves have created new park opportunities (for instance, along the Chenango River in Binghamton, New York) (6).

Not all multiple-purpose project sites could be assembled with the aid of renewal or recreation agencies, and, in general, a coordinated land acquisition program among all public agencies appears desirable in identifying multiple-use opportunities. This should be directly tied to the capital improvement programming process within metropolitan areas. Such a procedure might overlook potential private development projects not involving renewal land, but would include certain low-accessibility public facilities not yet mentioned—such as local primary and secondary schools, local parks and playgrounds, reservoirs, water purification and sewage treatment facilities, and pumping stations. Under the joint project concept, appropriate lands along planned freeway routes would be thoroughly examined to locate possible sites for both these kinds of public facilities and those discussed earlier (4). The emphasis would be on coordinating the timing and location of all public land investments, rather than strictly on achieving a multiple use of freeway lands.

It also appears desirable for existing Federal-Aid Programs concerned with coordinated metropolitan development—including highway, open space, urban renewal, land and water conservation, water and sewer, housing, and mass transportation—to encourage and financially assist joint development and multiple-use projects. For instance, the Delaware Expressway study recommends that 60 percent of the cost of covering the freeway should come from the Federal Highway Trust Fund, and that much of the remainder should come from the Open Space program of the U. S. Department of Housing and Urban Development, and the Land and Water Conservation Fund of the U. S. Department of the Interior (2).

INTERCHANGE DEVELOPMENT PROBLEMS

A serious problem affecting the feasibility of multiple uses within interchange areas is the question of providing access. In nearly every case, it is preferable to limit

access points to locations along the interchange cross-route, simply for reasons of freeway safety. Furthermore, these access points must be spaced far enough from ramp connections to avoid interchange confusion or congested operation. In the case of cloverleaf and directional interchanges, the use of frontage roads and indirect grade-separated access across ramps will usually be necessary. Ramp interior parcels of two acres or more in size are common within these larger interchanges and offer considerable development potential (1). The additional costs of providing ramp underpasses or overpasses are likely to be offset by the locational advantages of interchange sites.

Given that access from the freeway to such sites would be rather circuitous, and that grade-separated local access (pedestrian or vehicular) would be required, the principal remaining barrier to multiple-purpose interchange developments is a legal one. Problems here have not been thoroughly explored (and are complicated by the possible involvement of air rights over or under ramps), but the main difficulty lies in the "highway purpose" restriction. Present legislation in nearly all states will not permit the use of ramp interiors for appropriate (but non-highway) multiple purposes. Existing ramp interior development has consequently been limited to such uses as maintenance areas, highway offices, and parking (1). If these restrictions were to be relaxed, it would also be desirable to consider the expansion of interchange designs to create larger and more attractive ramp interior development sites. This possibility could be coordinated with a joint development program of freeway corridor land acquisition (at some points well in excess of normal right-of-way widths), conducted by an appropriate public agency or agencies. Such a program, in providing for multiple-purpose freeway land development, both at interchanges and along the mainline right-of-way, offers considerable promise for enhancing the environmental impact of urban freeways.

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Discussion

V. SETTY PENDAKUR, Associate Professor of Planning, and TERRENCE W. JOHNSTON, Richard King Mellon Fellow, School of Community and Regional Planning, University of British Columbia, Vancouver—Mr. Stuart's paper outlines the important principles and problems in multipurpose freeway land development in urban areas. The topic is of particular value to those interested in the comprehensive planning of the urban environment and are concerned about the efficient use of space within urban areas.

Mr. Stuart has, however, chosen to limit his discussion to the multiple use of freeway land. The reader is left with the impression that multipurpose land development is a fringe benefit of urban freeway construction rather than a concept of civic design that may aid in abating the problems of congestion and overcrowding in urban areas. Buchanan (16) suggests that urban areas consisting of buildings set along vehicular streets is only a convention. If buildings and streets are thought of together as constituting the basic unit of cities, then they can be combined and molded in a way that is more advantageous than the conventional street. Therefore, multipurpose land development should be considered as a part of comprehensive urban planning rather than at isolated points along an urban freeway only.

Some aspects of air space development should be studied in greater detail. Utilization of air space above railway rights-of-way has been practiced with considerable success for many years. To date, we have acquired little experience in the multiple use of freeway land, particularly where freeways and residential uses are combined. Joint development of freeway and urban renewal projects is promoted as a highly economic solution to the critical problems of transportation and renewal in urban areas. It is conceivable people could find living above an urban freeway highly undesirable. It would be valuable to compare attitudes of persons living in housing projects constructed above freeways with attitudes of persons living in other comparable redevelopment projects.

Another useful study could be directed toward the technical problems associated with air space utilization. Detailed study of noise, pollution and vibration problems could determine if the current precautions being taken to eliminate these hazards are adequate. The installation of ventilating systems capable of exhausting combustion gases above air space structures do not necessarily mean the air pollution problem has been solved. Similarly, precautions taken to dampen noise and vibration may not be adequate. Conversely, these problems may not be as serious as anticipated. Construction costs may be reduced, thereby making air space utilization more feasible.

Mr. Stuart has briefly discussed the additional costs of freeway platform construction and the evaluation of air space. It has been traditional to evaluate air rights by considering such factors as the value of comparable land, anticipated loss of residual value from economic or functional obsolescence, added capital costs of air rights platform construction, savings in excavation foundations, demolition, tenant relocation, income losses during relocation and demolition, and added interest and carrying charges as a result of added capital improvement (17). There appears to be a weakness in this method of evaluation in that public benefits such as additional tax revenues and factors of safety and convenience are not considered. These considerations could be of particular importance where the multiple use concept is applied to central business areas to effect separation of transportation modes and to utilize previously vacant air space.

Multipurpose development above high accessibility corridors may provide a useful source of revenue to assist in paying for improved transportation facilities. Traditionally, properties adjacent to high-capacity transport arteries appreciate in value and generally experience redevelopment. By locating new development directly above transportation facilities, the transportation authority collects revenues gained from increased property values and variegated use of land.

There are excellent examples of this in Montreal, Canada, where impressive commercial complexes are being developed above the subway stations (Place Ville Marie, Place Bonaventure, Place Victoria). As well as providing residential, office and retail accommodation that is highly accessible to subway patrons, it also provides a valuable source of revenue to the rapid transit system.

Mr. Stuart's discussion of multipurpose land development as related to coordinated transportation facilities has not included the pedestrian. Utilization of the multiple use concept provides means of separating transportation modes, thereby increasing the safety, convenience and efficiency of an urban transportation system. The City of Montreal has developed a system of underground pedestrian malls connecting major business complexes and subway stations. The subway system operates below the mall level and the surface streets are left relatively free to vehicular traffic. In Calgary, Alberta, planners are preparing plans for an elevated pedestrian circulation system that will free street surfaces in the downtown area for vehicle use. In Edmonton, Alberta, a plan is being developed for an underground pedestrian circulation system. Particularly in high density urban centers, consideration of pedestrian needs in any multiple use concept is of particular importance.

It is interesting to compare powers of public domain in Canada and the United States in matters of land acquisition. Mr. Stuart has described the limitations of state power in expropriating land for other than highway purposes. In Canada provincial and municipal governments have power to acquire land for any public purpose and dispose of surplus acquisitions as they see fit. The possibility of developing air space above publicly owned rights-of-way is therefore considerably less complicated in Canada than in the United States. On the other hand, legislation comparable to the United States Highway Act of 1961 or the United States Housing Act of 1964 that specifically encourages multiple use development and utilization of air space is needed to provide an impetus to planned development.

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The Washington Capital Beltway and Its Impact on Industrial and Multi-Family Expansion in Virginia

JULIA A. CONNALLY and CHARLES O. MEIBURG, Bureau of Population and Economic Research, University of Virginia

This paper reports on the impact of the Washington Capital Beltway on industrial and multi-family expansion in Northern Virginia. Between 1960 and 1965 industrial employment grew 71 percent, primarily because of the many industries which located near the Beltway. Interviews with 48 industry executives indicated that access to the circumferential was a significant factor in their location decision. The wholesale-distribution and research and development firms gave the greatest weight to accessibility to the Beltway. As well as promoting industrial growth, the Beltway has altered the commuting patterns of the industrial workers. One-half of 2,100 employees surveyed used the circumferential to commute. The Beltway has expanded the labor market to include Maryland and a much larger section of Northern Virginia. The Beltway area also spawned more than 3,000 new apartment units between 1964 and 1966. Like the industrial workers, 50 percent of the apartment residents commute via the Beltway, but their travel pattern is quite different. The large majority are employed in the District and Arlington County; only a few work in nearby industries. The implications of the study include the continued growth of industrial and multi-family development in the Beltway area, resulting in increased traffic on both the radials and the Beltway, with the greatest pressure occurring at the interchanges. The study concludes with an approach toward the control of land development in interchange areas.

•THE Bureau of Population and Economic Research of the University of Virginia is conducting a comprehensive study of the socioeconomic impact of the Virginia section of the Capital Beltway. (The Capital Beltway (I-495) is a 66-mile freeway that encircles the most densely populated part of the Washington metropolitan area. It was completed in August 1964. Twenty-two miles of the Beltway and 14 interchanges are located in Fairfax County and Alexandria, Virginia.) A wide variety of indices, including population distribution, real estate activity, land use, travel patterns, and public policy, has been analyzed to determine if, and to what extent, they have been affected by the Capital Beltway. The analysis has shown that the most dramatic impact has been the expansion of industrial and apartment development in the vicinity of the Beltway in Northern Virginia. This paper reports on this growth and illustrates the changes in commuting and residential patterns that have resulted. Some policy implications of this concentration of intensive uses along the Beltway are set forth. Figure 1 shows the location of the Capital Beltway within the Washington region.

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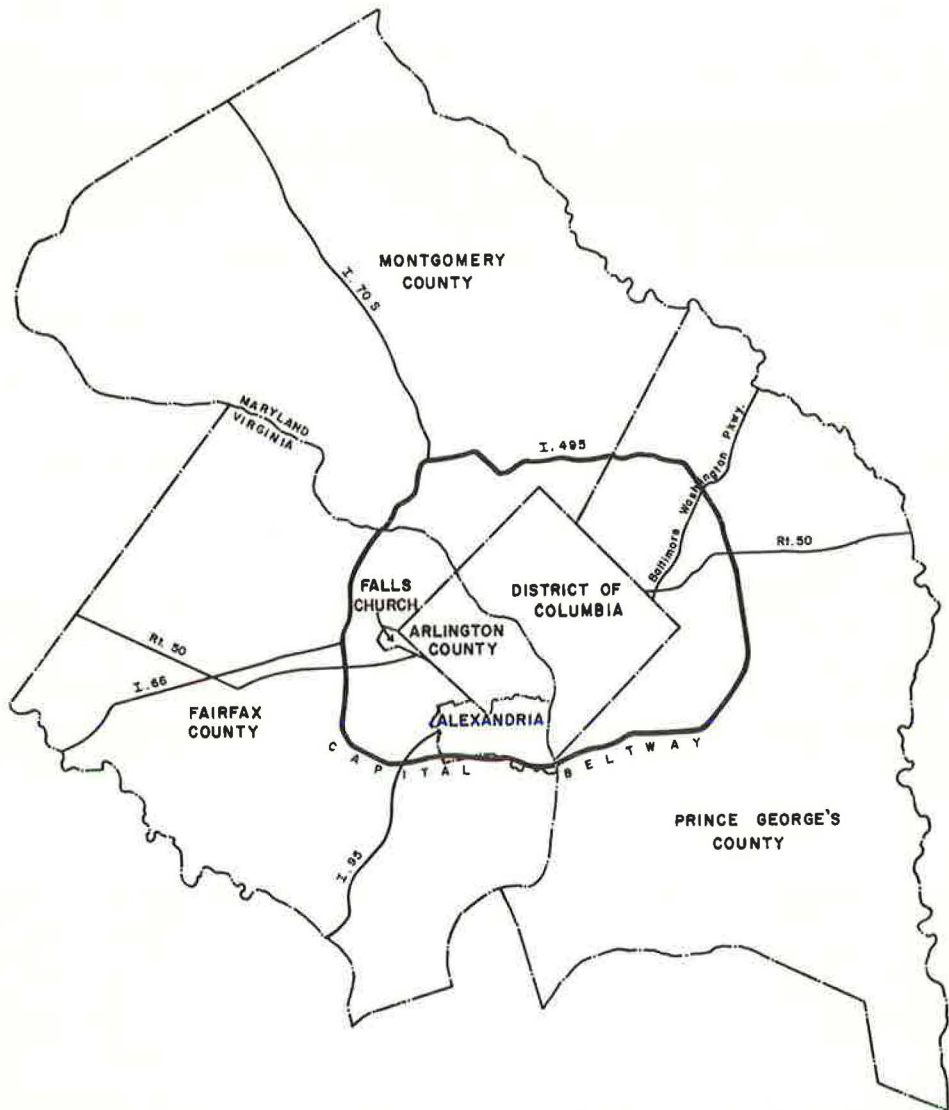


Figure 1. Capital Beltway (I-495).

INDUSTRIAL DEVELOPMENT

Northern Virginia (Arlington and Fairfax Counties and the cities of Alexandria, Falls Church, and Fairfax) has been experiencing rapid industrial expansion. Between 1960 and 1965 industrial employment grew 71 percent from approximately 14,000 to more than 24,000. A major proportion of the growth has been in the vicinity of the Beltway. By 1966 an estimated 11,500 workers were employed in the plants, warehouses, and research facilities located within 1.5 miles of the circumferential. To appraise the influence the Beltway has had on this expansion, executives of Beltway-oriented industries were interviewed concerning their firms, their decision to locate near the circumferential, and the benefits and hardships associated with the Beltway location, as they saw them.

