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Economic Impact of Selected Sections of Interstate Routes on Land Value and Use

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This study is an attempt to ascertain the economic effects of controlled-access facilities in North Carolina on surrounding property values and development. Techniques employed to isolate economic influence of highways include the use of the before-and-after method in combination with a multiple regression analysis for each period.

Three sections of Interstate routes (I-95, I-40, and I-85) in three counties (Cumberland, Guilford, and Rowan) across the State were chosen for investigation. To estimate the influence of these facilities, factors other than those associated with the highway are evaluated. Land value, selected as the indicator of economic influence, is determined by obtaining sales prices for parcels sold in the study periods. The effects of eight non-highway and two highway variables are estimated by utilizing a multiple regression analysis. The data are processed by standard procedures and then analyzed by electronic computer. Results of the analysis indicate that the average unit price of property increased significantly within all sites. However, patterns of significance for the independent variables are most erratic and, as a result, these increases cannot necessarily be attributed to the construction of the test facilities. The predominant type of land use within the study areas is farm land, whereas the most active category in terms of sales is vacant property. The statistical analysis indicates that the investigated highways have had no measurable effect on development within the study areas.

Conclusions are based on a lack of significant regression coefficients for the highway variables. If the roadway had exerted a strong independent influence, the influence would have been indicated by some consistency in in the factors affecting land value and land use. It is, therefore, concluded that the controlled-access facilities under investigation have done little to stimulate or depress surrounding property values and development during the study periods.

•WITH THE PASSAGE of the Federal Aid Highway Act of 1956, the largest highway construction program in the history of the United States was initiated. Under the program, some 41,000 miles of Interstate and Defense Highways are to be built at a total cost expected to exceed $41 billion. To North Carolina, this will mean the eventual construction of approximately 770 miles of controlled-access facilities at an expenditure estimated to approach $400 million.

Although it is generally agreed that these facilities will generate economic activity, quantitative measures of their impact on area economies are lacking. Yet such measures are urgently needed for the formulation of land planning policies, for public and private investment decisions and for fair evaluation of property values for right-of-way purposes.

In an attempt to satisfy this need, research, which has been concerned primarily with the collection of data on prices, uses, and number of sales of properties that

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have been affected by the construction of a roadway, has been conducted in various sections of the country. Although the results of these different studies have shown qualitative agreement, the quantitative agreement has been poor. Thus, the development of generally applicable quantitative measures and/or predictors of highway economic impact must await the collection of additional data.

This report contains the initial information obtained on the economic impact of controlled-access highways in North Carolina. Data concerning land prices, land uses and factors affecting land prices are presented for properties within three selected corridors along existing sections of the North Carolina Interstate System. For each corridor, data are provided for a period before and a period after construction of the facility, thus facilitating at least a quantitative estimate of the effect of the roadway. However, the major contribution of this study is its addition to the general body of information to permit the eventual development of valid and usable impact models.

METHODOLOGY

Multiple regression techniques were combined with a comparison of the areas before and after public notice of construction to ascertain the economic impact of the selected sections of Interstate routes. The general hypothesis investigated was that land value decreases with an increasing distance from the highway in the after period, whereas in the pre-highway period, land value follows no particular pattern with respect to the Interstate route. To test this hypothesis, correlations between the logarithms of sales prices of parcels of land and shortest straight-line distances from these parcels to Interstate access and right-of-way were determined for a 5-mile-wide band centered on the facility. Selected non-highway variables were also included in the analysis to remove non-highway effects and to gain a better insight into factors affecting land value and land use.

The sale price of each transaction was determined from the value of revenue stamps shown on warranty deeds, together with the outstanding balances of deeds of trust. In the original form, the unit prices obtained were grossly non-normal. It was found that a natural log transformation normalized them. This transformation was necessitated by the dependence of statistical tests on normality of data. Selection of influence area on previous impact studies has been arbitrary but generally has not exceeded 4½ miles.

Site Selection

As of July 1960 there were approximately 200 miles of completed Interstate highways in North Carolina. Selection of test sites from this mileage was limited to those sections of highways which had existed a sufficient time to exhibit an influence on the surrounding land. (Public notice of highway construction at least 3 years before July 1960 was necessary for a facility to be considered as a possible test site. Five sections totaling about 57 miles satisfied this condition. The locations of these sections are shown in Figure 1.

These five sections of Interstate routes can be classified as follows:

1. Radial-interurban highways passing through the rural-urban fringe (I-95 northeast of Fayetteville, I-85 southwest of Salisbury, and I-40 west of Greensboro),
2. Tangential or circumferential highways bypassing major urbanized areas in their immediate proximity (I-85 bypassing Charlotte), and
3. Urban freeways bisecting urbanized areas (I-40 passing through Winston-Salem).

This study concentrated on the radial highways in rural-urban fringe areas. The study of radial highways has the advantage over that of tangential roads on the edges of urbanized areas to the extent that distances from the facility and from the nearest central business district are perpendicular to each other. It is, therefore, less difficult to isolate the influence of the highway from the influence of the city per se. Moreover, the rural-urban fringe, being largely undeveloped, permits tracing of geographic change with greater clarity. Where radial roads pass through the fringes of urbanized areas, conditions on these roads are comparable to conditions on urban bypasses, so a study of circumferential highways was not considered to be essential. The only urban Inter-

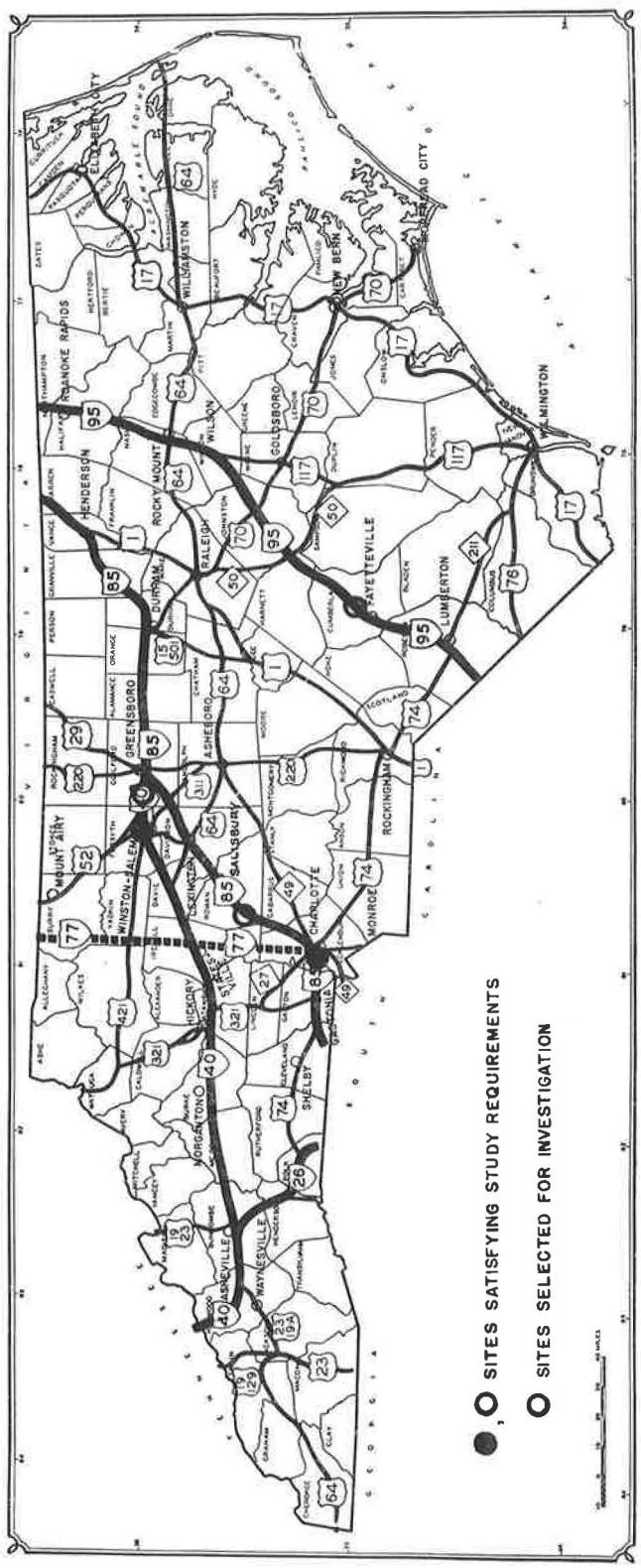

Figure 1. Location of test sites.

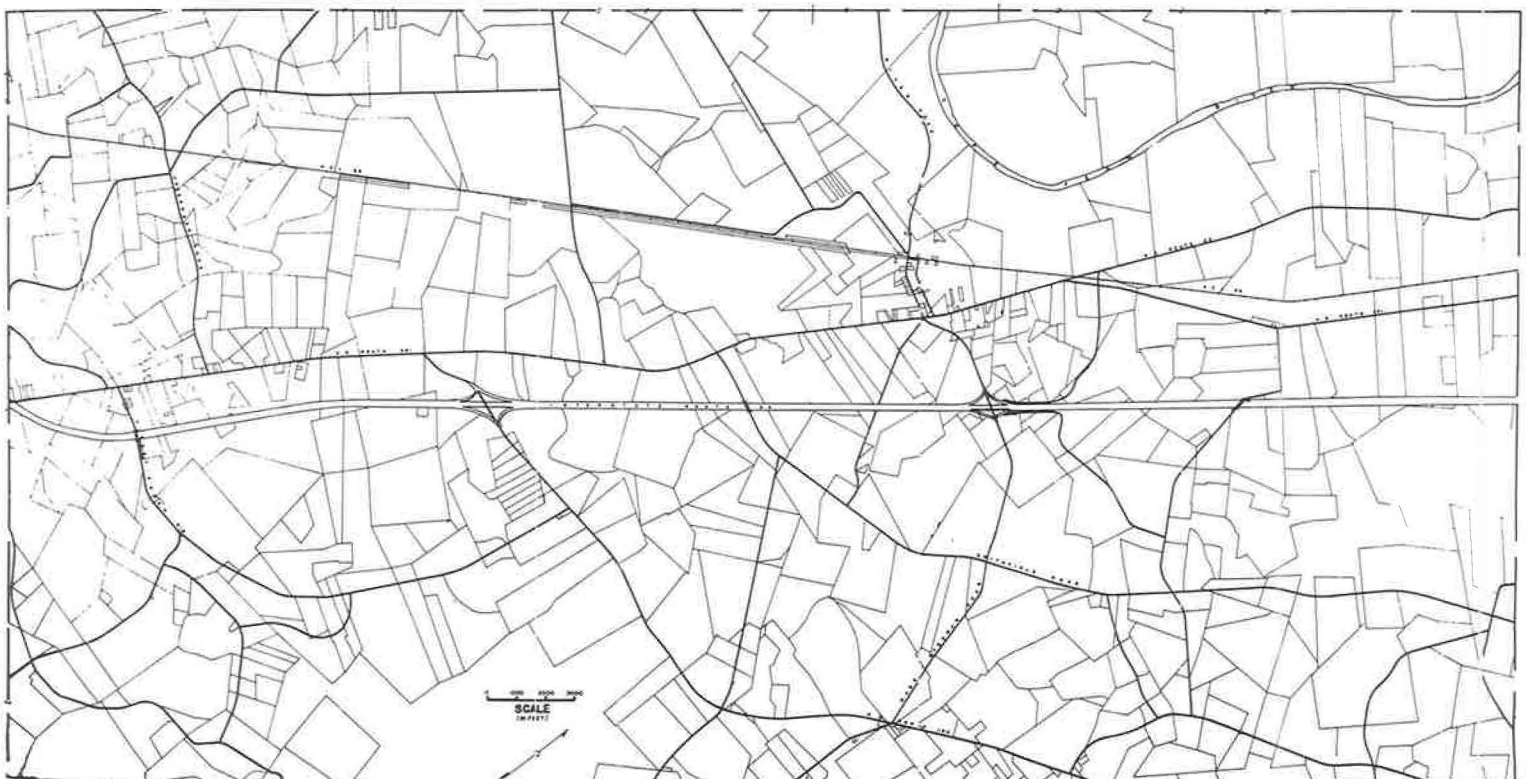

Figure 2. Site map of I-95 in Cumberland County.

Figure 3. Before-period aerial view of I-95 site.

Figure 4. After-period aerial view of I-95 site.

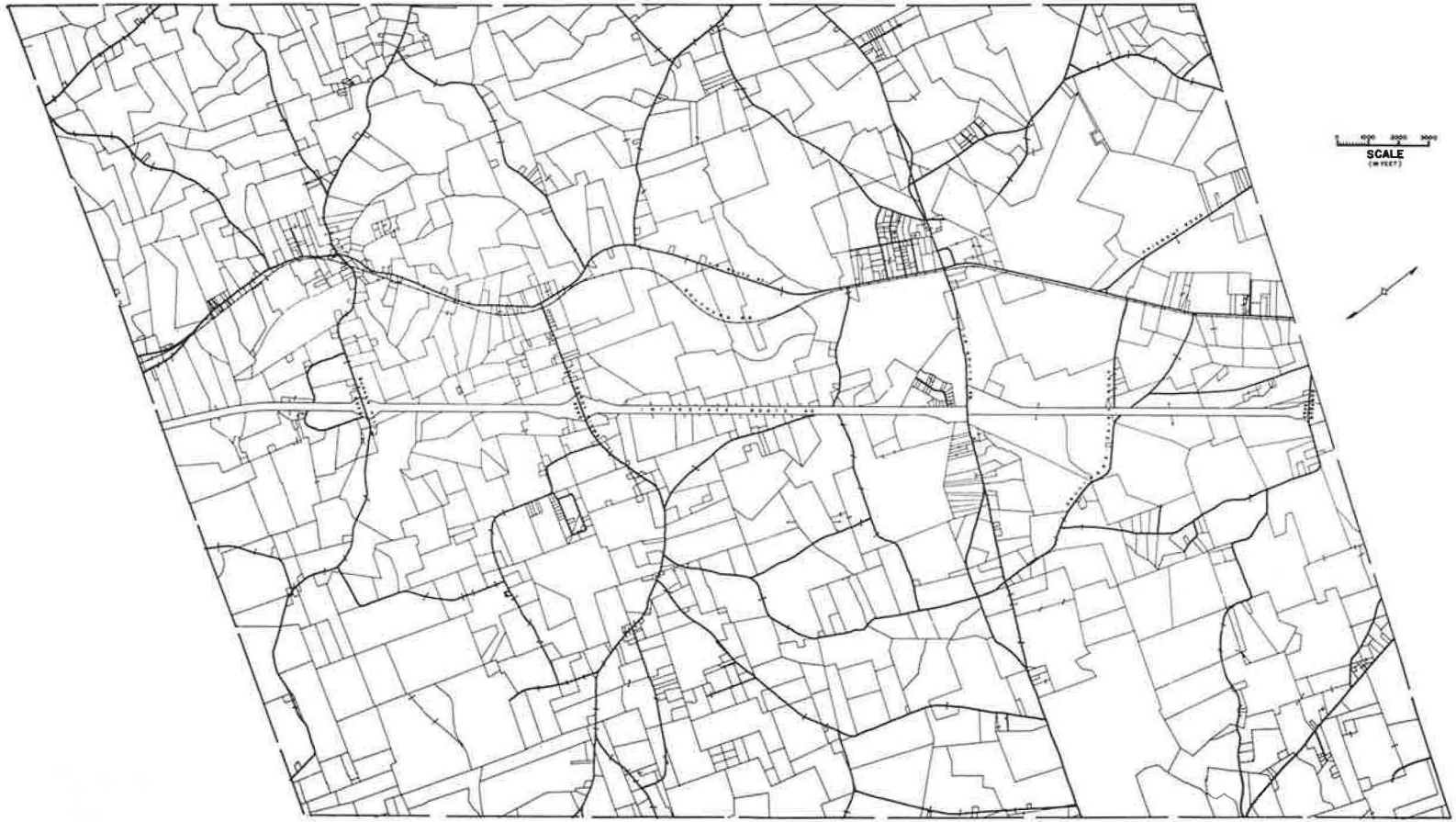

Figure 5. Site map of I-40 in Guilford County.

Figure 6. Before-period aerial view of I-40 site.

Figure 7. After-period aerial view of T-40 site.

state freeway in North Carolina is a 1-mile section of I-40 through Winston-Salem; the complexity of this urban situation placed it beyond the scope of this study. Because of these limitations, sites in three counties (Cumberland, Guilford, and Rowan) were selected for investigation.

Cumberland County Site.—As shown in Figure 2, the Cumberland County site includes a ten-mile section of I-95 lying northeast of Fayetteville. First public notice was given in January 1957, and the section was opened to traffic in October 1960. The surrounding area is primarily rural in nature with development scattered throughout the site (Figs. 3 and 4). Within the site, I-95 parallels US 301.

Guilford County Site.—As indicated in Figure 5, the Guilford County site includes a 5-mile section of I-40 located west of Greensboro. First public notice was given in September 1955, and the section was opened to traffic in August 1958. A considerable amount of development has taken place within the study area (Figs. 6 and 7). I-40 is parallel to US 421.

Rowan County Site.—The Rowan County site includes 5 miles of I-85 southwest of Salisbury (Fig. 8). First public notice was given in September 1955, and the section was opened to traffic in July 1958. Development in the area has been quite substantial in recent years (Figs. 9 and 10). I-85 in this area is parallel to US 29-601.

Before and After Periods

The time of public notice of proposed construction was used to segregate sales into the before or after period. As previously indicated, no facility was considered for study for which public notice of proposed construction had not been given before July 1957. This restriction was necessary to insure sufficient sales in the after period for determining post-highway conditions. Therefore, January 1, 1947, to June 30, 1961, was selected as the overall study period for all test sections. The beginning date was selected to provide an adequate number of sales in the before period to determine pre-highway conditions. The closing date, June 30, 1961, marked the beginning of data collection procedures in the field.

Data Collection

To perfect data collection procedures, a pilot study was conducted on a 3 ½-mile section of US 15-501 between Durham and Chapel Hill. Although the section was not an Interstate route, it was chosen because its nearness to Raleigh permitted any complication in data collection procedures to be resolved with expediency. Before and after airphotos of this site are shown in Figures 11 and 12.

The primary sources of information were found to be the county offices of the Tax Supervisor and Registrar of Deeds. Using property tax maps and records it was possible to prepare current base maps and determine present property ownership. Tax records and warranty deeds were used to trace successive ownership of each parcel back to the beginning study date. During this process, needed sales data (Fig. 13) were abstracted and property boundary changes were noted on the base map. Tax maps and records, warranty deeds, Agricultural Stabilization and Conservation airphotos, and field checks were used to determine land use. The pilot study base map and before and after land-use maps are shown in Figures 14, 15 and 16, respectively.

As previously mentioned, the land values obtained in this study were determined from revenue stamps affixed to the deeds of sale, together with outstanding balances due on deeds of trust. The validity of this procedure was investigated by a small home-interview survey conducted as part of the pilot study. The results of this survey indicated that for large samples, the tax stamp evaluation could be used as an approximate indicator of the actual sale price of land.

Data Analysis Techniques

The multiple regression equation used in this study is as follows:

Figure 8. Site map of I-85 in Rowan County.

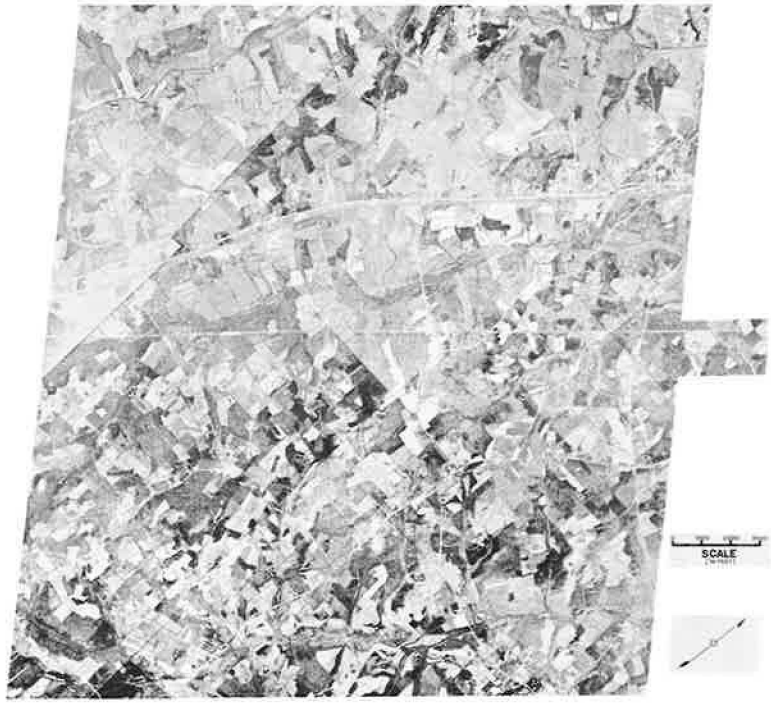

Figure 9. Before-period aerial view of I-85 site.

Figure 10. After-period aerial view of I-85 site.

$$y = b_0 + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + b_5x_5 + b_6x_6 + b_7x_7 + b_8x_8 + b_9x_9 + b_{10}x_{10} \quad (1)$$

in which

y = land value;
x_1 = size of parcel;
x_2 = year of sale;
x_3 = vacant-non-vacant land use;
x_4 = rural-urban land use;
x_5 = subdivision;
x_6 = roadside;
x_7 = alternate roadway;
x_8 = distance to right-of-way;
x_9 = distance to central business district;
x_{10} = distance to access;
b_0 = intercept on y axis; and
$b_1, \ldots b_{10}$ = contributions of $x_1, \ldots x_{10}$, respectively.

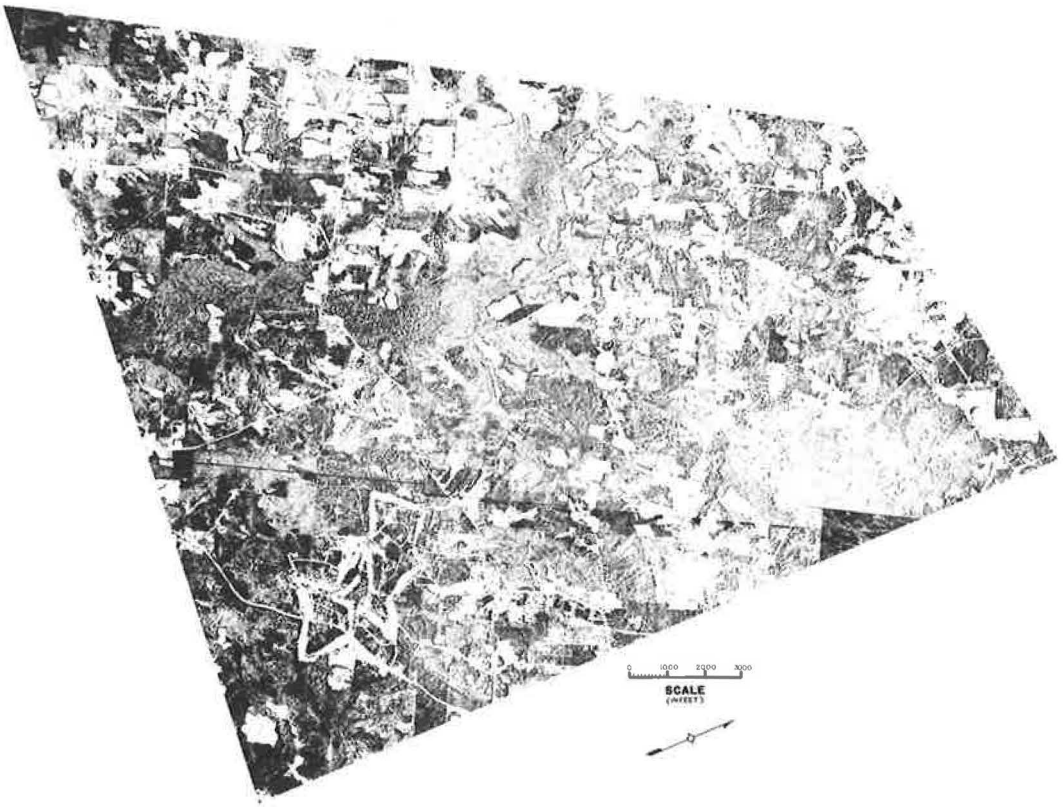

Figure 11. Before-period aerial view of US 15-501 site, Durham County.

This equation gives a measure of the linear effect of each of the specified variables on the log of the unit price. A brief discussion of each of the variables follows:

1. Size of Parcel.—The parcel area, measured to the nearest 0.1 acre, was recorded for each sale. This variable was included to isolate any log price variation attributable to parcel size.

2. Year of Sale.—The date of sale was recorded for each transaction. This variable removed any linear increase in log price occurring during the study period.

3. Vacant—Non-Vacant Land Use.—All sales were classified as being either vacant or non-vacant. This variable determined whether there was a significant difference in the sales prices of raw land as opposed to improved land.

4. Rural-Urban Land Use.—All sales were also classified as either rural or urban. This variable was included to disclose any difference in the sales prices of land primarily rural in nature and land located in urban surroundings.

5. Subdivision.—Each sale occurring within a subdivision was noted. This variable was included to ascertain if a significant difference existed between sales prices of parcels located in subdivisions and those located elsewhere.

6. Roadside.—Each sale was classified according to its roadside location with respect to the test facility. Because the Interstate route paralleled an existing major route within each test area, it was desirable to determine whether there was a significant difference between the sales prices of parcels with access to an alternate major route and those with access only to the Interstate route.

7. Alternate Roadway.—Sales of parcels fronting the existing major route were also noted. This variable determined any difference in impact on these parcels vs all other parcels.

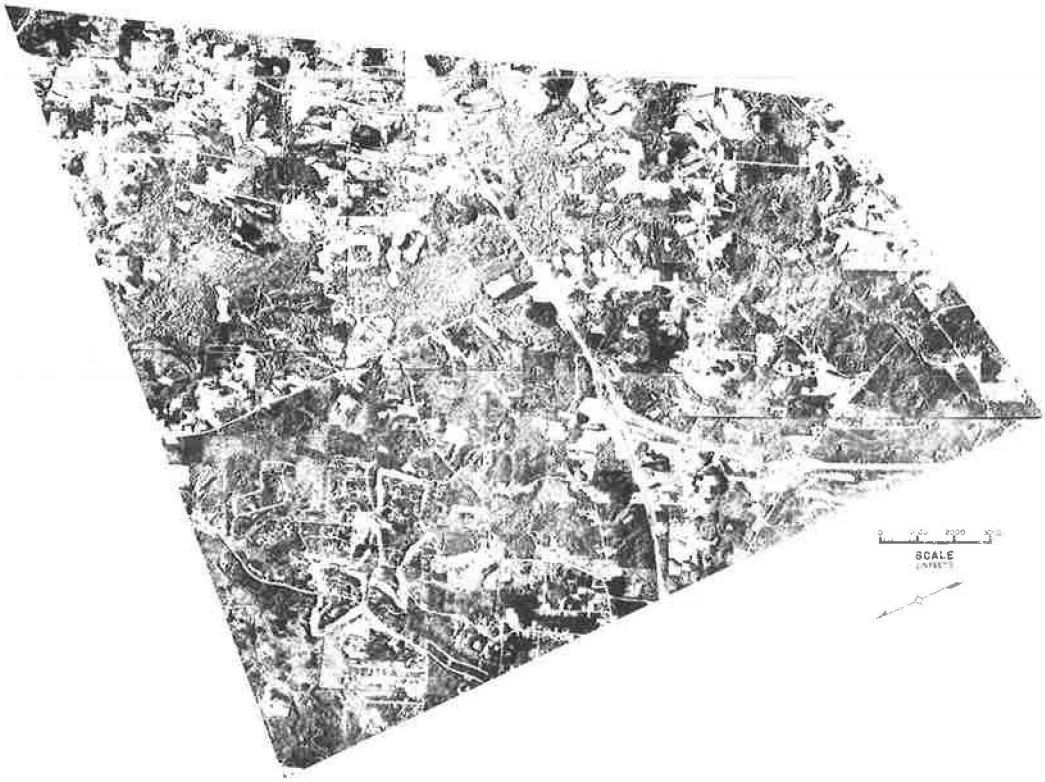

Figure 12. After-period aerial view of US 15-501 site, Durham County.

Site No. Deed Book Page

Map Block Lot

Recorder:

Grantee: Grantor:

Parcel Location:

Sale Date Day Mo. Yr.

No. Acres

Tax Stamps

Unit Price

Land Use Description

ROW ACC CBD

Index No. Land Use Roadside Period

Figure 13. Sample data card.

Figure 14. Site map of US 15-501 in Durham County.

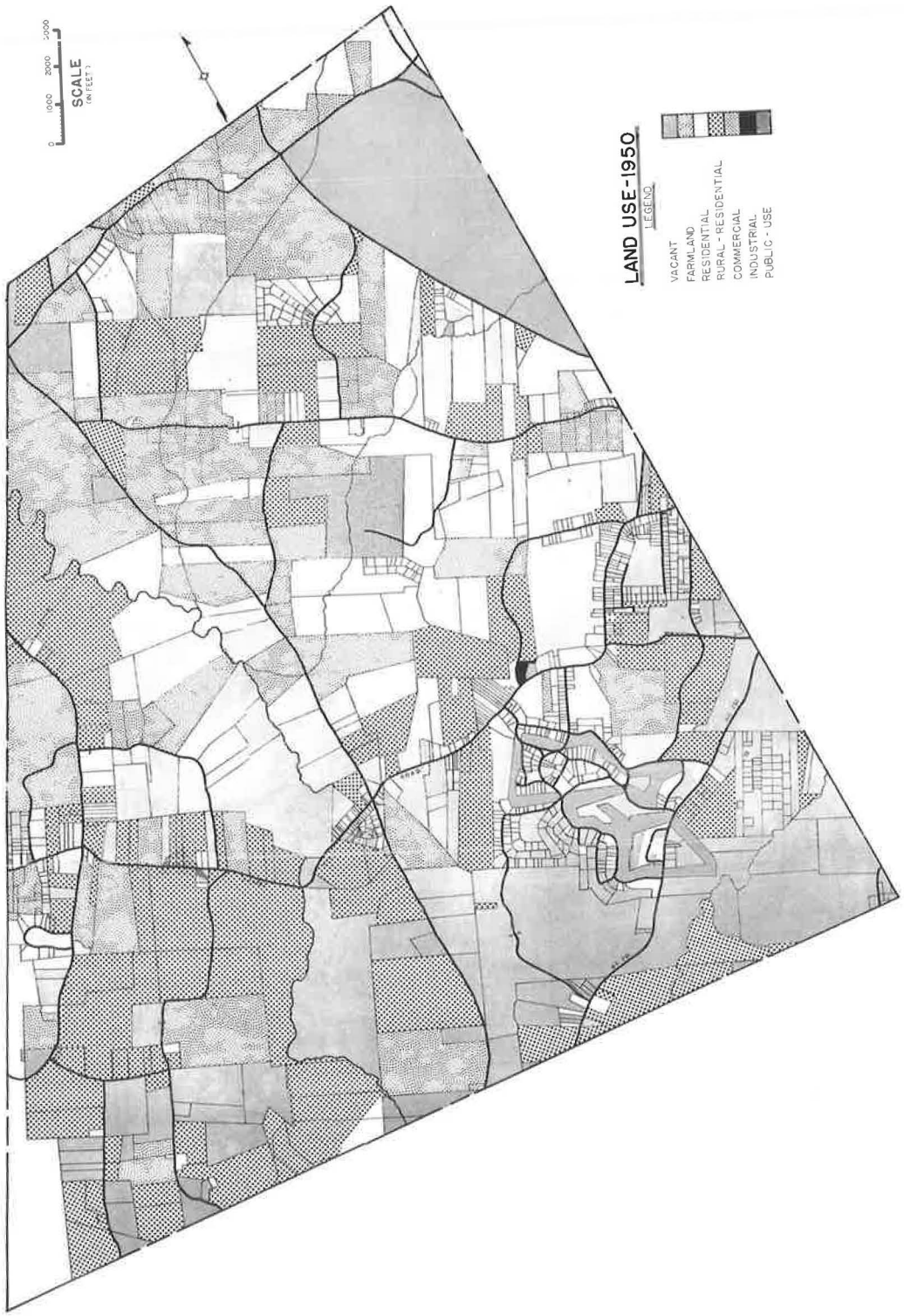
SCALE
(IN FEET)
0
1000
2000
3000
LAND USE-1950
LEGEND
VACANT
FARMLAND
RESIDENTIAL
RURAL - RESIDENTIAL
COMMERCIAL
INDUSTRIAL
PUBLIC - USE

Figure 16. Land use after US 15-501.

