SECTION 8

COMPARISONS OF VALUATION METHODS

This study utilized two different sources of data and methods for obtaining benefit estimates: a hedonic regression method applied to property value data and regression analysis of willingness to pay for improvements as reported on a survey. As discussed in this report, both methods have problems and limitations. Table 65 summarizes the problems and advantages of each method. Use of both types of data and methods allows us to define a range for benefit estimates.

8.1 Comparison of Alternative Hedonic Techniques

Hedonic benefits were computed using two different pollution measures (OZONE and PSI2) since it is not known which pollution measure was more correlated with home buyer behavior. The air pollution measures used were based on both the number of polluted days and the yearly average level of pollution. OZONE is based on ozone measurements. PS12 is a composite of several pollutants (ozone, CO, and TSP) which are associated with poor air quality. Benefit measures obtained using the PS12 measure were larger than those obtained using the OZONE measure since there are more polluted days than those associated with ozone. (The survey study indicated that general perceptions of air quality were most correlated with ozone but visibility was more correlated with PSI.)

Two estimation procedures for benefits were used: direct use of the hedonic property value equation and use of a three-step method. For the direct method, benefit estimates were obtained by evaluating the change in property values as a result of pollution changes. The three steps of the other method are: 1) estimation of the property value relation and calculation of marginal property values; 2) regression of the marginal values against pollution and socioeconomic variables to obtain a demand relation; 3) evaluation of benefits by integrating the demand relation over the pollution change and using the appropriate socioeconomic variables.

Often socioeconomic information needed to perform the second and third steps is not available at a household level. Here, because of good data sources, we could use household level information for all three steps. In comparison, the Los Angeles study used socioeconomic data at the city level

Table 65
GENERAL
COMPARISON OF. METHODS

Problem	Hedonic (Property Value)	Contingent Valuation (Survey)
Choice observation	Actual (market)	Hypothetical
{willingness to Pay observation	Indirect; estimated (3-step method)	Direct Observation
Quality of Data	Possibly out of date; Socioeconomic data may not match property value data	Current; willingness to pay and socio-economic data are matched
Sampling	Relatively unlimited	Limited by survey budget; snail size may lead to estimation error
Other Biases	Specification/estimation (both property value and WTP)	Survey Biases Specification/estimation for WTP regression
Pollution Measure and health and visibility values	Arbitrary but use only one because of correlation; can't estimate separate values	Can use perception measures to obtain separate health and visibility values

Table 66

CONTINGENT VALUATION BENEFITS
30% Improvement in Visibility and Health[a]

Monthly Willingness to Pay Per Household, ($)

	A	B	C	D	E
West Bay					
Suburban	9.76	8.85	9.98	8.58	8.93
Urban		8.19			
East Bay					
Suburban		2.84	4.51	3.55	
Urban		2.47			

Total Annual Willingness to Pay ($1000)

	A	B	C	D	E
West Bay					
Suburban	2424.6	16404.1	6230.3	23202.8	32329.1
Urban		28106.9			
East Bay					
Suburban		5040.8	7504.3	6672.9	
Urban		5128.0			
TOTAL	2424.6	54679.8	13734.6	29875.7	32329.1

GRAND TOTAL--133,043.8

[a]visibility in terms of PCTVIS and health as PS12

Table 67

HEDONIC BENEFITS
30% Decrease in PS12[a]

Monthly Household Benefits ($)

	A	B	C	D	E
West Bay					
Suburban	.72	2.26	3.41	7.19	23.46
Urban		1.12			
East Bay					
Suburban		.86	5.62	6.84	
Urban		.63			

Total Annual Willingness to Pay ($1000)

	A	B	C	D	E
West Bay					
Suburban	181.4	4188.0	8024.7	19348.0	84927.9
Urban		85.0			
East Bay					
Suburban	147.9	1526.8	9354.6	12854.9	
Urban		1309.7			
TOTAL	329.3	7110.3	17379.3	32292.9	84927.9

GRAND TOTAL-- 142,039.7

[a]from Table 33 on a monthly basis

for the second and third steps. Using the OZONE measure, the three step method using household-level data for all three steps gave a larger benefit value for air quality improvements than the direct property value method' applied at the tract level.

It can be inferred that the largest benefit measure would be obtained using a pollution measure based on more than one pollutant (such as PS12), the three-step benefit estimation method, and household level data for all three steps. To compare the magnitude of the difference using different estimation techniques, area E provides an example; the benefit estimate for a 30% improvement in air quality ranged from $172-435 annually. Generally for any area, the largest benefit estimate obtained was about twice as large as the smallest estimate.

8.2 Comparison of Contingent Valuation and Hedonic Results

Since PSI was used to measure air quality in both survey and hedonic studies, we may compare the two methods on this basis. Table 66 shows the evaluation of household monthly and total willingness to pay for a 30% improvement for each area with the contingent valuation method. For comparison purposes, Table 67 shows benefits evaluated from the tract-level hedonic model of property values. Both survey and hedonic methods give similar total benefits for a 30% improvement ($133 million annual benefit for the survey compared to $142 million for the hedonic study).

However, the two methods give quite different distributions of household benefits. The survey shows that persons in the cleaner areas (A-D) are willing to pay **more** than the predicted property value effect whereas persons in dirtiest area (Area E) are willing to pay far less than the predicted property value effect.

Thus, the hedonic study seems to underestimate stated willingness to pay in some (richer, cleaner areas) cases and overestimate willingness to pay in other cases (poorer, dirtier areas). Possible explanations of differences in the two methods of benefit estimation include differences in information, wealth effects, and differences in functional form.

For example, persons in poorer areas may not recognize to property value effect and thus may understate willingness to pay on the survey. Or, people in richer areas may be willing to pay more because of "benevolence". As another example of a wealth effect, the property value benefit may exist and be recognized but lower income respondents may not be willing or able to pay this amount from current income since they would not receive current income from a potential property value increase.

Another reason for differences is the functional form assumed explicitly or implicitly by the methods. The contingent valuation method assumes a constant value of a percent change in air quality with all other independent variables constant. The multiple step hedonic method implicitly assumes that willingness to pay increases exponentially as the initial air quality changes; this results in very large predicted bids for

for the second and third steps. Using the OZONE measure, the three step method using household-level data for all three steps gave a larger benefit value for air quality improvements than the direct property value method applied at the tract level.

It can be inferred that the largest benefit measure would be obtained using a pollution measure based on more than one pollutant (such as PSI2), the three-step benefit estimation method, and household level data for all three steps. To compare the magnitude of the difference using different estimation techniques, area E provides an example; the benefit estimate for a 30% improvement in air quality ranged from $172-435 annually. Generally for any area, the largest benefit estimate obtained was about twice as large as the smallest estimate.