The interviews provided information on the characteristics of typical Beltway industrial firms and their attitudes toward the circumferential. Of the approximately

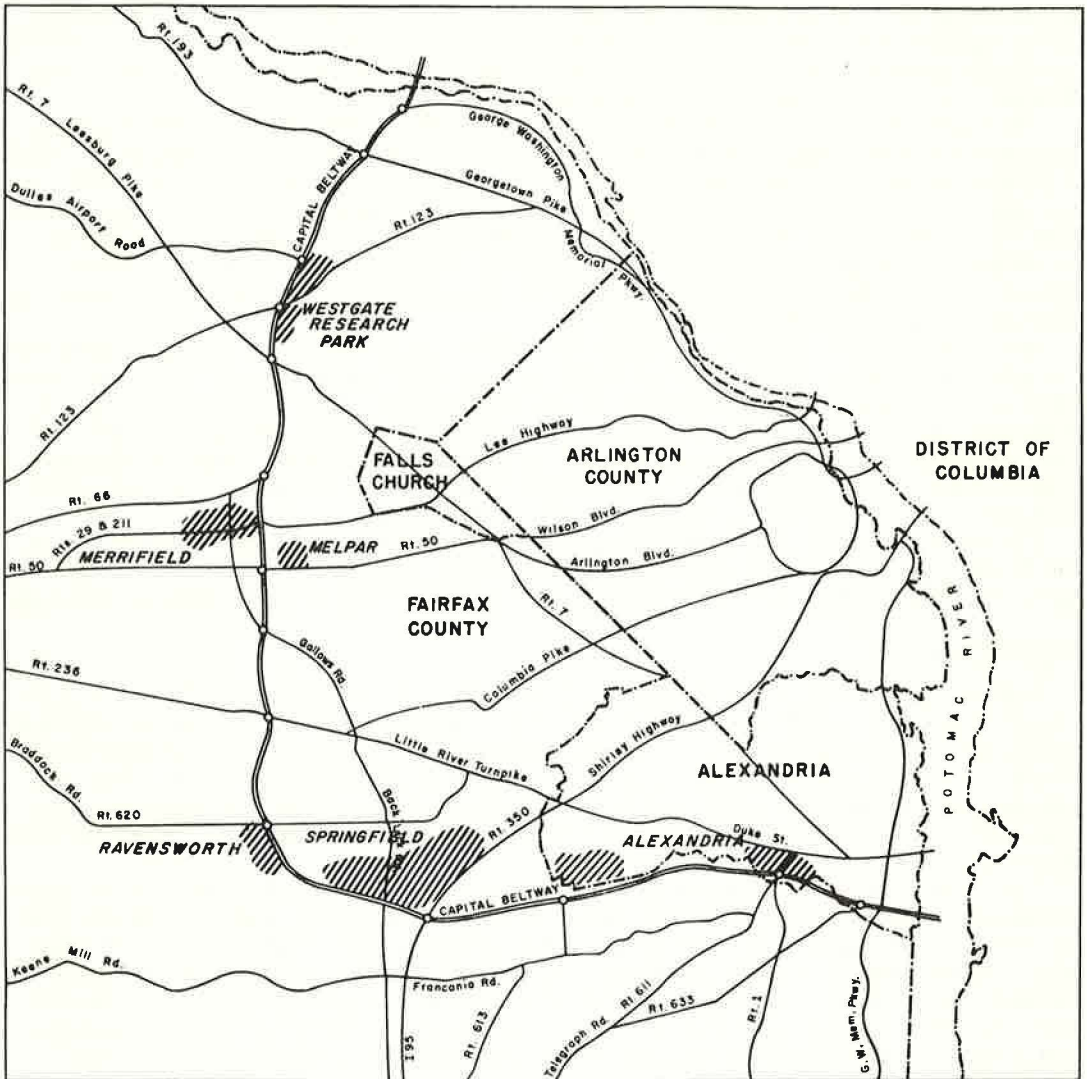


Figure 2. Generalized location of industries interviewed.

150 firms situated within 1.5 miles of the Beltway in Fairfax County and Alexandria, 48 were selected to be interviewed. The criteria were size of employment (over 25 employees), type of industry, location, and years at the site. The sample was representative of the variety of size and industrial types characteristic of the locale. The 48 had a total 1966 employment of 8,500 and included six research and development firms, 22 manufacturing, 15 wholesale and distribution, and five service industries. The interviews were conducted in August 1966.

Only a few of the industries were new to the Washington metropolitan area; most of those interviewed had been in the region for several decades. About 80 percent of those interviewed had relocated from either the District of Columbia, Alexandria, or Arlington County. The sample indicates that industrial growth accelerated in Northern Virginia after 1958, the year the alignment of the Capital Beltway was made public. Forty-one firms, 85 percent of the sample, located on their present sites after 1958. Fourteen of the firms occupied their sites in 1965 or 1966. Industrial parks have been the

predominant form of industrial development in the Beltway areas. Almost 70 percent of the sample firms were located in planned industrial or research districts. Figure 2 shows the principal areas of industrial concentration along the Virginia section of the Beltway, in which the firms interviewed were located.

The importance accorded the Beltway by the industrial executives is proved by the 80 percent who said that knowledge of the route of the Beltway or accessibility to it was a significant factor in site selection. If the reasons for site selection are grouped according to the firm's industrial category, all the industries except services cited proximity to highways as a major site criteria. The price of land appears to be a major consideration for general manufacturing firms but of much less importance to other groups. Proximity to highways and access to local clients and markets were of greatest concern to wholesale and distribution firms.

Most industries sampled were totally dependent on auto and truck transportation for personnel and goods, which explains their concern for highway access. Only nine firms used any rail transportation, although 13 had rail sidings. Ninety percent used truck transport exclusively. Public transit served only a few of the firms interviewed, and the vast majority of the workers commuted by private automobile. With the important exception of those firms employing a majority of blue-collar workers, the executives said that employees found the Beltway location convenient.

The interviews indicated a continuing interest by industry in Beltway locations. Of the 15 Beltway-related companies having made definite plans to expand their facilities in the Washington region, 13 have already selected sites that are oriented to the Beltway.

Implications

Industry will continue to seek Beltway locations. The circumferential and the interchange areas have a unique locational mix that is desirable to both new and established industries. The industries seeking prime Beltway locations will tend to be distribution firms, electronic manufacturers, and research and development facilities. High land prices along the Beltway will probably discourage expansion of general manufacturing and service industries. Lack of public transit and working-class housing in the Beltway area also tends to encourage this trend.

The traffic generated from the existing and new Beltway industries will put continuing pressure on the circumferential and radial highways. More auto and truck traffic will be generated through the interchanges, either moving on local radials or onto the Beltway. Unless these increasing peak-hour movements can be controlled and congestion avoided, many of the interchanges will soon be obsolete or require major reconstruction. However, if development continues to take place in planned industrial districts, and if density and access controls can be implemented, the problem will be more manageable.

COMMUTING PATTERNS OF BELTWAY INDUSTRY EMPLOYEES

Since the journey-to-work is a most powerful influence on regional automobile travel patterns, a survey was made of the commuting habits of the workers employed in selected industries near the Beltway. The purpose was to see if the Beltway could be directly related to changes in individual commuting patterns and to the selection of residential areas.

Eighteen of the 48 industrial firms interviewed were selected for the employee survey. At least two firms were selected from each major industrial center. The two largest employers were included and a relatively even distribution was sought among those firms locating before, during, and after the construction of the Beltway. The data were collected by means of a questionnaire that each participating firm distributed to its employees. Response was relatively good. Of the 3,678 questionnaires distributed, 59 percent or 2,162 useable forms were returned. Based on an estimated 1966 employment in Beltway-oriented industries of 11,500, the response represented 19 percent of all workers.

The study indicates that one out of every two workers uses the Capital Beltway to commute to work for an average of 8.2 miles. The Beltway has brought Maryland into

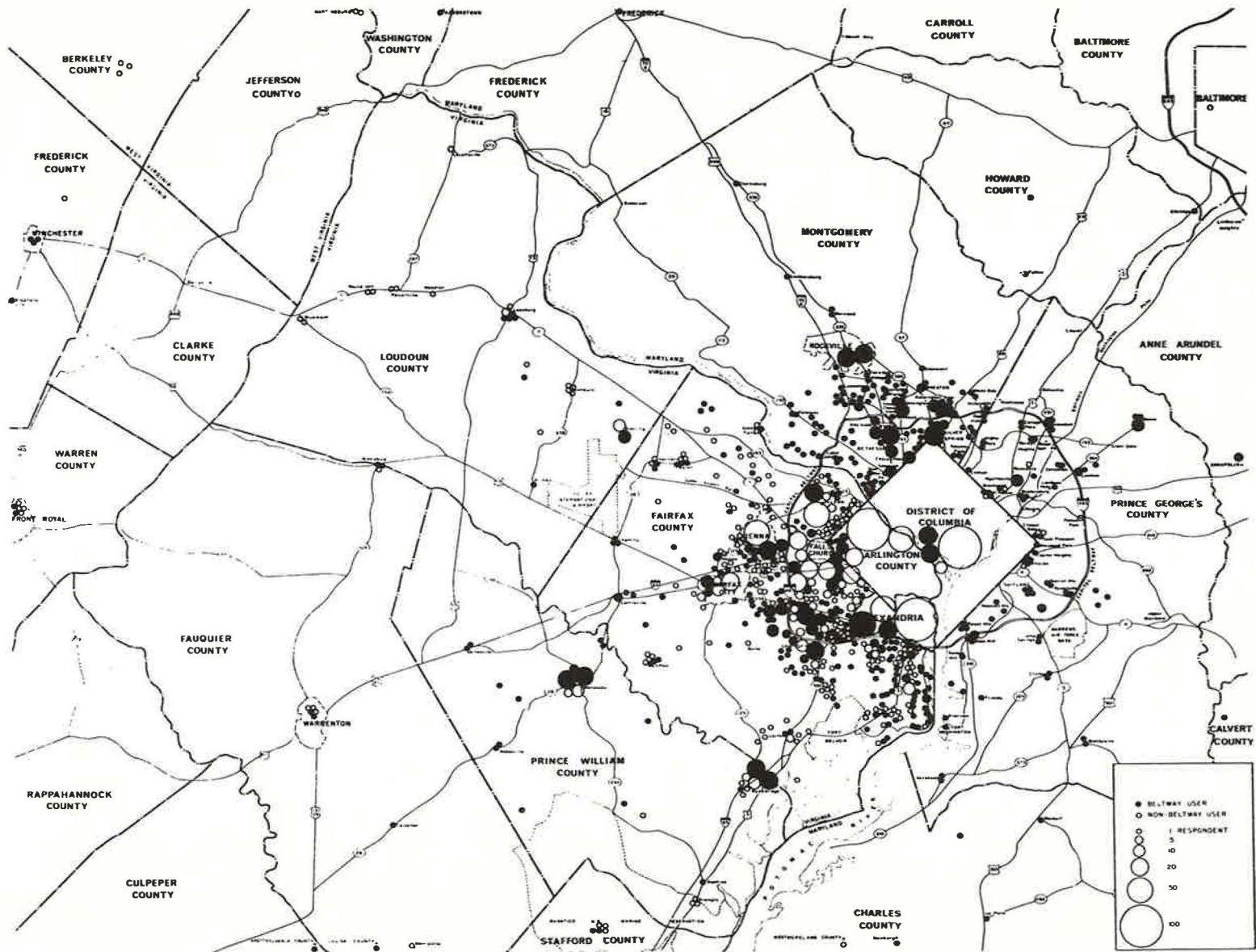


Figure 3. Residence of industrial workers.

TABLE 1
RESIDENCE OF FAIRFAX COUNTY WORKERS RECORDED
IN 1960 CENSUS COMPARED TO SAMPLED
WORKERS IN 1966

Jurisdiction	Percent of Workers	
	1960 Census	1966 Sample
Fairfax County, Va.	76	46
Montgomery County, Md.	1	12
Alexandria, Va.	8	11
Arlington County, Va.	6	9
District of Columbia	6	7
Prince William County, Va.	0	7
Prince George's County, Md.	2	5
Falls Church, Va.	1	3
Total	100	100

Source: U.S. Bureau of the Census, U.S. Census of Population and Housing: 1960, Census Tracts, Final Report PHC (1) - 166.

the labor market area of Northern Virginia industry. The tie-in between I-66 and I-95 and the Beltway has also enabled large numbers of workers to commute with relative ease from areas as far west as Winchester, Virginia, and as far south as Fredericksburg, Virginia. Figure 3 shows the place of residence of Beltway-industry employees participating in the survey.

The place of residence of Fairfax County workers recorded in the 1960 U. S. Census is compared in Table 1 with the findings of this study. This comparison illustrates the changes that are probably taking place in the configuration of the Northern Virginia labor market area. Although the figures are not entirely comparable, they

do suggest that many more workers now commute from Montgomery County, Maryland, and Prince William County, Virginia, than before the Beltway opened. The sharp decline in the share living in Fairfax County is also a function of the improved accessibility of the other areas brought about by the Beltway. For example, 95 percent of the Maryland commuters use the Beltway as do 73 percent of the Prince William County workers. The proportion of workers residing in Prince George's County, Maryland, did not increase as sharply as in Montgomery County, because Montgomery County's population is concentrated in the Rockville-Bethesda-Silver Spring area within easy access of the Beltway and the Virginia industries, while the bulk of Prince George's County residents live in the central part of the county which is less accessible to the Beltway and Northern Virginia. In addition, Montgomery County has a larger share of upper-income subdivisions that appeal to many of the professionals employed in Northern Virginia.

Table 2 indicates that Arlington, Falls Church, and the District have the smallest percentage of Beltway users. This is not surprising, considering their location inside the Beltway. Excepting the responses of Alexandria residents, the survey showed that the Beltway was primarily used by those commuting north and south, and that it had not significantly altered the commuting pattern of those living inside the Beltway or those commuting directly east or west within Northern Virginia.

The individual companies with the highest percentages of Beltway users were the research and development firms located in the Westgate Research Park. All these were new plants with predominantly professional staffs. The companies with the lowest percentages of Beltway users were located in Alexandria and Springfield and employed largely blue-collar workers. (Of all the industries surveyed, employment was 53 percent blue-collar, but in Springfield and Alexandria employment was 70 percent blue-collar.)

Although the majority of the sampled industries had relocated from the District, Arlington County, or Alexandria, only 26 percent of the workers lived in these places. Those Beltway users who had moved since August 1964, when the circumferential first opened, were asked if they considered being able to use the Beltway to get to work a major reason for selecting their present residence. Forty-three percent (or 161) said yes. In most cases, the affirmative respondents had moved to another location within the same political jurisdiction. Of the 42 Montgomery and Prince George's County residents who moved, only nine left the Maryland suburbs. The same trend was true for Fairfax County. Of the 49 who moved within or to Fairfax County, the majority, 70 percent, now live in Springfield, Annandale, and Ravensworth, areas adjacent to the Beltway. On the other hand, there is also evidence that the circumferential encourages some to seek houses as far away as Manassas, Woodbridge, and Sterling Park, Virginia, because of the excellent connections between the I-66 and I-95 and the Beltway.