8. Distance to Central Business District. —Distance to central business district was determined for each sale by measuring the shortest, straight-line distance from the parcel to the center of the adjoining city. This variable isolated any linear increase in log price associated with this factor.

9. Distance to Right-of-Way. —Distance to right-of-way was determined for each sale by measuring the shortest, straight-line distance from the parcel to the Interstate right-of-way.

10. Distance to Access. —Distance to access was determined for each sale by measuring the shortest, straight-line distance from the parcel to the nearest Interstate interchange.

As previously indicated, the variables directly associated with the highway are distance to right-of-way and distance to access. The significance of these two variables in influencing sales prices of land served to measure the economic impact of the selected sections of Interstate routes.

A regression analysis, using the preceding regression equation, was first performed for each test site on all parcels of land sold in the before period and on all parcels of land sold in the after period. All analyses were performed on the UNIVAC 1105 Computer at the Computation Center of the University of North Carolina. The program utilized was the multiple regression or correlation program NCGBC9. The results of this analysis indicated that the land-use variables x_3 (vacant-non-vacant land use) and x_4 (rural-urban land use) were highly significant factors in influencing sales prices. Therefore, a more detailed land-use classification was made and a second analysis was performed for each test site on each of the classifications. The land-use classifications utilized are: (a) vacant, (b) farm land, (c) residential, (d) public, (e) commercial, (f) industrial, and (g) rural-residential.

Because the x_3 and x_4 variables remain constant for each specific land use, they were omitted from the regression equation in the second analysis. The analysis provided the following statistical measures for each test site: (a) means and standard deviations of unit prices; (b) means and standard deviations of each independent variable; (c) simple correlation coefficients between the independent variables; (d) simple correlation coefficients between the dependent variable and independent variables; and (e) estimates of regression parameters, including b values, t values, standard errors, and multiple correlation coefficients.

ANALYSIS OF LAND VALUE FINDINGS

Discussion is restricted here to those classes of land use for which 30 or more samples were obtained in both the before and after periods. The use of this minimum sample size is necessitated by the large variation in the data. Vacant land in the Cumberland County site is omitted from the discussion because of the presence of an obviously abnormal sample. Although an attempt was also made to determine the impact of the test facilities on land values at interchanges, an insufficient number of parcel sales in the immediate interchange areas was available for such an analysis.

The results of this study indicate that the construction of a controlled-access roadway has no disruptive effect on the overall property values in the general area in which the roadway is constructed. This conclusion is based on the absence of significant correlation coefficients for the highway variable.

In each site, the average price of all land was significantly higher in the after period as compared to the before period (Table 1). This same general increase is also found at each site in all but one of the separate land-use categories. The single exception was rural-residential land in Rowan County, where the land value decreased 27 percent. The cause of this decrease could not be ascertained, but it did not appear to be directly connected with the construction of the highway.

Accompanying the consistent increase in price of land was a consistent decrease in the average size of parcels sold (Table 2). For all sites and land-use categories, smaller parcels were sold in the after period than in the before period. This, however, rather than necessarily reflecting any direct effect of the roadway, may simply indicate the effect of an increasing population on a fixed land supply.

TABLE 1

MEAN UNIT PRICES

Site	Land Use	Mean Values ($/acre)						% Change
		Before			After			
		N	Price	Std. Dev.	N	Price	Std. Dev.	
Cumberland Co.	All	199	2,592	11,769	115	2,687	7,756	3.6
	Vacant	81	5,352	17,961	32	3,891	11,881	-27.3
	Farm	109	168	289	66	203	331	21.2
Guilford Co.	All	367	1,059	4,252	304	2,632	5,166	58.7
	Vacant	164	949	2,161	127	1,166	1,499	22.9
	Farm	110	170	173	90	507	719	198.2
	Residential	55	6,327	6,836	58	7,976	7,390	26.1
	Commercial	13	5,781	11,298	10	10,817	13,195	87.1
	Rural residential	23	428	613	14	1,272	1,155	197.2
Rowan Co.	All	468	1,769	3,386	358	4,124	7,083	133.0
	Vacant	290	999	1,566	153	1,451	3,207	45.2
	Farm	43	160	144	21	205	116	28.1
	Residential	85	5,496	5,815	141	8,124	8,995	47.8
	Rural residential	41	563	603	31	422	465	-24.8

TABLE 2

AVERAGE VALUES OF INDEPENDENT VARIABLES

Site	Land-Use Type	No. Obser.	Period	Independent Variables							
				Size of Parcel	Year of Sale[a]	Subdi-vision	Road-side	Alt. Roadway	Dist. to ROW	Dist. to CBD	Dist. to Access
Cumberland	Vacant	81	Before	4.000	6.037	0.308	0.308	0.012	0.927	10.127	1.272
		32	After	1.456	12.937	0.250	0.187	-	0.498	9.380	0.999
	Farm	109	Before	44.506	5.733	0.247	0.385	-	1.078	9.732	1.444
		66	After	46.831	12.303	0.106	0.378	-	1.148	9.455	1.499
Guilford	Vacant	164	Before	8.849	5.128	0.158	0.579	0.408	1.068	10.281	1.389
		127	After	4.574	11.850	0.102	0.590	0.370	0.936	10.416	1.217
	Farm	110	Before	41.709	4.540	0.036	0.545	-	1.167	10.611	1.474
		90	After	30.398	11.177	0.033	0.411	-	1.118	10.607	1.375
	Resi-dential	55	Before	1.780	5.036	0.272	0.781	0.309	0.898	10.776	1.279
		58	After	1.479	11.586	0.137	0.672	0.293	0.980	9.954	1.261
	Com-mercial	13	Before	8.930	4.923	0.769	1.000	0.307	0.506	8.091	0.678
		10	After	29.590	11.200	0.400	0.800	0.200	0.568	9.010	0.703
	Rural-resi-dential	23	Before	12.817	4.782	0.043	0.391	-	1.292	11.372	1.623
		14	After	6.407	11.500	0.071	0.357	-	1.252	10.080	1.467
Rowan	Vacant	290	Before	5.872	4.727	0.241	0.682	0.627	0.979	5.022	1.081
		153	After	5.017	11.627	0.091	0.542	0.392	1.142	4.494	1.245
	Farm	43	Before	55.841	3.953	0.023	0.465	0.046	1.083	4.813	1.217
		21	After	78.057	11.666	-	0.333	-	1.371	4.885	1.449
	Resi-dential	85	Before	1.341	4.823	0.117	0.776	0.505	1.187	3.943	1.310
		141	After	.736	11.822	0.071	0.588	0.496	1.078	4.134	1.169
	Rural-resi-dential	41	Before	9.978	4.634	0.024	0.195	0.024	1.270	5.093	1.401
		31	After	8.254	11.580	-	0.129	-	1.047	4.975	1.178

[a]To determine the year of sale, add figure in column to base year 1947.

There are no other consistent trends discernible in the data. Although the average price of land increased in all sites, the magnitudes and percentages of these increases varied greatly between sites and between land uses. A further verification of the variability of the results is found in the simple correlation and multiple regression analyses of factors affecting land value (Tables 3 and 4). The most important single factor influencing land value for all of the land-use types is size of parcel. As expected, unit prices of property were consistently correlated negatively with size of parcel indicating that the smaller the parcel, the higher the unit price. The variables, year of sale,

TABLE 3

SIMPLE CORRELATION COEFFICIENTS

Site	Land-Use Type	No. Obser.	Period	Independent Variables							
				Size of Parcel	Year of Sale	Subdi-vision	Road-side	Alt. Roadway	Dist. to ROW	Dist. to CBD	Dist. to Access
Cumberland	Vacant	81	Before	-0.524[a]	0.207	0.176	-0.093	-0.073	-0.131	-0.222[a]	-0.093
		32	After	-0.354[a]	0.252	0.069	-0.376[a]	-	-0.127	-0.385[a]	-0.014
	Farm	109	Before	-0.400[a]	0.136	0.254	-0.053	-	-0.155	0.152	-0.212[a]
		66	After	-0.121	-0.006	0.033	0.330[a]	-	-0.193	0.114	-0.198
Guilford	Vacant	164	Before	-0.462[a]	0.142	0.153	0.374[a]	0.237[a]	-0.154	0.094	-0.143
		127	After	-0.399[a]	0.245[a]	0.134	0.409[a]	0.386[a]	-0.183	-0.199[a]	-0.275[a]
	Farm	110	Before	-0.273[a]	0.126	0.114	0.058	-	-0.049	-0.044	-0.102
		90	After	-0.225[a]	-0.016	0.221	0.241[a]	-	0.046	-0.429[a]	-0.045
	Resi-dential	55	Before	-0.432[a]	-0.063	0.319[a]	0.376[a]	-0.003	-0.096	0.181	-0.198
		58	After	-0.511[a]	0.333[a]	0.185	0.328[a]	0.120	0.145	-0.125	0.014
	Com-mercial	13	Before	-0.422	0.189	0.453	0.474	-0.039	-0.100	-0.085	0.820[a]
		10	After	-0.426	0.472	0.531	0.619	0.424	0.099	-0.002	0.071
	Rural-resi-dential	23	Before	-0.342	0.191	0.355	0.594[a]	-	-0.009	0.353	0.202
		14	After	-0.170	0.043	0.176	0.347	-	0.222	-0.071	0.068
Rowan	Vacant	290	Before	-0.403[a]	0.137	0.442[a]	0.263[a]	0.454[a]	-0.178	0.043	-0.210[a]
		153	After	-0.336[a]	0.186	0.298[a]	0.391[a]	0.386[a]	-0.110	-0.219[a]	-0.154
	Farm	43	Before	-0.435[a]	-0.191	0.318	0.037	0.071	0.122	-0.194	0.100
		21	After	-0.118	0.173	-	-0.223	-	-0.184	-0.339	-0.231
	Resi-dential	85	Before	-0.414[a]	0.040	0.126	0.330[a]	0.296[a]	-0.226[a]	-0.181	-0.283[a]
		141	After	-0.495[a]	0.042	0.169	0.357[a]	0.063	-0.134	-0.105	-0.136
	Rural-resi-dential	41	Before	-0.583[a]	0.114	0.090	-0.107	-0.055	0.386[a]	0.354[a]	0.424[a]
		31	After	-0.195	0.242	-	-0.230	-	0.436[a]	0.135	0.443

[a]Indicates significant coefficients at 95 percent level.

TABLE 4

MULTIPLE REGRESSION COEFFICIENTS AND STUDENT "T" VALUES

Site	Land-Use Type	Period	b & t Values	Independent Variables: Size of Parcel	Year of Sale	Subdivision	Roadside	Alt. Roadway	Dist. to ROW	Dist. to CBD	Dist. to Access
Cumberland	Vacant	Before	b	-0.104	0.083	0.912	-0.209	-2.301	0.924	-0.139	-0.195
			t	-4.874[a]	1.274	1.799	-0.439	1.333	1.359	-1.396	-0.350
		After	b	-0.241	0.340	0.105	-1.393	-	-0.067	-0.204	0.816
			t	-2.588[a]	1.480	0.134	-1.906	-	-0.061	-1.718	0.784
	Farm	Before	b	-0.008	0.062	0.613	0.071	-	0.671	0.117	-0.911
			t	-4.568[a]	1.914	2.030	0.307	-	2.176[a]	2.824[a]	-2.893[a]
		After	b	-0.001	0.023	0.348	0.891	-	0.175	-0.012	-0.309
			t	-0.595	0.184	0.581	2.385[a]	-	0.334	-0.172	-0.566
Guilford	Vacant	Before	b	-0.028	0.098	-0.048	0.774	0.058	-0.488	-0.072	-0.090
			t	-5.574[a]	2.393[a]	-0.154	3.892[a]	0.262	-1.407	-0.937	-0.271
		After	b	-0.019	0.160	0.744	0.784	0.245	0.158	-0.170	-0.369
			t	-2.230[a]	3.807[a]	2.506[a]	4.686[a]	1.478	0.576	-3.361[a]	-1.322
	Farm	Before	b	-0.007	0.062	0.341	0.086	-	0.268	-0.024	-0.363
			t	-3.260[a]	1.460	0.684	0.473	-	1.051	-0.426	-1.235
		After	b	-0.006	0.029	1.176	0.529	-	0.713	-0.174	-0.685
			t	-1.592	0.492	2.320	2.627[a]	-	1.636	-3.030[a]	-1.559
	Residential	Before	b	-0.164	0.001	0.487	1.397	-0.432	-0.071	0.027	-0.625
			t	-3.427[a]	0.005	0.995	2.585[a]	-0.957	-0.090	0.182	-1.096
		After	b	-0.336	0.121	0.814	0.626	-0.053	0.422	-0.063	-0.347
			t	-4.649[a]	1.795	2.048[a]	1.874	-0.163	1.008	-0.693	-0.793
	Commercial	Before	b	-0.092	-0.179	0.729	-	3.673	-7.460	-0.850	-1.606
			t	-2.086[a]	-0.693	0.586	-	2.560[a]	-2.435[a]	-2.053[a]	0.725
		After	b	-0.006	0.673	1.601	0.829	1.175	-0.940	0.251	0.251
			t	-0.650	1.884	1.391	0.472	0.886	-0.354	0.582	0.082
	Rural-residential	Before	b	-0.059	0.158	1.325	0.921	-	-0.423	-0.046	1.103
			t	-2.786[a]	1.406	1.040	1.278	-	-0.436	-0.158	1.242
		After	b	-0.041	0.030	-0.382	1.095	-	3.722	0.334	-3.971
			t	0.339	-0.710	0.108	-0.221	-	1.284	2.090[a]	-1.843
Rowan	Vacant	Before	b	-0.016	0.081	1.040	0.176	1.040	0.023	-0.302	-0.013
			t	-4.707[a]	3.068[a]	6.973[a]	1.412	7.346[a]	0.049	-6.146[a]	-0.027
		After	b	-0.031	0.095	0.771	0.513	0.785	1.254	-0.122	-1.277
			t	-3.886[a]	2.105[a]	2.376[a]	2.580[a]	3.924[a]	-1.708	-1.944	-1.659
	Farm	Before	b	-0.007	-0.021	2.478	0.478	-1.903	-0.267	-0.212	0.625
			t	-2.557[a]	-0.417[a]	2.353	1.571	-2.222[a]	-0.167	-2.072[a]	0.361
		After	b	0.002	-0.018	-	-0.458	-	1.937	-0.078	-2.263
			t	0.773	-0.189	-	-1.158	-	1.273	-0.671	-1.350
	Residential	Before	b	-0.177	0.067	0.162	0.619	0.394	-2.456	-0.215	1.902
			t	-3.521[a]	1.090	0.334	1.475	1.381	-1.935	-1.593	1.429
		After	b	-1.222	0.019	0.422	0.624	-0.354	-2.068	0.023	1.779
			t	-5.608[a]	0.324	0.910	2.334[a]	-1.417	-2.048[a]	0.243	1.742
	Rural-residential	Before	b	-0.057	-0.005	2.003	-1.310	-1.300	-3.627	-0.466	4.648
			t	-3.715[a]	-0.076	2.287[a]	-2.826[a]	-1.631	-3.092[a]	-3.487[a]	3.432[a]
		After	b	-0.055	0.163	-	-0.771	-	-0.639	-0.191	1.203
			t	-1.547	1.647	-	-1.408	-	-0.409	-1.098	0.694

[a]Indicates significant values at 95 percent level.

subdivision, roadside, alternate roadway and distance to central business district, failed to indicate any pattern of significance in these analyses. For specific land-use types, certain of the factors showed high simple correlations with price; however, these correlations vanished when the multiple regression analysis was used, indicating relationships between the independent variables rather than between the unit price and the independent variables.

A final possible trend can be noted in the variances in the data (Tables 1 and 5). The variances of most of the land prices are slightly higher in the after period than in the before period. This indicated that the roadways may have introduced additional price fluctuations into the local land markets. Eventually, when a new state of equilibrium is reached, the variances should approach their original values. Perhaps this

TABLE 5

STANDARD DEVIATIONS OF EACH INDEPENDENT VARIABLE

Site	Land-Use Type	No. Obser.	Period	Independent Variables							
				Size of Parcel	Year of Sale	Subdi-vision	Road-side	Alt. Roadway	Dist. to ROW	Dist. to CBD	Dist. to Access
Cumberland	Vacant	81	Before	9.471	2.874	0.465	0.465	0.111	0.692	2.312	0.669
		32	After	3.017	1.162	0.439	0.396	-	0.451	2.665	0.440
	Farm	109	Before	60.125	3.011	0.433	0.488	-	0.828	2.495	0.769
		66	After	100.664	1.300	0.310	0.488	-	0.777	2.538	0.734
Guilford	Vacant	164	Before	19.143	2.265	0.366	0.507	0.493	0.654	1.988	0.666
		127	After	9.615	1.877	0.304	0.493	0.484	0.649	1.737	0.684
	Farm	110	Before	42.015	2.236	0.188	0.500	-	0.784	1.926	0.731
		90	After	25.752	1.666	0.180	0.494	-	0.704	1.901	0.725
	Resi-dential	55	Before	4.056	2.142	0.449	0.416	0.466	0.409	1.932	0.502
		58	After	1.893	1.882	0.347	0.473	0.459	0.532	1.850	0.523
	Com-mercial	13	Before	9.288	2.325	0.438	-	0.480	0.223	1.259	0.255
		10	After	72.564	1.475	0.516	0.422	0.422	0.304	1.672	0.321
	Rural-resi-dential	23	Before	11.224	2.109	0.208	0.499	-	0.563	1.406	0.684
		14	After	5.799	1.556	0.267	0.497	-	0.640	1.464	0.582
Rowan	Vacant	290	Before	16.871	2.105	0.428	0.466	0.484	0.658	1.380	0.627
		153	After	10.796	1.894	0.289	0.499	0.589	0.740	1.664	0.709
	Farm	43	Before	43.750	2.170	0.152	0.504	0.213	0.849	1.447	0.814
		21	After	93.922	1.591	-	0.483	-	0.793	1.178	0.752
	Resi-dential	85	Before	3.550	2.284	0.324	0.419	0.502	0.555	1.486	0.517
		141	After	0.614	1.924	0.257	0.493	0.501	0.461	1.379	0.455
	Rural-resi-dential	41	Before	8.531	2.199	0.156	0.401	0.156	0.871	1.439	0.781
		31	After	5.509	1.928	-	0.340	-	0.814	1.490	0.760

trend represents a direct impact of the roadways on the economies of their respective areas. However, this impact is supported by such meager evidence that it should be regarded as speculation rather than fact.

ANALYSIS OF LAND-USE FINDINGS

A visual representation of the land use within the study areas both before and after construction of the test facilities is accomplished here by including before and after land-use maps for each site. Sources of information for determining land use were tax maps and records, warranty deeds, Agricultural Stabilization and Conservation airphotos and field checks.

As illustrated in Figures 17 through 22, the predominant types of land use are farm land and vacant property. In Guilford and Rowan Counties, the vacant property classification experienced the greatest number of sales, whereas in Cumberland County farm land was the most active classification.

The magnitude of the change in parcel size was erratic. A land-use category that doubled in size in one site increased only a small percentage in another. The location of property sales with respect to distance to central business district also followed no pattern between the before and after periods. In Guilford County, there was no significant change in the average distance to Greensboro for property sold in the before and after periods. In Cumberland County, the location of property sales moved significantly closer to Fayetteville. In Rowan County, vacant land moved closer to Salisbury, farm land moved farther away and residential land remained unchanged. Location with respect to access and/or right-of-way of the roadway was also inconsistent. A specific land-use type would move closer to Interstate right-of-way and/or access in one site, whereas in another site the converse would be true. The other location measures—roadside, alternate roadway and subdivision—showed the same absence of pattern.

Figure 17. Land use before I-95, Cumberland County.

Figure 18. Land use after I-95, Cumberland County.

Figure 19. Land use before I-40, Guilford County.

Figure 20. Land use after I-40, Guilford County.

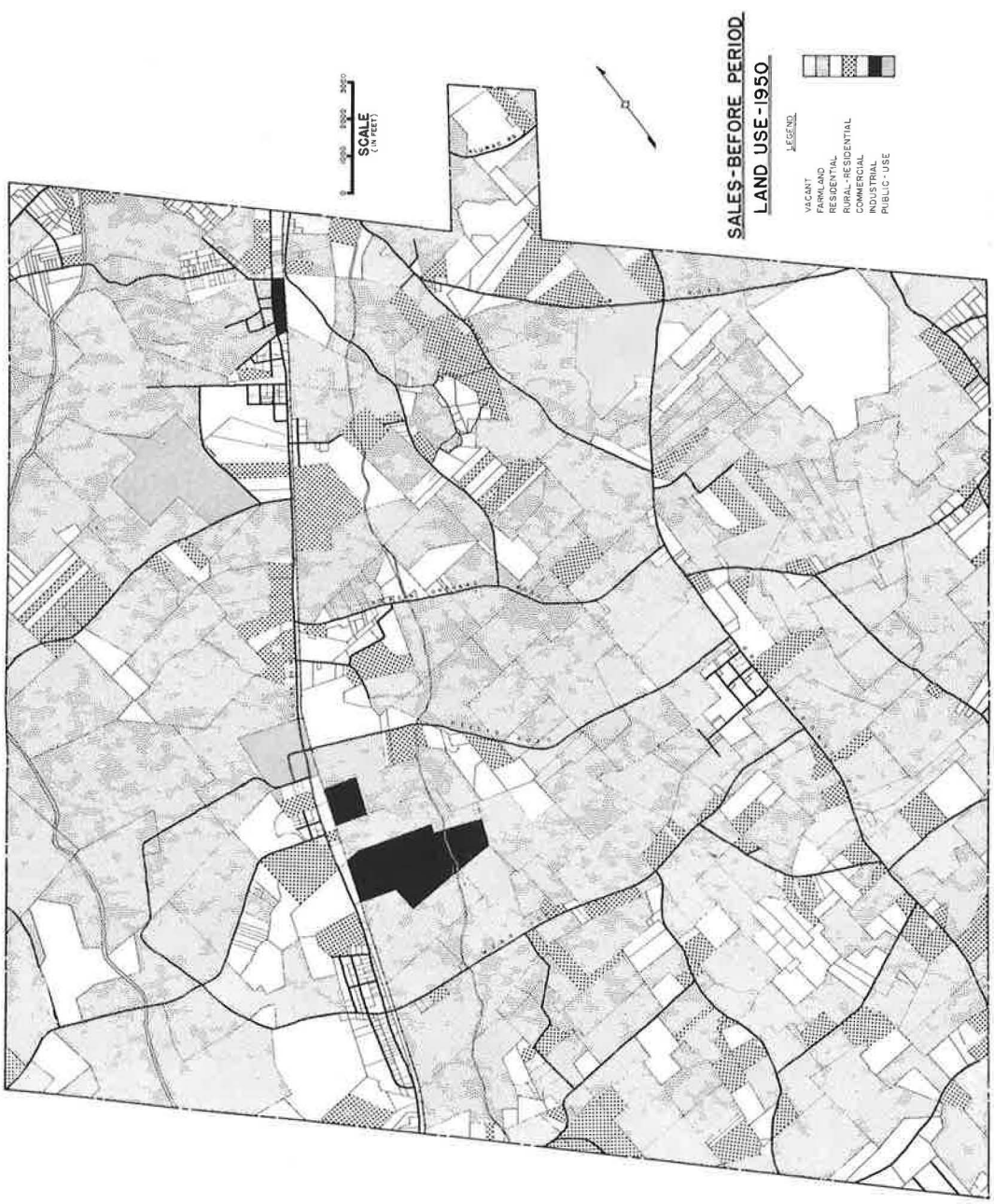

Figure 21. Land use before I-85, Rowan County.

Figure 22. Land use after I-85, Bowen County

SUMMARY AND CONCLUSIONS

This study has investigated certain factors associated with highway impact in an attempt to determine what influence the construction of controlled-access highways has had on surrounding land values and uses. Factors other than those directly associated with the highway were included in the analysis to remove their effect and thereby obtain a better estimate of highway influence. Land values were determined by converting the revenue stamp value to sale price and adding any balances due on deeds of trust at time of sale.

The effects of the independent variables were investigated by use of multiple regression techniques. It was determined that this analysis must be performed on each land use and test site separately because large variances prohibited the pooling of data. Factors that were highly correlated to unit price in the simple correlation failed to be so in the multiple regression analysis, indicating the existence of relationships among the independent variables rather than among the dependent variable and the independent variables. No discernible pattern in the significance of the highway variables appeared either within or between test sites. Although there were significant increases in unit prices of property, the results of this analysis do not allow these increases to be attributed to the construction of the highways alone.

The greater variances for the after period indicate that this period has not reached a state of equilibrium. This perhaps indicates that the highways have introduced additional land market fluctuations within the test sites. Possibly this is a direct effect of the roadways on the economies of the areas.

It must be concluded from this study that the controlled-access facilities under investigation have had little, if any, disruptive economic influence on surrounding property values and development during the study periods. This conclusion is based on the absence of any discernible pattern in the data. If the roadways had exerted a strong independent influence, this influence would have been indicated by some consistency in the investigated variables. The data indicate that general increases in land value appear to be determined largely by natural forces existing within the localities studied, and that these forces are interrelated with the facilities. Therefore, the findings of this study cannot be used as quantitative predictors of land prices and development.

Considerable justification can be provided to refute the general public belief that controlled-access highways will either rapidly stimulate or depress an area's land economy. The major effects of such construction will be gradual and intermixed with the effects of other factors controlling an area's economic development. If the economy of an area is basically sound and is growing, then it will continue to grow; if it is basically depressed, then it will remain depressed. This should not be interpreted to mean that the roadway will not immediately hurt owner A and help owner B. In the construction of any large public facility, there obviously will be benefactors and victims. However, through careful planning and location, major discrepancies in benefits can be minimized and any overall disturbing effects of the facility eliminated.

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Socio-Economic Change in Vicinity of Capital Beltway in Virginia

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•A STUDY, begun in September of 1958, of changing economic and social factors in the vicinity of the Virginia section of the Capital Beltway, I-495 is the basis of this report. The investigation is designed as a "before" and "after" study to determine over a period of time changes in land and real property values, land uses, traffic patterns, travel habits and residents, and business activity.

Only the before portion of the study has been completed. Some continuing inventories of data and analyses are presently being conducted by the Bureau of Population and Economic Research at the University of Virginia and will be used for comparative analysis in the after study. Some of these more recent inventories are also utilized in this discussion. Actually, it is too early for any final evaluation of the effects of the Beltway, but we can see many things happening in this blooming area that should be of some interest. Only some of the more obvious occurrences are discussed. Copies of the before portion of the study itself are available from the Bureau of Population and Economic Research. Change in population, land values and use, retail sales, and traffic volume are the principal indicators explored here.

The Beltway is a four- and six-lane limited-access freeway which encircles the most densely populated part of the Washington, D. C., metropolitan area. Located 6 to 12 miles from the Capitol, it is approximately 64 miles in length and has about 35 interchanges. Twenty-two miles and 12 of the interchanges are located in Virginia. The new highway facilitates bypassing of the District of Columbia and other congested portions of the area and permits the driver the choice of the most appropriate radial for entry to or egress from the central city. The road network becomes analogous to a great wheel. Vehicles can travel north-south over the rim without suffering the congestion and loss of time which they might incur in traveling through the hub. Or, vehicles can travel along the rim until they reach the radial which provides the most direct or least congested route to the central city or hub. Thus, assuming some relief of congestion on existing arterials and easier access between points, the Beltway represents a potential savings in time and money to the vehicle operators. However, the impact of the Beltway goes much further. The facility increases accessibility to land so that new sites are made available for new uses. It also affects transportation costs in general and alters the structures of demands and costs throughout the area. Thus, the Beltway is playing and will play a significant role in the determination of the future pattern of development of the region. Some of the changes which appear to be taking place, particularly in the vicinity of the new facility, are considered here.

NOTE ON METHODOLOGY

For the population analysis it was felt that census and subcensus tracts would be most revealing and would make the data comparable to other areas. For the most part, however, the county and city tax grid systems were used to define the Primary Study Area and to break this area down into small components. The Primary Study Area (Fig. 1) is an L-shaped corridor ranging in width from 1 to 2 miles on each side of the Beltway. It has been outlined in terms of tax-map sections in Fairfax County

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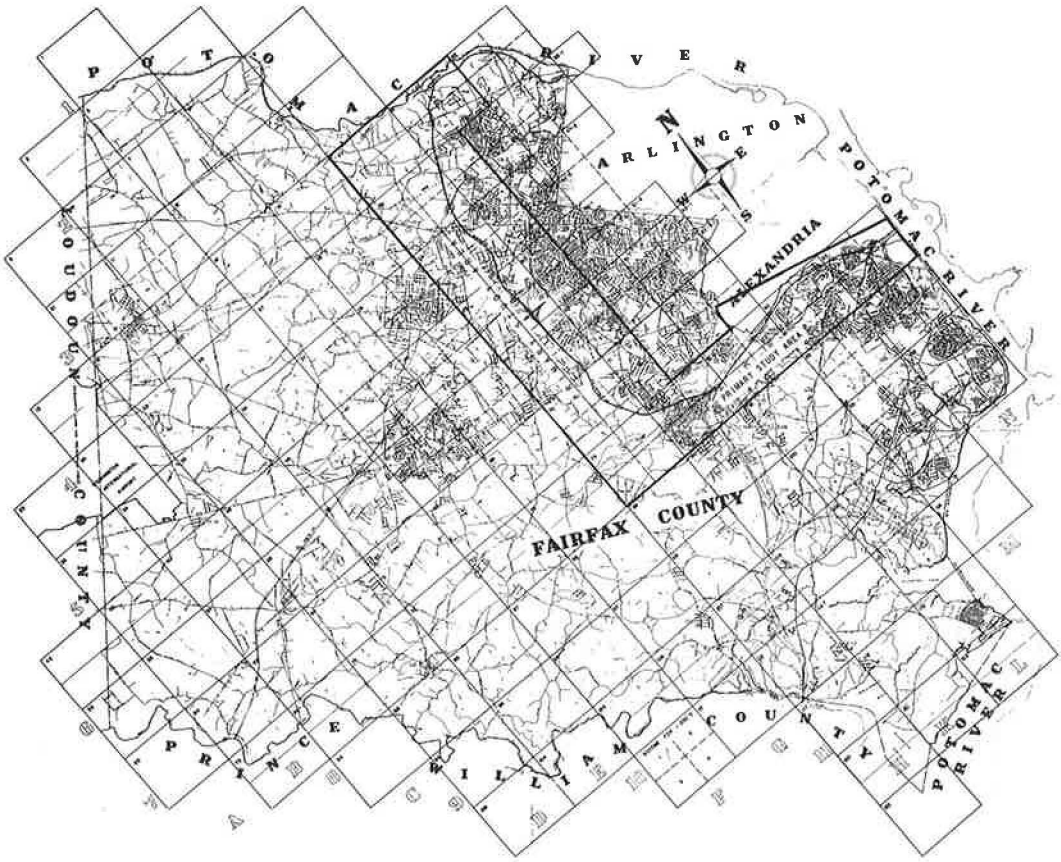


Figure 1. Primary study area.

and the City of Alexandria. The tax-map sections vary somewhat in size, but they represent a ready-made grid system which ties in directly with much of the data available in the two jurisdictions. By including in the Primary Study Area all map sections through which the facility will pass and map sections adjoining these sections, a corridor is outlined. Most of the map sections in Fairfax County are 6,000 by 5,000 feet and contain an average private land acreage of 560 acres. Map sections (including a combination of the smaller downtown sections in Section 100) in Alexandria range from 375 to 149 acres. Within each of these map sections are many individual parcels of land ranging in size from 1,800 square feet in downtown Alexandria to hundreds of acres in the more sparsely settled sections of the Primary Study area.