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Another reason for differences is the functional form assumed explicitly or implicitly by the methods. The contingent valuation method assumes a constant value of a percent change in air quality with all other independent variables constant. The multiple step hedonic method implicitly assumes that willingness to pay increases exponentially as the initial air quality changes; this results in very large predicted bids for the dirtiest area and very small predicted bids for the best area. One might question which is the most appropriate assumption.

Regardless of the reason for differences, given their information about air pollution and assuming the absence of strategic behavior, willingness to pay values stated on the survey are closer than property value changes to how people believe they value visibility and health.

8.3 Comparison of the San Francisco and Los Angeles Studies

Table 68 shows the comparison of the property value and survey results for this study and the Los Angeles study for a 30% improvement in air quality. As expected, a 30% improvement in air quality would result in bigger benefits in Los Angeles than in the Bay Area because of much worse air quality. Using similar methods and a comparable number of households to evaluate a 30% improvement, this study obtained $136 million annually and, the Los Angeles study obtained $950 million annually. However, using this method, the values obtained for benefits of a 30% improvement for a household in the dirtiest Bay area (area E) and for an average household in Los Angeles are of similar magnitude.

Finally, the consistency in magnitude of benefit estimates obtained from surveys and hedonic methods should be noted. This study obtained very similar benefit values ($133 and $136 million annually) for both methods. The Los Angeles study obtained similar magnitudes for the two methods. This consistency in the magnitude of survey and property value results provides support for the validity of the contingent valuation method.

Table 68

COMPARISON OF RESULTS

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WILLINGNESS TO PAY FOR A 30%
IMPROVEKENT IN HEALTH AND VISIBILITY, 1978

A. Bay Are

	verage Annual Value ($) er Household, 'est Bay Suburban					nnual verage ($), ay Area ousehold	'otal for Bay Area ($ million)
	A	B	C	D	E		
Direct Property Value, log-log model (tract data)							
OZONE	5	1	4	32	172	45	75
PS12	8	27	47	86	281	85	142
3-step method (city data)							
OZONE	6	0.30	6	51	337	82	136
Survey Regression, PS12	.17	106	119	103	107	80	133

B. Los Angeles

		nnual ($) verage, LA ousehold	'otal for LA rea ($ million)
Direct Property Value, linear-model, household data			
NO_2		1401	2600
TSP		620	1250
3-step method, (city data)			
NO_2		540	950
TSP		593	1100
Survey Regression		312	580

FOOTNOTES

[1]Earlier in the project, the possibility of using air quality data obtained from dispersion models was considered. One such model has ben developed for the Bay area (LIRAQ). Based on a detailed source inventory of emissions, the topography of the Bay area and a typical days meteorological conditions, the model projects expected ozone concentrations for regions throughout the Bay area. Based on discussions with air pollution meteorologists, it was felt that monitoring station data best suited for our purposes because of problems with expense and accuracy of data derived from models.

[2]TSP is not a daily measurement of particulate; it is taken every 6th day. The TSP measurement is assigned to the previous two days and the following three days to obtain a "daily" measurement of particulate.

[3]By comparison, in the Los Angeles air pollution-property value study, Brookshire et. al. defined two miles as representing poor visual range, 12 miles as moderate, and 28 miles as good.

[4]These cities were eliminated from the household sample pool but are included in the tract level benefit calculation.

[5]Unrepresentative tracts in these areas were also excluded from our sample pool .

[6]Work trips include private vehicle and public transportation to and from work.

[7]This of course requires making the appropriate assumptions about marginal utility of income and homogeneity of consumers.

[8]It should be noted that there are problems in using both a fire rating variable and a crime rate variable because of correlation: a higher crime rate (e.g., San Francisco) is associated with a lower fire rating, thus a positive coefficient is obtained for crime rate when the fire rating is present in the equation.

[9]Even with the ozone measure, collinearity problems between PCTVIS and the dummy variable indicating bayside occurred, thus we could not use PCTVIS in the regression analysis.

[10]The household sample was not drawn randomly from households. Recall that the tract selection was random but the tracts vary as to the number and type of sales. PCTVIS was used in the ozone regressions initially. However, it was never significant. Due to the small number of monitoring stations, there is not sufficient variation in the PCTVIS data and also the specified va4riable is correlated with the East/West Bay dummy variable.

[11]Temperature was used in the PS12 regressions; it was significantly negative only in the pool sample regressions.

[12] The Sonstelie and Portney study showed that distance to San Francisco was significant for the San Mateo market area and the Vincent study showed that distance to the city center was significant in a study of San Jose.

[13] In comparing the two studies, differences in the type of income data (household versus city level data) and accuracy should be recalled. Table A22 shows the Los Angeles demand equation.

[14] We thank Dr. Jon Livingston for the San Francisco scenes taken from Sutro Tower and Mr. Zev Pressman for the Palo Alto scene.

[15] We thank Mr. Zev Pressman for developing this technique and Mr. Ron Moore for his excellent airbrushing work.

[16] Initial study indicated that the weighted distance measure was not significant; therefore, we substituted the expected measure.

REFERENCES

Air Pollution and the San Francisco Bay Area, prepared by the Bay Area Air Pollution Control District, Eleventh Edition (1977).

Alonso, W., "A Theory of the Urban Land Market," in Papers and Proceedings of the Regional Science Association, Vol. 6, pp. 149-158 (1960).

Anderson, R.J. and Crocker, T., "Air Pollution and Residential Property Values," Urban Studies, Vol. 8, pp. 171-180 (1971).

Ball, M.J., "Recent Empirical Work on the Determinants of Relative House Prices," Urban Studies, Vol. 20, pp. 213-233 (1973).

Bahl, R.W., Coelen, S.P. and Warford, J.J., "Land Value Increments as a Measure of the Net Benefits of Urban Supply Projects in Developing Countries: Theory and Measurement," in Haveman, R.H., et al. eds, Benefit-Cost and Policy Analysis 1973, pp. 259-276 (Aldine, Chicago, Illinois, 19"/4).

Bay Area Air Quality Plan, prepared by the Association of Bay Area Governments (ABAG), Bay Area Air Pollution Control District (BAAPCD) and the Metropolitan Transportation Commission (MTC) (1979).

Bay Area Total Suspended Particulate: 1969-1976, Information 'Bulletin prepared by the Technical Services Division, Bay Area Air Pollution Control District (1977).

Blomquist, G. and Wurley, L., "Hedonic Prices, Demands for Urban Housing Amenities and Benefit Estimates," presentation at ASSA meetings (December, 1979).

Bourne, L., cd., Internal Structure of the City (Oxford University Press, Toronto, 1971).