Implications

As industrial employment opportunities continue to expand along the Beltway, one-half the additional workers are likely to be Beltway users, more if the majority of the new employees are professionals. This will represent thousands of additional vehicles flowing through interchanges at peak hours. If present trends continue, they will seek to live within easy access of the Beltway in Maryland as well as Virginia, or near an Interstate highway that ties into the circumferential. As more industries locate along the Beltway, the trend appears to be toward fewer commuters coming from inside the Beltway and toward further residential expansion in a generally southwest direction, along I-66 and I-95.

TABLE 2
RESIDENCE OF SAMPLED EMPLOYEES OF BELTWAY-ORIENTED INDUSTRIES AND PERCENTAGE WHO USE BELTWAY

Jurisdiction	Total Respondents	Percent Who Use Beltway
Fairfax County, Va.:	951	44
Fairfax City	(48)	(29)
Vienna	(85)	(32)
Rest of county	(817)	(46)
Montgomery County, Md.	250	99
Alexandria, Va.	223	32
Arlington County, Va.	190	9
District of Columbia	152	26
Prince William County, Va.	135	73
Prince George's County, Md.	107	93
Falls Church, Va.	59	15
Loudoun County, Va.	49	41
Other Virginia counties	27	48
Other Maryland counties	14	93
Other states and countries	5	0
Total	2,162	48

COMMUTING PATTERNS OF APARTMENT RESIDENTS

The employment survey showed that a large proportion of those who work near the Beltway reside some distance away from their employment. Yet, even a casual drive along the Virginia portion of the circumferential reveals that a considerable number of apartments are being constructed in the vicinity of the Beltway. Records show that between 1964 and 1966 more than 3,000 apartment units were built in Fairfax County within 1.5 miles of the Capital Beltway. Many of the sites were contiguous with its right-of-way. These units represented approximately 30 percent of the county's total multi-family construction during this period. Such concentration illustrates the importance accorded a Beltway site by the apartment developers. But what is the reaction of the apartment residents? What proportion use the Beltway to commute to work, and how many considered access to the Beltway an important factor when they selected their apartment? To answer these and other questions related to trip generation and travel patterns, a survey was made of the apartment residents living near the Beltway. They were asked where they worked, if they used the Beltway, and how much the Beltway location influenced their selection of an apartment.

Twenty-three hundred questionnaires were sent to residents of nine Beltway-oriented apartment projects in Northern Virginia. The two principal criteria for selection of the sample developments were (a) that they be located on an arterial highway not more than 1.5 miles from the Beltway, and (b) that the units had been occupied since 1964. The 2,300-unit sample was approximately 10 percent of the total number of apartment units (22,454) in Fairfax County in 1966 and 77 percent of those new units oriented to the Beltway. Of the 2,300 questionnaires sent out, 581 useable forms or 25 percent were returned. The percent of return was good, considering the lack of personal contact and the general reluctance of people to respond to mailed questionnaires.

Despite the fact that all the apartment complexes samples were located on major arterial highways, one out of two respondents (Table 3) said he used or sometimes used the Capital Beltway to get to work. This places multi-family units in the same class with industrial centers as major generators of Beltway traffic.

The influence of the Beltway on work trips can best be seen in the distribution of place of employment of the apartment residents. Figure 4 and Table 4 show

TABLE 3
USE OF BELTWAY BY SAMPLED APARTMENT RESIDENTS

Response	Number	Percent
Yes	205	35
Yes, sometimes	88	15
No	288	50
Total	581	100

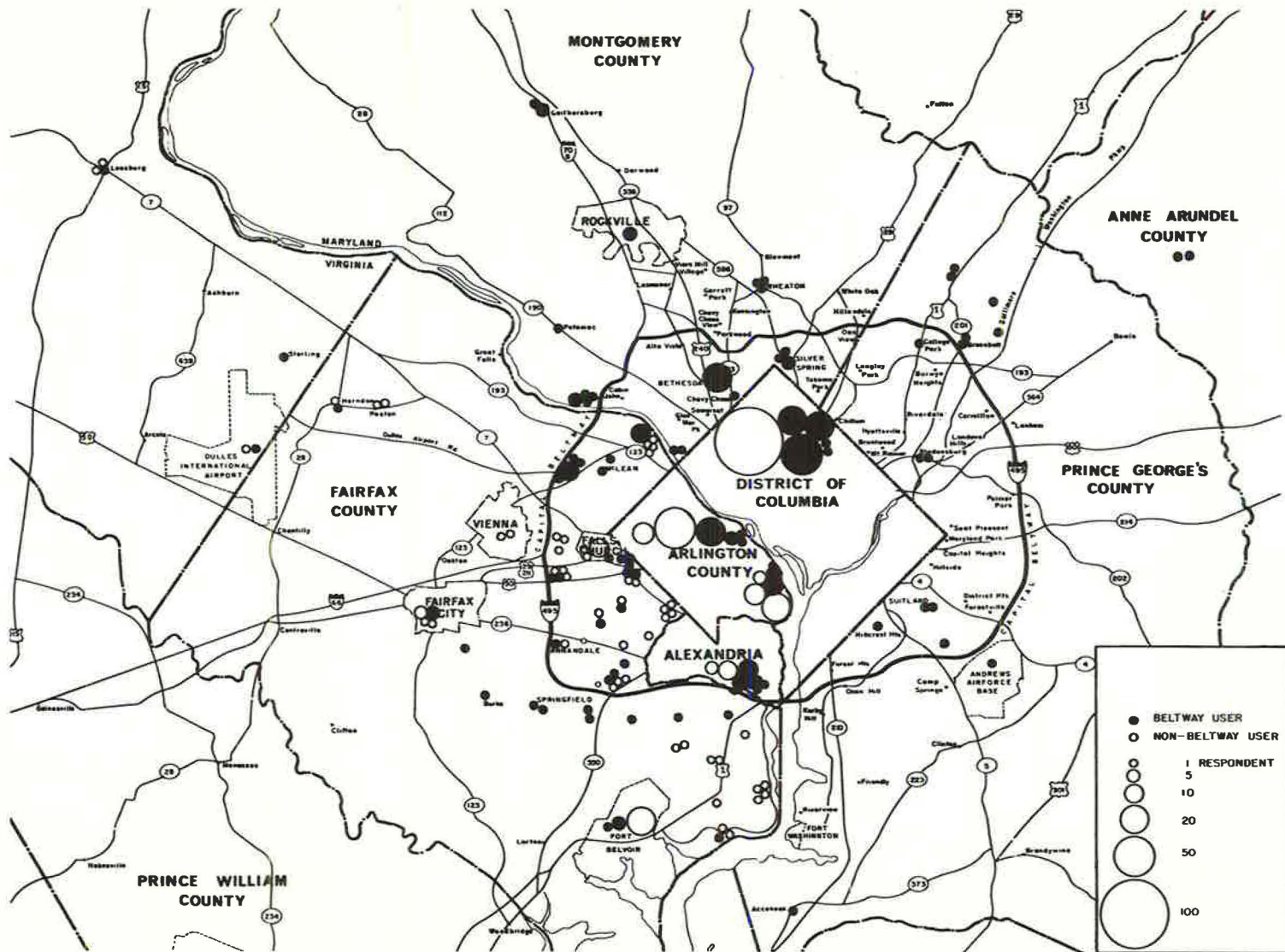


Figure 4. Place of work of apartment residents.

that the respondents' jobs were concentrated east of the Virginia section of the Beltway—in the District of Columbia, Arlington County and the Pentagon, or Alexandria. Despite the recent industrial expansion along the Beltway, only 64 respondents, 11 percent of the sample, were employed within 1.5 miles of the Beltway. Few worked at either Westgate, Ravensworth, Merrifield, or Springfield, the area's research and industrial centers.

Figure 4, which distinguishes Beltway and non-Beltway users, illustrates the varied functions the circumferential performs. First, the Beltway is the essential link between Maryland and Virginia. All workers employed in Maryland commute via the Beltway, since there is no practical alternative. The Beltway is also the route for those employed in Beltway-oriented employment centers, such as Westgate Research Park, and Springfield and Alexandria Industrial Parks. The Beltway is, in their case, a direct route from home to job. For others the Beltway acts as a connector to the major arterials that lead into Arlington County and the District. Although all the sample projects have direct access onto an arterial highway, many residents elect to drive up to 5 or 6 miles on the Beltway to connect with an arterial that is less crowded or is more convenient to their jobs. They are willing to drive additional miles on the Beltway because it either shortens their total trip time or results in an easier drive. The classic example of the Beltway detour is the large number of District employees who live within a mile of Route 29 or Route 50 but who take the Beltway north five to six miles and connect with the George Washington Memorial Parkway, a limited-access route into the District.

The 50 percent of the respondents who commuted or sometimes commuted via the Beltway were asked if they had considered being able to use the Beltway to get to work as an essential, very important, moderately important, or unimportant criterion when they selected their present apartment. Since a concentration of new apartment units did exist along the Beltway, it was of interest to learn how many residents valued access to the Beltway, and how many did not consider it important and had selected the apartment for other reasons. Sixty-eight percent of the Beltway users indicated that being able to use the Beltway to get to work was either essential or very important; 12 percent regarded it as unimportant. This demonstrates the demand, at least of the Beltway users, for locations on the circumferentials. It is interesting that over 85 percent of the respondents, who had experience commuting via I-495, considered Beltway access essential or very important. The other reasons for selecting a Beltway apartment may have been that the average Beltway project is newer, more attractively designed, and offers more landscaped open space than projects in Arlington and Alexandria available at comparable rents.

The commuting routes of the 581 respondents have been diagrammed to illustrate the direction and intensity of the traffic the apartments generate. The data were derived from the questionnaire, which indicated place of work, travel time, and whether the Beltway was used. Assignments to logical routes were made based on these data. Figure 5 is a generalized composite of the home-to-work traffic flow generated by the apartment residents. It illustrates the large volume of Beltway trips generated from Route 236 north to the Potomac by those headed north for Montgomery County, Maryland, and the George Washington Memorial Parkway, as well as south to Route 50 and the Columbia Pike. The use of Route 50 as a primary entry into the employment centers of Arlington County and the District is clearly shown. The high volume of commuters on both the northern and southern legs of the George Washington Memorial Highway is also evident. See Figure 2 for highway identifications.

TABLE 4
PLACE OF EMPLOYMENT OF SAMPLED APARTMENT
RESIDENTS AND PERCENTAGE WHO USE BELTWAY

Jurisdiction	Number	Percent of Total	Percent Who Use Beltway ^a
District of Columbia	190	33	48
Arlington County, Va.	134	23	31
Pentagon	(48)	(8)	(27)
Fairfax County, Va.	132	23	49
Maryland:	69	11	100
Montgomery County	(52)	(9)	(100)
Prince George's County	(15)	(2)	(100)
Rest of state	(2)		(100)
Alexandria, Va.	34	6	42
Falls Church, Va.	16	3	25
Other Virginia counties	6	1	50
Total	581	100	50

^aCombination of regular users and sometimes users.

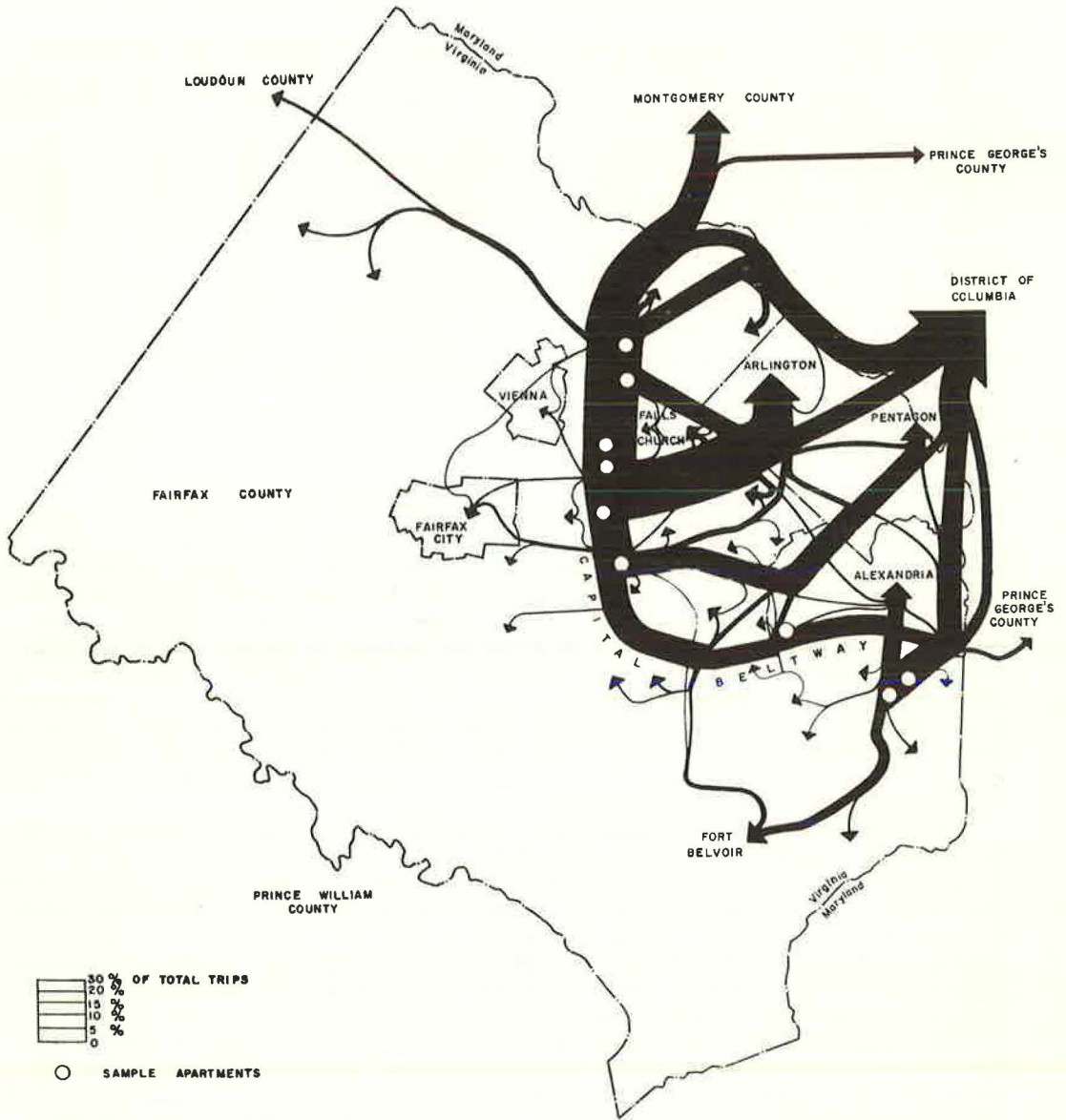


Figure 5. Home-to-work flow of traffic from Beltway apartments.