There are over 25,000 parcels and more than 2,000 real estate sales per year in the Primary Study Area. This study is more concerned with what occurs in areas such as interchange areas, market areas, communities of interest, towns, and cities than with what happens to the thousands of individual parcels. For this reason the collection and compilation of data have been on the tax-map section basis. No attempt has been made to retain identity of each residential parcel. There are 61 tax-map sections in the Primary Study Area and by working with each map section as a whole, the number of parcels is reduced to 61. In some cases it seemed feasible to combine all of older Alexandria into one section. This has been done and it has been designated Section 100.

The area approach seems quite practical as a means of examining socio-economic factors. By maintaining a consolidated record of changes in each of the 61 (or 56 if Section 100 is used) sections, it can be determined in which section significant changes

TABLE 1

GROWTH IN NUMBER OF DWELLING UNITS IN PORTIONS OF FAIRFAX COUNTY[a]

Census Tract No.	No. of Dwelling Units		
	1955	1958	1963
(a) Inside Beltway			
15	828	828	833
16	920	1,094	2,168
17	1,393	2,110	2,207
18	773	868	1,257
19	861	1,650	2,358
20	1,116	2,348	3,912
23	1,553	1,626	1,636
24	1,654	1,774	1,696
26	663	899	1,322
27	1,092	1,338	1,230
28	1,177	1,273	1,197
29	811	1,227	1,645
31	1,072	1,232	1,895
37	1,108	1,307	1,411
38	1,534	1,664	1,959
39	823	1,144	2,489
40	799	1,057	2,179
Total	18,177	23,439	31,494
Ann. rate of change (%)		9.64	6.84
Growth rate decline (%)			29
(b) Outside Beltway			
1	953	961	1,014
2	996	1,046	1,265
3	1,148	1,185	1,535
4	1,478	2,032	2,373
5	1,221	1,883	3,544
6	546	955	1,728
9	902	2,244	2,712
10	889	1,613	2,461
11	1,353	1,812	1,767
12	1,106	1,359	2,159
21	804	1,560	2,328
22	530	860	926
25	699	869	878
30	658	841	3,428
32	1,352	1,222	1,806
33	984	1,812	4,051
34	647	1,427	1,803
35	1,196	1,629	4,101
36	1,063	1,363	1,283
Total	18,525	26,673	40,734
Ann. rate of change (%)		13.0	10.3
Growth rate of change (%)			19

[a]Source: estimates of the Fairfax County Master Plan Office.

are taking place, and analysis of the pertinent factors in specific map sections can be carried out. Data for the map sections can then be tied in with the overall changes in the entire Primary Study Area, larger areas in Northern Virginia, the northern Virginia region and the Washington Metropolitan area.

POPULATION

Population growth has been rapid for the past 20 years in the Washington metropolitan area. With an eye toward determining the effect of the Beltway on the area, Fairfax County was divided into several areas. Data regarding two of these divisions and changes in number of dwelling units in each are given in Table 1. The two areas closest to the Beltway are (a) inside the Beltway and (b) outside the Beltway. In evaluating this situation, census tracts were used because of the availability of data on a census tract basis.

Data are given for the years 1955, 1958 and 1962. The 1955 figures were the result of a special census undertaken by the County at that time. The year 1958 is the year the facility was started and 1962 is the latest year available. Table 1 indicates the growth inside and outside the Beltway for the three selected years.

On both sides of the Beltway the growth rate has declined; it has declined more inside than outside the Beltway. Growth in population has continued at a faster rate outside the Beltway for the whole period under consideration (1955 to 1963). Inside the Beltway there were added 5,262 dwelling units between 1955 and 1958 (1,754 per year) and 7,955 dwelling units between 1958 and 1963 (1,591 per year). This slowing down is to be expected because the density of population on the inside was already high in 1955. Outside the Beltway there were added 8,148 dwelling units between 1955 and 1959 (2,716 per year) and 14,061 dwelling units between 1958 and 1963 (2,972 per year). Obviously residential construction is continuing at a much faster pace outside the Beltway. It is interesting to note that the two areas had about the same number of dwelling units in 1955. The inside increased by approximately 73 percent over the 8-year period, whereas the outside increased by 120 percent. Increased accessibility and the continuing pressure of expanding population have made the outlying areas, which contain vacant and larger land tracts, more desirable as subdivision sites. Certainly the Beltway cannot be regarded as a barrier to further dispersion of the population.

On the whole, the Beltway appears to be exerting what may be called a distributional effect. This effect is illustrated in Figure 2 which shows Route 236 in the center and the Beltway in Fairfax County. Route 620 is not visible in the background, being obscured by trees. The construction of the Beltway with points of access at Routes 236 and 620 greatly enhanced the accessibility of a large vacant tract just east of the new highway between Routes 236 and 620. This tract was recently zoned for apartments and

Figure 2. Interchange of Route 236 and Capital Beltway under construction in November 1959, showing large vacant tract in upper left.

Figure 3. Interchange of Route 236 and Capital Beltway in May 1963, showing new apartment project on vacant tract.

as of January 1, 1963, over 400 apartment units had been constructed with a population of 1,300 (Fig. 3). As of that date less than a third of the land zoned for apartments here had been developed. The developer at one time was thinking in terms of 3,000 apartment units. About 6 miles north of this location is the Tyson's Corner area (around the intersection of Routes 123 and 7) where quite a bit of apartment activity is planned. This activity is due in part to the fact that the Beltway forms a triangle with Routes 123 and 7 with full interchanges at each intersection. The County has zoned two large tracts for apartment development, one just west of the Route 123 interchange and one just northeast of the Route 7 interchange. The County master plan calls for further apartment zoning in this area. A great deal of commercial development is also anticipated. It might be added at this point that when the first survey was made of the Primary Study Area, it was felt that this subarea was about the most rural and the quietest place

TABLE 2

Tax-Map Section No.	Land Value ($)				Increase 1958/1951 (%)
	1951	1954[a]	1956[a]	1958	
71-1	576	811	973	1,322	129.5
60-1	487	550	805	1,429	193.4
49-3	376	318	474	518	37.8
30-3	236	293	379	410	73.8
29-3	259	252	354	354	36.7
39-3	233	233	238	278	19.3
21-3	224	233	254	325	45.1
81-4	142	201	302	381	168.3
29-4	120	145	146	159	32.5
79	69	69	119	163	136.2

[a]Assessed value of land only.

TABLE 3

RESIDENTIAL AND VACANT LAND VALUES[a]

Area	Year	$ per Acre	Change in Value (%)	No. of Sales
Primary Study Area (total)	1951	1,620	39	789
	1954	2,779	68	1,057
	1956	3,798	92	2,053
	1958	4,116	100	1,900
	1960	10,012	243	2,808
	1962	9,266	225	2,671
Fairfax County section	1951	1,507	39	703
	1954	2,648	68	975
	1956	3,668	95	1,871
	1958	3,877	100	1,786
	1960	9,806	253	2,605
	1962	9,086	234	2,569
City of Alexandria section (total)	1951	7,963	93	86
	1954	16,087	188	82
	1956	6,294	73	182
	1958	8,564	100	134
	1960	17,220	201	203
	1962	29,624	346	102
City of Alexandria (old section)	1951	27,870	59	73
	1954	24,916	53	61
	1956	28,889	61	48
	1958	47,306	100	62
	1960	47,999	101	60
	1962	62,317	132	30
City of Alexandria (annexed section)	1951	4,278	70	13
	1954	8,429	138	21
	1956	5,319	87	134
	1958	6,129	100	72
	1960	13,309	217	143
	1962	23,603	385	72

[a]Year 1958 used as base year; trends expressed as percentage of this year (source: records of the Real Estate Assessment Department, Fairfax County).

in the whole area. There appears to be little doubt that the Beltway is leading to more intensive land utilization, particularly in areas made easily accessible by interchanges.

In addition to the changes in number and distribution of dwelling units, another change is in progress in the area. As land has filled up closer to the central city and as accessibility has made land farther out more attractive, the character of the dwelling unit has begun to change. Apartment (primarily garden-type) construction has begun to move out into the County. In 1958, the two areas (inside the Beltway and outside the Beltway) contained approximately 4,600 apartment dwelling units. Between 1951 and 1958, there was very little apartment construction. Whereas single-family dwelling units increased over 100 percent, apartment dwelling units increased only about 10 percent. Of the 4,600 apartments, 1,300 were outside the Beltway and 3,300 were inside. The fact that most of the "outside" apartments are just south of Alexandria and that most of the "inside" apartments are adjacent to Arlington County along the Leesburg Pike between Seven Corners and Bailey's Cross Roads is a reflection of the importance of proximity to the central city. Since 1958, approximately 2,800 apartment dwelling units, 1,500 inside and 1,300 outside, have been constructed. There have also been many requests by developers for apartment zoning. As a result, the Fairfax County Planning Division conducted an apartment study, out of which developed the master plan for apartment development. There is no doubt that the Beltway has been considered in these plans which call for considerable apartment development in areas adjacent to the Beltway. Again this emphasizes the distributional effect of the Beltway; i.e., the facility plays a significant role in distributing the rapidly growing population in Northern Virginia.

REAL ESTATE SALES DATA: LAND VALUES

The vast amount of change in land use resulting from population pressure, transportation and other factors has enhanced the value of land in Northern Virginia. The assessment values, as determined by the local assessment office, indicate a great deal of value change in the areas of the county. Data pertaining to a few of the tax-map sections in the vicinity of the Beltway indicate considerable enhancement of value between 1951 and 1958 (Table 2). Typically, the sections indicating the lowest percentage increase are those in which little development activity has been contemplated or undertaken.

In an effort to quantify changes in the value of land in the vicinity of the Beltway, the Beltway corridor was divided into narrow bands at various proximities to the highway

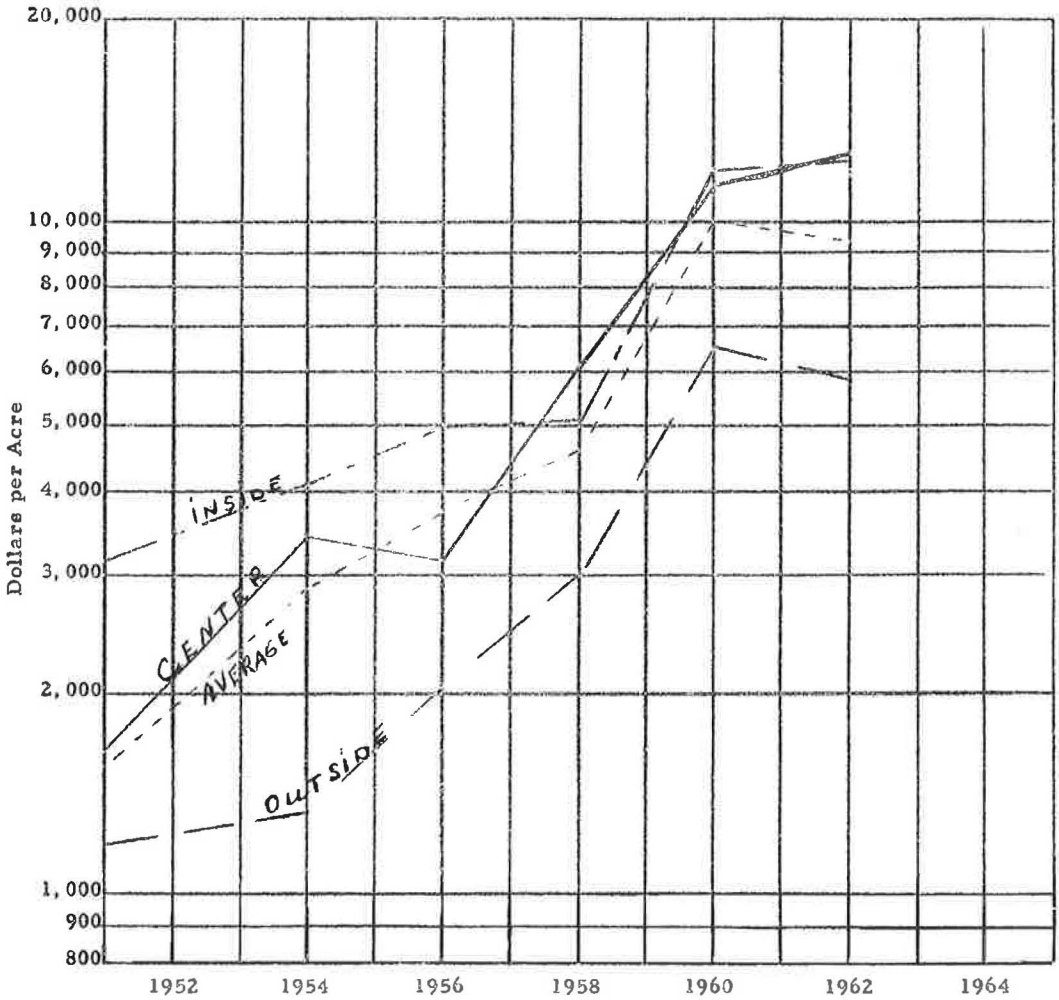


Figure 4. Residential and vacant land values based on market sales values for bands of Primary Study Area.

itself. Changes in land values were observed in the total area and comparisons were made between the total and the various band segments. The study bands were further divided into mile-square blocks. This technique allows comparisons of changes around an interchange, for example, with other areas having less accessibility to the Beltway.

Looking first at the Study Area, i.e., the Beltway Corridor as a whole (Table 3), land values show a steady rise for all trend years from 1951 with the exception of 1962. The increase is five-fold from 1951; land values have doubled since 1958. The decrease noted in 1962 represents an 18 percent drop from 1960. The cause of the decrease from 1960 to 1962 is not clear at this time. Perhaps overspeculation has caught up in some instances.

The greatest increases in land values in the Study Area were observed in Alexandria. In the section which was annexed from Fairfax County by Alexandria in 1952, land values have increased four times from 1958 to 1962. Whether or not it can be proved that this increase is the result of the construction of the Beltway, it is a fact that the completion of this facility puts this area in a unique position with regard to transportation facilities. The Beltway parallels two major railroad lines and, with the Shirley Highway, provides ideal transportation facilities for the area. One railroad has already developed a piggy-

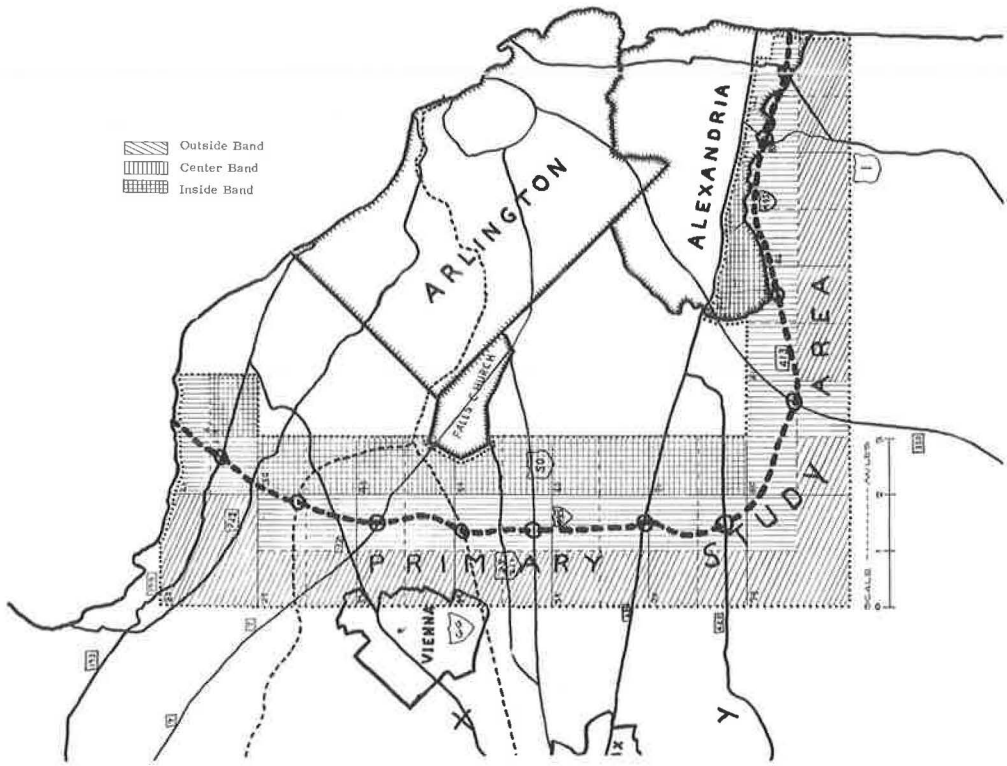


Figure 5. Capital Beltway, Northern Virginia study area, real estate sales.

TABLE 4

RESIDENTIAL AND VACANT LAND VALUES[a]

Area	Year	$ per Acre	Change in Value (%)	No. of Sales
Primary Study Area (total)	1951	1,620	39	789
	1954	2,779	68	1,057
	1956	3,798	92	2,053
	1958	4,116	100	1,900
	1960	10,012	243	2,808
	1962	9,266	225	2,671
Inside Band	1951	3,157	62	298
	1954	4,026	80	390
	1956	4,977	98	799
	1958	5,061	100	772
	1960	12,107	239	1,105
	1962	12,500	247	986
Center Band	1951	1,706	28	204
	1954	3,516	57	280
	1956	3,132	51	337
	1958	6,122	100	453
	1960	11,416	186	1,065
	1962	12,890	211	923
Outside Band	1951	1,165	39	293
	1954	1,335	44	391
	1956	2,031	68	927
	1958	3,008	100	678
	1960	6,570	218	638
	1962	5,754	191	762

[a]Year 1958 used as base year; trends expressed as percentage of this year (source: records of the Real Estate Assessment Department, Fairfax County and the City of Alexandria).

TABLE 5

RESIDENTIAL AND VACANT LAND VALUES OF AREAS OF LIMITED ACCESSIBILITY[a]

Area	Year	$ per Acre	Change in Value (%)	No. of Sales
Primary Study Area (total)	1951	1,620	39	789
	1954	2,779	68	1,057
	1956	3,798	92	2,053
	1958	4,116	100	1,900
	1960	10,012	243	2,808
	1962	9,266	225	2,671
Areas of limited access-ibility (total)	1951	1,224	27	133
	1954	2,387	53	176
	1956	2,727	61	372
	1958	4,491	100	368
	1960	8,588	191	425
	1962	10,017	223	692
Inside	1951	3,459	57	39
	1954	4,887	80	76
	1956	8,790	144	169
	1958	6,116	100	185
	1960	10,599	173	203
	1962	13,776	225	161
Center	1951	1,742	35	51
	1954	1,825	36	45
	1956	3,581	72	124
	1958	5,001	100	115
	1960	7,982	160	138
	1962	10,816	216	238
Outside	1951	797	32	43
	1954	1,708	68	55
	1956	1,485	59	79
	1958	2,518	100	68
	1960	6,563	261	84
	1962	8,100	322	293

[a]Year 1958 used as a base year; trends expressed as percentage of this year (records of Real Estate Assessment Department, Fairfax County and City of Alexandria).

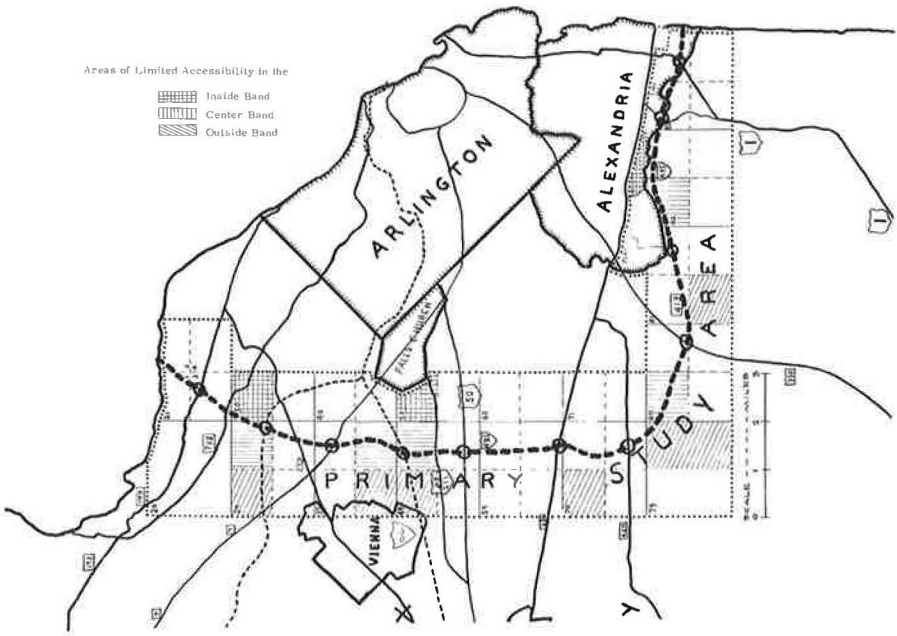


Figure 6. Capital Beltway, Northern Virginia study area, real estate sales.

back loading operation within a mile of an interchange, and the area's potential for industrial development looks promising.

We may consider next the land value studies using the band segments. The bands cover a 3-mile area of which the right-of-way is approximately the center. The Inside Band is the mile-wide area nearest the metropolitan center, the Center Band extends approximately ½ mile on either side of the highway itself, and the Outside Band is the outside mile, the area at the greatest distance from the metropolitan center. Because the bands are drawn in terms of tax-map sections on maps utilized by the local jurisdictions, the right-of-way is not exactly in the center of the middle band. Because of the way data were compiled, it was felt that this method was the best available.

To provide a picture of the different rates of change among these configurations, the data for each band were plotted on semilogarithmic graph paper (Fig. 4). These bands are shown in Figure 5. Table 4 gives value changes in the three bands.

From 1951 to 1956, aside from the trend of increasing land values, each area retained its position relative to the others in terms of value. Between 1956 and 1958, the rise in value of the Center Band exceeded that of the Outside and Inside Bands to the extent that this relationship no longer held. After 1958, the trend of values in the Center Band continued rising at the greater rate and, as a consequence, land values in this band are equaling and exceeding those of the Inside Band. The primary factor to which this marked change can be attributed is the Beltway.

This thesis, that the construction of the Beltway is the primary factor influencing the rapid rise in land values in the Center Band, is reinforced empirically in the study of land values in areas of least accessibility. The mile-square sectors of least accessibility used for this study are identified in Figure 6. Figures used in plotting the rates of change in these sectors (Table 5 and Fig. 7) represent a total depending on the location of the mile-square (tax-map) sectors in the Inside, Center or Outside Bands.

Although the general trend in the tax-map sections of least accessibility is one of increasing value, the sections in each of the three bands maintain their relative values to one another from 1951 through 1962. Hence, where the direct Beltway influence is not felt because of lack of accessibility, the picture of land value changes is not the same as in the overall band which includes the accessible areas.

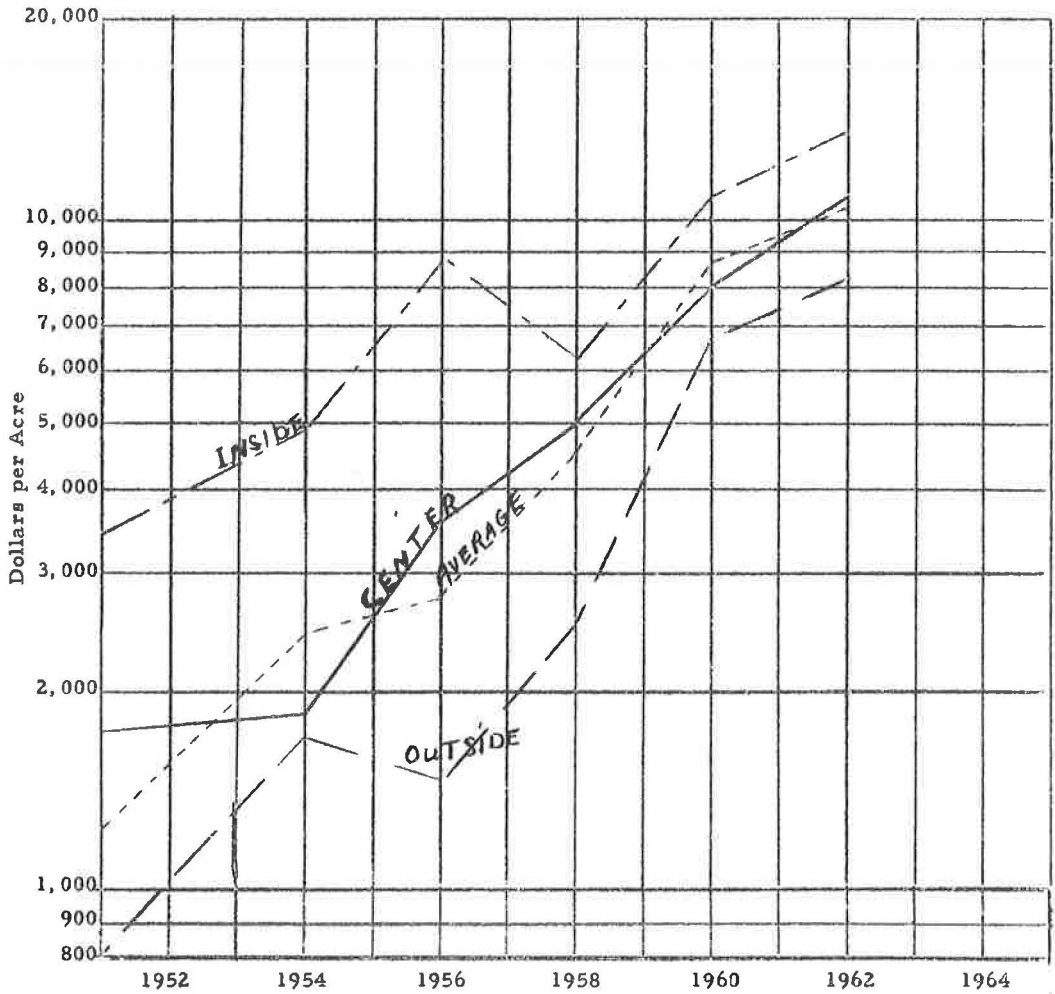


Figure 7. Residential and vacant land values based on market sales values for areas of limited accessibility.

From these data, the principal observations to date with respect to changes in land value in the Primary Study Area, the following conclusions may be drawn:

1. Sales data expressed as dollars per acre reflect an upward trend in land values.
2. The Beltway is exerting a direct influence on land values in those areas immediately adjacent to it, particularly in the more accessible places.
3. In the areas of least accessibility, there is no indication of the Beltway's overriding influence on land values such as was evident in the band adjacent to the Beltway.

BUSINESS ACTIVITY

Although commercial and industrial activity accounts for a relatively small portion of Fairfax County's total income, it has multiplied in recent years. Retail business has grown from 493 establishments and $54,458,000 in sales in 1954 to 652 establishments and $114,661,000 in 1958, a tremendous upsurge in retail trade (110.5 percent increase). Population during the same period expanded 38.5 percent. The fact that growth of retail activity far exceeded the growth of population points up the rapidity with which retail activity developed in the area to catch up with the population explosion.

TABLE 6

RETAIL SALES IN FAIRFAX COUNTY[a]

Trading Centers	1952	1954	1956	1958	1959[b]	1960	1962[b]
Annandale					(51)		(57)
Sales ($)	1,978	3,059	5,654	9,437	9,152	15,103	17,259
Index of change	21	32	60	100	97	160	183
Springfield[c]					(43)		(67)
Sales ($)	--	--	2,631	4,735	8,814	10,524	16,520
Index of change	--	--	56	100	186	222	349
Belle View					(18)		(17)
Sales ($)	2,123	2,925	4,645	4,556	5,280	5,594	5,663
Index of change	47	64	102	100	116	123	124
Penn Daw					(14)		(17)
Sales ($)	85	48	249	465	2,019	5,294	6,478
Index of change	18	10	54	100	434	1,138	1,393
Bailey's Cross Roads					(54)		(61)
Sales ($)	1,747	3,049	4,905	9,668	11,781	12,421	16,901
Index of change	18	32	51	100	122	150	175
Seven Corners					(67)		(66)
Sales ($)	--	4,466	17,567	35,342	40,674	42,892	46,666
Index of change	--	13	50	100	115	121	132
McLean					(36)		(52)
Sales ($)	899	1,197	2,364	4,406	5,753	10,316	12,814
Index of change	20	27	54	100	131	234	293
Vienna					(50)		(270)
Sales ($)	2,900	3,438	3,919	5,103	6,967	9,939	15,919
Index of change	57	67	77	100	137	195	312
Town and City of Fairfax					(99)		(181)
Sales ($)	1,848	2,929	8,643	13,153	16,371	24,233	38,301
Index of change	14	22	66	100	124	184	291
Primary Study Area							
Sales ($)	3,113	6,929	15,700	23,366	31,264	46,221	60,991
Index of change	13	30	67	100	134	194	261

[a] Source: Department of Assessments, Fairfax County, Va.
[b] Numbers in parentheses refers to number of retail outlets in 1959 and 1962.
[c] 1952 and 1954—negligible (gas station).

Estimates show that retail activity in Fairfax County has continued to increase since 1958, but at a considerably slower rate. (The annual rate of growth from 1958 to 1962 was 16.8 percent as compared with a rate between 1954 and 1958 of 27.6 percent.) Sales Management's "Survey of Buying Power" for 1962 estimates retail sales of $192,909,000, an increase of 67.4 percent over 1958. Even greater increases are revealed when specific commercial areas are considered (Table 6).

The creation of highly accessible vacant sites in the interchange areas will certainly exert some influence over the businessman's decisions as to location; it will be more of a factor in regionally oriented business than in local or neighborhood centers. There is little evidence that the "convenience goods" centers are as concerned with the Beltway's location as with location of subcenters of population in the metropolitan periphery.

TABLE 7

FAIRFAX COUNTY HIGHWAYS

Type	Mileage		
	1951	1962	% Change 1962/1951
Primary	164.2	132.8	-19
Interstate		28.3	
Total	164.2	161.1	- 2
Secondary			
Hard surfaced	406.3	1,021.7	+151
Untreated, all weather	203.0	103.9	-49
Untreated, light surface	83.8	53.3	-36
Unsurfaced	36.1	10.4	-71
Total	729.2	1,189.3	+63
Grand total	893.4	1,350.4	+51

As a matter of interest, the project research team decided to determine where shoppers came from who patronized a large neighborhood shopping complex and what routes they used in getting to the center, located in Springfield at the intersection of the Shirley Highway and Franconia Road about 7 miles southwest of the District of Columbia.

The purpose was to establish a pattern of travel and shopping habits in the before period, run the same survey in the after period, and attempt to evaluate the impact of the Beltway on the market area for the large neighborhood commercial complex.

Of course, the after survey has not been made and it remains to be seen what the long-run effect will be, if any. It is quite possible that the addition of shopping centers in the vicinity will greatly complicate the picture. Shortly after the survey was made, a center of some size (100,000 square feet of stores and shops and 1,000 parking spaces) opened approximately 3½ miles east. Sometime later a discount store opened only 2 miles to the north. These openings naturally affect the Springfield complex.

Results of the survey indicated that shoppers at Springfield came primarily from the more densely populated north; 43 percent of the visits originated 5 minutes or less away; 32 percent, 6 to 10 minutes away; 19 percent, 11 to 20 minutes away; only 6 percent, over 20 minutes away. The majority of the visitors came to shop three or more times a week. It will be interesting to determine the extent of change as means of transportation improve. There is evidence already in the zoning and development around the newly formed interchanges that the Beltway is creating desirable sites.

In manufacturing, although this activity is relatively light, value grew from $2,011,000 in 1954 to $6,053,000 in 1958 and employment grew from approximately 1,600 employees in 1950 to 5,600 in 1960. In wholesaling, sales increased from $10,148,000 in 1954 to $14,370,000 in 1958, with an increase from 215 employees in 1954 to 262 in 1958.

Traffic is not as heavy on the portions open in the northern half of the Virginia portion of the Beltway. From Route 7 to the Dulles Airport Road the average was 4,700 vehicles. Traffic between the Dulles Airport Road and the Maryland line, across the Cabin John Bridge, averaged 7,500 vehicles. These figures indicate that the volume of traffic which will utilize the facility, when completed, will be great. Most of the through traffic, bypassing Washington, will be added to traffic already being generated.