Brigham, E.F., "The Determinants of Residential Land Values," Land Economies, Vol. 41, pp. 325-334 (February 1965).

Brookshire, D., d'Arge, R., Schulze, W. and Thayer, M., Methods Development for Assessing Air Pollution Benefits: Volume II, Alternative Benefit Measures of Air pollution Control in the South Coast Air Basin of Southern California. EPA-600/6-79-O016 (1979).

Brown, G. and Pollakowski, H., "Economic Evaluation of Shoreline," Review of Economics and Statistics, Vol. 59, pp. 272-278 (August, 1977).

Cho, Chien-Ching and Reichert, A.K., "An Application of Multiple Regression Analysis for Appraising Single-Family Housing Values," Business Economics, pp. 47-52 (January, 1980).

Colwell, P.F., Gunterman, K. and Wade, C.E., "The Value of Neighborhood Schools," presented to Allied Social Science Meetings, Atlanta, Georgia (December, 1979).

Crocker, T., "Urban Air Pollution Damage Functions: Theory and Measurement," Final Report CPA22-69-52 of the National Air Pollution Control Administration, University of California, Riverside, California (1970).

Deyak, T. and Smith, K., "Residential Property Values and Air Pollution: Some New Evidence," Quarterly Review of Economics and Business, Vol. 14, pp. 93-100 (Winter, 1974).

De Vany, A.S., "An Economic Model of Airport Noise Pollution in an Urban Environment," in Lin, S., cd., Theory and Measurement of Economic Externalities, (Academic Press, New York, 1976).

Diamond, D.B., "Income and Residential Location in Urban Area," (University of Chicago, Department of Economics, 1975).

Duda, R. and Hart, P., Pattern Classification and Scene Analysis, (Wiley and Sons, New York).

Dygert, P. and Sanders, D., "On Measuring the Cost of Noise and Subsonic Aircraft," (Institute of Transportation and Traffic Engineering, Berkeley, California, 1971).

Edel, M. and Selar, E., "Taxes, Spending, and Property Values: Supply Adjustment in a Tiebout-Oates Model," Journal of Political Science, Vol. 82, pp. 941-954 (September/October, 1974).

Edelstein, R., "The Determinants of Value in the Philadelphia Housing Market: A Case Study of the Mainline 2967-1969," The Review of Economics and Statistics, Vol. 56, pp. 319-328 (August, 1974).

Emerson, F., "Valuation of Residential Amenities: An Econometric Approach," The Appraisal Journal, pp. 268-278 (April, 1972).

Everitt, B., Cluster Analysis (Wiley and Sons, New York).

Fisher, J.L., "Environmental Quality and Urban Living," Planning, pp. 178-186 (1967).

Flachsbart, P.G. and Phillips, S., "An Index and Model of Human Response to

Air Quality," (1979), forthcoming in Journal of the Air Pollution Control Association.

Frank, R. and Green, P., "Numerical Taxonomy in Marketing Analysis: A Review Article," Journal of Marketing Research, Vol. 5 (February, 1968).

Freeman, A.M., "Air Pollution and Property Values: A Methodological Comment," The Review of Economics and Statistics, Vol. 53, pp. 415-416 (November, 1971).

__________, "On Estimating Air Pollution Control Benefits From Land Value Studies," The Journal of Environmental Economics and Management, Vol. 1, pp. 74-83 (1974).

__________, "Hedonomic Prices, Property Values and Measuring Environmental Benefits: A Survey of the Issues," Scandinavian Journal of Economics, pp. 154-173 (1979).

__________, The Benefits of Environmental Improvement Theory and Practice, (Johns Hopkins University Press for Resources for the Future, Baltimore, Maryland, 1978).

Friedman, J., Housing and the Supply of Local Public Services, Ph.D. Dissertation, Department of Economics, University of California. Berkeley, California (1975).

Gillingham, R. and Lund, D., "A Hedonic Approach to Rent Determination," Proceedings American Statistical Association, (1970).

Goodman, A.C., "Hedonic Prices, Price Indices and Housing Markets," Journal of Urban Economics, Vol. 5, pp. 471-484 (1978).

Goodwin, S.A., "Measuring the Value of Housing Quality--A Note," Journal of Regional Science, Vol. 17, pp. 107-115 (1977).

Grebler, L. and Mittelbach, F., The Inflation of House Prices, (D.C. Health and Company, Lexington, 1979).

Green, P., Frank, R. and Robinson, P., "Cluster Analysis in Test Market Selection," Management Science, Vol. 13 (April, 1967).

Griliches, Z., "Hedonic Price Indices Revisited: Some Notes on the State of the Art," Proceedings of the American Statistical Association, (1967).

Hanneman, W.M., The Welfare Implications of Changes in Property Values, Giannini Foundation of Agricultural Economics, University of California, Berkeley, California (1979).

Harris, R.N.S., Tolley, G.S. and Harrell, C., "The Residence Site CHoice," The Review of Economics and Statistics, Vol. 50, pp. 241-247 (May, 1968).

Harrison, D. Jr. and MacDonald, R., "Willingness to pay in Boston and Los Angeles for a Reduction in Automobile-Related Pollutants," in National Academy of Sciences (Committee on Public Works), the Costs and Benefits of Automobile Emission Control, Volume 4 of Air Quality and Automobile Emission Control, (NAS: Washington, D.C., 1974) [SEE BOOK].

Harrison, D. and Rubinfeld, D., "Hedonic Housing Prices and the Demand for Clean Air," Journal of Environmental Economics and Management, Vol. 5, pp. 81-102 (1978).

Harvey, R.O. and Clark, V., "The Nature and Economics of Urban Sprawl," Land Economics, Vol. 41, pp. 1-9 (1965).

Hoch, I., "Variations in the Quality of Urban Life Among Cities and Regions," in Wingo, L. and Evans, A., eds., Public Economics and the Quality of Life, (Johns Hopkins University Press for Resources for the Future, Baltimore, Maryland, 1977).

Hyman, D.N. and Pasour, E.C. Jr., "Real Property Taxes, Local Public Services and Residential Property Values," The Southern Economic Journal, Vol. 39, pp. 601-611 (April, 1973).

Jud, G.D. and Watts, J.M., "School Quality and Housing Values," presented to Allied Social Science Association Meetings, Atlanta, Georgia (December, 1979).

Kain, J.F. and Quigley, J.M., "Measuring the Value of Housing Quality," Journal of the American Statistical Association, Vol. 65, Number 330, pp. 532-548 (June, 1970).

Keith, R., "Low Visibility Trends in the South Coast Basin," a report prepared for the South Coast Air Quality Management District (January, 1979).