As a contrast, Figure 6 illustrates the home-to-work traffic flow generated by employees in Beltway industries. These data are derived from the preceding employee survey. Although both apartments and industries generate large volumes of Beltway and arterial traffic, the patterns of movement are in general quite different. The industries tend to draw most of their employees from Alexandria and Fairfax County and nearby Montgomery County, Maryland, and attract relatively few workers from the District and Arlington County. This is in contrast to the heavy movement of apartment residents into the central city. I-66 and I-95 are also important links in the work-trip patterns of many of the Beltway industry employees but of little consequence to the apartment residents. The heaviest volume of Beltway trips by sampled apartment residents and employees was generated from Route 236 north to the Potomac River,

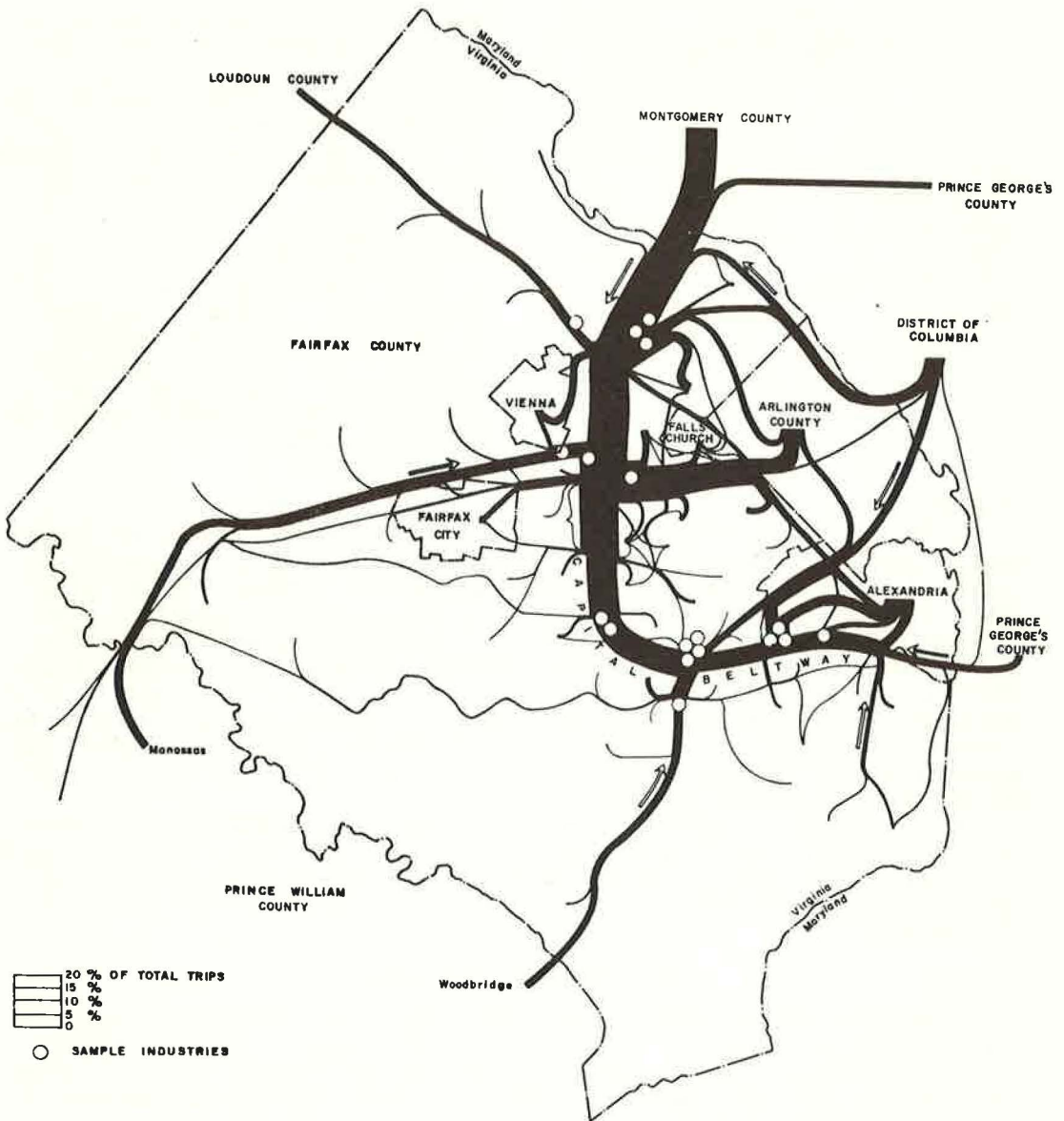


Figure 6. Home-to-work flow of traffic to Beltway industries.

an area that contains a concentration of apartments and the site of two of the county's largest industries.

Table 5 compares the findings on place of employment derived from this study with 1960 U. S. Census data for the census tracts in which the apartments are now located. The two sets of figures are not entirely comparable since the 1960 sample was of all the residents in the census tracts, 84 percent of whom lived in single-family units. (In 1960, Fairfax County census tracts 1, 3, 12, 23, 25, 30, 31, and 38 contained 11,986 dwelling units of which 10,080 were single-family and 1,906 were multi-family units.) But despite these differences, the comparison still provides an insight into changes in regional commuting patterns. The outstanding difference between the two periods is the larger proportion of residents employed in Maryland in 1967. This is a direct

TABLE 5
PLACE OF EMPLOYMENT OF RESIDENTS LIVING IN
BELTWAY AREA IN 1960 AND 1967

Jurisdiction	Percent of Total	
	1960 Census Tracts	1967 Apt. Sample
District of Columbia	37.3	32.7
Arlington County, Va.	15.7	23.1
Pentagon	(N. A.) ^a	(8.3)
Fairfax County, Va.	30.1	22.7
Maryland:	1.8	11.8
Montgomery County	(1.2)	(8.9)
Prince George's County	(0.6)	(2.6)
Rest of state	(0.0)	(0.3)
Alexandria, Va.	10.1	5.9
Falls Church, Va.	2.8	2.8
Other Virginia counties	2.2	1.0
	100.0	100.0

^a Not available.

result of the circumferential and its two new bridges across the Potomac. The difference in the share of residents employed in Fairfax County between 1960 and 1967 reflects the survey finding that Beltway apartment residents tend to be government employees, a large number military, who work in Arlington and the District. Compared to employers in Montgomery County, those in Prince George's County attracted relatively few additional workers from across the Potomac. This is because the majority of industry in Prince George's County is in the central part of the county, which is much less accessible to the Virginia suburbs than the Montgomery County industrial centers.

Implications

The Beltway, particularly the interchange areas, has become a focal point of multi-family construction, and indications are that the trend will continue. This will mean increased peak-hour traffic for the Beltway, since the survey showed that one out of every two workers travels on the Beltway for some portion of their work trip. The heaviest burden, however, will be on the radials leading into the major employment centers, since 65 percent of the Beltway apartment residents work in either the District, Arlington, or Alexandria, and only a few are employed in nearby industries. Of those who commute on the Beltway, many use it only as a connector and spend the major share of their trip on the radials. This pattern underscores the necessity for improving the system of arterial highways leading into the central city. (I-66, when completed into the District, will be a partial answer.)

The many who select Beltway apartments, despite a long commuting trip, reflect both the apartment projects' desirability and the promotional value of a Beltway-oriented site. The obvious implication is that this demand for, and subsequent construction of, new multi-family units will generate more traffic and congestion in and around the interchanges.

INTERCHANGE CONTROLS

The findings of the preceding surveys point up the increasingly common problem that when high-volume highways are constructed within metropolitan areas they tend to attract land uses that can in turn generate traffic volumes above the capacities of the newly built system. Congestion and obsolescence result. Although this observation has been based on experience in Fairfax County, Virginia, the issue is relevant to metropolitan highway construction throughout the country. Nowhere has an easy solution been found to the problem. One way in which highway traffic engineers have sought to deal with this problem is the limited-access expressway. To the extent that local government officials have attempted to cooperate in preserving the state's highway investment, they have relied primarily on traditional zoning procedures. Neither approach has proved satisfactory. Limiting access simply shifts the development pressure to the intersecting arterials and the interchange areas, and zoning controls have generally been unable to limit development effectively. The traditional comprehensive plan and zoning map, which designates precise locations for specific uses, have proved too inflexible, especially for the volatile interchange areas.

It is sobering but not surprising that we must continue to deal with congestion and premature obsolescence of segments of even our most modern highway system. In the first place, there has been a notable lack of communication and cooperation between highway planners and local planning agencies. In addition, the desire of local governments for high tax revenues is often in conflict with the desires of state highway depart-

ments to minimize interference and maximize traffic capacity on new highways. The competition between two neighboring localities along a given highway for tax revenues is certainly likely to lead each of them to encourage (through zoning) the development of intensive uses on property within its jurisdiction. Finally, at no level of government responsible for the provision of highways has any significant effort been expended to develop a feasible means of effectively pricing the use of highway facilities. We have continually reaffirmed the position that everyone with a properly licensed motor vehicle shall be entitled to use any highway at any time without regard to the costs that his presence on the road may add to others also desiring to use the facility. Since the trend is toward more limited-access highways crisscrossing our metropolitan areas, and since the method of controlling highway traffic implied in the last statement is not feasible, more workable techniques are needed to limit land development and traffic generation in areas adjacent to our major highways, particularly at the interchanges. The following is an approach to land control which is designed to achieve a better balance between land use and the traffic-carrying capacities of the interchange. It may have application in Northern Virginia as well as other developing areas. (This concept is based on a planning proposal made by the consulting firm of Marcou, O'Leary and Associates, first described in the "Comprehensive Plan for North Bay," a portion of Anne Arundel County, Maryland.)

Postulates

The following postulates underlie the scheme. First, because of the extraordinary importance of the interchange to the highway system, there is need for special land controls that can be applied specifically to interchange areas. Second, since the public investment in a highway interchange is substantial, the protection of its ability to distribute traffic should be a primary community goal. Land development should be limited to the highway's capacity to carry the additional traffic, at least until higher capacity facilities can be provided. Third, the control system must be responsive, within limits, to the many economic and political pressures for intensive land development in interchange areas. Unlike traditional zoning, the controls must anticipate the unpredictable nature of the marketplace and provide for some flexibility.

Development Sectors

The proposed control system is based on development sectors. Development sectors are areas, probably circles, up to two miles in diameter described around those interchanges that have significant growth potential. Future high-intensity uses could locate in these sectors only if they met specified site criteria designed, among other things, to protect the efficiency of the interchange. Depending on the needs of the area, there would probably be separate development sectors for high-intensity commercial uses, multi-family uses, research-institutional facilities, and industrial uses.

The sectors would be substantially larger than the anticipated market demands of each use, thereby avoiding monopoly situations found under present zoning techniques. Several development sectors could be described around one interchange. For instance, regional shopping centers and planned industrial parks might be permitted around one interchange and high-rise apartments and high-intensity commercial uses around another. The most intensive use "development sectors" would be described around interchanges providing greatest accessibility, i. e., the intersection of heavily traveled routes and less intensive uses around minor interchanges, i. e., intersections of two low-volume roads. The local planners would have responsibility to prepare detailed capital improvement plans for the sectors and to work with the highway engineers to determine the maximum traffic-carrying capacity of the road network within the sector.

Rezoning

Since most land within metropolitan counties is already zoned for one use or another, controlling the process of rezoning becomes the most practical and functional means of regulating the future pattern of land use. Under conventional procedures, public of-

officials do not usually have the benefit of planning criteria for judging rezoning petitions, and many rezoning decisions are arbitrary and damaging to the plan. The "development sector" technique is designed to prevent these rezoning abuses and to strengthen the often elusive link between the land-use plan and zoning map. It is proposed that the interchange development sectors be described in the local comprehensive plan and incorporated in the zoning ordinance. Although rezoning for development sector uses would not be mandatory, it would be permissible if standards were met.

Land within the development sectors would not necessarily be rezoned immediately after the interchange was designed or on a wholesale basis. It is conceivable that some property owners would not seek rezonings to intensive uses and would develop their land for single-family or other low-intensity uses. Rezonings within development sectors for intensive uses would take place in a gradual step-by-step process as private owners sought zoning map amendments to develop their individual holdings. Safeguards would be needed in the zoning ordinance to prevent speculative rezoning within sectors and to encourage large-scale development rather than small parcels in a scattered pattern.

Development Standards

Since one of the prime goals is to protect the public investment in the highway interchange, all rezoning requests for intensive uses on land lying within the sectors would have to conform with specific standards. These standards would be the "teeth" of the system, since they would regulate access onto arterials from abutting properties, limit maximum permissible development based on highway capacity and other utilities, and guard against conflicts with existing development. If the proposed intensive use development could not conform to these standards, the rezoning would not be granted. The following list is suggestive of desirable standards:

1. In order to provide for convenience of access, to reduce or prevent congestion in public streets, and to protect against danger and congestion in travel, the tract to be rezoned should be served by an internal street system which intersects with the radial highway at a minimum number of points. No access should be permitted onto a radial highway within a to-be-specified distance of the interchange. It would also have to be established that the connecting radial and the internal street system both have sufficient traffic-carrying capacity to serve the ultimate development of the proposed use without endangering the roadway network's ability to meet the demands of existing uses.