The traffic already on the Beltway is a reflection of the tremendous growth in traffic on the entire network of roads in the Northern Virginia area. Examples of this growth can be seen in many areas. For instance, in 1950 the 24-hour average daily traffic volume on Franconia Road at the Shirley Highway interchange was 450 vehicles. By 1960 the count had risen to over 10,000 vehicles. This is a two-lane secondary State road. On Back Lick Road, also two-lane secondary, at the Franconia Road intersection, the picture was much the same with volume growing from 1,000 vehicles per day in 1950 to 11,300 in 1960. These increases are indicative of the growth in traffic which has occurred as a result of the rapid expansion of population in Fairfax County, particularly in the eastern half. Table 7 shows growth and improvement of the highway network in Fairfax County between 1951 and 1962. Increased mileage of the secondary system is also indicative of the tremendous growth in Northern Virginia.

Since 1958, a total of 46 industrial plants have settled in Fairfax County, 20 of them in the vicinity of the Beltway. Total increase in employment has been 3,340. Eleven plants with a contemplated employment of over 1,600 employees have been announced or are under construction. (These figures have been furnished by the Fairfax County Industrial and Economic Development Committee.)

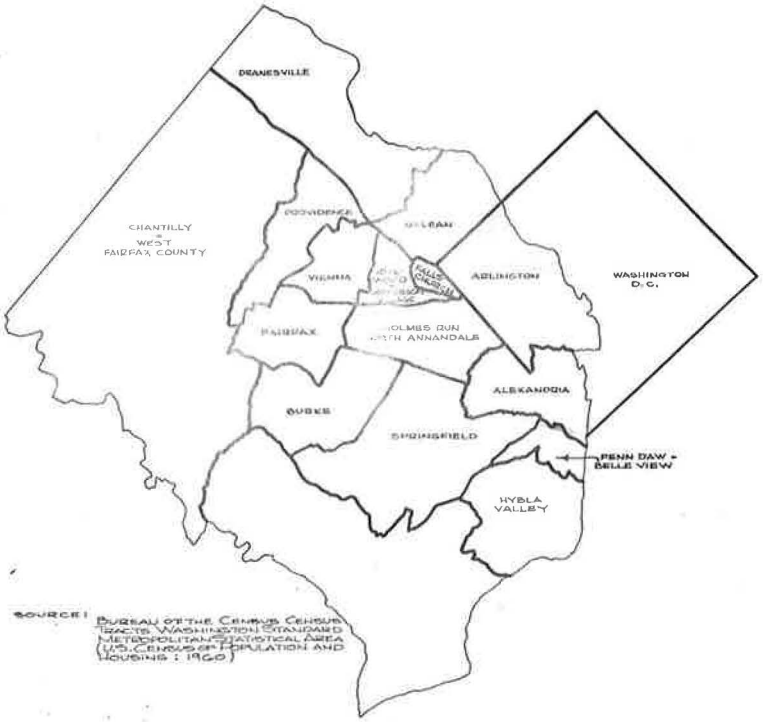


Figure 8. Location of 15 subregions.

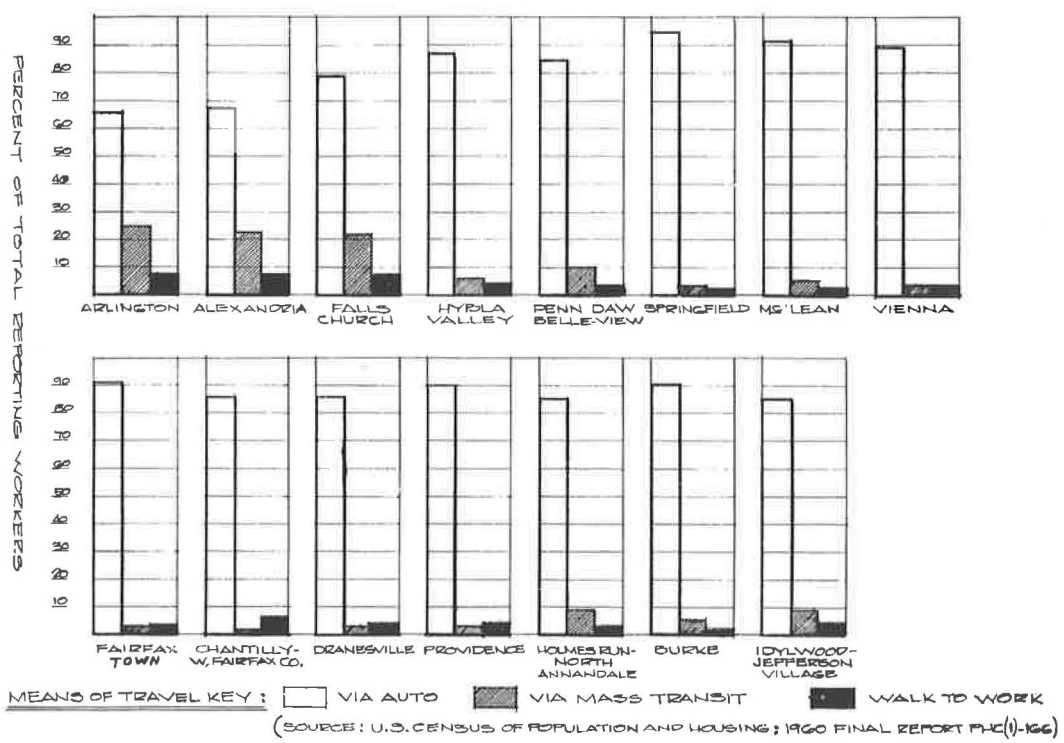
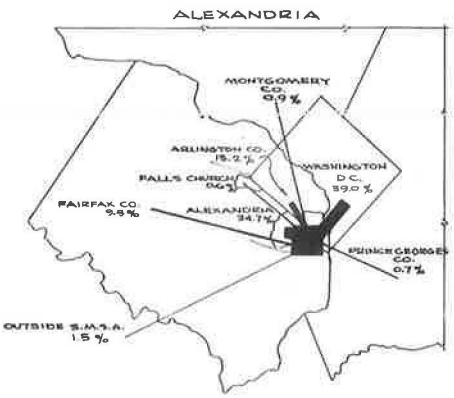
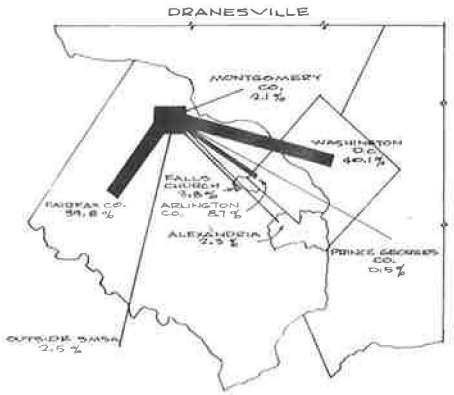
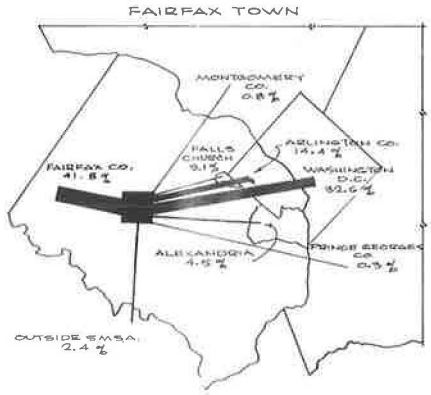
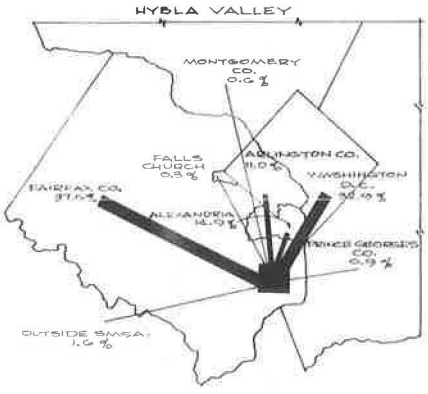


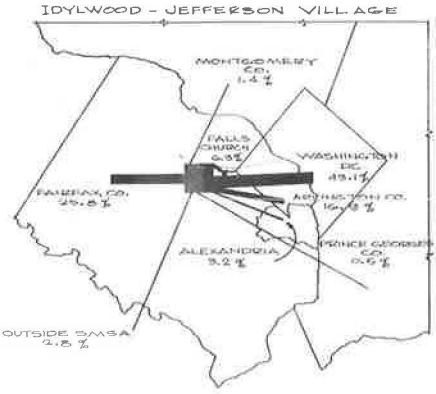
Figure 9. Relative distribution of trips by means of travel.

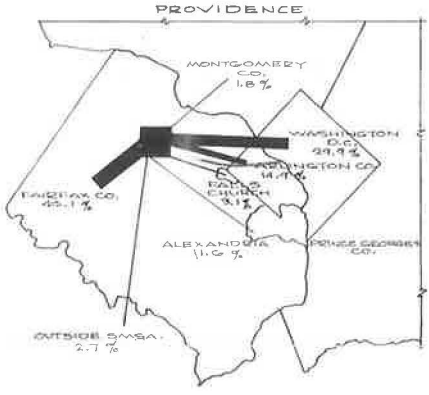












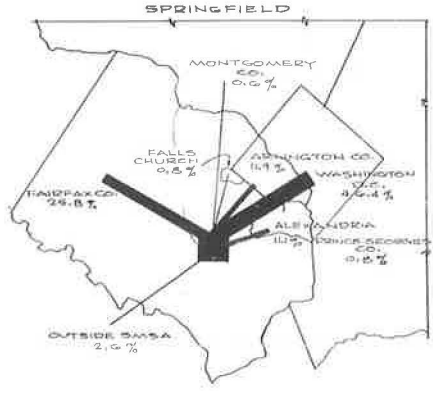
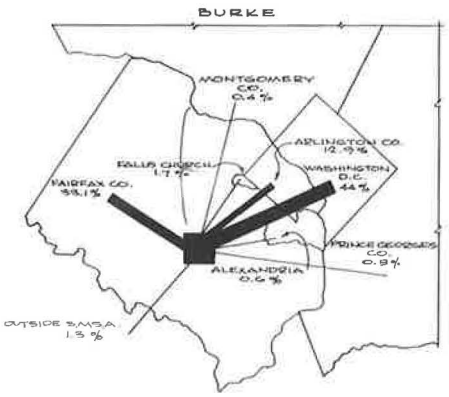
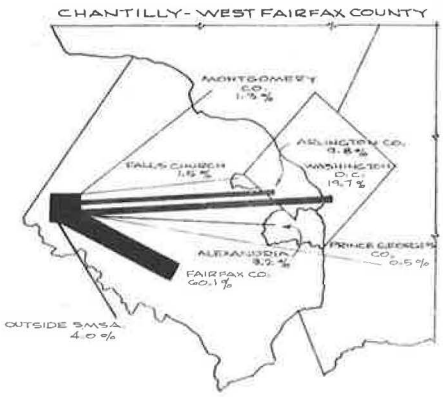
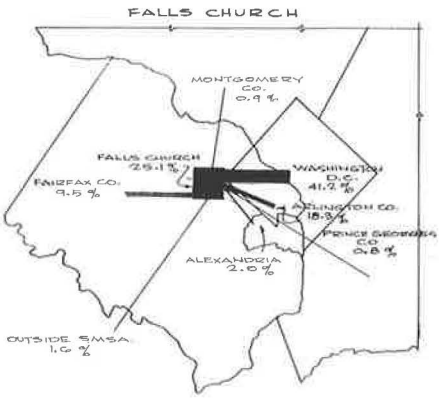
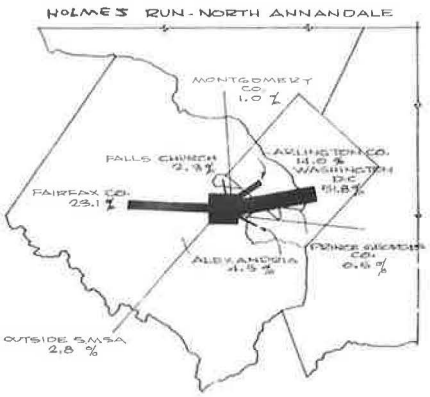


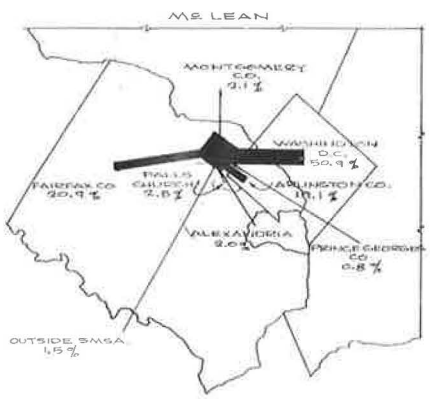
Figure 10. Journey-to-work

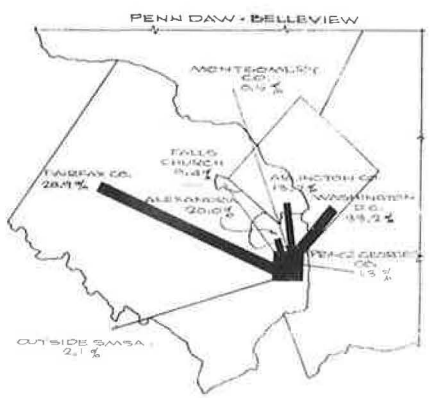


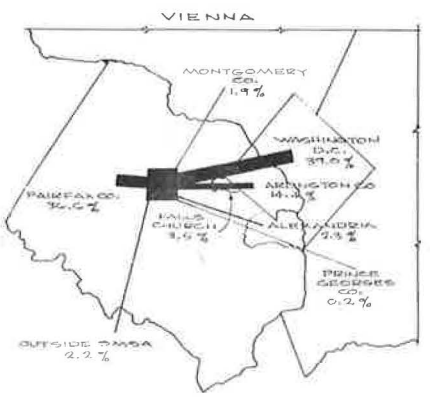












SOURCE: BUREAU OF THE CENSUS CENSUS TRACTS WASHINGTON STANDARD METROPOLITAN STATISTICAL AREA (U.S. CENSUS OF POPULATION AND HOUSING: 1960)

data for 15 subregions.

It is still too early to weigh the influence of the Beltway on industrial development, but when the large amount of vacant land around these interchanges is considered along with the fact that water and sewer facilities are available, it is unlikely that the Beltway will not exert some location effect and, in addition, generate new business with the accessibility it provides.

TRAFFIC

The influence the Beltway will exert on patterns is already becoming evident. Although only portions of the Beltway are open, spot checks indicate a great deal of traffic is already using the opened segments. The most traveled stretch is across the Woodrow Wilson Memorial Bridge to and from the Maryland line and US 1. Four 12-hour counts taken over a period of 9 months reveal an average volume of 14,200 vehicles per 12-hour period. This traffic started at 14,000 vehicles for the 12-hour period and changed very little between the initial and the final survey.

The average 12-hour count from Shirley Highway (Route 350) west to Braddock Road (Route 620) was 8,400 vehicles. The counts showed 7,900 vehicles in August 1962 and 10,000 in May 1963. These ranges cannot be considered exactly comparable because the counts may have fallen on different days.

Between Routes 620 and 236, the artery between Annandale and Fairfax, the average of four counts was 9,000 vehicles. All counts were substantially the same. North of Route 236 to Route 50, traffic averaged 6,500 vehicles. The range from the first count to the last was 4,300 to 8,600, a 100 percent increase.

Vehicle registrations in Fairfax County more than doubled between 1953 and 1959, as did the total vehicle miles traveled on the State secondary roads in the County. It is doubtful that the Beltway will do anything to relieve congestion substantially on these local feeders.

JOURNEY-TO-WORK

Although data are not yet available for evaluation of impact, the journey-to-work data for Northern Virginia given in the 1960 Census of Population and Housing were very interesting. A comparison of later data with the 1960 information should be quite revealing in terms of the effect of the Beltway on the journey-to-work habits of residents of Northern Virginia.

To lay the groundwork for observing change, the research team compiled certain data for areas in Northern Virginia. Information was available from the Bureau of Census on a census tract basis. These data were obtained for the Washington Standard Metropolitan Statistical Area, which comprises the following political jurisdictions: District of Columbia; Montgomery and Prince Georges Counties, Md.; Arlington and Fairfax Counties, Va.; and the independent cities of Alexandria and Falls Church, Va.

To show the travel patterns, certain census tracts were combined into larger subregions. The relevant data for the individual tracts were combined under the name of the subregion. Some of the larger census tracts are presented singly. The resulting subregions are shown and identified in Figure 8. These subregions represent considerable variations in degree of urban development, as well as in proximity to the Beltway path and the urban core. Thus, some interesting contrasts and comparisons should be possible when the new highway is in use and new data are available.

The percentage distribution of total work trips among the alternative forms of transport provide a basis for the study of vehicle choices both within and between the subregions. The percentages are depicted graphically in Figure 9 for those driving in private automobiles, riding mass transit facilities, and walking to work.

Figure 9 indicates that the privately owned automobile is used more than any other means of transportation to work in all of the subregions. Travel by mass transit is significant only in Arlington, Alexandria and Falls Church, all of which are relatively near the urban core. The figure suggests that the incidence of travel via mass transit facilities declines with distance from the center primarily because bus service to the urban core is more concentrated in the urban regions. Consequently, the highest incidence of automobile usage is in the more remote subregions.

The incidence of walking trips to work depends on the presence and scope of local employment centers. Although the percent of those walking to work is uniformly low, a relatively large portion of workers walk in Arlington, Alexandria, Falls Church, and Chantilly-West Fairfax County. It is obvious that the first three of these subregions are located either at or near the site of large-scale commercial and governmental activities.

The distribution of workers in the various subregions is rather interesting. To facilitate comparisons between the various subregions, the precentage distributions of reporting workers among the centers of employment are shown graphically through width lines in Figure 10. The maps shown in Figure 10 are largely self-explanatory. They provide a clear, easily assessed record of the sources and terminations of work trips in Northern Virginia. Similarly drawn maps in the after period should be quite revealing. Some changes might be indicated in the increased mobility of workers throughout the metropolitan area. For instance, very few of the residents of the subregions in Fairfax County worked in Montgomery or Prince Georges Counties, Md. The completion of the Beltway, with its two toll-free bridges, may change this picture considerably.

The importance of Washington, D. C., as an employment center is obvious with the percentage of trips to work terminating in the District ranging from 19 percent in western Fairfax County to 51.9 percent in Arlington County. To the researchers, some of these percentages were a little surprising. For example, it was thought (unscientifically) that the percentage of trips in the District from Arlington County would be higher in terms of percent of total trips, and higher than some of the other subregions farther out, which had approximately the same percentage (North Annandale and McLean).

CONCLUDING REMARKS

There is no doubt that the Capital Beltway is exerting its influence in the Northern Virginia Area. Changes in distribution of population, in land values, in traffic flows, and (soon) in journey-to-work travel habits can be attributed to the highway influence. In addition, as the outlying areas are made more accessible to the motorist who works in the central core but likes to live outside, further changes in land use will occur. Satellite shopping centers will follow the population movements and will tend to locate in areas of high accessibility such as those created by interchanges. Additional sites will encourage movement of business into the area and the relocation of business already operating in the area. The large percentage of vacant land in the interchange areas now being formed will contribute a great deal to this change.

A significant problem which has not been discussed in this paper is that of controlling land-use development in these interchange areas. There is no doubt that this is a problem of concern to local, State, and Federal government, and the potential conflict of interests between the local jurisdiction, which are hard pressed to increase their tax bases, and the State and Federal governments, which are concerned with the flow of traffic between regions and urban centers, will pose many difficult questions.

Highways as a Factor in Industrial Location

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•THIS PAPER is based on some of the more significant findings of a two-year research project conducted by the Department of Research and Transport Economics of the American Trucking Associations as a project of the ATA Foundation which is the informational and educational arm for supplier cooperation with the trucking industry. The study was sponsored by one of the foundation members, the Rockwell-Standard Corp. of Pittsburgh, Pa. Research and writing of the report was handled by James F. McCarthy, a consultant in ATA's Research Department.

The study was conducted in three phases. The first step turned to the immediate past for a review of findings on population movement, redistribution of industry, latest industrial technological trends requiring greater flexibility in the movement of employees and goods, and other related matters. Secondly, the study conducted field trips in representative states for an on-the-spot observation of today's industrial development process in action. Thirdly, the study conducted a questionnaire survey of manufacturing plants, distribution centers, and research and development facilities to determine, among other things, the type of establishments moving, where they were locating, and the role of modern highways in determining their location. This paper covers certain results of the questionnaire survey, the statistical heart of the study.

All 50 states now have departments charged with promoting industrial development. All are quick to report new industry locating within their borders, plants expanding, etc. From such reports a list of about 5,200 establishments was developed, including a wide cross-section of manufacturing, wholesale and warehousing establishments functioning as distribution centers and a number of research and development firms.

Each of the firms had made one or more of the following moves during the period from mid-1955 through the end of 1959: (a) begun business for the first time, (b) opened a new branch plant, (c) moved to a new location, and (d) expanded an old location. The period from mid-1955 through the end of December 1959 was selected so that the moves would be relatively recent, yet far enough in the recent past to enable plant managers to evaluate operations in the new location.

Of the potential mailing list of approximately 5,200 establishments, 1,050 questionnaires were found to be undeliverable, either because of insufficient address (as was the case with 686 questionnaires) or because the establishments had gone out of business (as was the case with 364 or 7 percent). There remained a survey universe of 4,150 establishments. A first mailing and a single follow-up to nonrespondents produced a combined response of 1,498 questionnaires, or slightly over 36 percent—an extremely good response rate for surveys of this type. Among the 1,498 returned questionnaires, about nine percent were judged to be nonresponsive for purposes of tabulation within the framework of the survey. There remained 1,363 replies on which survey findings were based.

Key questions in the survey contained a list of 13 factors commonly considered in plant location decisions. These were availability of suitable land, proximity to markets, availability of raw materials, abundant water supply, proximity to good highways, availability of rail service, proximity of related industry, abundant labor supply, favorable tax structure (state or local), existence of building at site, favorable leasing or financing, nearby vocational training facilities, and community's cultural-recrea-

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tional assets. Each recipient was asked to select the five most important of these factors in the selection of the site for the plant to which the particular questionnaire had been directed.

Another question asked the establishment's employment and nearly all respondents answered it, enabling results to be weighted in terms of employment. The questionnaire also asked the location of the establishment, whether in the city, the suburbs or a small town or rural area. A second location question, directed to establishments having moved, asked whether the former location had been in the city, suburbs, small town or rural area.

Four specific transportation questions were included. One asked the percentage of inbound and outbound freight moving by truck. A second question, relative only to truck freight, asked for percentages, both inbound and outbound, moving by private truck and by for-hire carriage. Often more than five factors are vitally important in plant location decisions. Thus, for those respondents not checking "proximity to good highways" among the 13 factors, a question was included to determine whether the highway factor was, nevertheless, critical in the plant location decision. A fourth transportation question asked if the plant had a rail siding and those plants which had moved were asked whether the former location had a rail siding.

Three areas of the questionnaire invited essay-type answers. Respondents could elaborate on the plant location factors generally, on the highway factor, in particular, and on factors to which they would give additional emphasis in future plant location decisions.

Replies were coded according to the Federal Government's Standard Industrial Classification (SIC). In all, 44 major SIC groups were represented, 22 of these with from 20 to 167 respondents each. All but 60 of the respondents fell within these 22 major SIC groups and separate analyses were made of each of these groups. The remaining 60 fell within the 22 other SIC groups and were lumped together to form a miscellaneous category.

Before examining survey results, we should look quickly at some of the SIC groups represented most heavily in the survey response. The chemical and allied products group, for example, was represented by 167 respondents, the fabricated metal products group by 133, machinery (except electrical) by 113, food and kindred products by 104, electrical machinery by 96, stone-clay-glass products by 76, apparel by 66, transportation equipment by 65, and paper and allied products by 57. Other representation included the wholesale trade group by 55, textile mill products by 50, primary metal industry by 49, furniture by 42, lumber and wood products (except furniture) by 35, rubber and miscellaneous plastics products by 33, warehousing by 27, printing and publishing by 27, athletic equipment, jewelery, etc., by 20, and professional, scientific and controlling instruments, leather, research and development and petroleum refining by 20 each.

Survey findings indicate that on the question involving the 13 plant location factors, those mentioned most frequently were, in this order, proximity to good highways, abundant labor supply, availability of suitable land, and proximity to markets. Of course, mention of the highway proximity factor involved many considerations. On the basis of essay-type replies, respondents mentioning the highway factor had in mind transportation of goods, of employees and of customers in addition to the advertising value of highway exposure. Nevertheless, the importance attached to the highway factor reveals a very significant trend in present-day plant location.

What comes quickly to mind from this particular survey result is the relationship between the four plant location factors found dominant in the survey and the findings now coming from highway impact studies and other research showing the growing importance of highways as industrial development magnets, the rise of the market factor in plant location, and the growing need for larger parcels of land to accommodate the new beauty and functional design concepts of modern plant construction.

Other plant location factors are important, of course. Depending on the type of establishment, at least six other location factors—rail service, raw materials, favorable state and local tax structure, favorable leasing financing, abundant water supply, and proximity of related industry—show up well, but their importance varies sharply

from industry to industry, whereas the importance of the top four—highways, labor, land, and markets—remains consistent throughout most of the broad band of industry represented in the survey response.

The ranking of plant location factors in each industrial group is covered in detail in the complete survey report, but few examples should be considered here. The highway factor was first or tied for first in 11 of the 22 SIC groups. It was first in furniture, printing and publishing, chemicals, petroleum refining and related industry, fabricated metal products, machinery, miscellaneous manufacturing and wholesale trade. It was tied for first with the labor factor in the rubber and transportation equipment groups, and with the land factor in the research and development group. The highway factor was ranked second by the food, textile, apparel, leather, stone-clay-glass, electrical equipment and warehousing groups. The labor factor, second in the national survey, was first in the textile, apparel, wood and lumber products, leather and electrical machinery groups. The land factor, third in the national survey, was first in primary metals and warehousing. It falls no lower than sixth and this is only in one instance–the stone-clay-glass group. The market factor, fourth in the national ranking, was first in the food and stone-clay-glass groups, second in wholesale, third in chemicals, petroleum, rubber, fabricated metal products, transportation equipment, scientific instruments, miscellaneous manufacturing and warehousing. Its lowest rank was seventh and this in only two groups, apparel and research and development.

Some plant location factors vary sharply in importance from one industry to another. On a frequency-of-mention basis, among all respondents, the factor "availability of rail service" ranked fifth in the national survey. But the rail factor ranged in importance from first to eleventh place. "Availability of raw materials" is another example of a plant location factor varying widely in importance from industry to industry. Ranked sixth in the national survey, the raw material factor ranged from a tie for first place with the rail factor in the lumber and wood products group to thirteenth place in the research and development group. As the size of establishments increases, measured by employment, the plant location factors of land, labor, rail, water, and proximity to related industry assume greater importance.

Further analysis of survey results show certain industries to be more heavily transportation oriented in their plant location decisions. These are industries in which both the highway and rail factor were given heavy emphasis, e.g., printing and publishing, wholesale trade, fabricated metal products, furniture, stone-clay-glass, and warehousing.

Where are today's plants being built? Survey results reflected a pronounced outward movement of industry. More than 48 percent of survey respondents reported present locations in small towns or rural areas. More than 24 percent were in cities; more than 26 percent reported locations in suburbs. Eighteen of the 22 industrial groups reported more plants in small town or rural locations than in either suburbs or city. The only exceptions were in the heavily market-oriented printing and publishing, warehousing, food, and wholesale groups. Dramatic evidence of this outward movement was found in miscellaneous manufacturing, electrical equipment, machinery, rubber, fabricated metal products, research and development, furniture, and transportation equipment.

The full study, in both its tables and text, shows how respondents in each industry group are distributed in city, suburban, or small town or rural area location. The degree of concentration in small town or rural area, for example, ranges from 75 percent in the leather and leather products group to 22 percent in the wholesale trade group. Among those reporting suburban locations, the concentration ranges from 44 percent in the case of the wholesale trade group to 8 percent of the textile mill respondents. The heaviest concentration in city locations was reported by the printing and publishing group (42 percent). The lowest, 15 percent, was reported by the leather group.

Although all industries covered can be assumed to have undergone some type of building program from mid-1955 through the end of 1959, they were asked specifically whether they had moved from another location. About half said they had. The 611 who

had moved reported both their present and former location. From these replies comes further evidence of the outward movement of industry. Here we are dealing with any one of nine possible directional moves: from city to city, city to suburbs, city to small town or rural area, suburbs to city, suburbs to suburbs, etc.

In the survey, however, three of these directional moves accounted for about 70 percent of the total movement. Approximately 22 percent moved from one city location to another. About 23½ percent moved from city to suburbs, and about 23 percent moved from city to small town or rural area. In short, firms reporting new locations in suburbs and in small towns or rural areas tended to come from the city. Moves in the reverse direction accounted for very little of the total. Most of the firms that did report new city locations came from other city locations, very few came from suburbs or small towns.

As expected, some of the industry groups reported more movement than others. Thus, because of the questionnaire's large response, the study was able to pinpoint certain more mobile industries—or at least industries in which plant location decisions are being made more frequently. Examples are printing and publishing, electrical machinery, machinery, fabricated metal products, miscellaneous manufacturing, warehousing, wholesale trade, scientific instruments, furniture, food and kindred products.

An interesting example of the type of detail the study presents on the movement patterns within specific industries is found in these findings on the textile mill products group: among all respondents, textile mill products ranked third on the list arranged by degree of concentration in cities. About 40 percent of these firms reported city locations, 52 percent small town or rural area locations, and only about 8 percent reported suburban locations. Almost half of the textile mill products group reported moving; among these, 71 percent reported new locations in small towns or rural areas. In short, this is one industry of traditional city concentration now moving to the small towns or rural areas.

This type of analysis shows cities losing fabricated metal products and electrical equipment plants to both suburbs and small towns and rural areas; the suburbs gaining chemical and rubber plants from the city and, to some extent, from small towns and rural areas, and the city registering gains in printing and publishing, paper and allied products, and the lumber and wood products group.

The trucking industry is, of course, particularly interested in survey findings on patterns of freight movement. To make full use of raw survey data in this area, frequency-distribution grids were constructed to show the percentage of inbound and outbound freight moving by truck. This was done not only for the response group as a whole but for each of 22 major SIC groups. Because the plants were picked at random and not from the point of view of anticipated truck use, we feel the findings on truck freight movements are powerful new indicators of just how extensive truck use is among hundreds of plants of sufficient variety to reflect freight movement patterns for a vast segment of American industry.

Some of the more significant findings from data supplied by the 1,315 respondents reporting percentages of inbound and outbound freight moving by truck are as follows: 872 plants—67 percent of the response group—shipped 90 percent or more of all outbound freight by truck; 766 plants—58 percent of the response group—received 90 percent or more of all inbound freight by truck; and 613 plants—almost half of the response group—reported receiving and shipping 90 percent of all freight, inbound and outbound, by truck.

As mentioned earlier, most findings could be weighted in terms of employment. This was true of reports on the percentages of inbound and outbound freight moving by truck. Even when this more conservative standard is used—attaching more importance to the larger establishments—results for the entire survey were as follows: 59 percent of all inbound freight was received by truck and 67 percent of all outbound freight was shipped by truck—more, in each instance, than all other transport forms combined.

Important as truck-use patterns were in this study, the rail factor was not overlooked. As mentioned previously, "availability of rail service" ranked fifth among the 13 factors on a frequency-of-mention basis and fourth when survey results were weighted for employment.

The questionnaire also asked recipients whether or not their present plant had a rail siding, and those who had moved from another location were asked whether the former location had a rail siding. About half of the survey respondents reported having rail sidings. Generally, when plants moved, they retained their same position relative to a rail siding. Those not having rail sidings at their former locations tended to select similar non-rail siding locations. Those with rail sidings tended to pick a rail siding when they moved.

It was found that slightly more moved from a non-rail siding to a rail siding than made the reverse move. At first, this might seem a little puzzling–but we believe it can be explained. Provision of a rail siding at a new plant location is only a small part of the total cost. It might just as well be provided. Also, many industrial locations have been available in proximity to rail lines on rail property which may be a residue of land owned by the railroads as a result of the land-grant days. These properties had perhaps nominal value when only the railroad was nearby, but with the construction of a new highway in the vicinity the property took on added value—it became a prime plant site, with the rail siding almost being part of the package. In fact, there have been many railroad-sponsored industrial development ads emphasizing that a proposed site had the double advantage of both railroads and good highways; pictures in the ads often show both means of transportation.