Kernan, J. and Bruce, G., "The Socioeconomic Structure of an Urban Area," Journal of Marketing Research, Vol. 9 (February, 1972).

King, A.T., "The Demand for Housing: A Lancastrian Approach," Southern Economic Journal, pp. 1077-1087 (October, 1976).

Kochanowski, P.A. and Wieand, K.F., "A Partial Equilibrium Analysis of Non-Linear Price Functions and the Production and Consumption of

Composite Commodities: The Case of Housing," Working Paper--Office of Policy Development and Research, HUD (1979).

Lancaster, K., "A New Approach to Consumer Theory," Journal of Political Economy, Vol. 74, pp. 132-157 (April, 1966).

Latimer, D., et al., The Development of Mathematical Models for the Prediction of Anthropogenic Visibility Impairment, Vol. 1, prepared for EPA by Systems Application Inc., San Rafael, California (September, 1978).

Little, J.T., "Residential Preferences, Neighborhood Filtering and Neighborhood Change," Journal of Urban Economics, Vol. 3, pp. 68-81 (1976).

Loehman, E., 1983. "Exact and Approximate Measures of Welfare for Evaluating Changes in Nonmarket Goods." Unpublished report, Dept. of Ag. Econ., Purdue University.

Majer, S.M., Riker, W.H. and Rosett, R.N., "The Effects of Zoning and Externalities on the Price of Land: An Empirical Analysis of Monroe County, New York," The Journal of Law and Economics, pp. 111-132 (1977).

Maler, K.G., Environmental Economics: A Theoretical Inquiry, (Johns Hopkins Press, Baltimore, Maryland, 1974).

Maim, W. et. al., "Human Perception of Air Quality," presented at "View on Visibility Conference," Denver, Colorado (25-28 November, 1979).

McFadden, D., "Modelling the Choice of Residential Location," in Studies in Regional Science and Urban Economics Volume 3, (North-Holland Publishing Company, Amsterdam, 1978),

McMillian, M.L., "Estimates of Households Preferences for Environmental Quality and Other Housing Characteristics From a System of Demand Equations," Scandinavian Journal of Economics, pp. 174-187 (1979).

Merkhofer, M.W. and Korsan, R.W., "Fluids Utility, Pollution control Options and Economic Analysis, Vol. 2: Cost Benefit Analysis of Alternative Sulfur Oxide Emission Control Policies," SRI International Report, Menlo Park, California (January, 1978).

Meyer, J.R. and Leone, R., "The Urban Disamenity Revisited," in Wingo, L. and Evans, A. eds., Public Economics and the Quality of Life, (Johns Hopkins University Press for Resources for the Future, Baltimore, Maryland, 1977).

Mieszkowski, P. and Saper, A., "An Estimate of the Effects of Airport Noises on Property Values," Journal of Urban Economics, Vol. 5, pp. 425-440 (1978).

Mullet, G., "A Comment on Air Pollution and Property Values: A Study of the St. Louis Area," Journal of Regional Science, Vol. 14, No. 1 pp. 137-138 (1974).

Nelson, J., "Residential Choice, Hedonic Prices, and the Demand for Urban Air Quality," Journal of Urban Economics, Vol. 5, pp. 357-369 (1978).

________, Economic Analysis of Transportation Noise Abatement, (Ballinger, Cambridge, Massachusetts, 1978).

Niskanen, W. and Hanke, S., "Land Prices Substantially Underestimate the Value of Environmental Quality," Review of Economics and Statistics, Vol. 59, pp. 375-377 (August, 1977).

Noto, N.A., "The Effects of the Local Public Sector on Residential Property Values in San Mateo County, California," Federal Reserve Bank--Philadelphia Research Paper No. 18 (1976).

Nourse, H.O., "The Effect of Air Pollution on House Values," Land Economics, Vol. 43, pp. 181-189 (1967).

Oates, W.E., "The Effects of Property Taxes and Local Public Spending on Property Values: An Empirical Study of Tax Capitalization and the Tiebout Hypothesis," Journal of Political Economy, Vol. 77, pp. 957-971 (November-December, 1969).

Oron, Y., Sheshinski, E. and Pines, D., "The Effects of Nuisances Associated with Urban Traffic on Suburbanization and Land Values," Journal of Urban Economics, Vol. 1, pp. 382-394 (1974).

Paul, M.E., "Can Aircraft Noises be Measured in Money," Oxford Economics Papers, Vol. 23, pp. 297-322 (July, 1971).

Pearce, D.W., The Social Cost of Noise, (OECD, Paris, 1976).

Pines, D. and Weiss, Y., "Land Improvement Projects and Land Values," Journal of Urban Economics, Vol. 3, pp. 1-13 (1976).

Polinsky, A.M. and Shaven, S., "The Air Pollution and Property Value Debate," Review of Economics and Statistics, Vol. 57, pp. 100-107 (February, 1975).

________, "Amenities and Property Values in a Model of an Urban Area," Journal of Public Economics, Vol. 5, pp. 119-129 (1976).

Polinsky, A.M. and Rubinfield, D., "Property Values and the Benefits of Environmental Improvements: Theory and Measurement," in Wingo, L. and

Evans, A., eds., Public Economics and the Quality of Life, (Johns Hopkins University Press for Resources for the Future, Baltimore, Maryland, 1977).

Richardson, D.H. and Thalheimer, R., "On the Use of Grouping Methods in the Analysis of Residential Housing Markets," Center for Real Estate and Land Use Analysis, University of Kentucky (1979).

Ridker, R.G., and Henning, J., "The Determinants of Residential Property Value with Special Reference to Air Pollution," Review of Economics and Statistics, Vol. 49, pp. 246-257 (May, 1967).

Rosen, S., "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," Journal of Political Economy, Vol. 82, pp. 34-55 (January-February, 1974).

Rubinfeld, D., "Market Approaches to the Measurement of the Benefits of Air Pollution Abatement," in Friedlaender, A.F., cd., Approaches to Controlling Air Pollution, (MIT Press, Cambridge, Massachusetts, 1978) .

Saxonhouse, G.R., "Estimated Parameter as Dependent Variables," American Economic Review 66, pp. 178-183.

Schnare, A., "Racial and Ethnic Price Differentials in an Urban Housing Market," Urban Studies, Vol. 13, pp. 107-120 (1976).

Schnare, A. and Struyk, R., "Segmentation in Urban Housing Markets," Journal of Urban Economics, Vol. 3, pp. 146-166 (1976).

Schuler, R.E., "The Interaction Between Local Government and Urban Residential Location," The American Economic Review, Vol. 64, pp. 682-696 (September, 1974).