2. To protect against undue population density in relation to existing community facilities and to guarantee the provision of adequate public water and sewerage, the applicant's tract would be required to have public sewer and water available to it or the applicant would have to provide the local governing body with information indicating that sewer and water facilities would be available within a suitable period.

3. To insure compatibility with surrounding development and avoid potential land-use conflicts, a finding should be made by the local officials that the proposed use would not adversely affect the health and safety of residents or workers in the surrounding area nor be detrimental to the use and development of adjacent properties or the general neighborhood.

4. In order to prevent overbuilding of commercial and multi-family uses, substantiation of an economic demand for the proposed use would be required.

5. To encourage large-scale comprehensive development in the interchange sectors, as opposed to small scattered development, rezonings would be limited to parcels of no less than 10 acres.

6. Since the sector allows flexibility in location and mix of uses, site plan review by local officials would be required for rezoning to most of the high-intensity uses.

7. To ensure preservation of natural resources, the proposed development would have to subscribe to the stream valley, flood plain, and other similar protective provisions included in the area comprehensive plan.

To illustrate the concept, Figure 7 shows a typical interchange of a limited-access freeway and a nonlimited-access arterial highway in a suburban area of a growing metropolitan region before beltway-related development has taken place. The area is

predominantly zoned for single-family residential uses, although there is some commercial development along the arterial, and a strip of industrial zoning along the railroad and an industrial site on the arterial. Figure 8 illustrates the type of land-use congestion that can and does occur at such an interchange. Soon after the freeway is opened, the procession of rezoning begins, usually overriding the plans of the local planners. The result is a jig-saw puzzle of industrial, commercial, multi-family and single-family uses which crowd the interchange. The arterial traffic flow is interrupted by many new streets and entrances.

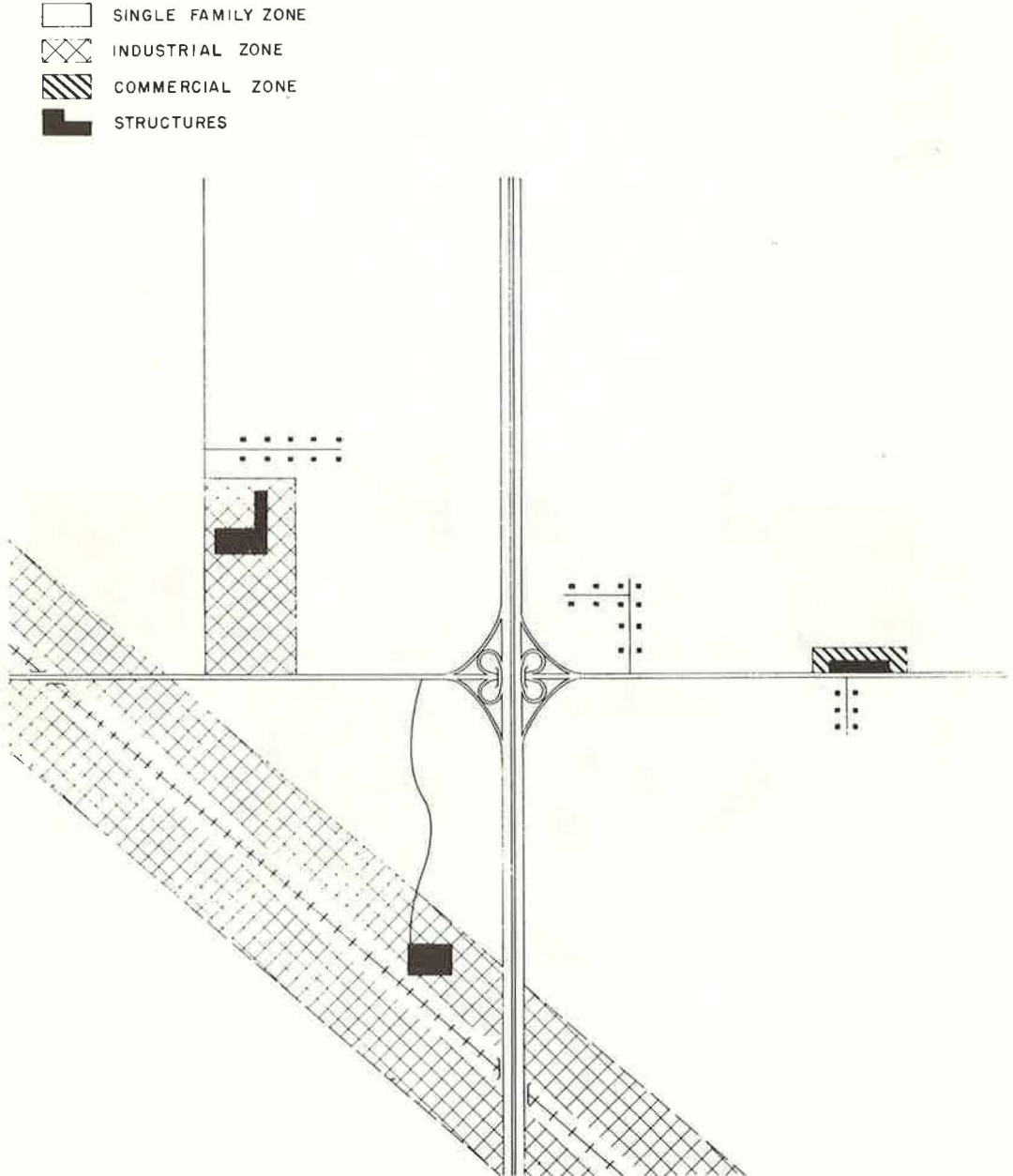


Figure 7. Interchange before intensive development.

Figure 9 shows the same interchange if growth had been controlled by the development sector concept. As can be seen, two development sectors have been described around the interchange, one permitting rezonings for low-density industrial use and the other for medium-density multi-family uses. The sectors are two miles in diameter and contain 2,000 acres. The development sector concept does not attempt unrealistically to eliminate intensive uses around interchanges, but it does control and limit these uses. Note that a large portion of the land is still zoned for single-family uses.

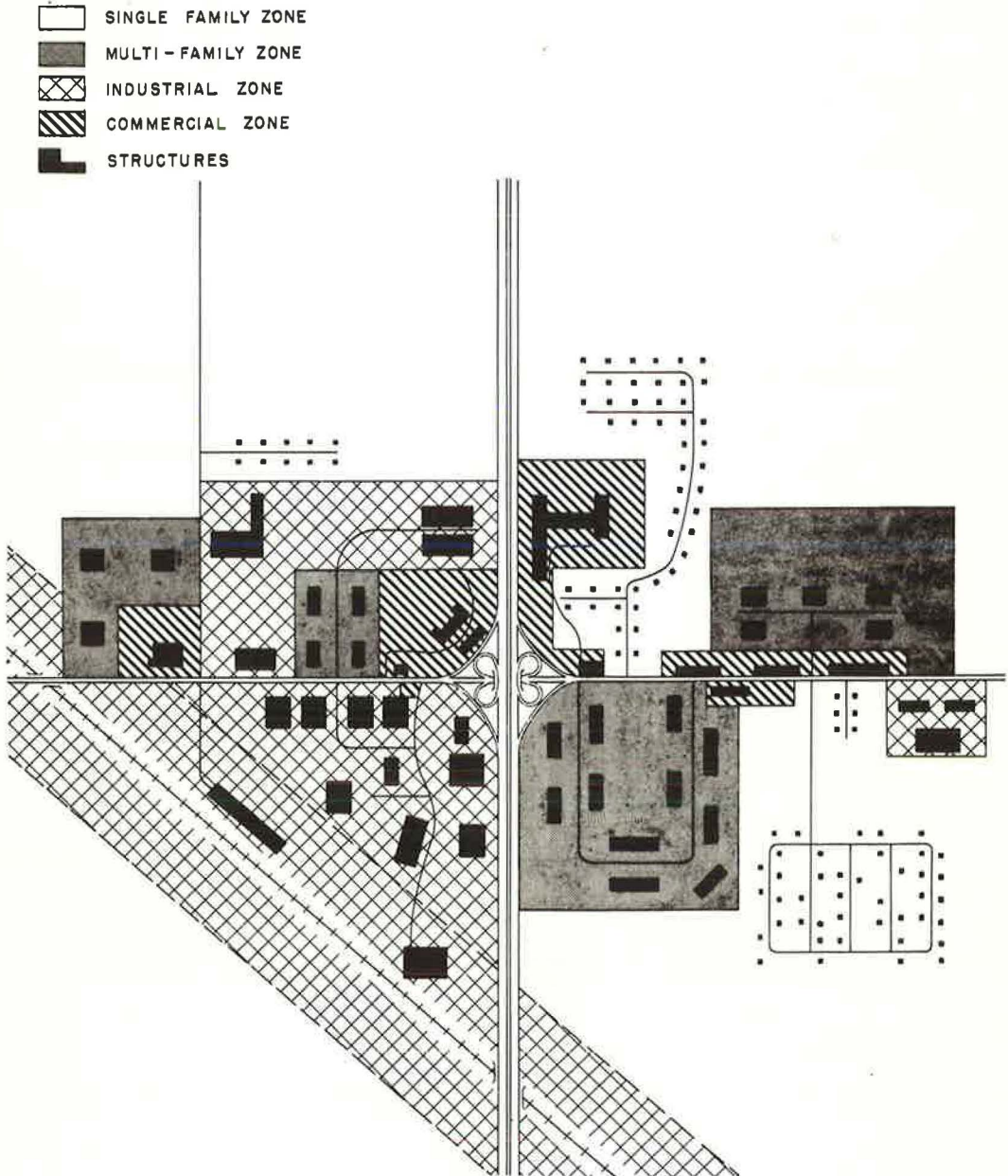


Figure 8. Interchange after intensive development.

Three quadrants, however, have been rezoned for industrial or multi-family uses. They have met the development standards set forth as a prerequisite to rezoning that relate to availability of public utilities, scale of development, traffic-generating capacity of the uses, and site plan design. Note that access onto the arterials is prohibited within $\frac{3}{4}$ mile of the interchange and all intensive-use complexes have their own internal circulation system. Since this interchange was not designated as a commercial development sector, commercial uses have been limited to the existing development. This diagram would probably represent the ultimate development of this interchange area with the exception of single-family uses.

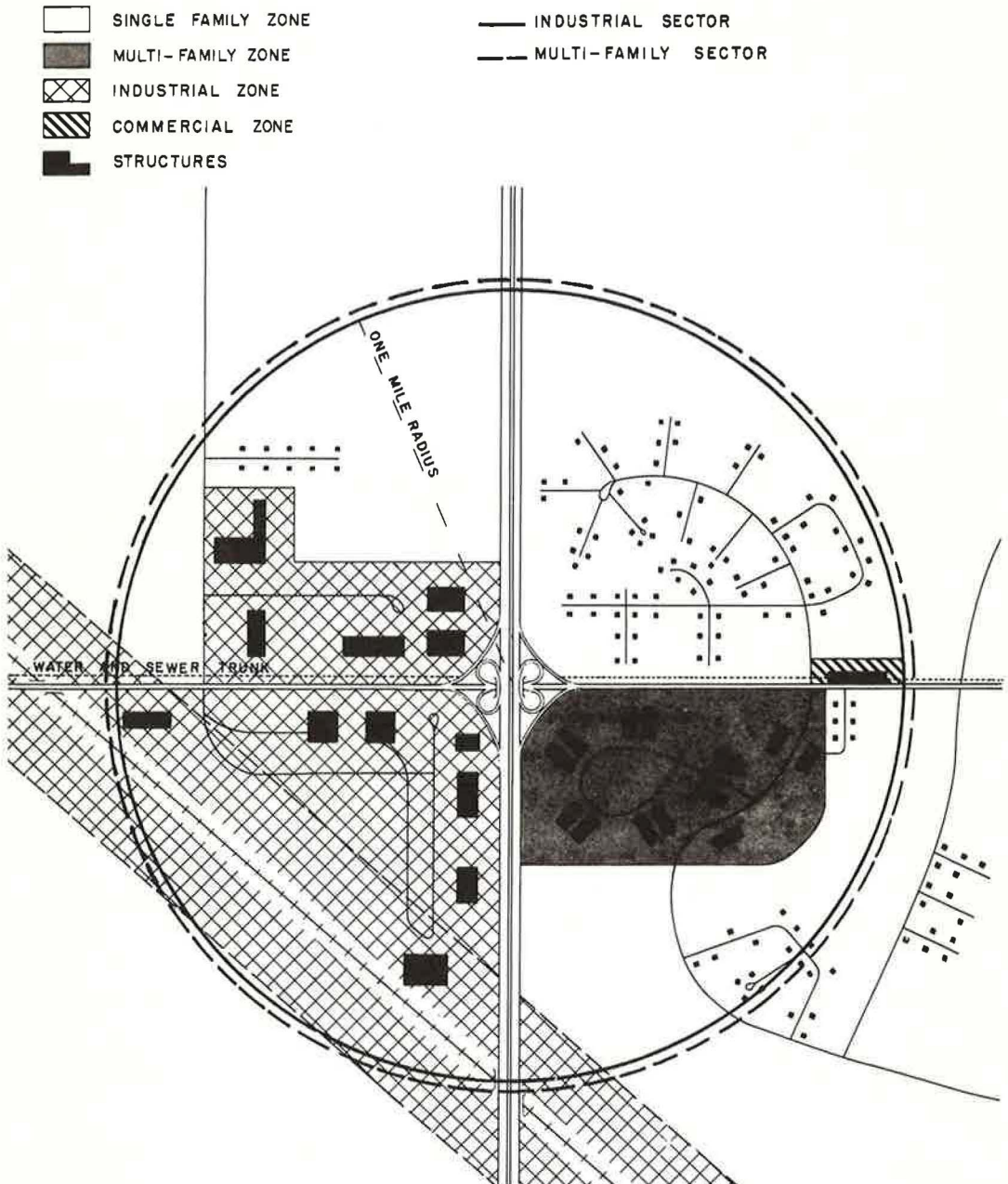


Figure 9. Interchange with development sector uses.