Specifically, the rail siding findings for those reporting having moved were as follows: from one non-rail siding site to another non-rail siding site, 45.6 percent; from a rail siding to a rail siding, 23.4 percent; from a non-rail siding to a rail siding, 17.0 percent; and from a rail siding to a non-rail siding site, 14.0 percent. But the fact that a plant has a rail siding does not mean today that it is using it heavily or at all. This was amply demonstrated by survey findings. For example, about one-fourth of the plants with rail sidings reported 90 percent or more of both inbound and outbound freight moving by truck.

A summary report of study findings and the complete study report on "Highways, Trucks and New Industry," published in book form, are available from the American Trucking Associations.

Economics of Highway Location: A Critique of Collateral Effect Analysis

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•CONSIDERABLE controversy exists over the type of analysis which best evaluates the economic changes due to realignment of spatial relationships caused by highway location improvements. A general classification of the analyses for measuring the actual impact or for estimating the potential effect of highway improvement shows that highway location methodology is trichotomous. First, the traditionally applied analysis is the engineering economy method based on total primary user benefits and costs. Second, welfare economists contend that maximum social efficiency in resource allocation requires measurement of the total secondary or tertiary collateral benefits and costs. The relationship between these two methods of analysis has been examined in detail in an earlier study in which the conclusion was reached that the collateral effect method does have certain advantages over the traditional engineering economy analysis (1).

The final category in this trichotomy is marginal analysis based on the equality of marginal user benefits and costs as the measure of efficiency in the use of resources in highway investment. Economists who advocate this last method have expressed considerable doubt as to the conceptual and operational relevance of the use of total values in this decision process (2, 3). The principal objective of this paper is to review highway location methodology in general, and discuss collateral effect analysis in view of the criticisms of the marginal theorists in particular.

The engineering economist accepts the proposition that the highway user effect is the proper category of variable to use. This is so only because of the practicability of measurement and the possibility of avoiding double counting if collateral variables were used. This implies that double counting is inherent in collateral effect analysis. Quite the contrary, it is the avoidance of double counting which gives collateral analysis an advantage. The idea of measuring effects of a higher order than the primary user effects is also a major criticism of the marginal analysts, but for a different reason.

The welfare approach relies on income accounting techniques adapted to the local problem and other methods derived from research connected directly and indirectly with the Highway Cost Allocation Study (4). Criticism by the marginal theorist aimed at the income analysts who must account for the value of public goods and services may be applied also to the problem of accounting for the geographical distribution of the effects of a highway improvement in a given corridor. It is feared if collateral variables become relevant criteria for location analyses, it would just be a matter of time before such criteria would be used for other highway investment decisions. The reason for such concern is the possible misallocation of resources due to overvaluing the benefits of the highway investment. Therefore, marginal cost pricing or the public utility pricing approach even for location decisions is strongly advocated (5).

The procedures of the engineering economy approach and collateral effect method are sketched briefly. The marginalist viewpoint is also presented, followed by its critique of the collateral effects approach. It is also shown that collateral effect analysis can predict the effects of several alternative highway locations on a given corridor and thereby serves as an adequate criterion for public services decisions. This is

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accomplished by comparing a series of models illustrating the characteristics of each approach in highway location analysis.

ENGINEERING ECONOMY METHOD

Once a corridor is designated for a new highway, there are usually several alternative locations which are technically acceptable. The benefit-cost ratio of the engineering economy method evaluates the most profitable alternative among several possibilities by comparing annual user benefits of each alternative with the added annual highway costs. Annual costs consist of the amortization of capital investment, interest on capital, maintenance and operation. Annual highway user benefits, on the other hand, consist specifically of savings in the cost of highway service between two common points.

According to the AASHO Committee on Planning and Design Policy, there are seven principal factors which should be considered: (a) solvency of a system or groups of systems of highways; (b) land, improvements to land, and community benefits; (c) cost of construction or improvement of the highway; (d) cost of maintenance and operation of highways and their appurtenances; (e) direct benefits to road users in the form of reduced vehicle operating costs and savings in time; (f) increased comfort and convenience to road users; and (g) benefits to road users in the form of accident reduction. Regarding quantification of solvency, land and community benefits, and accident reduction, the report adds that due to the character and the general absence of measurable values with acceptable accuracy, it is not possible to specify measurement techniques despite the importance of the factors (6).

It is frequently asserted by proponents of the engineering economy method that secondary effects of highways are only user benefits transferred; therefore, to add user and secondary benefits would be double counting. Likewise, there would not be any differential between user and secondary effects if calculated properly. The fact that only those benefits which accrue to the highway user are considered is further justified by the assumption that revenue supporting the highways is obtained from the users themselves. If this were true, it would be desirable to maximize the benefit-cost ratio based on user benefits.

Using the traditional procedure, an estimate of implied collateral effects is obtained from a sample origin-and-destination survey which provides data indicating the quality and quantity of current traffic flows among various land uses. From these data, used alone or in conjunction with land-use surveys, the projected traffic for a given year is determined, and the total highway user benefits are calculated. From this it can be seen that the problem does not lie in recognizing the importance of collateral effects but in the fact that they are not used operationally.

COLLATERAL EFFECT METHOD

Collateral effect analysis, a welfare approach, unlike engineering economy and marginal analysis, is founded on the precepts of mutually exclusive categories of effects occurring at the primary, secondary and tertiary levels of economic activity resulting from the highway improvement.

Three levels of collateral effect analysis are possible. Secondary collateral effect analysis deals with the nontransferential primary effects and the transferred primary effects, including the externalities measured at the primary and secondary levels. Tangible secondary collateral effects include retained earnings of motor carriers, changes in tax ratables, redistribution of increased earnings by motor carrier industry and highway transport-oriented firms, decreases in gross earnings of industries that are substitutes for the motor carrier industry, increases in gross receipts of firms complementary to highway service facilities, and changes in agricultural production adjacent to the highway.

A higher order analysis—extended-secondary collateral effect analysis-uses transferred secondary effects and nontransferential primary and secondary effects. A third method-tertiary effect analysis-measures the ultimate changes in the economy resulting from a highway improvement, e.g., land values and price level changes. A

larger degree of externalities is measurable at a higher order of analysis than at a lower level, but at the same time, the higher the level of analysis, the greater is the difficulty of obtaining meaningful data. Consequently, collateral effect analysis is discussed in terms of the secondary level.

The analysis (1) is essentially a five-step procedure. The first step is to determine the level, composition and normal growth trend of the economic structure in each alternative highway impact zone within the corridor. The relevant trend can be obtained by observing three major economic flow variables: industrial production, agricultural activity, and commercial activities.

The second step is to determine the ratio of the value of collateral effect variables to the value of selected economic structure activities. There is an interdependent relationship between the extent of highway improvement effect and the absolute level and composition of the preconstruction economic structure. This relationship can be determined precisely only after the elements of the economic structure have been broken down into highway-influenced and non-highway-influenced categories. The five specific activities considered as highway influenced are motor carrier industry transactions, agricultural production on land in the area adjacent to highway improvement, receipts of industries complementary to highway services, receipts of industries which are substitutes for highway services, and changes in tax ratables from highway existence.

The third step requires computation of a value for the total change in each collateral effect variable during the life of the highway improvement. The degree of change of the collateral effect variables is a function of the level and composition of the economic structure and the ratio of collateral effects to the economic structure.

In the fourth step, the predicted normal growth curve is modified to allow for the net benefit of the highway improvement. The result is a trend line which reflects the effects of a highway improvement in the zone. This method provides data concerning the net benefits from the improvement. The difference between this predicted growth curve and the normal growth curve computed in the first step provides a benefit value for the secondary collateral effect analysis benefit-cost ratio.

The final step consists of placing the differential obtained in the previous step–the net benefit of the highway improvement–in a benefit-cost ratio employing the traditional concept of costs. This ratio is a measure of the highway effect in a given zone. A similar ratio is computed for each alternative study zone, providing a basis for evaluating the alternative routes. The choice of the best alternative becomes the matter of selecting the route with the highest collateral benefit-cost ratio.

At the theoretical level, certain impacts of the highway improvement will be overlooked unless collateral effect analysis is used singularly or as a complement to traditional analysis. The advantage of collateral effect analysis is its ability to account for the larger degree of effects associated with highway improvements. This analysis is designed to measure the impacts of the highway improvement which originate with the highway, arise through use of the highway externally to the user, and are transferred effects from lower levels of occurrence.

MARGINALISM

Marginalism is an economic principle which explains a form of maximizing (or minimizing) behavior. When producers equate marginal cost with marginal revenue, they are maximizing profits (or minimizing losses). In equilibrium in a purely competitive economy, the allocation of resources according to this principle would be the most efficient, both privately and socially. The value of the product would equal the cost of production at the margin. In other words, the cost of producing an additional unit of output (marginal cost) just equals the amount the consumer is willing to pay for an additional unit (marginal revenue). This analysis would have to be modified appropriately as market conditions varied from the purely competitive assumptions.

The marginal approach as it is applied to highway investment follows the same logic. The efficiency of the allocation of resources into highway use is maximized when the marginal benefit of the highway, which is the addition to value to the highway user from employing another unit of highway service, is equal to the marginal cost of the highway investment. The marginalist accuses the welfare economist of forgetting this principle

when collateral effects such as externalities or net non-user benefits are included as a measure of social benefit. The marginal approach would argue that the cost of obtaining an extra externality is zero as far as the additional cost of the highway facility is concerned. Therefore, this value in the investment or location decision should also be considered as zero for efficient allocation of resources into highway use (7). The value problem is reflected in Adam Smith's famous diamond-water paradox:

> The things which have the greatest value in use have frequently little or no value in exchange; and on the contrary, those which have the greatest value in exchange have frequently little or no value in use. Nothing is more useful than water, but it will purchase scarce anything; scarce anything can be had in exchange for it. A diamond, on the contrary, has scarce any value in use; but a very great quantity of other goods may frequently be had in exchange for it. (8)

The answer to the paradox is evident today in the concept of the marginal cost. Diamonds are relatively scarce so the cost of getting an additional one is very high, whereas water is quite abundant and its cost is usually very low. This distinction in value as argued by the marginal theorists is relevant to highway location analysis in the following manner: the value or benefit of a highway improvement can be measured by the price users of the highway are willing to pay for additional highway services. This amount reflects the marginal benefit of the highway service. Assuming that the highway cost is to be borne by the highway user, this benefit received from the highway at the margin when equated with marginal cost would offer an appropriate criterion for comparing alternative locations. This approach to the evaluation problem implies that if the value of collateral effects cannot be obtained at the margin in the market through the price system, then it is inappropriate to use these as variables in the benefit accounting procedure. This is the primary marginalists' criticism of collateral effect analysis.

COMPARISON OF METHODS

This review of the three approaches to highway location analysis permits a closer look at some of the fundamental differences. The method of doing this is to review several representative models from the literature and to construct a composite model through which the nature of the assumptions, variables and results can be compared. These models demonstrate three specific issues among the engineering economy, marginal and collateral effect analyses: (a) the importance of externalities in measuring private and social welfare, (b) the inflexibility of supply of highway services due to indirect pricing of highway services, and (c) the nature of the multiplier or coefficient of expansion of transferred effects.

Pure Competition–Neutral Collateral Effects

The first model represents marginal analysis in an environment of pure competition and a heterogeneous distribution of resources (3). Buchanan assumes that highways are privately produced and marketed; all roads are toll roads. There are many owners of the roads and each owner is free to set his own toll. There are sufficient alternative roads to insure perfect competition in the marketing of highway services. Under these assumptions, the price of highway services will equal the marginal cost of construction and maintenance of highway facilities. The factors considered in the model include highway service, vehicle service and driving time. This model implies that a highway improvement which would increase the supply of highway services to the new level would occur in response to a previous increase in demand for highway services. The price of highway services at the existing level of supply would rise, thereby providing a sufficient incentive for the construction of additional highways. Eventually an equilibrium would be reached. The benefits to the users would be reflected in the prices of highway services which are equated to the marginal costs of the increase in the supply of highway

facilities. As long as the highway us ord
the highway owner a reasonable retu n-
sider collateral effects. The supply ased
on the response to direct pricing prc -
fects are uniform and their impact is

Zettel has constructed a model to
showing a similar neutrality of highw e-
neous spatial distribution of land uses
region which produces traffic and crea namic
in that there is economic growth and a static,
there would be no need for highway imp in
in equilibrium. An optimum, such as t h,
has been reached. Economic growth re
maintain the system in equilibrium. Hi ll
enough increments that the economy wou sive
degree of economic growth. Therefore, f.
The increase in population results in the -
way services. Each successive increas es
an increase in the supply of highway faci
services remains constant and the econo m
highways are just sufficient to provide th
found in the previous conditions of equili -
main in equilibrium.

The implicit assumption which Zettel is
tertiary effects of each increment accrue to
changes in prices and quantities of all substi and complementary goods and services
and the restructuring effects are neutralized through the equalization of changes in demand and supply of all goods and services within the economy. The indivisibility of highways and their services and the condition that highways are not ubiquitous are abstracted from the analysis.

Garrison arrives at a neutral effect of a highway improvement under somewhat different assumptions (10). The effects of a highway improvement accrue only to the highway user and the full amount of these benefits are taxed through a system of tolls. The tolls serve as revenue for providing subsidies to those made worse off by the highway improvement. Therefore, there is no net effect on the non-highway users and highway improvement effects on users have been neutralized. This example approaches the welfare concept. In all three models, collateral effects or externalities are ignored because secondary effects are neutral when the condition of the competitive model is assumed, as in the case of Buchanan and Zettel, or when the cost of the highway service is directly priced and compensation given, as in the Garrison model. The supply of additional highways is based on user demand, but the location of the new highway will be influenced not only by user demand but also by the degree and distribution of collateral effects. This latter consideration is necessary if maximum social benefit is to be obtained.

Monopoly-Non-Neutral Collateral Effects

The highway system in reality is publicly owned and the cost of highway services is priced directly so that there may be a divergence between maximum social benefit and maximum private benefit. Buchanan derives collateral or non-neutral effect by postulating a monopolistic highway model (3). The simplifying assumptions follow his competitive model very closely at first. There is a heterogeneous distribution of resources. Highways are privately produced and privately marketed. All roads are toll roads. Owners of the roads are free to set their own tolls. The monopolistic feature of the model is a result of the lack of enough alternative routes to insure competition. Under these conditions, the prices of highway services are greater than marginal costs. The result is the existence of collateral benefits. These will accrue to the monopolist initially and then will affect the economy. Because the highway facilities are privately

owned, there is no question for society concerning the locations of routes. Monopolists desiring to maximize profits would locate highways without the consideration of collateral effects. They are concerned mainly with maintaining the barriers to perfect competition in this situation.

Greater realism in the conditions of alternative highway location decisions is found in Zettel's non-neutral effect model (9, pp. 32-33). The objective of this abstraction is to show the problem which exists when only a limited number of highways can be built or improvements made. This model represents the engineering economy philosophy and assumes the following conditions:

1. There are two zones, x and y, respectively.
2. There is a heterogeneous spatial distribution of land uses and economic activities in each zone which produces traffic and creates a need for highways.
3. The economy is dynamic in that there is economic growth and an increase in population.
4. Economic growth requires additional highway improvements to maintain the economy of each zone in equilibrium.
5. Highways can only be built in discrete segments over time and at selected locations.

Priority of one highway improvement may be due to certain advantages for residential or industrial development which will suggest greater prospective economic growth even in the absence of the highway improvement. The priority will be determined by evaluating user benefits relative to the cost of the highway. Regardless in which zone the highway is built, the effect of the highway improvements will be distributed unevenly throughout the area.

The benefits accrue to the highway users as a class, but the degree of effect, both positive and negative, is a function of the users' locations relative to the highway improvement. The increases in revenues of highway users in the areas adjacent to the highway improvement will be greater than the costs assessed these users. The distribution of these net gains throughout the economy in higher levels of economic activity are considered by Zettel to be secondary effects which are shifted to the non-users of the highway through the capitalization process. He contends the total benefits at the secondary level can be no greater than the original amount of gain received directly by the user.

A more recent model representing the marginal approach, under noncompetitive conditions, was constructed by Forte and Buchanan (7, p. 113). A public good and service, which may be assumed to be a highway, is provided in a limited quantity within an implied heterogeneous distribution of resources. The services are available without direct charge. It is further assumed that a "fully competitive adjustment" does not take place. The result is that returns to the factors of production may be greater than their cost. For purposes of this analysis, this would be returns to highway users or to other highway-oriented activity. These differential returns to the factors, which may be called rent, replace the cost of production and at the margin in the marketplace become included in the market value of private output. The implication here is that user effects may be transferred to final consumers in cases where highway services are intermediate. The conclusion is reached in this case that value at the margin has no relation to the cost of production because the price of the service is indirect (7, p. 113). If this is interpreted correctly, the basic principles of marginalism seen in the two earlier Buchanan models would suggest that direct pricing of highway services is required if marginal value is to equal marginal cost. Cost would determine the supply of highway services, which is not now the case with indirect pricing. The divergence between marginal value and marginal cost created by the pricing method postulated in this model creates a difficulty for using marginalism as a criterion of highway investment.

The conditions in which collateral effect become important have been abstracted so far. These effects can be made explicit by constructing a composite model. As in all previous models, the distribution of resources is assumed to be heterogeneous. A

limited supply of highway service resulting from a highway improvement causes an unequal distribution of effects throughout the location corridor. The economy is dynamic and responsive to highway investment changes. Some degree of unemployment exists and is distributed unequally throughout the corridor. The highway network is supplied as a public good by the government. Indirect charges are made on highway users, but not in response to the supply and demand for highway services. Therefore, fully competitive adjustments cannot take place in the price of highway services. In addition, certain externalities occur from highway construction and highway use. It is further assumed that transferred highway user effects create secondary and tertiary economic activity which results in an increase in the level of the economic structure at rates which can be expressed as "multipliers" or coefficients of expansion. When these data become incorporated into the procedure of the collateral effect analysis, the total effect of the highway location includes the nontransferred user effects, secondary transferred effects and externalities of highway construction and use; this total value is a more complete measure of welfare than would be obtained by other methods.

These models have demonstrated how the wedge of externalities and indirect pricing of highway services forces the effects of the highway improvement to differ in value as the assumptions differ from those of the purely competitive market. The forces of spatial monopoly and imperfect knowledge create an ever-widening differential between private benefit and social benefit.

The Zettel and Garrison models reflected the engineering economy concept that transferred benefits must equal highway user benefits. In the Buchanan models, the marginal principle of maximizing private benefit in terms of user benefits and highway cost is explicit. The Forte-Buchanan model incorporates the institutional difficulty in public service indirect pricing which in following their criterion is applicable to public highways as well. Finally, the composite model emphasizes the importance of externalities, transferred effects and the differential in the measure of economic benefit.

CONCLUSIONS

It is now possible to summarize the implications and conclusions of the methodological difficulties which have been demonstrated in this series of models. These difficulties are the importance of externalities, the inflexibility of supply of highway services, and the nature of the coefficient of transferred effects.

The importance of externalities or external economies results from the public nature of the highway facility. Certain benefits of the highway are rendered collectively, rather than privately. Inasmuch as these are external to the highway user, collective decision-making is required. It is impossible to have the benefits of a highway for some without providing them for all in some degree because the by-product effects impinge inseparably on many people (11). On the other hand, private decisions, under the direct pricing assumption, might still fail to evaluate the worth of externalities in terms of highway use because of the lack of private ownership of the collective effects. Collateral effect analysis would account for the effect of externalities through the change in value of the gross corridor product.

If, under the extreme assumption, marginal user costs on all alternative routes were equal for private maximization, collateral analysis could evaluate the degree of secondary transferred effects and externalities. In a sense this is moving toward the Pareto Optimum, which if the welfare concept of achieving a position whereby somebody is made better off without anyone else being made worse off.

When the equality assumption is relaxed and a differential is measured by the marginal approach, the situation exists as to whether the same direction and degree of difference would be measured by the welfare concept. If the differential is in the same direction, there is no problem. However, if it is not, an additional question may be raised. Is the benefit measured by the collateral effect approach greater than the loss in highway user benefits reflected by the marginal approach? This situation involves a value judgment of interpersonal comparisons of the value of the loss to that of the gain. The additional problem of compensation enters at this point. Are those experi-

through externalities and transferred effects willing to compensate
to take the loss? In the decision-making process, this would be nec-
a consensus as to the location of the highway.
g models show that under private ownership of the highway, externali-
e priced and would not enter the decision process. The cost of obtaining
nalities is zero in terms of the cost of producing extra services. There-
of the externalities should not enter the highway decision. These values
iately accounted for in the price and quantity changes of private produc-
ve value for these externalities in highway investment analysis would
vestment. This marginal principle maximizes private investment and
ount for a divergence in the level of private and social welfare. The en-
nomy method implies the existence of externalities, but only in the degree
erate additional user effects.
analytical difficulty and point of contention of the marginal approach is that
ity inherent in indirect pricing of highway services leads to erroneous al-
esources because the supply of highway services is not a function of price.
ffect analysis accounts for this by valuing the additional supply of highway
rms of the total effect of the highway in the absence of direct pricing. If
ng were the rule, the need for collateral analysis would be reduced unless
ve locations resulted in precisely the same marginal values. In this case,
ry collateral analysis would maximize not only the private allocation of
ut also the social allocations. Engineering economy imputes the cost and
ghway services to the user, thereby avoiding the problems resulting from
pricing.
l area of difficulty is the concept that secondary effects may be greater than
user effects. Marginal analysis concludes that the value of externalities be accounted for in relative price changes or price level changes in the economy. This we have already observed is a part of the tertiary collateral effect analysis. However, these values could not be attributed to the highway investment in the marginal approach. Engineering economy analysts proposed for practical purposes that secondary effects cannot be greater than user effects because they are only capitalized user effects. Collateral effect analysis, through adding up mutually exclusive effects, does determine a coefficient of expansion representative of the degree that the total effect of the highway location is greater than the sum of use effects.

In view of these conceptual problems, there is a place for collateral effect analysis in alternative highway location decisions. Nevertheless, the applicability of collateral effect analysis varies with the conditions of this problem. Collateral effect analysis would be most effective if the goal is to maximize the economic welfare of a society within a corridor in which a highway is to be located, because it offers the most sensitive comparison of economic variables even in light of the difficulties arising out of externalities, indirect pricing and multiplier effects.

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Interchange Protection and Community Structure

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A general framework of research for interchange locations in rural and suburban areas is set forth. The framework involves three separate but related facets: prediction of growth, land-use planning for highway protection, and community structure favorable to the development of highway protection programs. Major emphasis is placed on the development of an empirical model for land-use planning at interchanges. The primary objective is to explain and demonstrate the interrelations existing among land management units for purposes of highway protection. The model assumes homogeneous land management (residential) units. Essentially, this model recognizes that land use will alter both the practical capacity of the interchange and the volume of traffic using it. The model may be expanded to include other types of land management units (e.g., commercial and industrial), thereby making it more comprehensive and more generally applicable. In the latter stage, the model provides a guide for land-use planning which indicates how many and what new developments can be allowed to locate until surplus capacity is utilized.

•THIS PARTICULAR presentation treats two separate but very related topics. The first is the design of land-use plans for interchange protection or, more specifically, the development of a model for land-use planning at interchange communities. The purpose of the model is to aid in establishing planning standards for interchange communities. In its final form, it is hoped that the model will allow the evaluation of alternative land-use plans for highway protection. The second aspect of this presentation is concerned with the implementation of plans for highway protection. The constituents of a local area have to put the land-use plans into effect. Some areas do a very good job in implementing plans and others do very poorly. The sociological aspects of the planning process are no doubt important, and community structure, for example, may be highly related to the implementation of plans.

The two aforementioned topics are visualized as two sides of a research triangle (Fig. 1). The third segment of the triangle, namely prediction of growth, is receiving attention concurrently. The purpose of the models being developed is to help estimate the amount of growth that may take place in different interchange communities and anticipate the adjustment problem that may be created by highway change. The objective of the intergrated research design is to provide the knowledge necessary for the rational guidance of social and economic change in communities affected by highway improvement.

DESIGN OF LAND-USE PLANNING MODEL

The Federal-Aid Highway Act of 1956 authorized a tremendous additional public investment in highway improvements. Highway change of this magnitude requires much

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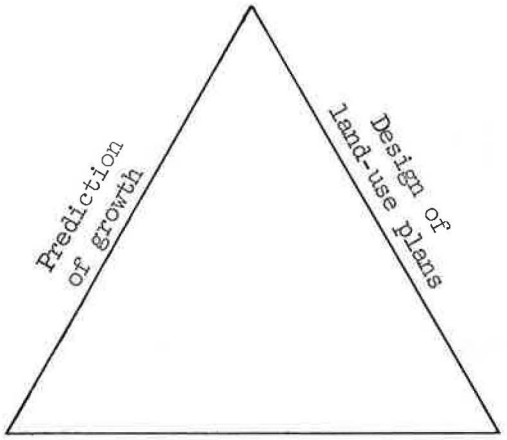

Implementation of plans for highway protection

Figure 1.

adjustment that will no doubt continue for many years after this authorized construction is completed. The changes which have taken place already have usually been accompanied by transformations in the land use of the areas served by the new facilities. These land uses induce changes in the volume and composition of highway traffic. The traffic attributable to the new land uses in many instances has caused congestion not only on the limited-access facility but also on the ramps, and even on the connecting roads.

As congestion occurs in the interchange area, the facility becomes technically obsolete, frequently in a very short period of time. Changes in land use and subsequent traffic often occur at a very rapid rate, and some thought should be given to the protection of the public investment in the highway improvement. Land-use planning at the interchange area is one modus operandi of achieving this protection. However, if the land-use planning is to be consequential, it must be predicated on a comprehension of the relationship between highway use and land use.

It is well recognized that the composition and volume of traffic are determined to a large extent by the use of the land served by the highway and that any attempt to forecast traffic must consider expected land-use patterns. However, changes in land use and in associated traffic are not as well understood and are less amenable to control than are design and access features of our highways (1). The functional efficiency of the highway is often reduced by failure to control emerging land uses induced by highway improvements (2).

A conceptual framework for land-use planning at interchange sites was presented in an earlier paper (3). The specific objectives of the presentation included a delineation of the general problem of land-use planning for highway protection, the suggestion of a methodology for research into land-use planning at interchange locations, and a proposal of research needs for the development of improved land-use planning standards. In general, the analysis emphasized the relationships between land-use adjustments and highway capacity at interchange sites and recognized that land-use adjustments alter both the practical capacity of the roadways and the volume of traffic constituting the flow of traffic.

In an effort to provide information that could be used in the development of more comprehensive standards, emphasis was placed on an arrangement of land management units which would minimize the need for new highway construction. The analysis developed was built around the objective of permitting and encouraging the economic growth that any given highway segment could accommodate. The principle of selection was that the number, kind, and location of land management units should not create traffic demands that would bring about congestion.

Determination of surplus capacity is the first requirement of the research design. To be able to determine surplus capacity, it is first of all necessary to determine design capacity of the highway. Design capacity, Dc, is defined as the maximum number of vehicles that can pass through a highway segment, considering safe speed commensurate with engineering satisfaction. The design capacity is a function of the width of the highway (w), the obstructions (o), and the surface type (s). This may be written as:

$$Dc = f\ (w,\ s,\ o) + e \qquad (1)$$

in which e equals other variables, treated as constant.

The next phase is a determination of the practical capacity of the highway segment which is a function of the preceding variables, but the factors previously held constant (e) now become variable. Practical capacity (Pc) in this context is a function of the volume of traffic entering the highway, the volume leaving the highway, the proportion of different classes of vehicles in the traffic stream, and any other unique or special factors affecting the highway segment in question. Viewing these factors as restrictions to the designed capacity, the relation can be written as

$$Pc = Dc - H \tag{2}$$

in which H is equal to the volume of traffic hindered or obstructed.

The total traffic hindered or obstructed (H) can be estimated by classifying various public and private intersections (e.g., those with stop signs, traffic lights, etc.), by determining the volume of traffic that is restricted by various amounts of traffic entering and leaving these intersections, and by taking into account the product mix or proportion of different classes of vehicles in the traffic stream, as well as any special factors that restrict traffic on the segment. These variables can be symbolized as follows:

- Ve = type of intersection with a given volume of traffic entering the highway segment;
- Vl = type of intersection with a given volume of traffic leaving the highway segment;
- Mx = product mix or proportion of different classes of vehicles in the traffic stream; and
- E = any unique or special factor which restricts traffic on a given highway segment

The next requisite is a knowledge of the actual volume of traffic (Av). The difference between the practical capacity and actual volume gives the surplus or absorption capacity (Sc). This can be stated as:

$$Sc = Pc - Av \text{ or } ADT \tag{3}$$

The actual volume of traffic is composed of four basic types: generated traffic (G), attracted traffic (A), local traffic (L), and through traffic (T). The actual volume of traffic can thus be stated as:

$$Av = G + A + L + T \tag{4}$$

The volumes of generated and attracted traffic were subclassified according to land management uses. For purposes of simplification, the following categories were used: residential units (R); commercial units (C); industrial units (I); other units (O); and public intersections (K) abutting the segment. (Although the public intersections themselves do not create a flow of traffic, they are treated as generators and attractors when they intersect the segment in question.)

SPECIFIC ILLUSTRATION OF MODEL

Assuming the existence of a homogeneous group of land management (residential) units, the initial objective was to present a computerized simulation model programmed to include the unique characteristics of a specific interchange area. These are, among others, topography, the existing highway network and the present land-use pattern. The present lack of the complete empirical data precludes the immediate presentation of the pertinent program. Some applicable data, however, are presented to illustrate their relevance to planning for interchange protection.

Although the use of a simulation model of land-use planning may be questioned, it was felt that in this instance a dynamic model is needed to allow the researchers to make many repetitions of the process and thereby to foresee the outcomes of various mixes of land management mixes. Further, a simulation is designed to incorporate the most significant features of the process being examined (4), and a properly designed simulation model simultaneously considering many variables will allow investigators to visual-

ize some probable effects that any plan could have and will permit an opportunity to modify and refine first thoughts into a more meaningful plan. Thus, the model provides an experimental laboratory which allows study with no influence on the real situation.

Site Application

The present application of the model will focus attention on one interchange in the York, Pa., area. The data presented herein were gathered at this particular interchange, designated as Interchange B. The interchange is located south of York and is part of I-83 which superceded US 111. The new route was opened in segments from 1956 through 1958. A bypass east of York and a number of interchanges constitute the development in the York area. Four of these interchanges, two north and two south of York, are under study at our institute; all four interchanges are within 8 miles of downtown York. Seven civil subdivisions are included in whole or in part in the study area.

Initial Constraints

The beginning model focuses attention on one segment or link of the local road leading to the expressway. This roadway is a two-lane highway with two-way traffic. Weather conditions are assumed to be ideal and, consequently, the road surface is clear. The lane width is 10 feet with normal shoulder width. The segment or link of the road to be considered is defined as 1 mile in length with maximum curvature of 5 degrees.

Residential units are adopted as the starting point for the illustration of the model because they represent the primary generators of traffic in this country. Also, residential units are important with regard to the attraction of traffic. The consequences of household generation and attraction can hardly be overstated. This point is illustrated by the fact that approximately 80 percent of all urban area trips are made either to or from the household (5). The residential units in this analysis are assumed to have equal traffic generation and attraction factors, and each unit is assumed to have a similar private intersect with the road link. Each of the lots on which the residential units are located is assumed to be standard, i.e., 75 front feet. This means along a roadway 1 mile in length, it is possible to locate 140 units if both sides are amenable to development.

Design Capacity

As stated previously, the starting point for analysis is the establishment of the design capacity of the roadway. The design capacity provides a point of departure for estimating the practical capacity of the road segment and, as previously defined, is the theoretical maximum flow of traffic for the link in question. The illustration assumes a design capacity of approximately 1,700 veh/hr. This figure includes allowance for commercial vehicles (6, pp. 35-65).