Skov, I., "Does Air Pollution Affect Residential Property Values," dissertation, Department of Economics, University of Southern California (1976).

Small, K., "Air Pollution and Property Value: Further Comment," The Review of Economics and Statistics, Vol. 57, pp. 105-107 (1975).

Smith, B., "Measuring the Value of Urban Amenities," Journal of Urban Economics, Vol. 5, pp. 370-387 (1978).

Smith, K.V. and Deyak, T.A., "Measuring the Impact of Air Pollution on Property Value," Journal of Regional Science, Vol. 25, No. 3, pp. 277-288 (1975).

Smith, K.V., The Economic Consequences of Air Pollution, (Ballinger, Cambridge, Massachusetts, 1976).

Smith, R.S., "Property Tax Capitalization in San Francisco," National Tax

Journal, Vol. 23, No. 2, pp. 177-191.

Sonstelie, J.C. and Portney, P.R., "Gross Rents and Market Values: Testing the Implications of Tiebout's Hypothesis," Journal of Urban Economics, vol. 7, pp. 102-118 (1977).

Soskin, M.D., "Extraction of Pollution Costs from Urban Housing Data: A Multivariate,Inv.estimation of Multicollinearity and Specification Problems," paper presented at the 71st Annual Meeting of the Air Pollution Control Association, Houston, Texas, Susquehanna University, Selinegrove, Pennsylvania (June, 1978).

Straszheim, M., "Hedonic Estimation of Housing Market Prices: A Further Comment," The Review of Economics and Statistics, Vol. 56, pp. 404-406 (August, 1974).

Tiebout, C.M., "Inter-Urban Location Problems: An Evaluation," American Economic Review, Vol. 51, 271-278 (1961).

Tolley, G.S. and Cohen, A.S., "Air Pollution and Urban Land-Use Policy," Journal of Environmental Economics and Management, Vol. 2, pp. 247-254 (1976).

Tyron, R., Identification of Social Areas by Cluster Analysis, (University of California Press, Berkeley, California, 1955).

_________ "Prediction Group Differences in Cluster Analysis: The Social Area'Problem" Multivariate Behavioral Research, (October, 1967).

_________, "Comparative Cluster Analysis of Social Areas," Multivariate Behavioral Research, (April, 1968).

Vincent, P.E. and Reinhard, R.M., "Tax Burden Distribution and Property Tax Capitalization in School Districts in California," prepared by Education Finance Center (Denver, Colorado) for California State Department of Education (1979).

Waggoner, A.P. et al., "Sulphate-Light Scattering Ratio as an Index of the Role of Sulfur in Tropospheric Optics," Nature, Vol. 261, pp. 120-122 (1976).

Wales, T.S. and Wiens, E.G., "Capitalization of Residential Property Taxes: An Empirical Study," The Review of Economics and Statistics, Vol. 56, pp. 329-333 (August, 1974).

Walters, A.A., Noises and Prices, (Clarendon Press, Oxford, 1975).

Wheaton, W.C., "A Bid Rent Approach to Housing Demand," Journal of Urban Economics, Vol. r, pp. 200-217 (1977).

Wieand, K., "Air Pollution and Property Values: A Study of the St. Louis Area," Journal of Regional Science, Vol. 13, No.1, pp. 91-95 (1973).

_________, "More on Air Pollution: A Reply to Mullet," Journal of Regional Science, Vol. 14, No. 1 (1974).

Willig, R.D., "Consumer's Surplus Without Apology," The American Economic Review, Vol. 6, No. 4, pp. 589-597 (September, 1976).

Winger, A.R., "HowImportant is Distance from the Center of the City as a Determinant of Urban Residential Land Values," The Appraisal Journal, pp. 558-566 (october, 1973).

Witte, A.D., Sumka,H.J. and Erickson, H., "An Estimate of a Structural Hedonic Price Model of the Housing Market: An Application of Rosens Theory of Implicit Markets," Econometrics, Vol. 47, pp. 1151-1173 (September, 1979).

APPENDIX A

DATA AND DATA BASE MANAGEMENT

DATA SET DESCRIPTION

Data for this study were obtained at several hierarchical levels: cities, 440 zones, census tracts and households. Data for each hierarchical level are described below.

City Level

City Data--

City data was obtained from a multiplicity of sources including the Census Bureau, other Federal agencies, various state, county and city organizations and regional agencies such as the Association of Bay Area Governments (ABAG). Information was obtained on population, public service expenditures, socioeconomic variables, vacancy rate, temperature, housing, employment, etc. Table A5 indicates city data used and its sources.

Computed Variables--

Certain of the variables at the city level, such as the representative tax rate (TAX), school tax rate (SCHTAX) and school scores (SCORES), were not directly available at the city level. The representative total tax variable (TAX) required special computation because of overlapping districts not corresponding to city boundaries.

For the purpose of tax assessment, each taxpayer is assigned to a tax rate area. Each tax area has its own designated tax rates based on school and other special tax districts included. Taxpayers living within the various tax rate areas in a city may be subject to different tax rates. In most cities, there are numerous tax rate areas. For instance, San Jose has over 700 tax rate areas -- many with different tax rates.

Because of the varying tax rates within a city, we used a representative tax rate for a city. To calculate the representative total tax variable, we determined the tax rate areas representing 75 percent of the assessed valuation within a city; usually only a few tax rate areas accounted for 75% of the valuation. To obtain the representative tax variable for each city, the tax rates from these areas were averaged, using as weights the fraction of the assessed valuation against which the tax was being applied. Since school district boundaries do not follow city boundaries, the same procedure was followed to obtain the representative school tax rate (SCHTAX) for each city. The various tax rates (from the tax rate areas providing 75 percent of the valuation within a city) were averaged to obtain SCHTAX.

The measure of school quality, SCORES, is the sum of 6th and 12th grade reading and math scores from the California Assessment Tests. For cities entirely within one school district, the district wide average was used as the school score measure. For cities including multiple school districts, the city's SCORE value was computed by weighing district scores by the fraction of students represented by each district.

Pollution. Data., ..

As indicated in section 3.1, each city was matched with the monitoring station which most accurately reflects the level of a particular pollutant for that city. Table A6 in the appendix indicates the pollution data used in this study,

440 Zone Level

440 Zone Data--

The 440 zone level, is the basic analysis unit for the two major regional planning agencies in the San Francisco area, the Association of Bay Area Governments (ABAG) and the Metropolitan Transportation Commission (MTC). According to this system, nine counties in the Bay Area are divided into 440 zones. In all but a few cases, each of the zones completely encompass a single tract or a few tracts. Utilzing the available zone data, we are able to obtain detailed land use information from ABAG. This data included information on the amount of land utilized for residential and industrial-commercial purposes, the amount of vacant land, the land occupied by streets and highways and the total number of housing units. Table A7 defines the variables used at the zone level.