Other Considerations

Under existing regulations, no time limit is ordinarily imposed on the owner of open land within which to carry out actual development after receiving a grant of rezoning. As a result, rezoning is often done on a speculative basis with the unimproved land held off the market for lengthy periods of time. The practice is clearly an obstacle to orderly growth. A reasonable time limit for initiation and completion of development should be imposed as a condition for rezoning within interchange sectors.

To implement this type of proposal, there must be continuous cooperation between land-use planners and highway engineers. The capacities of the intersecting highways and the design of the interchanges will determine the type of development sectors proposed for the interchanges. These decisions will have to be coordinated because of the inevitable reciprocal feedback between land development and highway use.

The major purpose of the development sector concept is to provide owners, investors, and developers with a maximum freedom of choice consistent with the capacities of the major public facilities and the area's overall development objectives. In a growing suburban area, where large amounts of land are vacant and the development pattern has not been clearly established by past growth, broad but enforceable guidelines such as these appear preferable to the specific but usually ineffective proposals incorporated in the conventional master plan and zoning ordinances.

Discussion

NORMAN PEARSON, Town and Country Planner, Ontario, Canada—With the development of the extensive metropolitan forms in our major urban areas, there are arising two major challenges to the thinking of planners: (a) the evidence of the need to protect the effective life and usefulness of the major highway network that is the backbone of regional and metropolitan development; and (b) the evidence of the need to measure the public costs involved in the degree of use of major interchanges in critical transportation areas.

This challenge raises two further basic issues: (a) the philosophical question as to whether it is realistic to let transport planning and land-use planning evolve in separate paths, when methodologically the questions of land use and transport are inextricably interrelated systems; and (b) the fundamental question as to the need for obviating interchange breakdown and conflicts between land-use changes and shifts in transportation, by some method of using a combined planning approach to guide the evolution of transportation corridors, setting them as in a positive fashioning of development, rather than simply letting metropolitan or regional structures emerge piecemeal. This also involves discussion of the competition for first-quality locations within a framework that would seek to avoid breakdown, and that would conserve public investment.

Such issues have been dramatically illustrated in a major case currently before the Ontario Municipal Board, a Provincial tribunal in Ontario, Canada, which conducts public hearings to give final determinations of issues of master plan policy and issues of zoning changes. This case involves discussion of the proposal to build one of the largest shopping centers in the world at a vital metropolitan interchange in the western sector of Metropolitan Toronto at the junction of two expressways, the Queen Elizabeth Way and Highway 27. The case has been before various tribunals for a number of years, and has been referred to the Ontario Supreme Court and the Provincial Cabinet. It has involved the discussion of planning principles and very detailed examination of market analyses and of traffic characteristics. A massive amount of expert testimony and a number of key decisions have emerged that make this a landmark case of significance for all concerned with these vital issues.

The case has clearly illustrated the problems of breakdown that can occur if public priorities take second place in the discussion of such issues, and has involved consideration of the feasibility of an alternate approach by which such generators are

located where they can positively assist in the structuring of the urban area and its arterials and expressways, perhaps in some form as in new towns.

The case has been referred back to the Ontario Municipal Board by the Cabinet upon appeal, after a series of decisions that rejected the proposal on planning and traffic grounds and in consideration of the public costs involved.

The charge to the tribunal involved specific reference to traffic considerations including a new commuter rail service recently instituted in the western area of Toronto. When the case is concluded, examination of the findings and the massive evidence assembled will yield interesting research findings of significance to all concerned with highway research.

G. A. BACCHUS, A. D. Margison and Associates, Limited, Ontario, Canada—Mrs. Connally's paper is an excellent piece of research on the causes of unanticipated congestion and premature obsolescence of urban freeways with specific recommendations for controlling this problem. The "development sector" approach as explained by Mrs. Connally seems to have some merit, but the executing agency would have to be non-political to make it work. Very close liaison between land-use planners and traffic engineers must occur if any effective control is to be made and it would only be with an authority separate from government control. This would eliminate dollar planning at the local level and permit the highway system to keep operating properly. As Mrs. Connally points out, the prime consideration must be the protection of the investment made in the highway system and it is my opinion that this can only be achieved if land-use planning in the freeway interchange areas is taken from local municipal control and placed in the hands of the highway authority responsible for the construction and operation of our freeway system. Until senior levels of government recognize that the public investment in highways is far greater than the tax income to local municipalities from indiscriminate development, than I fear we will continue to experience the premature obsolescence of our roadways that Mrs. Connally has so ably illustrated.

The Truck Comes First

JOSEPH T. WHALEN, Supervisor, Right of Way Condemnation; and
THOMAS M. FLYNN, Right of Way Agent II, Right of Way Section, Condemnation
Division, Arizona Highway Department

•THE creation of the Interstate Highway System in Arizona, coupled with advances in the field of automotive engineering relating to trucks and the demands of the consumer necessitating rapid, economical, and efficient transportation of products, has had a decided effect on type of services and service facilities that must be provided to satisfy the desires and demands of the drivers of interstate and intrastate trucks.

The Southern Route through Arizona—I-10 from San Simon through Tucson to Casa Grande, then I-8 to Yuma—carries more truck traffic than any other east-west or north-south route in the state. This route also has more service facilities catering to the trucker than any of the other routes.

This basic information, combined with an interest and a curiosity in the rapidly expanding truck services in Arizona, the determination of directional truck volumes, and fuel volumes, was considered of utmost importance.

This concept of the economics of the services provided to the trucking industry could be valuable in highway design, traffic control, appraising and land acquisition, and in the preparation of eminent domain cases. The Condemnation Division of the Right of Way Section was directed to undertake the gathering and formulation of all available data and from this to determine if reasonably accurate conclusions could benefit the aforementioned interests within the highway department.

Travel on the Interstate Highway System, together with travel on the state primary and secondary systems, has caused a demand by the consumer, not only in Arizona but also in the majority of the fifty states, for better and more complete service facilities. In the passenger-car field, major oil companies have teamed with major motel chains to provide a complete one-stop service.

Because of the nature of the trucking industry, all necessary services should logically be provided at one place, under one operation. Data and information gathered for this study support this premise and indicate that businessmen in Arizona are lagging behind the other states in the type and quality of services that must be provided to our trucking industry.

SPECIFIC STUDY AREA

The Condemnation Division formulated a study to determine the extraneous factors involved in a loss of business of certain truck stops in the Jaynes Station area near Tucson. Owners of these truck stops claimed their businesses suffered a loss in value due to the limitation of access caused by the construction of I-10 immediately in front of their businesses.

It was the feeling of the Condemnation Division that any losses suffered by these businesses were not due to a reduction in the market value of their properties but, where any losses had occurred, they were mainly due to an increase in new and modern competition.

An extensive four-month study was undertaken with the cooperation of the Motor Vehicle Division to determine the habits of truck drivers. Further information was

gathered from the owners of the larger truck lines and from various truck stop owners throughout the country, but with particular emphasis on those with stations in the Tucson area.

TRUCK STOPS AND THE TRUCKING INDUSTRY

There are three truck stops in the immediate Jaynes Station area near Tucson that appear to be the mainstay of the business enterprises. Further observation revealed that, since these were the major businesses in the area, the other businesses all were related in some fashion to these truck stops.

Looking around the state, the Condemnation Division discovered that truck stops are unique. There is no way that they can be compared with a service station orientated to automobile drivers. These truck stops were designed to serve the peculiar needs and wants of professional truck drivers. A truck is considered by the average motorist to be a monster with gas tanks so large as to enable it to traverse several states without stopping for fuel. It is true that most large trucks have fuel tanks that hold a minimum of 150 gallons and as much as 300 gallons.

Discussions with several dealers who sell large trucks revealed that fuel tanks vary for each truck and there is no standard size for tanks. These dealers report any order which they send to the factory without specifications for size and type of fuel tanks will be returned until that information is supplied. Dealers feel that if all capacities of these tanks were taken collectively, the average would be more than 150 gallons. This appears to be a rather large figure since most cars have about a 20-gallon capacity. We must further visualize the tonnage trucks pull, and just observing trucks up and down highways we can realize that loads are very large. These large loads increase fuel consumption to a diminutive average of 4.5 miles per gallon. This gives the average truck a range of only 675 miles. This range seems rather large compared to automobiles, as it is about two times the range to which the average highway traveler is accustomed; but the fuel capacity of a truck is about 7.5 times the capacity of the auto.

The 675-mile range of the average truck is large enough to enable it to traverse several states without fueling. Realizing there are numerous reasons for the large amount of diesel fuel purchased on the Southern Route, it is sufficient to observe for this report that the truck stops along this route are a very good business venture.

Most states realize the potential usage of their highways by vehicles propelled by diesel fuel and liquid petroleum, rather than gasoline, and have enacted laws that enable them to impose an excise tax on these users as a means of partially compensating states for construction and maintenance of their highway facilities. The use fuel tax imposed by Arizona on vehicles using diesel fuel is based on the proportionate share of their total monthly gallons per mile that is used in their mileage within the state.

Neither this method of taxing nor the amount of tax imposed on the same fuels in adjacent states would seem to justify an advantage in the truck stop business within the state.

Truck drivers, being only human, must stop to eat and use restroom facilities just as any other motorist traveling the highways. These facilities are usually incorporated with a truck stop. They may not be on the same property but they are in very close proximity and with good reason. In today's growing real estate market, the price of land has skyrocketed. The average cafe only needs to have sufficient land to accommodate automobiles. A cafe catering to truckers needs much more land for parking trucks and much excess land to enable large rigs to maneuver. To incorporate a truck stop with cafes, restroom facilities, and other needs or wants of truckers is purely an economic move so that all facilities use one parking area and related maneuvering room rather than have separate ones for each.

FACILITIES IN STUDY AREA

The first step was to investigate the various truck stops under study. A detailed inspection was made of each, and the facilities compared. A comparison of the facilities available at each truck stop in the Tucson area is given in Table 1.

TABLE 1
SUMMARY OF FACILITIES AVAILABLE AT TUCSON TRUCK STOPS

Truck Stop	Double Fueling Capability	Late	Showers	Trunks	Laundry	Barber Shop	Clothing Sales	Stoles	Ice	Butane	Western Union
Triple T	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Texaco	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Art Hague's 84 Truck Stop	No	Yes	Yes	Yes	No	No	Yes	No	No	Yes	Yes
American	No	Yes	Yes	Yes	No	Yes	Yes	No	No	Yes	Yes
Oil	No	Yes	Yes	Yes	No	No	No	No	No	No	Yes
Ken's 76	Yes	Yes	Yes	Yes	Yes	No	No	No	No	Yes	Yes
Possun											
Brown	No	Yes	Yes	Yes	No	No	No	No	No	Yes	No
Graingers	No	Yes	No	No	No	No	No	No	No	Yes	No

The Tucson Truck Terminal, commonly known as the "Triple T," is the newest and largest in the Tucson area. On May 10, 1966, it opened in the present new location at the intersection of Craycroft Road and I-10 on a one-way, westbound frontage road. It is advertised by Enco as the "World's Largest Enco Station." Diesel fuel sells for 25.9 cents per gallon with regular selling for 35.9 cents, whereas at major service stations within the city regular sells for 11 cents less. Stalls in the paved parking area are sufficient for 50 to 60 trucks with excess maneuvering room remaining (Fig. 1).

The Texaco Truck Terminal, the second largest in the area, is owned by the Kelber Brothers who own another extremely large truck stop in Fresno, California. The Tucson operation opened for business in September 1963 at the intersection of Wilmot Road and I-10. Like the "Triple T," it is on a one-way, westbound frontage road. Fuel prices are lower than at the "Triple T," but high for the general area. Parking stalls in the paved area are available for 35 to 40 trucks, with adequate maneuvering space remaining. A cattle rest facility located one-half mile to the east on a two-way frontage road may have an effect on the volume of business (Fig. 1).

The Art Hague Truck Stop is the oldest in Jaynes Station, having been built in 1956. The facilities available are as complete as any in the area but lack much that is contained in a modern stop. Table 1 shows a cafe included; however, it is on adjoining property that is owned by the lessee of the truck stop. The two combined properties create increased parking area, much of which is unpaved, but it is restricted as compared to today's standards. Price is the lowest in the Tucson area at 18.9 cents for the lowest grade diesel fuel. Its location is on a two-way frontage road about midway between two diamond interchanges on I-10 (Fig. 2).

The 84 Truck Stop is the oldest in Tucson; however, the present facilities are relatively new, having been built in 1957. The original truck stop was in front of the present location and was purchased for additional right of way of I-10. A diesel motor repair in a separate building on the property and a nationally recognized refrigeration expert in the main building undoubtedly attract additional clientele. The property is on a one-way, northbound frontage road; however, it is considerably south



TRIPLE T ENCO



TERMINAL STATIONS-TEXACO

Figure 1. Truck stops.



KEN'S UNION 76



AMERICAN OIL



ART HAGUE



84 TRUCK CENTER

FREEWAY TRUCK STOP

Figure 2. Truck stops.

of the Prince Road Interchange on I-10. Access for eastbound trucks involves more than a mile of difficult maneuvering but is apparently not a factor to consider since the station receives a larger percentage of eastbound traffic than westbound (Fig. 2).

The American Oil Truck Stop in Jaynes Station has only been open under the present management since December 1965. It was vacant for the prior six months as the former lessee moved out in May. The present lessee claims a large volume will never be possible because of the very limited parking area. The restricted size of the land area also prohibits the inclusion of additional related facilities. The location is a few hundred yards south of the Hague facility on the same side of the road (Fig. 2).

Ken's Union 76 Truck Stop is across I-10 from the Hague Truck Stop and is also on a two-way frontage road. Although built in 1963, it does not have the quality nor quantity of facilities indicated by the recent trends in truck stop construction. Developed and undeveloped land area are sufficient for the operation today and for the foreseeable future. The present manager is not the type of individual the industry would consider a truck stop operator, because the professional operator is considered a special breed. This is probably a big factor in the amount of business (Fig. 2).

Possum Brown's Truck Stop is the former location of the "Triple T." The facilities are small and old with unpaved parking areas. It is located opposite the westbound lane of a divided primary highway. Crossovers in the median are located at the extremities of the property. Price of diesel, 25.9 cents, may be a factor limiting business here as this is as high as the "Triple T"; also, the lack of Western Union could be a further business prohibition.