Actual Volume

The household as a land management unit uses up a portion of capacity by adding traffic to the system; that is, the actual volume of traffic increases. The increase in the actual volume is derived from Eq. 4:

$$\Delta Av = \Delta G + \Delta A + \Delta L + \Delta T \qquad (5)$$

The household information was obtained during the summer of 1960 as part of an origin-and-destination study. The field work followed standard procedures for gathering household origin-and-destination information. An interviewer visited the sample households several days before the initiation of the travel period and returned to complete the travel schedules when the period ended. A sample check was made by telephone to verify that the information had been obtained by the interviewers. A 3-day travel period was utilized during the study which commenced at 4:00 AM on Tuesday and terminated at 4:00 AM on Friday.

For purpose of analysis, there is the additional assumption of no development along the 1-mile segment of the local road in question. The hinterland beyond the link does, in fact, generate and attract traffic which utilizes the link; that traffic is considered in the illustration.

One could work with average daily figures for generated, attracted, local, and throug traffic. However, this approach would not be meaningful because traffic will be peaked at certain time periods during a 24-hour period. Therefore, it becomes necessary to determine when the traffic appears on the roadway because congestion will be reached at certain hours much sooner than at others. The data collected at the interchange site showed that the heaviest hour of travel occurred between 5:00 and 6:00 PM as can be seen from the tables to be presented subsequently. The initial volume of traffic using the roadway between 5:00 and 6:00 PM is 159 vehicles (117 east and 42 west). In comparison with the design capacity of the segment (1,700 vehicles), this initial volume is relatively light.

It now becomes necessary to consider the impact of adding 140 households to the segment. From the traffic generation for households in the general area (Table 1), it can be seen that 195 households generate 38 vehicles during the 5:00 to 6:00 PM period. With 140 households, the appropriate traffic generation figure for the segment under consideration would be approximately 27 vehicles. When this is added to the initial volume figure of 159 vehicles, the new volume is 186.

In addition to the traffic generated, the attraction factor of the households has to be considered. Table 2 indicates that 89 vehicles were attracted to the 195 households in the sample between 5:00 and 6:00 PM. Converting for 140 households yields the appropriate attraction figure of approximately 64 vehicles. Adding this figure to the previous total of 186 yields a new volume of 250 vehicles.

According to Eq. 4 consideration must still be given to local and through traffic. A sample of 200 trip cards from households in the area indicated that 10 percent of the traffic was local. Assuming that this is a typical figure for local traffic, this traffic would account for approximately nine vehicles on the segment during the pertinent time period. This figure was derived by taking 10 percent of the generation and attraction

TABLE 1

HOURLY TRAFFIC GENERATION FOR RESIDENTIAL UNITS

Time	No. of Vehicles	
	AM	PM
12- 1	8	54
1- 2	0	22
2- 3	0	18
3- 4	1	17
4- 5	1	34
5- 6	3	38
6- 7	51	31
7- 8	8	55
8- 9	31	29
9-10	27	34
10-11	24	43
11-12	14	10
Total	168	385
Grand total	-	553

TABLE 2

HOURLY TRAFFIC ATTRACTION FOR RESIDENTIAL UNITS

Time	No. of Vehicles	
	AM	PM
12- 1	9	38
1- 2	6	18
2- 3	2	13
3- 4	1	26
4- 5	1	57
5- 6	6	89
6- 7	26	34
7- 8	26	34
8- 9	31	32
9-10	26	46
10-11	32	34
11-12	42	14
Total	208	435
Grand total	-	643

data presented for households (91 vehicles). Including local traffic in the generation and attraction data and not treating it separately would have amounted to double counting.

In this particular framework of analysis, the through traffic is treated as a constant and would be equal to the initial volume of 159 vehicles. Through traffic is the residual after G, A, and L have been determined. Therefore, with a known Av, through traffic can be determined as follows:

$$T = Av - (G + A + L) \tag{6}$$

The through traffic may also be treated as a constant with allowance for a growth factor if a solution for some future Av is required.

Summarizing the data in the context of the original formula yields $Av = 27(G) + 64(A) + 9(L) + 159(T)$. As stated previously, the household would use up a portion of the capacity by adding traffic to the system. Viewed in this context, with an initial design capacity of 1,700 vehicles there remains a theoretical absorption factor of 1,441 vehicles (1,700 - 259). However, in addition to this facet of the problem, the households also reduce the practical capacity.

Practical Capacity

The effect of the households on practical capacity is a function of certain factors. The appropriate relationship is expressed as follows:

$$\Delta Pc = f(\Delta Ve, \Delta Vl, \Delta Mx, \Delta E) \tag{7}$$

If a variety of public and private intersections exist, they must be subclassified, e.g., those with stop signs, traffic lights, and yield right-of-way. However, in this particular analysis, the only intersections handled are private, and it was assumed that these intersections were all similar. Therefore, it is only necessary to determine the reduction in practical capacity by various amounts of traffic entering and leaving these private intersections, taking into account the product mix or proportion of different classes of vehicles in the traffic stream and any special factors which restrict traffic on the segment.

The initial design capacity of 1,700 veh/hr allowed for a normal element of commercial traffic, and there were no unique factors restricting traffic on the segment in question. Therefore, the pertinent problem becomes one of determining the restriction factor of the volume of traffic entering and leaving the private intersections. The volumes have already been determined and previously presented.

Considering the volume of traffic entering the road segment from the private intersections of the households, the assumption may be made that this traffic would not restrict the vehicles already on the road segment. In other words, there should be a sufficient gap in the traffic to allow the vehicles entering the traffic stream to enter without obstructing other traffic. What constitutes a sufficient gap is resolved by individual drivers entering the stream. The size of the gap would vary to some extent depending on the driver and the physical features at the point of intersection. Also, the longer the period of time the driver waits, the shorter would be the gap he would probably accept as sufficient. In addition, the direction the driver wished to turn would be important because a left turn necessitates a gap in two different streams of traffic. Therefore, the volume of traffic in both lanes and the proportion of turns in both directions have some impact. Another facet worth mentioning is the timing of the traffic entering the stream within any given hour. An hourly volume is really too long a time interval to have much meaning within the framework of this analysis. Because there was a total of 36 vehicles, 27 generated and 9 local, it is improbable that they all entered the segment of the roadway at the same point in time.

This analysis is not concerned with how long vehicles in private intersections wait to enter the roadway. The important question here is how by entering the road segment they delay the traffic flow already on the segment. Referring again to the gap that drivers of entering vehicles will accept, one source indicates that when there is a car spacing of 9 seconds, drivers are affected by the presence of the vehicles ahead. Fur-

ther, under nearly any conditions of speed and traffic volume, approximately two-thirds of the vehicles will be spaced at the average distance or at less than the average distance between vehicles (6, p. 39). Thus, if the traffic volume in one direction is 100 vehicles, about 42 percent of the constituent vehicles will be separated by an average time interval of 9 seconds or less. With 200 vehicles, about 55 percent will be spaced in this fashion. However, another source reports that over 80 percent of the drivers making left turns onto a major roadway and over 90 percent making right turns consider a gap of 9 seconds as sufficient for entering the traffic stream (1). Also, on a two-lane highway with no restrictions on sighting distances, it is possible for an hourly traffic volume of 800 vehicles to travel at least 45 mph. Because there were only 159 vehicles originally on the roadway and only 36 entering the roadway from the households during the 1-hour period under consideration, it would appear safe to conclude that no traffic was restricted by the turning movements. Stated more specifically, it seems reasonable that the drivers entering the traffic stream accepted gaps of sufficient length that no traffic was obstructed or hindered.

The remaining facet of the determination of practical capacity is the number of vehicles leaving the traffic flow of the road segment to enter a private intersection. During the 1-hour time interval, the actual volume leaving the segment was 73 vehicles, 64 attracted and 9 local. (Local traffic must be considered twice in the determination of practical capacity because of its dual impact, the initial movement onto the segment and the terminating movement off the segment.) In this particular instance two major factors must be considered: (a) the direction of proportional volumes on the segment, and (b) the proportion of left and right turns from the segment. Other things being equal, left turns should have a greater impact on practical capacity. The driver negotiating the left turn has to wait for a sufficient gap in oncoming traffic to negotiate the turning movement. If the traffic volume in the opposite direction is of considerable magnitude, then the left turn would probably cause considerable delay.

Even though the impact of a right turn would probably be less, traffic must slow down to sufficient speed to negotiate the turning movement, and the deceleration process varies with drivers. If there is a queue of traffic of sufficient length behind the right-turning vehicle, there could be considerable delay to the vehicles following.

Empirical evidence is necessary to determine how a segment's practical capacity is affected by the traffic which enters and leaves the segment. When this information is available, the absorption or surplus factor can be solved for as follows:

$$Sc = Pc - Av \tag{8a}$$

or

$$Sc - (\Delta Pc + \Delta Av) = 0 \tag{8b}$$

In dealing with a homogeneous group of land management units, these relationships can be rewritten as:

$$\frac{Sc}{\Delta Av + \Delta Pc} \geq 1 \tag{9}$$

Additional Research Considerations

The remaining factor to be considered is that of public intersections abutting the segment. In the model it is assumed that ramps lead to and from the expressway abutting the road segment. Vehicles entering the segment from the expressway will be generated randomly by Monte Carlo techniques from a given distribution at a preselected hourly volume. As the vehicle is generated, it is randomly assigned a turning movement.

As suggested previously, the basic objective is an arrangement of land management units which will protect the highway against congestion and at the same time maximize the development of the interchange area. The increase in traffic associated with land management units and the resultant effects of the traffic on practical capacity are very important. In the computation of average daily traffic, a very simple formula (Eq. 4)

was utilized. The preceding analysis dealt with one segment of the local road. A more realistic formula for traffic on this segment would appear to be

$$Av = Gs_1c + Gs_1e + As_1c + As_1e + Ls_1c + Ts_1c + Ts_1e \quad (10)$$

in which

Gs_1c = generated traffic from land management units on Segment I to connector;
Gs_1e = generated traffic from land management units on Segment I to expressway;
As_1c = attracted traffic to land management units on Segment I from connector;
As_1e = attracted traffic to land management units on Segment I from expressway;
Ls_1c = local traffic on Segment I, i.e., moves entirely within the limits of Segment I;
Ts_1c = through traffic on Segment I (connector road); and
Ts_1e = through traffic on Segment I entering the expressway.

Once again it would be more reasonable to deal in terms of capacity at peak hours. It was assumed that capacity designation was a moving figure for the entire segment. Actually, there are different capacity figures at different points along the segment. The most crucial point of congestion probably would be where the public intersections from the ramp leading to and from the expressway are located. These particular intersections would probably lower practical capacity more than would any other intersection, especially private intersections.

The analysis of households shows that they would have a twofold impact on highway capacity: (a) they would add volume to the system by increasing the actual traffic flow, and (b) they would reduce the practical capacity of the segment by adding a congestive factor attributable to the turning movements of vehicles entering and leaving the added private intersections. An increase in traffic associated with households would be important, but the potential absorption capacity of the roadway would remain large in spite of the added households. Reduction in practical capacity has not been measured empirically, but it appears that its impact would not lead to congestion unless through traffic were to increase significantly.

Service Stations

Some preliminary data on service stations also were obtained. It was felt that service stations represent a type of land management unit ubiquitous to interchange areas. The information obtained at service stations included the following: (a) a count of all vehicles passing the service stations, (b) the number of vehicles entering and leaving the premises, and (c) delay information associated with turns into the service station because it was deemed important in ascertaining the impact of turning movements on practical capacity. In addition, information pertaining to the origin and destination of all people using the service station was gathered by the researchers. Eight service stations were sampled in the interchange area.

Subsequent analysis for service station development will follow the same outline as that presented for residential development. The assumptions will be the same; i.e., that there is a 1-mile segment of road with no development, that the vehicles utilizing the segment are associated with development in the general area, and that there is an estimated design capacity of 1,700 veh/hr. Once again, the peak traffic periods assume paramount importance.

The first item to consider in determining the increase in actual traffic associated with the addition of service stations is the volume of traffic generated, but the situation for service stations differs from that of households. The primary source of traffic generation for residential units are the members of the household. For service stations, the only analogous type of traffic is the departure of employees to make service calls or to return home.

The conception of the service station primarily as an attractor of traffic poses an analytical problem. When service stations are added to the segment, they tend to attract vehicles from the existing stream of traffic and would not, therefore, be too im-

portant in terms of added traffic. The major concern here is the determination of the increase in traffic associated with the addition of service stations.

In the sample information gathered on service stations, customers were questioned as to whether they had used or intended to use the interchange at origin and/or destination. Vehicles using the interchange at origin and destination can be classified as new traffic or added traffic in the accepted sense. Although there were as many as 74 vehicles which entered the service stations during a 1-hour period, there were never more than 5 per hour which used the interchange at both origin and destination. Thus, the new traffic was relatively light. It should be noted that some of the other vehicles would probably be classified as added traffic, but how much would be difficult to determine. Special mention should also be made of the fact that the sample information indicated that service stations located off the throughway ordinarily do not have a wide drawing area.

The greatest impact of service stations would appear, therefore, to be on the reduction in practical capacity caused by vehicles entering and leaving the business. The analysis for this situation would closely follow that presented for households. However, in this particular instance some empirical measurement was obtained by clocking the delay caused by vehicles entering the service station. The total time delay to all vehicles during the entire sampling period was only 73 seconds. Therefore, it would appear that the addition of one service station would not seriously reduce practical capacity under the present conditions. If the actual volume, however, was closer to the capacity of the highway, then impact would, of course, be much greater.

COMMUNITY STRUCTURE

Once the results of the various land management mixes are known and the optimum arrangement is selected, the appropriate control mechanisms must be implemented. The latter may include such factors as zoning, subdivision regulation, programming, taxation, and private controls (8). The specification of suitable control measures is important, and it is necessary to be cognizant of which controls are most effective. Preceding the selection of appropriate controls, however, the community must be organized for action. The degree of organization poses a problem of major proportions, and it is in this realm that community structure becomes important. Stated specifically, community structure may be instrumental in determining whether institutional control measures are adopted.

Some measurement of community structure could enable one to predict the probability that control measures would be implemented. In other words, are the social conditions conducive to interchange protection? Community structure is assumed here to involve demographic data, community organization, leadership attitudes, and social stratification.

Demographic Information

Population changes in a community can be important because significant increases bring changes in the citizenry which may stimulate interest in the adoption of planning standards. As new people arrive on the scene, new homes are built and auxiliary enterprises enter the picture. The development which takes place, of course, may follow some haphazard pattern with consequent incompatible land uses and unused land parcels. The view of this as a possibility may become the driving force behind the adoption of measures for control.

At Interchange B, there were 4,502 people living in the area in 1950. By 1960, this figure had reached 8,506. The population change represents an increase of approximately 89 percent. The considerable increase is indicative of some susceptibility to change because an increase of this magnitude means new people moving into the area. This movement of new people into the area means that this location must have some desirable attributes. The migratory nature of the population is substantiated by the fact that the community had a migrant ratio of 63.2 (number of migrants per 100 nonmigrants). It is believed that new people, having themselves made a recent change, are usually much more susceptible to change.

TABLE 3

AGE DISTRIBUTION OF INTERCHANGE COMMUNITY B

Age	Number
0- 4	1,013
5-14	1,703
15-24	1,045
25-34	1,294
35-44	1,337
45-54	948
55-64	633
65 +	533
Total	8,506

Other demographic information about the community substantiates this hypothesis concerning the community being amenable to change. The relative youth of the population is indicated by 1960 census figures (Table 3). The raw data show a significant concentration in the lower age groupings. The mean age of the population is 29.15. A previous paper suggested that a young population appears more likely to be receptive to change and take the necessary steps to initiate some protective land-use programs (9). This conclusion is justified on the basis that younger people, particularly recent arrivals, do not have deep-seated feelings about existing surroundings. One can appeal to reason with younger and, in this case, better educated people, whereas older people are more likely to be sentimental and/or emotional about the status quo. Here demographic data appear favorable for control implementation.

Community Organization

In the present context, community organization has a somewhat limited definition. It refers only to a number of factors controlled by local communities, weighted factors that indicate some movement toward community planning on a comprehensive basis. The total of these weights is referred to as the Index of Community Complexity. The factors making up the index are assigned weights based on a judgment as to the difficulty of implementing them. These factors along with their weights are as follows: master plan, 7; planning commission, 6; zoning commission, 5; land subdivision control, 4; school district change, 3; building code, 3; sewer authority, 3; water authority, 2; annexation, 2; parking authority, 1; and classification change, 1. The respective weights of the items were developed with the assistance of the University's Institute of Public Administration. The index score for the community in question is given in Table 4.

None of the communities under study has attained the maximum score. As another point of reference, the study community had a score of only 9 in 1956. The latter demonstrates that a considerable amount of progress has been made. The score on the Index of Community Complexity validates what was concluded with respect to demographic data.

TABLE 4

INDEX OF COMMUNITY COMPLEXITY—1962

Factor	Score
Zoning	5
Land subdivision regulation	4
School authority	4[a]
Building code	3
Sewerage (partial)	2
Water authority	2
Classification change	1
Total	21[b]

[a]Assigned a higher weight because they have a complex jointure.

[b]Score will probably be higher in near future due to development of planning commission and master plan.

Leadership Attitudes

Community leaders' opinions concerning the community complexity situation may indicate a potential for future changes. Sherif and Sherif (10) propose the committal dimension of an attitude as follows:

> Forming an attitude toward a group, an institution, a social issue is not an idle matter. It means one is no longer neutral to them; they are value laden for him in a positive or negative way.

Bressler and Westoff (11) have the following to say about leadership attitudes and action:

> . . . it seems safe to say, if attitudes are at all predictive of behavior, that the leadership group as a whole will exert its influence to affect positive adjustments to change.

Eight area leaders were questioned concerning the complexity situation. All eight were in favor of a master plan, a planning commission, zoning, land subdivision regulation, building code, and a sewerage authority. The only difference of opinion was on the topic of a water authority, and here there was still a majority (5 to 3) in favor of the authority.

Along with the leadership attitudes toward the elements of the community organization, their attitudes toward local highway improvements are important. When asked how they felt at the time of the proposal of the highway construction, seven were in favor and one was against the proposed expenditures. When asked how they felt at the time of the interview, all were in favor of the expenditure. When asked about the major purpose of the major route, five of the eight had a particularistic viewpoint as opposed to an universalistic viewpoint. The former means they felt the major route was important in terms of local access and not as a part of an overall system. Keeping in mind the local orientation toward the highway, the fact still remains that the leaders looked with favor on the highway change and, therefore, the general atmosphere should have been good during the development period.

Another interesting question posed to the leaders was how they felt about highway expenditures. Of the eight questioned, three felt too much had been spent, two felt the expenditures were adequate, two felt that not enough had been spent, and one did not express an opinion. These responses are somewhat difficult to interpret because it is not known for sure that these individuals were cognizant of the total highway expenditure. Nonetheless, opinions are in many instances the basis for action.

There are not enough responses here to gage their real import. However, four of the leaders who responded felt that the expenditures were about right or too little, which would indicate that there was no overwhelming antagonism toward the amount spent for highways. At least, it would be difficult to conclude that the leaders were against highway expenditures.

Social Class

The information reported here was secured from interviews with a respondent sample in the York Study Area. First, respondents were classified according to whether they migrants or nonmigrants. The former were those individuals who had moved into the community before December 31, 1956; the latter had moved into the community since that date. The second aspect of the classification was social class rating. The social class of the respondent was established by utilizing a modified version of the method suggested by Bell and Meier (12).

Using the Bell-Meier classification, each respondent is given a certain number of points relative to his income, education, and occupation. The points for each of the variables are added and the sum expressed as a single score for the social class rating. The information obtained for this area is given in Table 5.

TABLE 5

DISTRIBUTION OF SAMPLE BY SOCIAL CLASS RATING[a]

Class	Migrants[b]		Nonmigrants[c]	
	No.	%	No.	%
Upper	19	28	17	16
Middle	40	60	65	61
Lower	8	12	24	23
Total	67		106	

[a]Mean class value of both groups, 15.60; $n = 173$, $t = 2.58$, $0.01 > p > 0.001$.
[b]Mean class value, 16.60.
[c]Mean class value, 15.00.

The cutoff points for the various classes were upper class 21 to 27 points, middle class 11 to 20 points, and lower class five to ten points. The migrant average score or rating was higher than that of the nonmigrants. This finding is somewhat typical in terms of migrant-nonmigrant comparisons as substantiated in other studies. The score of the migrants is relatively high and

based on the findings of previous studies of adoption practices, would indicate an atmosphere conducive to interchange protection via planning. The difference between migrant and nonmigrant scores is statistically significant. The influx of new people raised the community's overall social class and, as previously suggested, there is reason to believe that this higher social class rating indicates greater receptivity to new ideas and procedures.

SUMMARY

Traffic congestion on roadways represents one of the most vexatious problems highway officials have to consider. This presentation has treated two areas related to the problem of protecting against congestion, namely, the impact of land use on highway efficiency and the effect of community structure on the implementation of land-use plans. The effect of alternative land-use plans on traffic flows is important, but without knowledge about the implementation of these plans, the analysis would be fruitless.

Households were selected as the starting point for the illustration of the model because they are so important in terms of traffic generation and attraction. Attention was devoted to a 1-mile segment of a local road leading to Interchange B where it was assumed that no development had taken place. The analysis proposed the addition of 140 households to determine their potential impact on the efficiency of the roadway in question. Households would have two effects on the segment. The first would be to add volume to the system in the form of generated, attracted, and local traffic. The impact of this traffic would be to reduce the capacity of the segment by the amount of the actual volume introduced into the stream. The second effect would be a reduction in practical capacity because of the congestive factors associated with the movement of traffic to and from households. Yet, in this analysis, the actual volume of traffic associated with 140 households was interpolated to be 259 vehicles during the pertinent time period. Assuming a design capacity of 1,700 vehicles, a theoretical absorption of over 1,400 vehicles would remain.

Measurement of the reduction in practical capacity caused by vehicles associated with the households presents an obvious problem. Although a specific measure of this reduction was not determined, some salient considerations were analyzed. In addition, attention was devoted to the possible effects of a few service stations.

Several factors related to community structure have been presented. Each of these is believed to be associated with a community's inclination to engage in such practices as are essential to highway protection. The demographic features, the development of community organization, the attitudes of community leaders, and the social class ratings all appear favorable in the study community.

By and large, the increase in numbers has resulted in a younger population which has at least condoned land-use controls. These controls, as measured by the Index of Community Complexity, have increased. Community leaders were favorable toward local highway development and toward the major controls conducive to the prevention of the unplanned obsolescence of the major thoroughfare. Additionally, if the findings of other research are applicable here, the community's social class rating indicates an atmosphere in which further necessary change would be favorably received.

This paper has dealt with partial treatments of the design of land-use plans and the implementation of plans for highway protection, two legs of the research triangle set forth previously. As the model for the prediction of growth, the third leg, is developed, additional empirical evidence will be introduced and analyzed. Growth, design, and implementation theoretically and practically are inseparable. Taken separately, they provide a mental gymnasium; taken together, they can provide the knowledge necessary for rational adjustment to highway change and thereby to both community and highway protection.

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Seminar on Sociological Effects of Highway Transportation

Introductory Remarks

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•SOME OF the sociological effects of highway transportation have been discussed in previous Highway Research Board meetings. Recently, for example, a sociologist has stated that there are in the United States more automobiles than bathtubs and more drivers' licenses than library cards. The sociological effects of highways are everywhere apparent.

The following papers call attention to some of the different sociological effects of highways and to some of the different ways in which highways affect people. For many people, the opening of a new freeway means gaining precious minutes driving downtown or perhaps a more convenient trip to a major city. It may mean a few more shows in town or a few more days at the shore each year. Each mile seems to bring us a little closer to the safe, efficient road network that today's automobiles demand. But to the people in residential areas adjacent to a highway or to the people displaced when right-of-way is acquired, a proposed highway may not seem to be such a blessing. These people may wonder whether the advantages from the easier mobility provided by the highway are sufficient to outweigh the disadvantages, particularly when the disadvantages may not be known for sure.

Some of these problems and the seriousness of such problems are the bases for these discussions. Are apprehensions about traffic noise and exhaust fumes justified? In areas that might be called "socially stable" should right-of-way payments reflect such intangible factors as friendships and social relationships? For displaced people who are unable to find comparable housing, is it enough to compensate for fair market value (or fair market value plus a nominal allowance for moving)? What comfort can we take from the fact that residents relocated from highway right-of-way typically improve their living conditions if this upgrading results because the relocated resident cannot find housing in the price range of his former home?

On the other hand, how serious is the change in residence associated with right-of-way acquisition in a dynamic society where so many people move so often? Should highway people be held responsible for such social problems as finding relocation areas for low income and minority groups when these problems were serious even before land was taken for highway use? Are some of these problems like some of the benefits associated with highways—dependent on a number of ingredients and perhaps only set off or catalyzed by the presence of a highway?

Perhaps our thinking will also be directed to some of the purposes which may be served by knowing more about the social effects of highways. Whereas it is interesting and, no doubt, desirable simply to know more about these effects, of what practical use is such information? Can it be used for highway planning or for public hearings? If we are to make use of information about sociological effects of highways, do we need to be able to measure or quantify these effects? If we cannot measure or count such effects, can we ignore them or do we, as Hennes has said (1), need to exercise intuitive judgment in determining social effects in the absence of precise instruments for measuring changes?

Included also are comments on such matters as the traffic generation characteristics of different types of households, the effects highways typically have on the supply of

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community leaders and on the attitudes of these leaders, and highway effects on recreation or other nonwork associations.

These are some of the matters which are considered in this seminar. The authors have training in traffic engineering, economics, law, city planning, political science, and sociology and should be able to bring some of the sociological effects of highways into sharp focus.

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Five Years of Highway Research: A Sociological Perspective

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•RESEARCH into the economic and social impact of highway improvement is now in its sixth year at the Pennsylvania State University. This paper reviews in brief the researchers' efforts with emphasis on those facets of study which are of special interest to the sociologist. Indeed, the sociologist's proclaimed interests at times seem extremely widespread. With regard to highway impact, his concern may focus on the broader aspects of technological development through time and the concomitant increase in the complexity of a given society. At a lower theoretical level, as is the case here, he may emphasize various highway-community relationships. Even within this narrower framework, however, all relationships cannot be reasonably considered; i.e., they cannot be given the equal treatment they merit. Thus, the researcher must decide which factors he deems most worthy of consideration.

In this study, the sociological interest has been directed specifically toward changes in population, changes in level of living as measured by a social class rating, community values as evidenced to an extent by attitudes expressed, and degree of community organization as ascertained through use of an Index of Community Complexity. Sociologists themselves have been known to confess that their discipline is, at times, merely accumulative rather than being in a more preferred state of being "systematically cumulative." The sociological perspective presented here is posited on the assumption that systematic cumulation offers the best avenue to the understanding of highway-community interrelationships. Further, it is felt that this understanding is essential to the acceptance and success of the action programs affecting these interrelationships.

STUDY SITES

Three research sites in Pennsylvania have been studied intensively by the Pennsylvania State University research staff. These are Monroeville near Pittsburgh, Blairsville in Indiana County, and four interchanges in the vicinity of York. Because these locations and their respective highway changes have been described and presented graphically elsewhere, there is little need for reiteration here (1, 2, 3). It is sufficient to say that Monroeville had three major highway changes: the opening of a turnpike interchange, the opening of a new throughway to downtown Pittsburgh, and a widening of the major highway through the community. Many of the changes in Monroeville were compared with changes occurring in 38 other communities located on a ring equidistant from downtown Pittsburgh. Blairsville experienced the bypassing of its business district, and the York County communities were traversed north—south by an interstate highway and witnessed local construction of interchanges. Most of the findings set forth in the following relate to these three sites.

During 1963, researchers expanded the study to include 40 interchanges as a pilot study for the prediction of statewide interchange economic growth. Of these, 22 were selected for sociological study to initiate an effort to develop a predictor model pertaining to potential interchange protection as related to community structure. Two other communities, located in north central Pennsylvania, are also being studied. These were surveyed for attitudes toward planning and zoning. The objective of this part of the research is to study the effectiveness of personal contact and planning literature on related community attitudes.

FINDINGS

The findings with which the researchers have been most concerned pertain primarily to the decade of the 1950's, essentially to changes associated with recent highway construction as determined by the "before and after" technique. These findings, even treated quite generally, can shed some light on highway-community relationships, but they are probably more meaningful when cast in historical perspective. The early histories of the communities were studied through use of various published documents, commemorative booklets, and school records. Materials pertinent to the 1950's were gathered from local newspapers, interviews, tax records, and other government documents (1, 2).

On the whole, the case study communities have long highway-related histories. Monroeville, for example, first felt the importance of a highway in 1810 when the Old Northern Pike finally connected Philadelphia and Pittsburgh. Blairsville's highway history antedated Monroeville's by at least 23 years. In 1787, the legislature had authorized a state highway between the heads of navigation of the Juniata and Conemaugh Rivers, from Frankstown to Newport, the settlement which preceded Blairsville. Before the 1920's and the advent of a modern highway, Blairsville had been influenced by a canal; both communities had been affected by the railroad. Both communities had also been affected by the coal mining industry; thus, occupational structures had undergone pronounced change. There is little evidence that any of the communities studied paid much attention to orderly growth. Certainly there was little concern for whether community growth would lead to the unplanned obsolescence of the major arteries through the communities.

During the 1950's, the effects of highway development were recognized. Building of all types, but particularly residential, increased. Pressures on local facilities, schools, churches, and recreation areas were felt. Moves were made toward planning and zoning to prevent haphazard community growth, but whether highway protection is to become an integral part of those plans remains a moot question.

Intensive study has actually been undertaken in six communities, even though only three sites have been set forth. The York study area, as treated here, includes four distinct townships.

Population

Population data (1, 2, 3) were obtained from various sources, census materials, health department estimates, school records, and tax records. Detailed characteristics for households were obtained from interviews.

Of the six communities, all except Blairsville may be considered suburban. They, and the counties in which they are located, grew even though the nearby central city populations declined. Blairsville's population declined, but not quite as much as did the county in which it is situated. The community's decline no doubt can be attributed more to property condemnation for flood control than to the highway bypass situation. However, arterial highway communities exhibited greater growth than did nonarterial communities, even though the environment was otherwise similar. Those communities closest to larger population centers grew most. All study communities, following highway construction, attracted migrants who on the whole were younger and better educated than were those whose residence predated the new facility.

Level of Living

Data on level of living (1, 2, 3, 4) came from some public records such as occupations tax rosters, school census rosters, and poll books. Household interviews provided some of the information on incomes, education, and occupational mobility.

There is little question that the overall level of living of the study communities was higher after highway construction than it had been before. Blairsville's pool of unemployed and retired persons increased over 5 percent during the 1950's, whereas the professional category increased by 2½ percent. Unfortunately, the community suffered a net loss of two manufacturing firms during the decade, but a part of the loss was overcome by the entrance of a major employer in the area, but outside the borough limits. The other research communities recorded noticeable gains in the number of manufacturing concerns, 13 in Monroeville during the decade and 17 in the York area from 1956 to 1962. Two inferences can be made: (a) new highway construction had some bearing on the location of these firms, and (b) some of the new residents were probably attracted by the firms' locations. However, all recent arrivals were not employed in these new plants, and these migrants made their contribution to local levels of living. Not only were they better educated than the preconstruction population, but on the average they were employed at higher occupational levels and had higher incomes Moreover, it seems reasonable to hypothesize that, in addition to their geographic mobility, they had been upwardly mobile occupationally.

Attitudes

Information for the study of attitudes (3, 5) came primarily from two sources. One of these was several years of newspaper files which researchers surveyed systematically. The other was interviews of two types, one with a sample of heads of households and the other with a sample of selected community leaders.

In each of the six communities, the attitudes of leaders and those of other citizens were found to differ little. In all communities, majorities expressed favor toward recent highway developments in their localities. Most felt that the amount of expenditure had been "about right," and most felt that the cost should be broadly borne. Further, there is reason to believe that the favorable attitude toward the respective developments became more widespread after a period of time, presumably during which the residents became more accustomed to the changes.

On an intercommunity basis, there were some differences in attitudes. Suburbanites were more prone to view the highway as intended for local use. Correspondingly, they were proportionately more favorable toward construction costs. Furthermore, the suburbanites were more likely to express the feeling that the new construction had been beneficial and that they had favored it when it was proposed.