Transit information (the distance and time to employment centers) was also available for all 440 zones from MTC. We obtained information regarding the estimated distance and time from each 440 zone to twenty designated major employment centers in the Bay Area. The time estimate is based on the minimum zone-to-zone travel time for 1975 along a highway network at peak hour. The distance estimate is the zone-to-zone distance over the minimum time path. The twenty employment centers are listed in Table A3 in the appendix.

Computed Variables--

Work trip data from MTC gives the percentage of all work trips (private vehicle and public transit trips) generated and attracted to al 1 areas in the Bay Area for 1975, for 23 transit zones in the 6 county area. Work trip data are estimated by the Metropolitan Transportation Commission (MTC) staff as part of a travel demand model 1 ing study. For the purposes of our study, all 440 zones, cities and tracts within the same transit zone were assigned the same information regarding work trip destinations. The zone variable CENTER gives the percent of trips from each zone ending in each of the 20 major employment centers. Table A4 in the appendix shows the percent of work trips beginning in each transit zone and ending in each zone. The diagonal of this matrix is the variable EMRSTR (used at the city level) which indicates the percentage of all work trips both generated and attracted to the same area. This variable distinguishes bedroom communities from areas which are more closed with respect to residence and employment.

Census Tract Level

Census Tract Data--

At the census tract level, various socioeconomic and housing information was obtained from the Special Profile of California: 1970 Us. Census of Population and Housing for San Francisco-Oakland and San Jose SMSA's. Additional census tract information (tract land area, earthquake susceptibility, elevation, slope and noise intensity levels) was obtained from ABAG. Table A8 lists tract level data with the associated variable names.

The measure of earthquake susceptibility (QUAKE) indicates the maximum expected earthquake intensity in the Bay Area. The maximum intensity in a specific area depends on the ground motion characteristics of the earthquake, the distance of the area from the fault that slips and the type of geologic material that underlies the area. Based on a procedure developed by three U.S. Geological Survey scientists (Borcherdt, Gibbs and Lojoie-1975), ABAG estimated the maximum intensity for all regions in the Bay Area. According to this system, the Bay Area can be divided into 6 earthquake intensity zones ranging from maximum to minimum earthquake intensity; each tract in our study was assigned an expected earthquake intensity level according to these six zones.

The measure of noise intensity (NOISE) resulted from a joint study by ABAG and MTC of Bay Area airports. This measure indicated the area within each tract which experiences a level of 65 CNEL (Community Noise Evaluation Level) or greater. This was based on averaging the noise level during a 24-hour period weighted for different times during the day. This noise measure only indicates the noise intensity near airports. Other areas with high noise levels, such as downtown locations or areas close to freeways, are not considered in this measure.

Computed Variables--

Terrain Measures

The average tract elevation and the average tract slope (also obtained from ABAG) was originally produced by the Defense Mapping Agency using U.S. Geological Survey quad sheets. The mapping agency supplies this information on "digital terrain tape". From this tape, an elevation and slope value is available for each cell area (100 by 140 meters) in the Bay Area. These cells were matched to census tracts by ABAG. The average tract elevation was calculated by ABAG by averaging the elevation over the cells within a tract.

Slope is the change in elevation over a change in distance. The slope for tracts was calculated by ABAG from the same source. The tract slope is obtained by averaging all the cell slope values within the tract, where a cell slope is the maximum value of the slope calculated from cells adjacent to a given cell.

Expected Distance to Employment Centers

Classical land use theory implies that distance from the central part of a city has bearing on residential land values. In the Bay Area, San Francisco is the major employment center. However other major employment centers exist in the area in San Jose-Santa Clara and along the East Bay in and around Oakland.

To take into account the impact of multiple employment centers on housing values, some property value studies have utilized a measure of distance weighted by employment. This measure is normally of the form:

$$\text{Weighted distance} = \sum_i a_i x_{it}$$

where a_i is the proportion of employment at center i to total employment and x_{it} is distance from t to i. In this study we used "expected distance" instead;

$$\text{Expected distance}_t = \Sigma_i p_{it} x_{it}$$

where p_{it} is the proportion of work trips from tract area t to employment center i and x_{it} is the minimum road distance from tract t to employment center i. The expected distance for each tract was calculated using distance (DISTANCE) and work-trip exchange matrix (CENTER).[18]

Household Level

At the household level, two sources of data were available, SREA Market Data and California Department of Savings and Loan. The housing characteristic data obtained from the SREA Market Data Center pertains to houses sold in 1978 and contains detailed information on household characteristics. This information includes the sales price, living area, number of rooms, age of house and various amenity measures such as the type of house, view from the house, quality of the house, etc. Table A9 describes the data available from this source. The Market Data Center collected this information on a voluntary basis from State and Federal Savings and Loan institutions, the Federal Housing Administration and mortgage institutions (not from multiple listings at real estate offices). The sales represent about 30-35 percent of the total volume of sales in this area.

The second source of household characteristic data is the California Department of Savings and Loan. This department provided loan transaction data as reported by state licensed savings and loan associations for houses sold in 1978. This data contains detailed information on borrower characteristics (sex, race, age, income, etc.) and the loan (interest, amount, term, etc.). Some additional information is provided concerning household characteristics such as sales, price, living area and the age of the house. Table A1O indicates data available from the California Department of Savings and Loan.

T-tests were run between variables that were common to both the Market Data Center and Savings and Loan data sets (average sales price and living area) to determine the similarity of the two data sets since individual house transactions from the two data sets could not be matched. For each common variable, a tract average was computed and used in the t-test. The results of the test indicate that the difference in mean values between these corresponding sets of variables was not significant.

DATA BASE MANAGEMENT

This study required utilizing data for census tracts and communities in the Bay Area with data from several hierarchical levels. The data management functions and the statistical analysis of the data was performed using the Statistical Analysis System (SAS). The data base is organized hierarchically according to geographical designations. The hierarchy, from the largest to the smallest geographical entity, is as follows:

- City
- 440 Zone
- Tract
- Household

Each data set at a particular level (e.g., city level) can be linked to any other data set by the use of identifiers. City-level records contain a city identifier, 440 zone-level records contain city and zone identifiers, and tract-level and household-level records contain city, zone, and tract identifiers. By using these identifiers information can be distributed from a higher level down to a lower level and vice versa. Using the system, any data set can be accessed with any or all others to meet different analytical needs. Additional identifiers used included market area, city and tract type and air quality type.