The Grainger American Station has only been open as such since September 1965. The facilities are very limited, as is parking. A cafe is located on the property to the east and a motel on the property to the west, but these do not enhance the overall facility. Price of diesel fuel is also 25.9 cents which seems unrealistic compared to the services available. The access is to a conventional four-lane, undivided highway.

The Freeway Truck Stop is located across I-10 from the 84 Truck Stop on a one-way, southbound frontage road. The last operator was unable to continue in business and closed his operation on June 6, 1966. Gallonage figures were unobtainable from Humble Oil Company so this station was disregarded except to see the effect of its closing on the volume of the other truck stops.

SUMMARY OF FACILITIES

Through careful examination of the facilities at the more recently constructed truck stops we can see that every possible convenience is being offered to attract the professional truck driver. The Pure Oil Company and the Skelly Oil Company, generally recognized as the leaders in the truck stop industry, have embarked on vast building programs and are presently constructing complexes throughout the Midwest. The facilities being built follow the same trend as the Triple T and the Texaco Terminal Stations in Tucson.

After viewing a newer truck stop, one can visualize the huge investment required to set up and operate this type of business. No average cost can be established for a typical truck stop as each is different and of course land values and building costs will vary. However, it can be said that, at the present time, a cost of \$1.6 million would be the upper limit as that is the construction cost of the most costly one built in the United States according to nationwide figures. A lower limit would be extremely hard to establish because of what may or may not be offered in the way of related facilities. In general, throughout the nation the trend is to a homogeneous complex to serve each and every need of a professional driver.

While the professional driver is the one to be served, an eye is kept on the average traveling motorist and a service station for automobiles is frequently included in the complex. After all, why should a large segment of the highway traveler be overlooked? Studies indicate that the service station included in the truck stop complex will do a business that exceeds most highway stations operating as a single unit. Another important fact is that these stations usually charge more for a gallon of gasoline than do stations in town. They are further unaffected by gas wars that crop up from time to time, especially in the Tucson area.

The development of truck stops into a highly sophisticated industry is easily discernible. In the last ten years the trucker has realized his position on today's social ladder. In the past the trucker has been on the lower end, but in recent years he has realized his rightful position. The trend has been for the driver to own the truck and lease it to various businesses, pulling their trailers. The investment required by a driver ranges from about \$25,000 to \$40,000, depending on the truck and extra equipment. A person owning one or more trucks has a sizeable business to operate. As 98 percent of the trucks operating on highways today are owned in this manner, catering to the desires of these owner-operators has become an even bigger business.

The emergence of the new type of driver has made certain changes necessary in the makeup of the truck stop complex. Yesteryear's owners of each separate business at a truck stop allowed no control over the entire setup. These various businesses are now being integrated under one ownership as can be seen in the newer facilities. The various auxiliary facilities are being built by individuals and then leased out to others while control of the entire complex remains under one ownership. Usually one ownership controls the truck stop directly but does not directly participate in operation of the other units. He, too, is more of a businessman than in past years and recognizes the need for separate management of diversified business.

The auxiliary facilities have changed as much as the truck stops themselves. Cafes have changed from the "greasy spoon" type to one every bit as clean and modern as found in the heart of a city. It is no longer just a place to get a bowl of chili and a hamburger but is now a complete, first-class restaurant. The bunkhouses closely resemble a small motel rather than a large room with several cheap cots. Cleanliness seems to be one of the main themes influencing the operation of all units. This is in keeping with the trend of the drivers themselves to keep a cleaner atmosphere around the trucking industry.

The driver has changed from a rough and rugged, greasy-handed driver to a businessman-driver. In past years he was not concerned about his fuel and the price paid for it. It was not his money he was spending, which led to ticket padding through which he made extra money to supplement meager earnings. Today it is his own money. He must watch costs closely. This has led to inclusion of scales at newer truck stops enabling him to weigh his load so he may evade the taxes or fines for overweight vehicles. This has further led to rather erratic fueling habits.

4-DAY DRIVER INTERVIEW

The Condemnation Division obtained the cooperation of the Motor Vehicle Division in a four-day interview of truck drivers at the San Simon and Yuma Inspection Stations. The inspectors at these stations commenced this interview at 12:00 noon on August 26, 1966, and concluded at 12:00 noon on August 30, 1966. The information requested from each driver was: (1) do you fuel in Arizona, (2) in what towns, and (3) at what truck stops. The answers were submitted for tabulation.

Investigation of the "Truck & Bus Sheets" of the Motor Vehicle Division enabled us to determine which of these trucks used the Southern Route through Arizona. We then knew the total vehicles passing through both Yuma and San Simon going either direction, the total vehicles either westbound or eastbound at each location, and the total coming into the state that would take the Southern Route from each location.

Whatever period of time was selected for this study, there would be some traffic missed. Those doing the actual questioning at the inspection stations assured us this period of time would be as representative as possible.

During the study time, a total of 2,575 commercial vehicles passed through the San Simon inspection station. Of these, 1,747 were westbound or 68 percent of the total. We found that of those westbound, 1,083 vehicles or 62 percent of the westbound traffic took the Southern Route. The Southern Route traffic westbound represents 42 percent of the total vehicles going through the San Simon station in either direction.

During the same period of time, a total of 2,300 commercial vehicles passed through the Yuma inspection station. Of this number, 1,375 or 60 percent were eastbound out of Yuma. Of the eastbound vehicles, 1,104 indicated they were going to use the Southern Route or 80 percent of the total eastbound traffic. Southern Route traffic going

eastbound represents 48 percent of all commercial vehicles passing through the Yuma Station bound in either direction.

It is rather difficult to draw a comparison of the two stations. Since the Southern Route involves the length of the entire state, a greater percentage of those going westbound from San Simon will go north from Tucson to Phoenix or south from Tucson to Nogales than will go straight through to Yuma. It can be reasoned that there are two main routes to get to Phoenix from the eastern part of the country—on US 66 or by way of the so-called Southern Route. A detailed study of "Truck and Bus Sheets" revealed that the origin and destination of trucks indicated the Southern Route would be the most logical choice. The same is not true at Yuma. Most of the trucks coming into Yuma eastbound originate their trip in California, so a more direct route to Phoenix may be used and is preferred to the Southern Route. Therefore, because 80 percent of all eastbound trucks use the Southern Route out of Yuma, and only 62 percent of all westbound trucks use this route out of San Simon, the traffic patterns out of the two stations cannot be compared favorably.

It was determined that with a reasonable amount of accuracy the figures taken from each station considered separately could be projected to yearly figures. By doing this, we could forecast the number of eastbound and westbound trucks going through Yuma. It must be kept in mind that the total number of vehicles passing through these points could be obtained by actual count for any given month or year. For a desired higher degree of accuracy, these figures should only be projected on a yearly basis. This would eliminate any bias caused by in-season farm products that would tend to affect monthly figures, especially in this area.

We may further forecast or project these figures into the number of trucks traveling the Southern Route. The same methods would be applied as above. In this case the degree of accuracy will decrease and any error involved in the above projection will be compounded or enlarged in these projections.

Truckers entering at San Simon indicated 53 percent were going to fuel in Tucson and 29 percent were going to fuel in Yuma. Other locations totaled about 10 percent. The reason for the high count in Tucson was that it is the first major area a trucker encountered in southern Arizona going westbound from San Simon. The survey also indicated that 93 percent of all trucks traveling the Southern Route stop in Tucson but only about half of these buy fuel. The other half must therefore stop for some other reason, such as rest or food. These other desires will generate an income for some related business such as restaurants, bunkhouses, and the like. A truck stop, catering to all drivers, should therefore have all these facilities available to be considered in the main competition of today's market.

It is rather significant to note that almost 29 percent of the westbound trucks fuel in Yuma just prior to leaving the state. This fact is hard to explain because a truck with full tanks can usually make it to Los Angeles or other destinations in California.

Of the trucks entering the state at Yuma, 59 percent fuel in Yuma and 37 percent fuel in Tucson. These figures are somewhat misleading as a number of trucks fuel in both cities. A count of these could not be obtained because of the manner in which the questions were formulated. It is rather interesting to note a certain amount of trucks do fuel in both locations because of the close proximity of the two cities. In comparing gallonage figures in the cities, trucks apparently did not fill their tanks in Yuma but rather just added a lesser amount and completed their fueling in Tucson. A certain amount of this can possibly be explained by the fact that the facilities available at the Tucson Truck Terminal and the Texaco Terminal Station far exceed any in Yuma. It is thought that these other related, superior facilities will tend to draw more fuel customers as well as business to the auxiliary facilities.

When studying the places where trucks stop for fuel without regard to where they entered the state, Yuma and Tucson capture a fairly equal share of the market. This is not borne out by the gallonage figures, however. Again we must look to related studies for the answer. We find that the trucks entering the state at San Simon travel the Southern Route to a lesser degree than do trucks entering at Yuma. As explained earlier in this study, these trucks may travel north from Tucson to Phoenix or south to Nogales and Mexico. It can be reasoned that a certain unknown percentage of these

will fuel in Tucson and therefore boost gallonage figures in the Tucson market so they appear to be far greater than those obtained in Yuma.

When the study revealed the locations where trucks stopped, a more enlightening figure turned up. In the Tucson area, the Tucson Truck Terminal serves 54 percent of the trucks entering at San Simon as compared to 52 percent of those entering at Yuma. The Texaco Terminal Station gets 16 percent of the business entering at San Simon and 17 percent of those entering at Yuma.

All of the truck stops in Tucson follow the same pattern of service to an equal percentage of trucks entering at San Simon and at Yuma. This trend would contradict the theory that service stations should be located on the incoming side of a town. It further shows that any attempt to compare the habits of truckers with the habits of automobile travelers is impossible.

The study figures indicate the stops in Yuma generally follow the same pattern as Tucson. Again it makes little difference which way a truck enters the city. The main difference appears to be the share of business the mavericks or wildcatters get from each direction. The study shows that they get 15 percent of the business when the truck enters at San Simon but only 2 percent when the truck enters at Yuma. Overall, wildcatters or mavericks account for only 7 percent of the diesel fuel business in Yuma. This figure, although higher than Tucson, is still rather low when you realize that we only include four Yuma truck stops in our study as compared to seven in Tucson.

MAJOR CARRIER SURVEY

The four-day interview did not include the major carriers, so a separate inquiry had to be made to determine their habits. We attempted to see if the habits of major firms differed from those of independent drivers.

A questionnaire was sent to all truck lines which averaged more than 30 trucks per month along the Southern Route of Arizona during July 1966. In all, 116 firms were sent the questionnaire and 66 were returned. A return rate of 57 percent was the final result. It should be noted that several responded, but could not answer because they owned their own fueling facilities, which is one of the factors we sought to discover in the questionnaire.

In answer to the first question, the respondents stated they stopped on an average of once every 231.66 miles. In terms of hours it averaged 4.2 hours. Not all of these stops were for fuel, and the average mileage between fueling points could not be determined. Stops made for any reason will generate some income for the auxiliary facilities at the truck stops having other facilities.

In response to question No. 2, most firms indicated stops in Tucson and Yuma. Of those responding, 92 percent indicated a stop in Tucson and 89 percent indicated a stop in Yuma. Rather surprising was the fact that 40 percent indicated a stop in San Simon. Phoenix was mentioned on 30 percent even though it was not included on the Southern Route; however, the percentage stopping shows it is large enough so it should be noted. There were stops at other points on the route, but the percentages were rather small.

In analyzing the results of these questions, it is apparent that the stopping points do not follow in direct proportion to gallonage. This indicated other facilities were sought. A few respondents indicated they stop where there is good food and plenty of parking, so these features should be included in a major truck stop if it is to compete in today's market. Inclusion of these auxiliary facilities will undoubtedly attract customers who might purchase fuel.

The respondents to question No. 3 gave answers that more closely follow the gallonage figures given by the various stations. They also gave answers that are in keeping with the four-day interview made in connection with this report. About 25 percent of those stopping in Tucson said they stop at either the Tucson Truck Terminal or the Texaco Terminal Station. Since the Jaynes Station area is of particular interest, it should be noted that only eight firms said they stopped in that area. Five went to Art Hague's and three used Ken's Union 76. This gave the Jaynes Station area about 14 percent of the responses.

Question No. 4 showed that only about 10 percent of these firms have contracts to fuel at a specified place. One of the contracts was verbal and one was only an authorized

stop. Where these 10 percent have their contracts is not known, and an attempt to find out from the truck-stop operators shed no light on the problem.

Question No. 5 sought to determine the length of time any contracts may be enforced. No answers were given to this question and the reason is unknown.

Question No. 6 asked if these firms had changed truck stops from the ones they patronized prior to 1964. The responses indicated 23 percent had changed.

Question No. 7 went on to ask why the change took place and a variety of answers was given. Of the 14, six listed convenience or service. Other answers included credit reasons and more convenience in terms of mileage and price. One respondent said he changed due to fuel ticket padding. Since truck drivers are very clannish, news of this sort can easily spread through the industry and an economic boycott can be enforced although not organized.

THE ECONOMIC ANALYSIS

Now that we have completed a look at the services provided by the various truck stops under investigation and the desires of the drivers to be served, let us see if industry sales bear out the ideas and trends indicated in the foregoing analysis. We shall look at sales in a different manner. It is an attempt to analyze the product preference as suggested previously.

Product preference is the expression of the total impact on the consumer of product characteristics, price, advertising and promotion, and the distribution methods and channels employed. The level of preference for a particular product will fluctuate with the effort expended in these various directions, not only in behalf of a particular product but also in behalf of competitive products. The disappearance from the market of products that once enjoyed acceptance, or even a high degree of preference, offers evidence of inconstancy in consumer preference.

Measuring product preference is not simple. Although it would appear reasonable to use sales volume as a criterion of product preference, this measurement has several drawbacks, as follows:

1. Sales are affected by economic factors, and product preference may remain constant or actually be waning while sales volume is increasing because of expanding economy, shortages, etc.
2. The sales volume of an individual company is most meaningful when it can be related to the total market and to the sales volume of competitors. The movement of the share of market being realized by a company may reflect the level of product preference that it has achieved, if proper consideration is given to circumstances which may be having an abnormal effect on the sales of competitors' products.
3. Sales volume as a criterion of product preference is often too insensitive a barometer to serve as an exclusive measure. Once product preference has declined to a level at which sales volume is seriously affected, it may be difficult to regain consumers' favor. It would be much more desirable to be informed about the level of preference for your product before demand shifted into a competitors' product.