Community Organization

Data for this portion of the research (3, 4) were initially gathered by questionnaires to township and borough secretaries and subsequently from local and state government documents, interviews with planning officials, and school records. Community organization, as used here, refers to the existence of a number of local governmental functions or conditions which indicate progress toward comprehensive community planning. The degree of organization is measured relatively by the assigning of appropriate weights to each of the items. The summation of these values for a given community yields the community's score on what has been designated earlier as an Index of Community Complexity.

Use of this index revealed that highway communities tended to exhibit higher scores than did nonhighway communities. Although almost every community's score increased through time, nonarterial communities appear to have lagged about 10 years behind those on arteries. For those study communities on the same artery, the degree of organization was highest for those closest to the most immediate major population center. It was also found that the degree of planning development was related to community size and to level of living (social class rating) as evidenced by occupational

composition, income, and educational attainment. Additionally, there appears to be a relationship between community leaders' attitudes and the extent to which planning and zoning practices exist.

Highway Use

Data on use of the new thoroughfare (6) were obtained through interviews with heads of households and pertain to the Monroeville and York area sites. Use, as discussed here, relates to travel for work, shopping, and recreational purposes.

There appears to be a relationship between degree of use and selected socio-economic characteristics. Heavy users had higher level occupations, higher incomes, and more formal education. Homeowners and persons with numerous organizational memberships were likely to be heavier users, and newcomers were more likely to use the new roads than were the long-time residents. Many of these findings were substantiated by home O and D materials.

IMPLICATIONS

These findings are subject to a variety of interpretations, yet some facts are clear. The study communities had experienced considerable change before the most recent highway changes, but these latter changes appear to have had considerable impact on the communities. The influx of new people became marked; levels of living rose. Attitudes toward recent construction were generally favorable. Communities, for the most part, organized to direct their future development. Recent analysis indicates that those who were better educated and who were employed at the higher occupational levels were more likely to have expressed strong support for planning and zoning practices (7). Another effort, dealing with local government officials, indicates that they were favorable toward nearby construction and at the same time were generally favorable toward planning and zoning practices. Township officials, however, were less favorable than were borough officials (8). This is a problem which highway department personnel must face as they seek to have interchanges protected; this is particularly true in Pennsylvania where most of the proposed interchange construction is to take place within township boundaries.

Most of this project's work so far has been focused on suburban communities. It is well known that these are areas of growth and that the newcomers are the most prevalent users of the new roadways; something is known of the characteristics of the people. Given these facts, coupled with the idea of a favorable reception for the new roads, one would anticipate little problem for highway department personnel in suburban areas. Still, highway officials report otherwise and request an explanation.

Part of the answer may lie in the disparity between the times involved. Most research into the subject of the acceptance of local highway construction has occurred after the fact. Highway personnel must face local residents before construction, before the influx of new residents, at a time when local citizens are yet committed to stability as a major value.

Perhaps another partial explanation has been offered by Lash (9). His report, covering 12 years of study in one area, suggested that, although all conflicts could not have been avoided, the public hearings were not of a type to encourage a search for consensus. He pointed up the existence of differences in values and points of view and proposed that discussion at an earlier level might have permitted consensus and allowed participation in the democratic process. Virtually all present were opposed to the highway department's proposals. The same may be said of a public hearing attended by the author. There is little doubt that lack of information or late information can be detrimental to the overall process of discussion and negotiation. Research in south central Pennsylvania indicates that a number of landowners had no prior information that a highway was to go through their property. Their first knowledge came when they saw workmen driving stakes along the right-of-way (10). Obviously there is room for improved relations; possibly sociological research can eventually contribute to the desired improvement.

INTEGRATION

The project's first publication treated problems arising from the location of major highways and from unplanned land uses (11). This interest has continued, and the impact of community change on the highway has become a major concern. Since the inception of this concern, sociological interests have been quite visibly intertwined with those of the economists. Land-use planning at interchange locations of necessity recognizes the presence and importance of social factors (12), and a very recent presentation sent forth some specific aspects of community structure which are felt to be related to a community's inclination to engage in planning practices for highway protection (13).

The overall project design, as presently conceived, can be expressed as a triadic relationship:

1. The prediction of economic growth at interchange locations;
2. The design and programming of alternative land-use plans at those locations; and
3. The prediction of community willingness to adopt such plans in view of projected growth.

Given the physical and economic conditions necessary for community growth, an understanding of what changes may occur cannot ignore the importance of social factors. These latter variables are antecedent to any change and may, in fact, be cogent predictors of the form a planning program will assume.

Considerable reliance seems to have been placed on zoning as a mechanism to protect the highway right-of-way near interchanges. One research group has concluded that there has been unjustified confidence that zoning powers protect against the pressures of market demands (14). This same research group has warned that it is doubtful whether current planning practices afford a sound basis for the integration of land-use development and protection of transportation facilities (15). There are suggestions that some aspects of eminent domain may be feasible for highway protection, but often there are questions of acquisition costs, local acceptance of public ownership, and appropriate management. Another caveat relates to the difficulty of determining what the land-use pattern ought to be at any given interchange. Further, it is reasonable to question whether controls, exercised locally, would do other than to shove the problem beyond a specific community's political boundaries. Moreover, because local zoning, standing alone, may have some weaknesses, it makes sense to investigate the utility of related auxiliary control mechanisms. Admittedly, these are matters of concern and must receive the attention of action-oriented parties, but difficulty alone, or even past failures, should not preclude additional research effort. Too little is known about existing interrelationships and about potentials for mutually satisfactory adaptations.

OUTLOOK

The importance of understanding the highway-community relationship in Pennsylvania is accentuated by the magnitude of proposed interchange construction. Present plans call for 388 interchanges located in eight cities, 31 boroughs, 23 first-class townships, and 155 second-class townships.

It is the intent of the researchers to study a sample of 100 interchanges which are not located in cities, and the research focus is to be the three-pronged approach previously suggested. The sociological phase of this effort involves the development of a quantitative predictor model incorporating socio-economic and community structural variables.

One objective of sociological analysis is to identify the social forces that explain variation in the acceptance of those planning and zoning measures conducive to highway protection at interchange sites. Indeed, the future of interchange protection, in large measure, may rest on the extent to which there is study of these social forces.

Moreover, there appears to be a need to awaken local citizens to the consequences of interchange and other highway development. At present, local planning and zoning are in the hands of the local community. This authority can be used in some effort to prevent the unplanned obsolescence of a multimillion dollar expressway, for example,

by controlling development at interchange locations. Aware that such local power frequently has not been utilized, the Pennsylvania Senate has considered Senate Bill 543 which provides for succession of zoning authority from the community to the county to the state level if the interchange is not protected.

The reciprocities of the highway-community relationship are crucial to both highway and community development. That the past may illustrate little relationship between favorable attitudes toward highway protection and the existence and enforcement of the mechanisms to achieve that end does not mean that research into the attitude-action complex should cease. Rather there could be the implication of a message to be carried to local communities. It is highly possible that research couched in a sociological perspective may be of assistance in providing some of the content of that message.

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Informal Notes on Sociological Effects of Highways

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•THE SOCIOLOGICAL effects of highways are many and diverse. They are both direct and indirect. It is virtually impossible to separate the user effects of a sociological nature from the non-user effects. There is a school of thought which asserts that effects of these kinds are actually transferred from user to non-user groups.

The first question that might be asked is: What are these sociological effects and can they be identified? In this connection, it might be indicated that the very fact of highway and motor vehicle use, in and of itself, is a sociological manifestation. The highway business considers origin-and-destination studies as a part of the highway planning process. In the past, they have been dealt with in an engineering environment largely. Actually, these define sociology in action.

The highway improvement process itself also involves certain impacts of a sociological character. Urban highway improvement especially results, of necessity, in a certain amount of displacement and relocation of residence. The Federal-Aid Highway Act of 1962 provides for the rendering of relocation advisory assistance to this class of persons and permits Federal reimbursement of the costs of moving such families, up to a maximum of $200 each, if such costs are authorized to be paid under state law.

Also included in this general subject matter is the matter of highway aesthetics. Highway officials have become increasingly concerned with aesthetics and are seeking to build facilities that will be pleasing to the eye as well as functional in their operations. Higher standards of performance in this area are present today than ever before.

Control of billboards along defined corridors of the Interstate System is authorized by the Federal-aid laws, and a bonus of 0.05 percent is authorized to be paid to those states which voluntarily embrace the program. About half of the states have already enacted the necessary legislation, appropriate agreements have been executed, and some of the states have already received bonus payments.

Highway officials are presently emphasizing the preservation, to the maximum extent, of fish and wildlife habitats and historic monuments. They are participating in studies that hopefully will lead to the preservation of some of the best of the nation's wild rivers. Additionally, a study is under way to define and establish a national program of scenic roads and parkways through the vehicle of the Recreation Advisory Council.

All of these programs and developments might be considered to define elements of the sociology of highway transportation. There are also other elements. Perhaps we could get some better insight into them by reference to several works in this area. For example, some interesting implications for sociological transportation research have been posed by Meyerson (1):

> What is the meaning of driving to the individual: does the suburban wife-mother become in large measure an unpaid chauffeur? Does ferrying her family about deny her time she believes would be spent more advantageously on other activities of her choosing, or does the resulting contact with other aspects of the community expand what might be a privatized, lonely existence? For the adolescent boy has driving the family car become a sign of maturity as the wearing of

long trousers used to be? Is driving regarded by the commuter as a skill in which pride of accomplishment may be measured, or is it a chore, denying the person time to spend, say, in reading the newspapers (which could be done on mass transportation facilities)?

To what extent are contacts with other persons minimized or maximized through transportation facilities? Does the automobile help to build family solidarity through shared experiences (in a confined space)? What types of conversations with how many persons can be carried on in one mode of transportation as contrasted with another? Do carpool riders build up a special feeling of identity and interaction with each other? Do people prefer to pool rides or to drive alone? How are reactions to minority groups likely to be structured—e.g., is there a qualitative difference in interaction on a mass transit vehicle and the attitudes engendered through private vehicle operation contact?

To what extent is commuting regarded as pleasant? What are the limits of tolerance in terms of commuting time, distance, noise, other irritants? Does commuting permit a transitional or adjustment period from one major role to another, say the shift from occupational role to parental role? (Sociological literature has indicated that individuals play many different roles—a person may be a plumber, a father, a Mason, a member of the school board, an Irishman, a taxpayer, a musician, a union member, a reader of a metropolitan newspaper.)

Another study (2) derived data concerning the impact of highway improvement on local governmental services, including education, fire and police protection, and libraries. This subject matter involves the sociology of the human being, if ever there is such a concept.

Up to this point, we have been talking mainly about highway transportation and sociology. We could extend the field considerably by indicating that all kinds of transportation are involved in the sociological impact. Transit, whether it be bus or fixed rail, also implies certain sociological consequences, some good and some bad.

A discussion of transportation, especially in its urban environment, necessarily involves many other related elements—elements which involve the human being in relation to other humans. For example, transportation cannot be discussed without almost immediately getting involved with land use. Therefore, we must talk not only about transportation but also about overall planning and all other activities which affect or are affected by transportation.

A complex of private activities are also involved. One of the university groups engaged in highway research recently completed a first study of the impact of highway transportation on the medical services industry (3). Three or four decades past, the doctor went to the patient. This was the era of the country doctor. The doctor paid the transportation bill directly, and the number of patients he could attend during the course of a day was defined by the efficiency of his transportation vehicle, the nature of the roads, and the elements. Today, due to the motorized vehicle and good roads, the doctor is domiciled generally in a clinic or complex of medical offices. The patient comes to him, and the patient pays the transportation bill. This means that the average doctor can now see 15, 20 or 25 patients a day, rather than the 4, 5 or 6 whom he formerly saw during the course of a day. Understandably, this fact, above all else present, has accounted for the fantastic increase in the income of the average medical practioner.

Another matter which merits at least brief comment concerns the measurement of this sociological impact. In recent years, efforts have been made to quantify such effects, as well as their economic counterparts or associates. Some students of the problem have thrown up their hands in defeat, asserting that it was futile to seek quantifications.

The author does not share this defeatist attitude. If we persist, we will be able to derive reasonable measures of quantification of these elements. Quantification, however, does not necessarily refer to measurement in dollars. Quantification can be in other terms and can be put on a comparison basis. For example, if a city offers free concerts to its inhabitants, it would be almost impossible to measure the benefits

derived in dollars. But we might ascertain how many citizens attended each of the concerts and what percent this was of the total in the area. Other meaningful relationships could be developed which would certainly be helpful in evaluating the benefits of the concert series. The same thing could be done with sociological and economic data.

In conclusion, several other works on highway sociology should be mentioned, including one by Black and Black (4) and another by Thiel (5). Highway location studies in several states have also explored economics and sociology to a considerable extent. These include the Inner Belt studies in Boston (6), the Westside Freeway studies in California (7), and freeway studies in Tallahassee, Fla. (8).

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Who Makes the Trips? Notes on an Exploratory Investigation Of One-Worker Households in Chattanooga

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•THE ANALYSIS of urban travel has usually centered on the residential unit and the amount of travel its members can be expected to generate on an average weekday. Households may be stratified according to number of members, income classification, the number of cars owned or regularly used by members, residential densities, and various other criteria. Trip generation models are often designed to relate to trip modes and purposes.

The trip generation models are used to prepare estimates of future travel demands, based on projected numbers of persons and households, cars owned, jobs available, etc. Much significance attaches to the travel generated for work purposes because weekday peak-hour travel contains a higher proportion of these movements. One of the imponderables of traffic forecasting is the significance that should attach to changing work habits. There is much speculation heard these days about shorter working days

and/or shorter working weeks. How would such changes be likely to show up in future urban travel demands?

It was this question that led to the brief study reported here. The home-interview surveys record travel by working populations, as well as all others who make trips. With a little manipulation, the approximate length of each individual's working day can be computed from his trip reports. Does a short working day result in more or less travel by the worker? If a regularly employed person does not report to work on the day of interview, does this fact relate to his travel behavior on that day?

Data for Chattanooga, Tenn., were conveniently at hand. Travel reported in direct interviews in more than 7,000 households was tabulated according to length of working day, number of household members, number of cars owned, income class (five) and number of residents with steady employment. Travel performed by working members of the households was tabulated separately from trips by non-workers.

Households were classed according to number of working members into three groups: (a) households with no working member (approximately 630); (b) households with one working member (approximately 3,370); and (c) households with two or more working members (approximately 3,080). Thus, nearly half of all households in the survey were found to contain one employed person, whereas fewer than 10 percent had no working member. Two or more of the residents in each of the remaining households were employed, many of them in part-time occupations.

The sample of one-worker households has been examined in considerable detail. Although nearly as many households are represented by two or more workers, the study of them is complicated by the need to stratify households into classes or combinations of full-time and part-time workers. This reduces the number of samples in each population, thereby limiting the number of variables that can be examined simultaneously to produce meaningful results. But the study of multi-worker households should be quite illuminating, and the results may be much different from the behavior patterns found for one-worker households.

Trip generation in the one-worker households is clearly illustrated in Table 1 and Figure 1. Households without cars generate very few trips, with total trip production closely related to the size of household. One-car households account for nearly twice as many trips as no-car families of each size, and two-car families make still more trips.

The most interesting aspect of Figure 1, however, is the share of travel accounted for by the worker himself. In households without cars, the worker's travel changes very little with family size. This is not the case in car-owning households, where the worker himself makes an increasing number of trips as the members of his household increase in number. In fact, when households of two persons or more possess two cars, the worker makes more trips, at every family size, than does the worker in the one-car family. In the largest families (five persons or more), which generate the largest volumes of travel per household, the one working member of the household accounts for more than three-fifths of the total.

Speculation on the reasons for this pattern relate to the likelihood that the working member of a one-worker household uses his car to go to and from his place of employment (a 1959 study of St. Louis showed that about 75 percent of all cars owned by area residents were driven to and from work). In a one-car family, the worker and his car are called on to perform most of the errands associated with maintenance of the household. This does not explain the greater demand on the worker in two-car households, although it may be safe to assume that the worker now regards one of the cars as solely his responsibility, rather than a joint concern of all family members, and may choose to use the new freedom implied in making a variety of purely personal trips that he would not otherwise make. (Trip purposes have not been examined in this study—analysis along this line might help answer this question.) Psychological evaluation of the attitudes engendered among household members when a second (and third) car are made available for use might prove very interesting.

Another question that is particularly important in any attempt to forecast future travel in urban areas has to do with the social environment that might induce other household members to travel as much as the worker (or that might induce the worker

TABLE 1

ONE-WORKER HOUSEHOLDS

No. in Household	No. Cars Owned	Daily Trips Generated in Household by			
		Workers	Nonworkers	Total	% by Worker
1	0	2.54	—	2.54	100.0
	1	3.95	—	3.95	100.0
	2	—	—	—	—
2	0	2.69	1.77	4.46	60.3
	1	5.55	3.04	8.59	64.7
	2	7.15	3.40	10.55	67.7
3	0	3.07	3.55	6.62	46.4
	1	6.15	5.11	11.26	54.7
	2	8.62	4.18	12.80	67.3
4	0	2.75	3.67	6.42	42.9
	1	6.70	4.87	11.57	57.9
	2	9.05	5.47	14.52	62.3
5	0	3.07	5.27	8.32	36.9
	1	6.70	6.40	13.10	51.2
	2	9.65	6.11	15.76	61.2

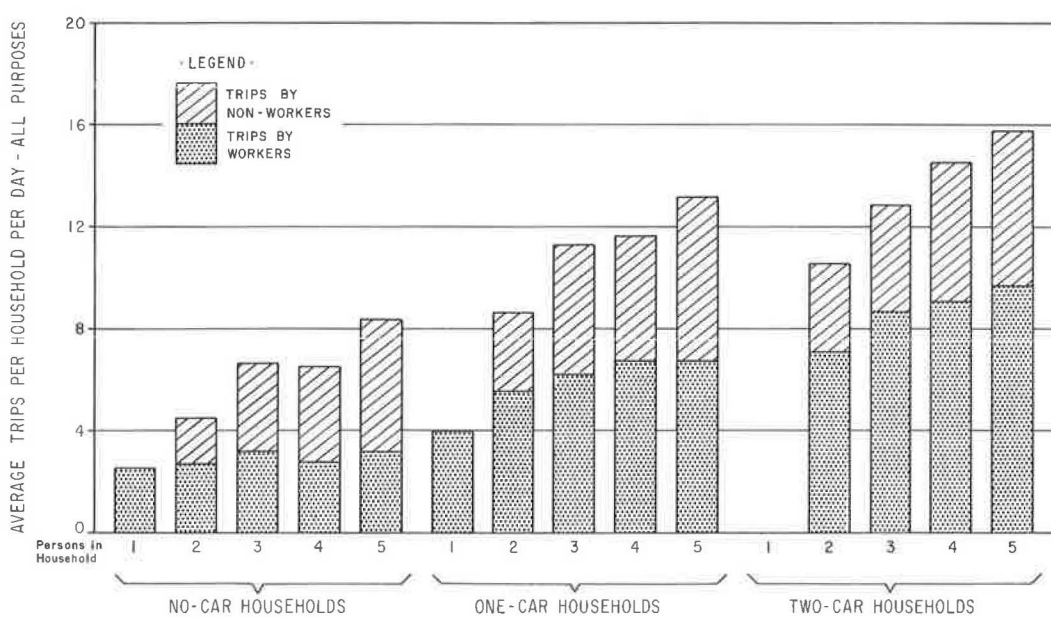

Figure 1. Worker and non-worker trips, all members of one-worker household by all modes.

to travel less). Perhaps in-depth analysis of data already available can be used to indicate the answers to this question. It is an important query, whether or not additional travel is regarded as a "good thing" for the individual. If all, or a portion, of the household members who perform little travel today were to develop radically new travel habits over the next decade or two and produced trips in substantially the same proportions as the workers, estimates of future travel demand would be far different from those developed using the conventional generation models, based largely on analogy with today's generalized trip characteristics. What might trigger such a change? Would a cheap, automatically controlled vehicle encourage more travel by more household members? Will eventual automation of more household chores leave the housewife free to make more trips, and will she use the time to travel or for other activities?

In Table 2 and Figure 2, the amount of time that the worker spends in travel each day is related to number of persons in his household and the number of cars at the family's disposal. Trip-time has been compiled from the times of departure and arrival reported for each trip in the home interviews and represents "portal-to-portal" time. Because Chattanooga is a quite compact city, very few reported trips exceeded 30 minutes. Median trip-time was about 8 minutes for all reported auto driver trips. Mean trip length was a little less than 4 miles.

Figure 1 shows that the worker performs more trips when he has a car than when he does not. Figure 2 shows that he also spends more time in travel when the household has a car, and still more when it has two. Time spent in travel seems to relate directly to car ownership and is indifferent to increase in family size. The worker in a two-member household spends but slightly less time in travel each day than the worker in a five-member household; although workers in two-car households spend more time in travel than those in one-car families, the difference between two-member and five-member families is, again, relatively small. In both situations, the number of trips shows proportionately greater increase than the time spent in travel. This inconsistency is not explained in the data at hand but may relate to the purposes of travel, the geographic distribution of households (large, car-owning households may be more highly concentrated in suburban areas, resulting in longer work trips), or other characteristics which further study could identify. It is conceivable that the worker, generally, recognizes a "travel-time budget" and his trip frequency is high or low, depending on the average amount of time required for his trips. But this relationship, if true, would appear to be modified by social or psychological factors associated with the number of cars available to the household.

In Table 3 and Figure 3, the travel mode by the worker has been examined in relation to the length of working day. Workers have been separated into three groups: (a) persons who worked less than 8 hours, (b) persons who worked more than 8 hours, and (c) employed persons who did not work on day of interview. Data for each group of

TABLE 2

TIME SPENT IN TRAVEL EACH DAY BY WORKING MEMBER OF HOUSEHOLD[a]

No. in Household	No Car		One Car		Two Cars	
	Household (no.)	Avg Hr (no.)	Household (no.)	Avg Hr (no.)	Household (no.)	Avg Hr (no.)
1	134	0.67	141	0.83	-	-
2	156	0.76	546	1.14	135	1.57
3	78	0.82	501	1.18	162	1.66
4	55	0.77	485	1.32	201	1.62
5	116	0.95	491	1.27	169	1.80
Total	539	-	2,164	-	667	-

[a]One-worker households.

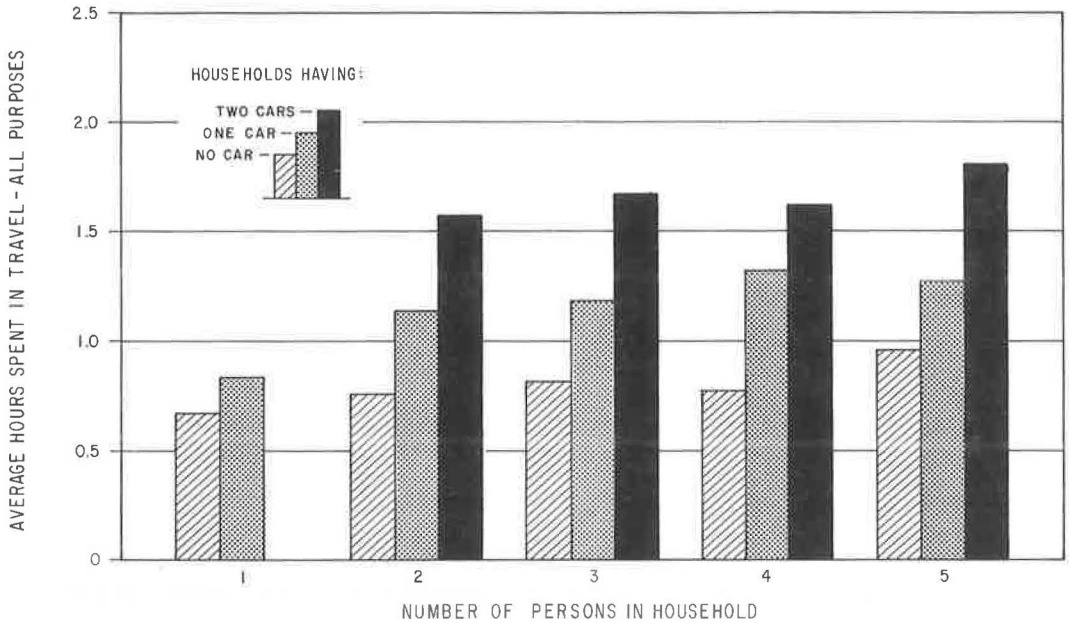

Figure 2. One-worker households: time spent in travel each day by working member of household.

TABLE 3

ONE-WORKER HOUSEHOLDS: TRIPS BY WORKERS

No. in Household	Hr Worked	No Car		One Car		Two Cars	
		Household (no.)	Avg Trips (no.)	Household (no.)	Avg Trips (no.)	Household (no.)	Avg Trips (no.)
1	<8	28	2.53	32	4.00	—	—
	>8	59	2.54	74	4.00	—	—
	0	47	2.55	36	3.80	—	—
2	<8	21	2.90	108	6.44	28	9.40
	>8	78	2.55	322	5.48	72	7.26
	0	57	2.54	115	4.82	35	5.43
3	<8	10	3.90	66	9.00	31	9.78
	>8	45	2.91	320	5.87	99	8.72
	0	23	3.00	115	5.27	32	7.16
4	<8	8	2.75	77	8.65	32	12.70
	>8	30	3.10	278	6.40	131	9.00
	0	17	2.11	130	6.15	38	6.05
5	<8	15	2.87	91	8.33	35	11.25
	>8	56	3.30	280	6.55	101	10.15
	0	45	2.84	120	5.73	33	6.27
Total		539	—	2,164	—	667	—

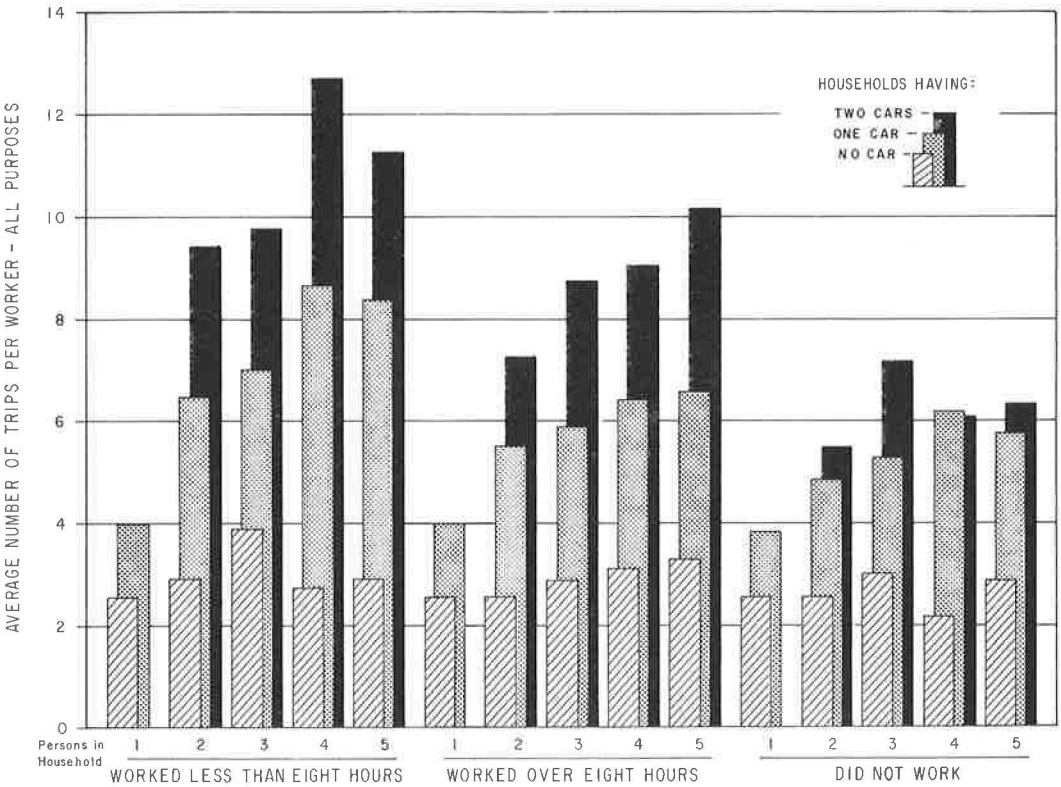

Figure 3. Daily trips by working member of one-worker households.

workers have been related to car ownership and number of persons in the household. In each workday class, the relationships shown in Figure 1 are apparent in Figure 3. Worker trips increase dramatically with the introduction of a car into a household, under each condition of working hours, and increase still more when the second car appears. A relationship also appears between trip production and length of working day. For each family size, the number of trips generated is less for workdays in excess of 8 hours than for those less than 8 hours. Tentative studies (not shown) that break workdays under 8 hours into periods of less than 4 hours and over 4 hours appear to show that the shorter the workday, the more trips a worker can be expected to make.

Travel by workers who did not go to work seems contrary to this indication, unless one considers that employed people who did not go to work include some who are ill or otherwise incapacitated. In general, persons who did not work performed less travel than those who did, although the difference is not great, with family size and car ownership reflected in similar patterns of behavior.

Considering only those who worked, persons who work a short day very often take time off from scheduled work periods to perform special errands of a personal nature. To some extent, then, the increases in travel on short days do not necessarily reflect the travel patterns that would result if the conventional 8-hour workday were shortened. However, fewer hours at work mean more hours during the day for other (non-work) activities. Inevitably, additional activities imply some increase in travel. In future interview surveys, the significance of shorter working days might be better defined if information were obtained on the normal length of working day in each case. Behavior of those who took time off for special purposes could thus be isolated and the implications of reduced working hours more clearly defined.

In Table 4 and Figure 4, the significance of family income levels has been explored, again related to car ownership and length of working day. The pattern of trip generation

TABLE 4

ONE-WORKER HOUSEHOLDS: TRIPS BY WORKER

Hr Worked	No. Cars	Income 1		Income 2		Income 3		Income 4		Income 5	
		House-holds (no.)	Avg Trips (no.)	House-holds (no.)	Avg Trips (no.)	House-holds (no.)	Avg Trips (no.)	House-holds (no.)	Avg Trips (no.)	House-holds (no.)	Avg Trips (no.)
<8	0	20	2.90	53	2.94	8	2.38	-	-	-	-
>8	0	58	2.86	162	2.69	46	3.47	2	2.0	-	-
0	0	52	2.79	98	2.46	33	3.18	1	3.0	5	2.0
<8	1	18	6.11	140	7.14	193	8.25	7	11.0	6	10.33
>8	1	68	4.33	485	5.60	687	6.35	35	5.69	9	5.78
0	1	25	2.72	213	5.66	256	5.42	15	4.40	7	4.71
<8	2	-	-	20	9.60	84	11.05	12	11.66	10	10.90
>8	2	5	5.80	68	6.78	262	9.27	42	8.84	26	11.65
0	2	2	2.00	31	5.84	87	5.97	11	8.90	8	6.75
Total	-	248	-	1,270	-	1,656	-	125	-	71	-

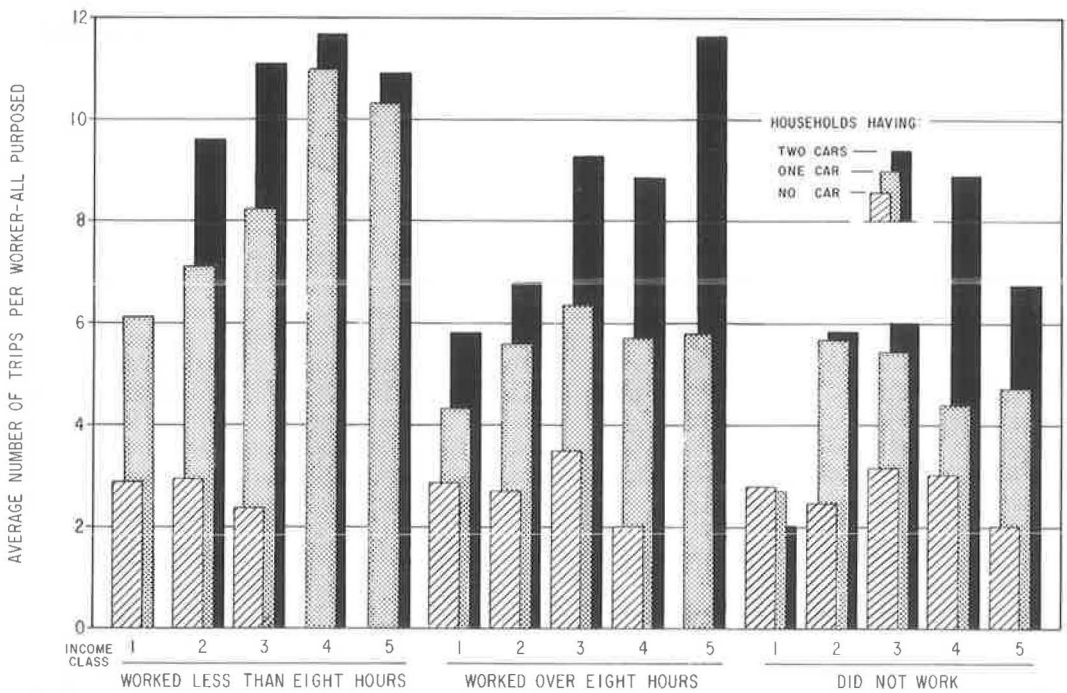

Figure 4. Trips by worker in one-worker households.

shown in Figure 4 is much like that in Figure 3, although income level has been substituted for family size. Trip rates increase with increased levels of income, decrease as working hours become longer, and are lowest at each level of income on days when the worker did not report to his job. Again, the second car increases the worker's travel at every level of income and is clearly not the province of the upper-income group alone.