TRACT AND HOUSEHOLD FILES USED IN THIS STUDY

The initial tract data set consisted of 946 tracts. From this set, we eliminated all unusual tracts (boat docking areas, unusual tracts having no sales of property, tracts with no median occupants per house, etc.). Furthermore, unincorporated areas (46 tracts) having no city service or tax information were deleted. After these deletions, a “master tract file” for 822 tracts was created; these are the tracts used in the final benefit estimation.

This set of tracts was further pared in order to assure a data set which would have the least error of measurement due to demographic variables and air pollution variables. We also deleted tracts in very high growth areas (inaccurate socioeconomic data), low density areas, low owner occupancy areas, and very high density areas. (See section 4 for how these areas were identified.) Elimination of these tracts created a set of tracts which were of a “normal” density (single family residential) type. After elimination of unusual tracts as from the master tract file, a file of 295 tracts, termed “pool tract” file was created. A smaller number of tracts (42) were chosen randomly from the pool tracts as described in section 4. This smaller file is termed the “household sample” file; it contains complete data at the household level (about 2500 households) for 42 tracts.

Each of these files contains the same types of information used to perform regression analyses (see section 5). However, household information for the “master tract” and “pool tract” files is aggregated to the tract level, whereas for the “household sample” it is not.

Tables A11-A13 shows the mean values and standard deviation of selected variables used in our analysis for each of the tract files used. Tables A14-A21 show property value models for alternative market areas.

Table Al

CITT - MONITORING STATION CORRESPONDENCE

CITY	Monitoring Station Assignment CO	O3	TSP
Alameda	Oakland	Oakiand	San Francisco
Albany	Richmond	Richmond	Richmond
Antioch.	Pittsburg	Pittsburg	Pittsburg
Athertcn	Redwood City	Redwood City	Redwood City
Belmont	Redwood City	Redwood City	Redwood City
Belvedere	Richmond	San Francisco	San Rafael
Berkeley	Richmond	Richmond	Richmond
Brentwood	Pitttsburg	Pittsburg	Pittsburg
Brisbane	Burlingame	Burlingame	Burlingame
Burlingame	Burlingame	Burlingame	Burlingame
Cambell	Saratoga	Los Gates	Saratoga
Clayton	Concord	Concord	Livermore
Concord	Concord	Concord	Concord
Corte Madera	Richmond	San Rafael	San Rafael
Cupertino	Saratoga	Saratoga	Saratoga
Daly City	Burlingame	San Francisco	Burlingame
El Cerrito	Richmond	Richmond	Richmond
Emeryville	Oakland	Oakland	Sac Francisco
Fairfax	Richmond	San Rafael	Sea Rafael
Foster City	Burlingame	Bur lingame	Burlingame
Fremont	Fremont	Fremont	emo
Gilroy	Gilroy	Gilroy	Gilroy
Hayward	Fremont	Haywar d	Fremont
Hercules	Richmond	Richmond	Richmond
Hillsborough	Burlingame	Burlingame	Burlingame
Halfmoon Bay	Burlingame	San Francisco	Bur lingame
Lafayette	Concord	Concord	Concord
Larkspur	Richmond	San Rafael	San Rafael
Livermore	Livermore	Livermor e	Livermore
Los Altos	Redwood City	Mt. View	Redwood C ity
Los Altos Hills	Redwood City	Mt. View	Redwood City
Los Gates	Saratoga	Los Gatos	Saratoga
Martinez	Concord	Concord	Concord
Menlo Park	Redwood City	Redwood City	Redwood City
Morgan Sills	Gilroy	Gilroy	Gilroy
Millbrae	Burlingame	Burlingame	Burlingame
Mill Valley	Richmond	San Rafael	San Rafael
Milipitas	San Jose	San Joee	San Jose
Monte Sereno	Saratogs	Los Gates	Saratoga
Moraga	Oakland	Oakland	San Francisco
Mountain View	Redwood City	Mt. View	Redwood City
News rk	Fremont	Fremont	Fremont
Nuvato	San Rafael	San Rafael	San Rafael
Oakland	Oakland	Oakland	San Francisco
Pacifica	Burlingame	San Francisco	Burlingame
Palo Alto	Redwood City	Redwood City	Redwood City
Piedmont	Oakland	Oakland	San Francisco
Pinole	Richmond	Richmond	Richmond
Pittsburg	Pittsburg	Pittsburg	Pittsburg

Table A1 continued

CITY 4	Monitoring Station Assignment		
	CO	O3	TSP
Pleasanton	Livermore	Livermore	Livermore
Pleasant Hill	Concord	concord	Concord
Ross	San Rafael	San Rafael	San Rafael
San Anselmo	San Rafael	San Rafael	San Rafael
San Bruno	Burlingame	Burlingame	Burlingame
San Carlos	Redwood City	Redwood City	Redwood City
sso Francisco	San Francisco	San Francisco	San Francisco
San Leandro	Fremont	San Leandro	Concord
San Mateo	Burlingame	Burlingame	Burlingame
San Pablo	Richmond	Richmond	Richmond
San Rafael	San Rafael	San Rafael	San Rafael
Santa Clara	San Jose	San Jose	San Joee
Saratoga	Saratoga	SaraCogs	Saratoga
Sausalito	Richmond	San Francisco	San Rafael
San Jose	San Jose	Sea Jose	San Jose
South San Francisco	Burlingame	Burlingame	Burlingame
Sunnyvale	Saratoga	Saratoga	Saratoga
Tiburon	Richmond	San Francisco	San Rafael
Union City	Fremont	Hayward	Fremont
Walnut Reek	Concord	Concord	Concord
Wooside	Redwood City	Redwood City	Redwood City

Table A2

HEALTH AND VISIBILITY DAYS BY CITY,
AVERAGED OVER 1977 and 1978

CITY	HEALTH DAYS			VISIBILITY DAYS	
	Moderate Days	Unhealthful Days	Very Unhealthful Days	Moderate Days	Poor Days
Alameda	56	1	0	57	20
Albany	80	1	0	57	20
Antioch	133	3	0	20	15
Atherton	122	2	0	67	20
Belmont	122	2	0	67	20
Belvedere	40	0	0	67	20
Berkeley	80	1	0	57	20
Brentwood	133	3	0	20	15
Brisbane	92	1	0	67	20
Burlingame	92	1	0	67	20
Campbell	130	12	2	78	47
Clayton	192	5	1	20	15
Concord	130	5	1	20	15
Corte Madera	50	1	0	20	15
Cupertino	127	3	1	78	47
Daly City	92	0	0	67	20
El Cerrito	80	1	0	57	20
Emeryville	56	1	0	57	20
Fairfax	50	1	0	20	15
Foster City	92	1	0	67	20
Fremont	144	5	0	78	47
Gilroy	158	2	0	57	20
Hayward	140	2	0	57	20
Hercules	80	1	0	20	15
Hillsborough	92	1	0	67	20
Half Moon Bay	92	0	0	67	20
Lafayette	130	5	1	20	15
Larkspur	50	1	0	20	15
Livermore	172	2	0	57	20
Los Altos	132	2	0	78	47
Los Altos Hills	132	2	0	78	47
Los Gates	130	12	2	78	47
Martinez	130	5	1	20	15
Menlo Park	122	2	0	78	47
Millbrae	92	1	0	67	20
Mill Valley	50	1	0	20	15
Milpitas	169	29	7	78	47
Monte Serano	130	12	2	78	47
Moraga	56	1	0	20	15
Morgan Hill	158	2	0	57	20
Mountain View	132	2	0	78	47