Company sales figures are not sufficient for measuring progress or competitive effectiveness. Even current sales to consumers are not an indicator of trends that are in the making. Even more important, unless sales are compared with competitors' sales or against total industry sales, the company has no way of knowing whether it is doing as well as it could do or ought to do in terms of the share of the market it is securing and the potential that is still there to be won.

For the purposes of this study, we shall look at product preference in the terms of a share of market analysis. We shall not attempt in any way to determine the factors in the marketing mix that lead to product preference but only at product preference itself. Again for the purposes of this study the term product shall be construed to mean all goods and services offered at a singular truck stop. We know that brand of fuel, service, auxiliary facilities, location, and many other factors intermingle to provide a certain desire for a trucker to stop at a particular truck stop. The truck stop shall have considered as its product the combination of everything it has to offer the consumer.

Our analysis, while not highly complex, had to be done in several ways to get the true overall picture. We found that we have an overall possible competitive area throughout southern Arizona, one within the Tucson area and one within the Yuma area. If 100 percent accuracy were desired, we would have had to analyze the sales of every truck stop in the nation because of the carrying capacity of the fuel tanks on large trucks. Our level of accuracy was of course reduced somewhat but not to any level where we were purely guessing. It is impossible to give the degree of accuracy obtained with the figures given in this phase of the report; but we assumed that they were within 5 percent of the comparable figures that would have been obtained on a nationwide basis. This was made possible because of the broad area covered and the different analysis made within.

The value of this type of study can be easily seen by comparing the gallonage figures of a leading truck stop in either Tucson or Yuma with the share of market figure for the same location. It is easy to see how an operator can be lulled into a false sense of security by only watching his own gallonage figures.

THE TUCSON MARKET

Tucson being the largest area of concentration for truck stops and the area with greatest sales, we shall discuss it first. We were able to obtain gallonage figures for all truck stops discussed within the report in the Tucson area and are therefore able to figure total industry sales within the Tucson area. Here we must assume the figures given to us were the actual figures.

Because of the different times for which gallonage figures were given, we shall restrict our analysis to the period from January 1, 1962, through June 30, 1966. During this period, conditions were continually changing in the Tucson area and these can be ruled one of the determining factors in the major changes of the various "share of market" figures contained within the report.

During 1962, the first year we shall analyze, we find only four truck stops open. The Triple T, Art Hague, and American Oil enjoyed unlimited access to four-lane highways during this period, while the 84 Truck Stop was on a one-way frontage road adjacent to an Interstate highway. It is interesting to note that although the "84" captures the smallest share of the market, its share is not that much less than the American Oil station. We therefore believe it is safe to conclude that limitation of access can be overcome with superiority in other areas of the marketing mix.

Conditions began to change in 1963. In September, the Texaco Truck Stop opened at an interchange location on I-10. At about the same time, the access was being hampered at Art Hague's and American Oil. Because these changes happened late in the year, they have little effect on yearly figures when compared to 1962; however, comparison by any other manner will not be fair and figures might vary widely.

A glance at figures for the Texaco Truck Stop, when compared with others, shows who is losing the business they gain. It is also interesting to notice that figures for the Triple T remain substantially the same. At the time, it was the only major truck stop with unlimited access. If access were the primary consideration, the Triple T's share of the market should have increased to upwards of 90 percent.

Again, in 1964, we find yet another truck stop opening so conditions do not lend themselves to analysis in the best possible manner. In September, Ken's Cut Rate opened with several fueling contracts with major truck lines and cattle pens for resting livestock in accordance with ICC regulations. The yearly share of market figures for this location are not spectacular; however, the monthly figures are higher than when the new Texaco station opened.

Yearly figures show some very interesting ideas when compared to figures of 1963. The Texaco Truck Stop, in its first complete year of operation, has hurt all others in the Tucson area in a somewhat similar manner. The 15 percent share of the market that Texaco now enjoys seems to come in more or less equal amounts of somewhat less than 4 percent from each of the others.

One interesting thing must be noticed in a glance over monthly figures and that is the low figure for American Oil in March. When looking at the figures for American

Oil, we see them steadily increasing from March to the end of the year, yet they still show a yearly loss because of one low month. Actually if March and April are not considered, American Oil has not suffered because of the new Texaco operation.

We must keep in mind that, all during 1964, construction of the new Interstate highway was taking place in front of Art Hague's, American Oil, and Ken's. We cannot determine the effect of the construction on Ken's business. American Oil has been analyzed above and it appears that the construction did not have a drastic effect on its business except perhaps during March and April. This is impossible to determine accurately due to the lack of relevant data being recorded by highway construction officials. We can see that Art Hague's business has suffered but no determination can be made as to what part, if any, is due to construction and what part, if any, is due to the increased competition. Although it is impossible to determine the cause, it is fairly reasonable to say that a large percentage of the loss is due to increased competition, because the American Oil station would have been affected by the construction in a like manner. Competition would not have the same effect on both places, because any change in the marketing mix would have an effect on the share of market of each. Based on the monthly figures, the American Oil station was apparently successful in counteracting the increased competition, while Art Hague was not.

The year 1965 finds yet another type of change taking place in that the American Oil station was closed from June through November. This closure will necessarily mean that their business moved elsewhere, but it is impossible to say where it went. Analysis of the share of market captured by the other truck stops in Jaynes Station does not reflect an increase anywhere near the share formerly done by American Oil, so, if their business stayed in Jaynes Station, an equal loss was suffered by the stations in this area to other locations.

Again in 1965, we find an increase in the share of market being captured by the new Texaco location as it continues to grow with its superior facilities. At this point Texaco was second only to the Triple T, which obviously suffered because of the increased competition. A look behind the scenes finds the Triple T planning a new ultra-modern facility to open in 1966 in order to cope with increasing competition. Art Hague apparently is unable to get a new location because of the terms of his present lease and he is hampered somewhat by space and the inability to add improved facilities. Ken's had steadily increased throughout the year despite construction in the area and the competition provided by Texaco.

The determining factor leading to the closing of the American Oil Station was virtually impossible to discover. Sales seemed to fall off at a time when highway construction started in the area and about the same time the Texaco facility opened. The operator stated that he was used to making more money in another business than he ever had in this type of business. This would indicate that, for him, the entire operation was marginal even before sales slumped.

In 1966 we only have complete figures for the first six months, so only the first year can be put to analysis. For this period of time, all six truck stops in the area were opened with few, if any, changes and all construction had been completed. An analysis of this period is of little value because changes are so slight as to have been caused by ordinary day-to-day businesses and we are interested in extraneous factors.

An overall analysis from 1962 to present shows some most interesting facts. From 1962, with four truck stops in existence, an ever-broadening market has increased this number to six with one changing to a new, modern facility in addition to the two new facilities. The two new ones have moved in to garner one-third of the market for diesel fuel, which shows a lack of some type on the part of the existing truck stop operations.

One thing that does not shine through any figures is the effect of management. Since "Ken's 76" was opened in September 1964, four managers have operated the station. A separate analysis was made of the effect of these changes. Gallonage figures were plotted on chart paper and the periods of management shown. Even a quick glance at such a chart shows the drastic effect a poor manager can have on an operation. In most cases, a personal problem required the change in management. The only other management change in the Tucson area during the period under analysis was at the American Oil station in Jaynes Station. After one manager gave up, this operation was

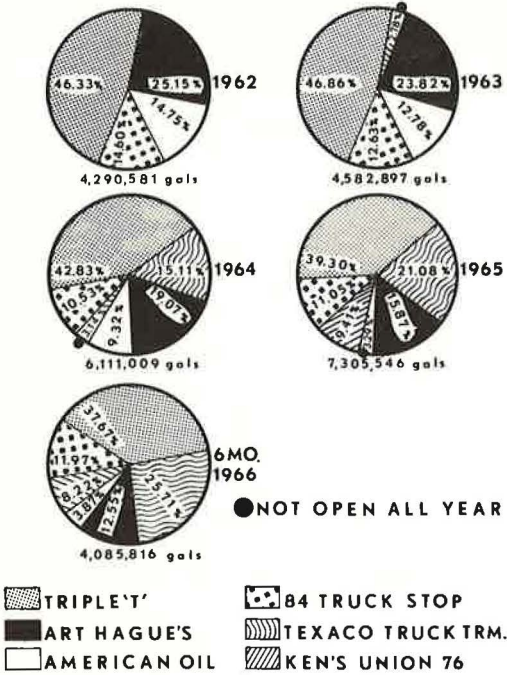


Figure 3. Percentage of gallonage market—Tucson truck stops.

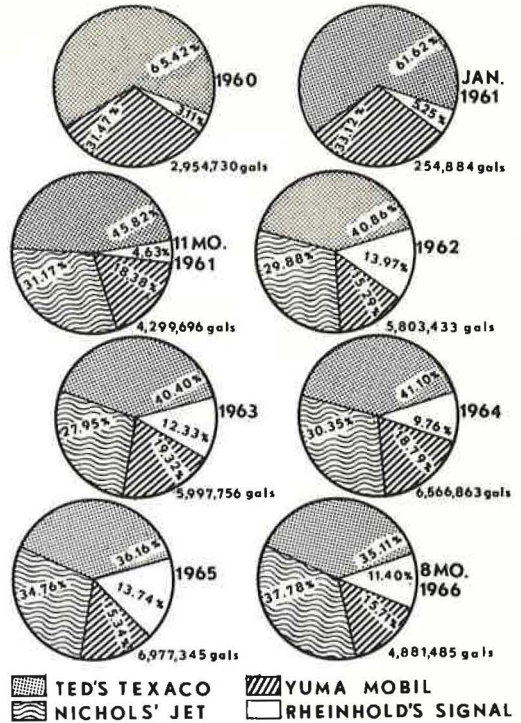


Figure 4. Percentage of gallonage market—Yuma truck stops.

closed for several months before new management took over and, because of this lag in the change, a chart analysis cannot be made fairly.

A comparison of the percent of gallonage market being enjoyed by the six most effective facilities in the Tucson area is shown in Figure 3.

THE YUMA MARKET

The Yuma market was not scrutinized as closely as the Tucson market. The constantly changing conditions which exist in the Tucson area are not present in Yuma. All facilities are similar and all are located on the same highway with similar unrestricted access. About the only change in Yuma has been the opening of the Nichols' Jet station in February 1961. Although Nichols' Jet is new to Yuma itself, it was formerly located in California just a short distance from Yuma. Undoubtedly, a large share of his business has followed him in his move; however, no determination can be made as to what percentage of business formerly patronized him in California and what percentage is new business which may have been taken from other Yuma operators.

The introduction of Nichols' Jet in February 1961 seemed to have no immediate effect on the actual gallonage pumped by the others, although in terms of share of the market the effect has been both immediate and drastic. Over the entire period under study, it is obvious that the presence of Nichols' Jet has had a marked effect on business, especially that of the Yuma Truck Stop and Ted's Truck Center. Prior to the opening of Nichols' Jet, these two were doing 90 to 95 percent of the business in the Yuma area and it would have been most reasonable on their part to expect competition to come in and at least attempt to take some of the market away. Apparently this was not done or everyone marked time until such time as the new freeway was established in the Yuma area. It is interesting to note that both Nichols' Jet and Ted's Truck Center have purchased land in the immediate vicinity of the proposed freeway. It is known that

Ted's has plans for a new facility similar to the Triple T in Tucson. Nichols' new site will be hampered by lack of size as the highway right-of-way has substantially reduced the 10 acres he bought.

It is not necessary to analyze the share of market figures on a month-to-month or even a year-by-year basis as the changes that existed in Tucson are not present in Yuma (Fig. 4).

THE SOUTHERN ARIZONA MARKET

This study is included as a part of the report merely for information rather than for an analysis of any type. It would not be fair to compare the locations in Tucson with those in Yuma, because those in Tucson were experiencing problems, such as highway construction, that cannot be controlled by the operator. No attempt was made to see what effect construction might have and therefore it is not even possible to adjust figures to attempt to minimize the effect of this construction.

Changes which take place are not as drastic as those in which only Tucson or Yuma was included. When a more encompassing study such as this is done, the frame of reference must be changed so that changes of 2 percent or more should seem as important as a 6 to 7 percent change in a smaller study. Based on answers given to our questionnaires, Tucson and Yuma are both stops for a majority of the drivers so that separate analyses of both the Tucson and Yuma markets hold more meaningful information and should therefore be subject to more scrutiny than this study of the southern Arizona market.

Multiple Use of Lands Within Highway Rights-Of-Way

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ABRIDGMENT

•THIS paper reports on a survey of present experience in the multiple use of land within controlled-access highway rights-of-way for purposes other than the movement of traffic. Basic data for the study were obtained by questionnaires sent to state highway departments, toll road authorities, and several foreign countries, as well as personal interviews with officials from some of these agencies and an extensive review of published materials. The enabling legislation dealing with highway law for each state was also reviewed to summarize provisions concerning the use and disposition of controlled-access highway rights-of-way. A general evaluation of the multiple uses reported by the survey was made relative to potential demands for such uses, types of right-of-way utilized, effects on traffic operations, safety, cost, and benefits. Developments utilizing air and subsurface rights of freeways were excluded from extensive treatment by the project contract.

The survey identified some 25 types of multiple uses that have been developed in this country, utilizing all types of highway rights-of-way—medians, side strips, interchange ramp interiors and understructure areas. Multiple-use development opportunities utilizing only normal highway rights-of-way are limited generally to activities which can adapt to a linear configuration (except for ramp interiors) and which can coexist with the highway's traffic-carrying function without producing (or suffering from) adverse effects. Ramp interiors and understructure areas are conducive to a wider range of multiple-use developments than are normal medians and sidestrips. The greatest opportunity, however, for multiple-use development lies in the combining of unused portions of right-of-way with adjacent non-highway land to form developable parcels.

Inadequacies and ambiguities in existing state highway enabling legislation relative to the acquisition, interim use, and possible disposition of unused highway rights-of-way hamper the multiple use of these lands. Permitted uses under the term "highway purposes" should be identified and expanded. State highway agencies should be given powers to lease on an interim basis rights-of-way not immediately needed for highway construction, and to sell or lease on a long-term basis those lands no longer needed for highway purposes.