In Tables 2, 3 and 4, the number of households are given from which the averages have been computed. Statistical stability is reasonably good for the data plotted from Tables 2 and 3 but is less reliable for certain class intervals in Table 4. (Data for Table 1, containing only 14 classes, are all regarded as statistically stable.) The value of the picture shown in Figure 4 is enhanced, however, by the consistency of patterns plotted from very small amounts of information, indicating the basic regularity of the relationships shown. Interpretation of some of the more extreme variations in Figure 4 should take sample size into account, however.

CONCLUSIONS

As noted in the introductory statement, the brief study reported here is based on a very tentative analysis of trip data from a single, medium-sized city and may be regarded as "fallout" from the conventional analyses and transportation plans that the original study was designed to produce. The review of these data has revealed some interesting relationships and has suggested areas that might fruitfully bear further investigation.

Among the facts that emerge from the study are these:

1. Travel by the employed member of a household containing one working member increases, on the average, as the number of household members increase.
2. The worker's trips increase substantially when the household acquires one car, and increases again, by an almost equal amount, when the household acquires a second car.
3. The worker in one-worker households accounts for one-half to two-thirds of all trips generated in car and transit by all members of the household. In Chattanooga this was found to be true even in the largest category of two-car households.
4. The worker makes more trips on short working days (under 8 hours) than on longer working days. He makes the fewest trips on days when he does not report to work.
5. The size of his family is not as important as the fact of car ownership in determining the daily amount of time that the worker spends in travel for all purposes. In households of two or more persons, the amount of time spent in travel increases sharply with increases in car ownership. However, at each ownership level, time spent in travel is relatively constant for households of every size.

Several questions arise from the study which can only be answered in a satisfactory way by further investigation, using larger samples of data from a number of sources:

1. Why does the frequency of worker trips increase as households become larger? Why does travel time show less variation than number of trips?
2. Is trip-making by non-workers increasing? If so, is the increase more or less rapid than travel by workers? What would cause non-workers to spend as much time in travel as the workers?
3. Do shorter working hours result in more travel, or is the increase indicated here merely a reflection of special activities that inspired the worker to take time off for the purpose of travel? Would a shorter standard workday lead to more travel? For what purposes?
4. What are the social-psychological considerations responsible for the added travel by workers in households that add a second car? How can these be identified and measured?

Social Impact of a Highway on an Urban Community

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•IN JUNE 1963, the National Capital Planning Commission (NCPC) contracted with the Health and Welfare Council of the National Capital Area for a study of the social implications and relocation requirements of the North Leg of the Inner Loop. The Planning Commission, as one of the participants of an advisory group to the District Commissioners who were to report to the President, believed that one of the factors in its deliberations should be the social impact of such a major highway on the community through which it was proposed to go. It turned to a citywide agency concerned with the social welfare to prepare a report with two major objectives: (a) with knowledge of the impact on those who must move and those who would remain, the decision makers could be influenced in determining the location and type of artery; and (b) with this knowledge, programs to reduce possible harmful effects on the people concerned could be developed as a part of the total operation.

An exhaustive search of the literature, interviews with persons identified with the highway planning field, and information from others in sociology, community organization, and relocation indicate that little or no work has been done in studying the social effect of any major improvement on a community before its construction. This includes not only highways, but also urban renewal, dam construction, and other public programs. Hopefully this may foreshadow a new trend in physical planning-social planning relationships. Certainly the NCPC should be congratulated for initiating this inquiry. A city (or physical) planning agency and a health and welfare council are but two major participants in this joint effort, and much experimentation still must go on before the role of each is defined. Thus, regardless of the results of the study or the techniques used, it was an exercise which should prove useful to those in the urban affairs field who are interested in the relationship of people with their physical environment.

Although the time period originally set for the study was 6 months, it had to be completed in 4 months due to the pressure from the planning advisory committee which wanted to make its recommendations on type and location of artery in time for the District Commissioners to include the results of its decision in the next year's budget.

The time spent trying to determine the actual impact on the residents through interviews was 1 month because the six alternative proposals which were being considered were not released till the beginning of October. As a result, only 71 families in a study area containing about 10,000 families were interviewed. Therefore, the opinions expressed can only be described as illustrative. Twenty-seven civic, school, church and business leaders were also contacted for their opinions as to the effect of a freeway through their community and what it might mean to the residents and to their institutions.

Without a more thorough knowledge of the characteristics of the families in the study area and a much larger interview sample, the findings cannot be considered definitive. However, with what is known about peoples' reactions to urban renewal and from the views expressed at public hearings on highway matters, it is very likely that many of these are representative of the views felt by those directly affected by a major public improvement program.

The study area was a rectangular strip between P and U Streets, N. W. and 5th and 22nd Streets, N. W. Those who are familiar with Washington, D. C., will recognize that not one but three identifiable major neighborhoods are involved. To the west, between Massachusetts and Connecticut Avenues, is a high-income, predominantly white area with a high percentage of childless couples and single-person families. The center sector between Connecticut Avenue and 15th Street has a mixed racial composition with a median income placing it in the low-middle income category, with a number of older persons who have lived there for a number of years. Recently, there have been efforts to upgrade the area with new apartment building construction and renovations. The eastern sector, that area between 15th and 5th Streets N. W.,

is predominantly Negro with low incomes accompanied by the family instability and social problems associated with underemployed and undereducated groups. It is interspersed with pockets of good housing owned by long-time residents.

Simple, easy-to-read maps were prepared illustrating three alternate highway proposals; the other three proposals were variations of these. One showed a likely location of an eight-lane freeway which, if adopted, would be eligible for the 90 percent-10 percent funds from the Federal highway program. The second showed a six-lane tunnel idea and the third, alternate one-way streets which would require an expansion of the present right-of-way. These, plus an open-ended interview schedule were the tools of the interviewers, who were assigned homes throughout the area and given a three-hour briefing to prepare them for any contingency. It was known that probably no one in the area was familiar with the specifics of the proposals, and very few had any knowledge of the projected highway.

A summary of the views expressed and several illustrative quotes reveal the follofwing attitudes:

1. The general consensus was that the residents did not want to be dislocated from their present location. In selecting one of the alternate proposals in terms of their preference, the interviewees were first concerned as to whether their homes were to be affected, and second, that the proposal finally approved be the one that affected the least number of homes causing a minimum relocation problem. The majority favored the proposed tunnel, believing that this would fit the aforementioned criteria.

> A physician living on the west side of Connecticut Avenue "hopes the Commission will take human values into consideration—people still continue to be the most important factor."
>
> A white homeowner who had purchased his property a few years ago and was proud to live in an integrated neighborhood, said that he felt strongly that "changes affected thus far and those contemplated, including the alternate proposals for the North Leg, have been made or considered without due regard for the interests of citizens in general, the underprivileged especially, Negroes in particular." He believes that major changes are generally made in the interest of large property owners and builders who profit from these developments.
>
> A long-time resident said that "widening the one-way streets would be bad for schools affecting a lot of children. The freeway wouldn't be good either because traffic would be going so fast. The tunnel would be best because it would save more homes, but tunnels aren't pretty. They don't do anything to beautify a neighborhood." She commented that it seems a shame to take people's houses when they do not have any other place to live. "That's how they did in the Southwest area. That is why there is so much overcrowding and so many people living in one house. It looks like something ought to be done about people who have to move. They put up apartments that are too expensive for people in the low bracket incomes. There should be some low-rent homes."
>
> An elderly couple, originally from South Carolina, commented: "I don't agree with any of it. People ain't got nowhere to live now. Tear down more houses to take care of traffic? I don't see no sense in it—in any of the proposals. They're tearing down places now all over town—making parking lots out of them. They're always looking out for traffic. They're doing all they can for people passing through; how about the people living here?"

2. There was special concern expressed by and for the elderly and long-time residents, including homeowners, as to their psychological and financial future if forced to vacate their homes.

> A long-time resident commented: "I think it's just awful. All or many of these people have been living in this neighborhood for 40 years or more. I guess it would just about kill some of these old people around here, and it would make everybody mad, but the Government's going to do whatever it wants, so why worry about it at all?"

A 71-year-old widow who has owned and lived in her home for 31 years said that she didn't feel that it would be difficult for her to find a home in some other area of the city or the suburbs. In fact, she felt that it would be relatively easy for her to sell her home for a sizeable profit and purchase a smaller place in Maryland. The most difficult part about this type of move or change is that it would involve leaving old friends and attempting to make new ones. "Life would never really be the same again, and it would sort of be like losing a part of your body."

A retired white couple stated that they would not put up a fight as long as they are treated fairly. The wife felt they could easily find a place to go even if it would mean moving in with one of their children. However, she added that there are several elderly couples living in the block that are not as fortunate as they are; these couples do not have children and change in their lives would be difficult. She was concerned about the Government forcing people to sell. "People should never be forced to give up or sell anything that is rightfully theirs. This is the real core of our democratic system."

Another retired couple, living in their house for 35 years, responded: "I think it's just awful. All or many of these people have been living in this neighborhood for 40 years or more. Why do they have to go around taking people's homes, especially old people? How are they going to live? Many of them have chopped up their homes into apartments and rent out two floors and live on the first floor. Even if they were paid for the houses, they couldn't live on it for the rest of their lives. At our age, we just don't want to move."

A widow of 81, living in her present home for 40 years, asked: "What's all this tearing down going to do for the children? No longer do they get settled than they're unsettling them. Well, I'm going to just stop thinking of them and start on us. But every time I do, I guess I just get sort of sick in the pit of my stomach 'cause I'm scared. What's going to happen to us, lady? We're so old and sick and the people on this street are so good to us and the church people too, and if all our houses are taken from us all, they won't have no time to bother about us."

An elderly retired couple reported that they had paid ten times in renovations what the house had originally cost. Now their home was really beautiful. "Why, only this year, and even last, folks had been by wanting to buy this home of ours. But we're too old to pull up roots. We just want to end our days here. Yes, I feel sorry for the children and everything. But lady, I'll tell you the truth. I feel most sorry for papa and me."

3. The civic leaders expressed what was so often implied by the householders—that no displacement should occur until there was sufficient housing available for the displaced.

A civic leader said that any displacement of homes by the construction of a freeway would meet with intense opposition unless provision were made for the relocation of the residents. The displacement effect of the Southwest construction was cited as being vivid in the minds of the area's residents.

Another civic leader said a successful plan must have both rapid transit and freeways; highways alone are not the answer for many reasons. It is likely that they will not adequately carry the traffic load, and they dislocate too many families. Practically no preparation is now being made for dislocated families and the needs for new families coming into the city are not being met. Private investors are unwilling to build low-cost housing because of the high cost of land. The Government must subsidize this as well as the rehabilitation of houses.

A minister said that housing for low-income groups is the greatest need—substantial low-cost housing. The housing situation is the primary moral problem.

A minister strongly objected to the freeway because of the displacement of people. A better solution would be an efficient transit system with subways. It would serve the needs of the suburban commuters and would not uproot people. He thinks the planners take the line of least resistance and the people here do not have an effective voice. Even if a good and humane relocation program were developed, a freeway would not be a good idea because (a) the city needs the space--we should keep it and improve or replace the housing; (b) freeways in cities are divisive and cut neighborhoods off; and (c) he is bitterly opposed to any kind of freeway that goes through a city.

4. There was resentment expressed by both whites and Negroes towards the suburban communities which were forcing District taxpayers to move from their homes to permit the building of roadways for the convenience of the suburban commuters. This criticism implied that many Negroes seemed to harbor a deeper resentment towards whites than was openly expressed. A number of Negro families expressed a desire to be able to move to the suburbs themselves.

A respondent wondered how any of the proposals would help the people living in Washington. "If this is another scheme to improve transportation for people living out of the District primarily, then the whole idea should be abandoned."

A well-informed elderly lady commented that "It just isn't just for those people out in Maryland and Virginia with such beautiful homes to expect us to give up the little we have just so they can get into the city more conveniently." She said that she hoped that she will be dead before they begin displacing people for the North Leg; she foresees that the problems will be very bad because they already have so many people from the Southwest in the area now.

A Washingtonian stated that "cars have taken over the city when schools are so poor all over the city. Washingtonians resent all of the taxes they must pay to sponsor these construction projects which are for the convenience of the people who live out of town. There are racial implications involved too. When the commuters come to work in Washington, they take up all the parking spaces on the streets and don't pay taxes in the city."

A dental student with a young family who had grown up in the area said: "You can tell whoever you are working for that I want to be relocated in Silver Spring or Takoma Park. I want to live where I want to, not where somebody says I got to. I want to live in one of those apartment buildings that's got a swimming pool and be able to get out with my white neighbors. Sure I know why they want to get that freeway through here. It's so the white folks will have a better way to get to the suburbs."

A mother of three children, receiving public assistance, told the interviewer she wouldn't mind if she could get a good location in the suburbs. In fact, that is what she would like. She would love to move now, but rents are too high.

A civic leader conceded that "someone has be hurt with progress." He added that the problem is that routes always seem to go through depressed areas. "Of course it is because these are the areas where land costs are lowest, but it seems as if the freeway always goes through the Negro neighborhoods to bring in the suburbanites. Highway planning is often dominated by the suburbs and is not in the best interests of minority groups."

"A freeway is not necessary--traffic should be kept out of the city." This was the opinion of another civic leader. He claimed that most of the cars parked on a particular street in his neighborhood are from Maryland and Virginia, and he wondered if the highway department was not responding to the desires of these commuters for cheap transportation and parking at the expense of the District residents more than to the welfare of the District.

5. There was generally little known about the North Leg proposal. Those who were best informed received the information from the civic associations and Parents and Teachers Associations. The majority of those interviewed expressed appreciation when learning about the proposals through this personal contact. One response to the interviewer is worth noting:

> "Well, this is the first time I've known the Government to send anyone around to show us maps and all. Tell 'em thanks for that, lady."

6. Those in the lower income groups believed that regardless of their opinion, the Government would do what it wanted to. Some of the white families who objected to the freeway proposals, although recognizing their relative ease of housing mobility, believed they could have an effect on the final highway decision.

> A respondent said she did not care when and if construction started because she could not do anything about it. "You don't have the vote in Washington, so there's nothing you can say. You can't buck the Government. You live longer if you become reconciled to it." Her husband said they "always put these highways in Negro settlements where they shake the houses down from the impact of the traffic."
>
> A World War I veteran said he was not too concerned because the Government was bigger than he and that they already knew which type of freeway they would have. "Listen, lady, are you dumb enough to think that the Government is giving a hoot about which I'd prefer or what I do? Why didn't they ask before they decided on just three types? I don't want any."
>
> A prominent Republican family felt that all of the people in their neighborhood would be financially able to relocate, but they are also financially able to put up a strong fight against putting a freeway through their property.
>
> A resident manager of 18 years' standing assured the interviewer several times that the people in the elegantly kept-up and restored houses across the street from her "would never stand for having any freeway go through near enough to spoil the area." She refused to consider what she or her neighbors might do if one did come through because to her it was not even a remote possibility, these neighbors being apparently all-powerful in their ability to stop it.
>
> A family, maintaining an estate near Silver Spring but enjoying their town house in the city, said: "I wish you would tell these people (for whom you are making the survey) how much I hope Washington will realize before it is too late that a rapid transit into the city, not across it, is the great need that should take precedence over all highway building." She realized that a freeway is bound to create hardship and dislocation to the people in whatever areas through which it passes, and fears the people in certain areas would have less voice in the matter than she and her nighbors.

7. The factors which made these neighborhoods desirable to the residents included convenience of location to shopping, bus lines, and the central business area; accessibility to employment; the schools and play areas; community cohesion as illustrated by block organizations; the racial and income mixture which makes it a desirable cross-section of the city; and efforts to upgrade the area by public and private action.

> A couple with a preschool-aged child had just moved into the area because of a new school now under construction. The mother believes that the new school will be less crowded and have more play space. They like the area very much and attend church within walking distance. They are near a health center and a hospital.

A housewife, living in her home for 41 years, had reared two children there "without any difficulty." She said the area is going to the dogs. It is now a commercial zone. "I know we are in the slums, but it's my home and I enjoy it. I really think this is the nicest location in the city."

A 65-year old domestic worker found her neighborhood convenient for everything. She is thankful for the health care and services that are available.

8. Those features which made their neighborhoods undesirable to some included the influx of undesirable people in the community (several specifically identified these persons to be the displacees from the Southwest redevelopment project) who tended to cause the physical and social deterioration of the area, fear for one's life and property because of inadequate police protection, a need for more play space, overcrowded schools, landlord exploitation, and poor city services in the area.

A mother on public assistance with three daughters said: "The neighborhood is not a good one to bring up children in. The schools are close enough, but what can you do about all the teenage parties? The noise and racket is terrific." She had lived in the neighborhood for nine years, found the play space was adequate and transportation and shopping facilities were good. There was still a secret hope that relocation would bring a nicer neighborhood.

A mother of an 11-year-old daughter lives in a house full of roomers, with five families using one bathroom. She does have a private kitchen but feels that an 11-year-old girl should not sleep in the same room with her parents. The neighbors have been very kind. However, the children in the neighborhood are terrible and think nothing of "cursing the adults out." She does not allow her child to go anywhere alone in the neighborhood. She dislikes the neghborhood's physical setting but not the people.

A couple who had been living in their own home for 15 years were anxious to move out. "This neighborhood is terrible. If it was up to me, they'd tear all these houses down and put up new ones. You can't expect 13 or 14 people living in one house to keep it clean." Children from her block, including her own son, have to cross a one-way street to get to the playground, and this is very dangerous. Her husband said he would like to live in a suburban section where he could get some sleep. He invited the interviewer to spend a night there some time to see how noisy the neighborhood is. "It would be impossible to go anywhere that would be worse."

A widow of 67, living in her home for 46 years, wishes the neighborhood were back to what it used to be when everybody owned his own house and took care of it. "Now the people here don't care. The change has been within the last 15 years, brought about by World War II and breaking up the Southwest. Now the people who need to live in Southwest are living in rooming houses." The neighborhood is good for shopping, and transportation is good. But the real reason she does not want to move is that she is too old and too sick to start over.

A couple with three children really did not like where they lived. The street was not to their liking and neither was the apartment. But others were so high that they had decided, after having to move from a rented house in Northeast which was sold, that they would live cheaply for five years, save, and later pay down on some little house. They did not allow their parents and other relatives to visit them in the evenings because it was too dangerous.

9. Neighborhood identification tended to be based on selective features such as the church, the block, neighbors of similar education and income background, prestige or status of an area, or on sentiment.

A retired white widow who has owned her home for 31 years said, "All of my memories are wrapped up in my home, and I couldn't part from these at this stage of life." She stated that she knew several elderly women living on the block who are property owners and are devoted to the community. Several of these women are infirm and truly depend on the convenient shops and stores in the area for their survival.

A well-educated, middle-income family whose home has been in their family for almost 50 years is openly unhappy about living there because of the neighbors and the neighborhood. One of the wife's principal concerns is the reflection such a neighborhood has on their otherwise very high socio-economic status. "Most of the decent people have moved out, except for two or three families; they're all riff-raff here. They should fix the area for decent people." Her husband pointed out that this was once a good neighborhood, but they were all homeowners. Now the large houses have been converted to rooming houses, partly to accommodate persons displaced from urban renewal in Southwest and Foggy Bottom, making this a slum area. He said that the real estate operators turned this into a slum, but he does not hold them responsible. "The basis of any slum condition is economic--it's a matter of dollars and cents." He said he likes the location, not the neighborhood.

The father of three boys has lived on his block all of his 38 years. He said that the block had remained intact for Negroes more than any other location in Washington. His three boys were born here, and to them this location is very dear. There are block socials. The neighborhood club looks out for sickness and other happenings of note. He trains his sons to look out for the welfare of the old people living on the block by calling on the sick and the old. They also help with smaller children on weekend excursions. In the civic association, PTA, and church, this couple is concerned with the people and houses. "The houses need so much, and the people need even more."

10. There was an expressed hope that whatever action was taken would result in a better life in a better environment, either in the existing neighborhood or a new one if relocation occurred.

A family from Virginia, living here for three years, hoped that the Government would help them to find a nicer place to live. Her 12-year-old daughter would like very much to live in a better neighborhood so that she could associate with people whose ideas about living were a little bit better than some of the children she is exposed to.

A mother relocated from Southwest Washington said she would want to have a better house, but could not "say about the neighborhood. It might or might not be better. You never know what kind of neighborhood it is until you live in it." On the other hand, if she stayed in the neighborhood, she would expect the houses to be fixed up. "They would have to be."

The mother of six children who found her neighborhood had nothing to offer her children said she was anxious for the change and hoped it would come tomorrow. She also hoped the freeway would run right through her house and give her a chance to get away with her children. "I want something better for my children and for us too."

A minister said, from the Negro point of view, it would be tragic to wipe out a church that had existed as a Negro church since 1841. From a communal point of view, the goal of the District should be to become a first-class city in every respect. Transportation and other facilities are needed. What is good for the city would be good for the area, and he would go along with any proposal that would make the District a healthy place to live.

A civic leader said a freeway is needed, and progress always makes changes and causes discomfort. What is needed is some way to relocate the people who are here now. A freeway might help to clean up the city if the relocation problem could be solved.

11. In terms of action the Government should take, the general feeling was that the District should remove uncertainty about the North Leg, allow no displacement until housing is available, and have more Negro representation and citizen participation in the decision-making process.

A mother of a young daughter said that it would be good if the Government told her to move because the Government always tries to improve the housing situation when it places families, and maybe then she would get a better place to live. She thought that she and her family could adjust to any place if only they could have a decent place to live.

A retired Government worker, a widow who has lived in her present home for 46 years, said about moving, "I'm not a young woman. I can't go out and start again." The Government should make sure that there would be adequate housing for all those who are displaced. But people "shouldn't take their say-so—the Government should build the houses first." In Southwest, they promised the people houses but they did not keep their promises.

A man whose wife's family has owned their home since 1915 said regardless of which proposal was put into effect, people whose homes would be razed should be given reasonable notice (defined as a minimum of one year) and suitable accommodations should be built or otherwise arranged for displaced families beforehand, particularly for those with no money or other resources. He noted that the failure of the District Government to do this in Southwest and Foggy Bottom worked an undue hardship both on the displaced persons and on those neighborhoods blighted by the new arrivals.

A block leader said people are reconciled to the freeway proposal. The housing has deteriorated because it has been discussed since 1957. The basic injustice is that it "all depends on the convenience of Maryland and Virginia—what they want for their convenience is a serious situation with us." There should be more Negro representation in highway planning and more representation for the city residents.

The neighborhood is going downhill. There is so much absentee ownership that there is a feeling on the part of the residents that upkeep may not be worthwhile because highway or redevelopment may be coming. They also feel there is neglect by the city. The District could give the area some future security for planning purposes, and could provide more adequate public services and more park and play areas for the young who have nowhere to go. The crowding is increasing, probably because of many southern immigrants coming in and the failure to provide relocation for the families displaced from Southwest redevelopment area. Also, there is failure to enforce the Housing Code, and the tenants fear eviction if they complain.

A civic leader thought there should be better coordination among the various District agencies. The municipal government, he feels, is unresponsive to the needs of the city and its citizens because the major share of the city employees are not residents of the city and, therefore, have no real stake in the welfare of the District. He felt this was particularly true in the highway department, which explains their eagerness to cut up the District with large highways to enable themselves to get downtown in a hurry. He wondered if the lack of housing code enforcement is not due to favored treatment for landlords who live in the suburbs as neighbors to people who should be doing the enforcement. "If the various agencies—police, welfare, housing—would do the job they are supposed to do, the neighborhood would be much better."

A better understanding of the potential effects of a physical change on a people can lead to the incorporation of programs that can help to dispel fears, immobilize some of the opposition, and produce results which not only correct the situtation as the public improvement aims to do but also can contribute to the betterment of the community itself and to the satisfaction of most of its residents. Without programmed activities,

there is the possibility that resentment and hostility may increase towards such programs as highways and urban renewal to the point where public officials and political representatives, reflecting the views of their constituents, may postpone or cancel possibly necessary and desirable physical changes to the detriment of the city's progress.

As a result of the illustrative sample plus knowledge gained from experience in relocation related to urban renewal, the following propositions are offered:

1. Any involuntary move is upsetting, though much of one's attitude toward such a move depends on the availability of other housing. There were many expressions to indicate that, if there were housing available in unit sizes and at prices which could be afforded, in communities where the facilities were pleasant, adequate and easily accessible, and in locations which have a certain status attached to them and cause the residents to take pride, there would be little opposition to moving into them and adjusting to the new neighborhood of homes. However, minority groups face a limited housing supply from which to select, regardless of income. Low-income groups, regardless of race, have a small supply of decent housing from which to choose in Washington. It is a landlords' market. Many new units are being added to the citywide supply, but the overwhelming majority of these are of such size and price that they are of no use whatsoever to about 25 percent of the District population. The National Capital Housing Authority, which presently has 7,891 public housing units under management, has a waiting list of 6,162 families.

Areas of low-cost housing are steadily diminishing due to such factors as slum clearance, housing code enforcement, increased cost of inner city land, highway construction, other public improvement programs and private action which attempts to use land to its "highest and best use." Recognizing the difficulties which they will face, many low-income families would prefer to remain where they are. They at least know what they have. Others may view their homes or neighborhoods in terms of health and safety. But they would rather not trade it for the uncertainties and possibilities of higher rent, overcrowding, inaccessibility or locations which are unfamiliar to them. Opportunities for higher income groups, mainly white, to find other desirable housing which they can afford are much greater, and an involuntary or forced move becomes mostly a nuisance. Opposition to displacement on these families' part reflects present satisfaction and an objection to being forced, especially by the Government, to being inconvenienced.

2. Sense of neighborhood seems to be directed through sentimental attachment to specific neighborhood features such as church, school, block and homogeneous neighbors. The ethnic sense of neighborhood or the small-town type of neighborliness which we associate with some communities (perhaps more so in the suburbs rather than within the inner city) does not appear to be comparable to the sense of neighborhood which we find in many of our Northern lower income areas which have been affected by mobility and migration of Negroes and lower income whites. For lower income groups, especially Negroes, their choice of housing is limited and their sense of neighborhood developed perhaps more as a sense of security and self-defense. There is a need for mutual aid during the adjustment period to the new city for the migrant in finding housing, jobs, schools and social agencies, and for the long-term resident in his poverty situation. One might conclude that there is a sense of apathy in these areas towards the neighborhood, a feeling of making-do with whatever one can choose from and afford. It is very likely that the effect of disrupting these neighborhoods or changing their characteristics can be minimized if persons had confidence that there was housing available in locations and in other neighborhoods which are as desirable as or more so than the ones they are now living in. Until there is this assurance, the opposition from spokesmen for the lower income groups, particularly minority groups, will be vociferous and, in many situations, effective.

With higher income groups, sense of neighborhood is identified and becomes more meaningful; these families have chosen to move where they did because of certain qualities they liked or preferred. Their opposition to any disruption will be well organized and sometimes more influential politically. Often, however, if they feel they are getting

fair compensation for their property, or enough time to look elsewhere so they do not feel pushed, this opposition can be minimized.

3. People of low income, whose mobility is limited by racial or income factors and by familiarity with only certain sections of the city in which their employment, social service facilities, schools, recreational facilities, or shopping is located or easily accessible, tend to move into areas similar to the ones from which they have been displaced and close to or adjacent to these areas. One stays close to what one knows and is secure with, especially when experience and opportunities are limited. As a result, we find that some blame is attached to those displaced from the Southwest urban redevelopment project for the deterioration of the area which was studied. We do know that families from the Southwest did move into this area but not to the great extent indicated by the interviewees. It is a normal reaction for those who have lived in an area for a long time to be disturbed about forces which adversely affect their neighborhoods. They find a scapegoat. The meaning of their accusation is important to the policy makers. The diminishing supply of low-cost housing within the District limits has caused the few remaining areas where such housing can be found to be overcrowded by those who can afford no better. Whether it has been the Southwest displacees who were removed from one low-cost area in such large numbers in such a relatively short period of time, those from the South who move into these areas because of their limited incomes while hoping to find economic opportunities to better themselves, those forced out of their homes because housing code enforcement or the upgrading of neighborhoods cause higher rentals, or those of continuing unemployment who are unskilled and functionally illiterate, the fact does remain that this particular area offers low-cost housing resources to those seeking it. The supply diminishes but the demand is as great. Action taken in one part of a city can have an important impact on other sections. This is a problem tied in with more than housing; it involves economic opportunities, more appropriate education, and more effective social services.

4. Major physical changes in a neighborhood require a readjustment on the part of the inhabitants. Some will accept them and remain, others will reject them or find them a threat and will leave. The remainder will take a wait-and-see-and-hope attitude. There are various acculturation aids which are required by all urban inhabitants to make theirs a more healthful and satisfying life. Community institutions and facilities are a major supplement in providing for some of the needs of all residents. Easy accessibility and knowledge of these facilities help determine where inhabitants shall live. In planning for changes, these community aids cannot be neglected.

The following recommendations are not only directed to the highway planners, but apply to all urban officials as they program projects which can have such a significant impact on residents and other citizens alike.

a. Housing for low-income families, especially for those with large numbers of children and for the elderly living on small pensions or social security, must be built or greatly expanded. This is one of our major problems today. The local government has the responsibility to see that this need is met before authorizing any program which will result in the displacement of more low-income families. More public housing units are needed; private enterprise must accept a role in this; ideas must be tried such as tax concessions, subsidies or other financial inducements. A city is actually worse off in the long run with its public improvement because its possible benefits are offset by its effects throughout the rest of the city.

b. Community organization, including citizen participation, is accelerated by emergency situations directly affecting the lives, interests or property of those concerned. Highway planning can be a basis for initiating civic concern and action by the residents, thus serving as a catalyst and a major positive force. With the help of the residents serving as community advisors, the planners and community can not only work together to integrate the highway, urban renewal area, or whatever the public improvement may be into the community, but also take advantage of this upheaval to add other or additional facilities to service the community. Here is a good opportunity for the coordination of physical and social planning. Reaching as many people as possible while the plans are being formulated may help to shape the plans to satisfy the greatest number, give everyone a chance to participate in the decision-making process

and to react to the problems which may arise in the community so that solutions might be found while time is in their favor. When construction is completed, a new and strengthened community remains.

c. An effective relocation service must be provided to help all those displaced by government action. This includes assistance in finding other housing and in moving expenses. Relocation offices should also be prepared to help families with special problems and include appropriate social services. A central relocation service can work with the displacement agencies to schedule construction and relocation so that the projects need not be postponed or seriously hampered.

d. The social effect of a public action should be as important to the decision makers as are the economic, technical and aesthetic effects. The impetus of a major highway programmed through a specific section of an urban area has an effect on the currents of life within the whole community—those who remain, those who are displaced, other neighborhoods, public officialdom, private business and future projects. The engineer, the planner, the public official, the social scientist, the resident, the businessman, all citizens have a common objective—the betterment of their city. Only through their mutual concern, cooperation and respect can it be achieved.