Table A2 continued

CITY	HEALTH DAYS			VISIBILITY DAYS	
	Moderate Days	Unhealthful Days	Very Unhealthful Days	Moderate Days	Poor Days
Newark	144	5	0	78	47
Novato	102	2	0	20	15
Oakland	56	1	0	57	20
Pacifica	92	0	0	67	20
Palo Alto	122	2	0	78	47
Piedmont	56	1	0	57	20
Pinole	80	1	0	20	15
Pittsburg	133	3	0	20	15
Pleasant Hill	130	6	1	20	15
Pleasanton	172	2	0	57	20
Portola Valley	122	2	0	67	20
Redwood City	122	2	0	67	20
Richmond	80	1	0	57	20
Ross	102	2	0	20	15
San Anselmo	102	2	0	20	15
San Bruno	92	1	0	67	20
San Carlos	122	2	0	67	20
San Francisco	69	2	0	67	20
San Jose	169	29	7	78	47
San Leandro	74	1	0	57	20
San Mateo	92	1	0	67	20
San Pablo	80	1	0	57	20
San Rafael	102	2	0	20	15
Santa Clara	169	29	7	78	47
Saratoga	127	3	1	78	47
Sausalito	40	0	0	67	20
South San Francisco	92	1	0	67	20
Sunnyvale	127	3	1	78	47
Tiburon	40	0	0	67	20
Union City	140	2	0	57	20
Walnut Creek	130	5	1	20	15
Woodside	122	2	0	67	20

TABLE A3
BAY AREA EMPLOYMENT CENTERS

Employment Centers	1979 Employment*
Antioch	12,038
Berkeley	58,838
Campbell	14,719
Fremont	43,103
Hayward	42,636
Livermore	15,622
Martinez	8,908
Mill Valley	6,695
Morgan Hill	2,778
Oakland	161,907
Palo Alto	37,030
Redwood City	30,134
Richmond	34,664
San Francisco	370,413
San Jose	246,246
San Mateo	41,255
San Rafael	19,235
South San Francisco	22,287
Sunnyvale	59,711
Walnut Creek	16,364

Employment data obtained from State, County and selected City Employment and Unemployment Jan-Dec 1979. U.S. Bureau of Labor Statistics, Washington, D.C. (NTIS PB-293-080 Part 1 March 1979). For Martinez, Mill Valley and Morgan Hill employment data obtained from Projections '79, Association of Bay Area Governments (ABAG) Berkeley, California (April 1979)

Table A4

Commuting Flows Distribution Matrix

Counties		1	1	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
San Francisco	1	7.8	5.1	.8	.8	.8	.3	.1	.1	--	--	.1	.3	1.5	.6	.2	--	.3	--	.2	.2
San Mateo																					
Northern	2	6.8	39.1	5.6	3.7	1.2	.8	.1	.1	--	--		.4	.9	.2	.1		.2	--	.1	.1
Central	3	8.9	24.)	35.8	12.6	3.3	1.7	.2	.s	.1	--	.1	.7	.6	.1	.1	.1	.1	--	.1	.1
Southern	4	8.9	9.4	8.7	45.3	1$.$	4.9	.5	1.2	.2	--	.1	.4	.3	.2	.1	--	.1	--	.1	.1
Santa Clara																					
Northern	5	4.J	3.3	1.?	10.6	50.8	18.4	4.1	4.3	1.1	.!	.4	.4	.1	.1	--	--	.1	--	--	--
N. Central	6	2.8	2.7	.0	5.2	20.8	45.8	1.2	12.1	1.3	.1	.4	.4	.3	.1	.1	--	.1	--	--	.1
S. Central	1	1.8	1.0	.5	2.5	10.$	28.6	25.3	15.1	2.3	--	.s	.3	.3	.1	.1	--	.1	--	--	.1
Eastern	8	1.1	1.2	.4	1.5	5.2	21.2	9.1	52.3	4.5	.1	1.5	.6	.3	.1	.1	--	.1	--	--	.1
Southern	9	.8	1.4	.3	1.4	3.5	17.3	b.1	15.2	29.8	.1	.6	.3	.2	.1	--	--	.1	--	.1	--
Alameda																					
Eastern	10	3.2	1.1	.6	.6	.6	1.9	.2	1.1	--	53.1	4.6	15.9	10.2	2.3	.4	.2	3.0	.2	--	--
South., *	11	3.1	3.4	.8	3.6	6.1	10.0	1.6	5.1	.5	1.2	36.5	17.4	● .a	1.1	.2	.1	.4	.1	--	--
S. Central	12	5.9	2.1	.6	1.1	1.4	1.7	.2	.7	.1	.2	5.1	46.4	27.2	3.0	.1	.2	.7	.2	.1	--
N. Central	13	2.1	.9	.1	.6	.6	.6	.1	.1	--	.4	1.2	9.1	00.1	10.1	1.2	.2	1.2	.1	.1	.1
Northern	14	5.6	1.1	.3	.3	.6	.7	.1	.5	--	.5	.6	4.0	16.8	39.9	5.3	. .*	1.1	.2	.1	.1
Contra Costa																					
Western	15	0.8	1.2	.)	.4	.6	.6	.1	.3	--	.1	.$	2.6	12.7	20.0	40.2	4.4	2.0	.4	1.3	.5
Northern	16	5.8	.5		.5	.1	.5	· ·	.3	--	.3	.3	1.8	7.8	9.4	22.8	21.0	15.7	4.1	.3	.3
Central	17	3.8	1.3	.4	.5	.5	.1	.1	.4	--	1.5	.5	3.5	12.6	7.3	1.0	6.2	43.4	3.5	.1	.1
Eastern	11	2.9	.2	—	.2	.2	.5	--	--	--	.1	.2	1.8	2.5	1.0	1.7	o.1	11.2	62.1	--	--
Mar 1.																					
Northern	19	14.8	1.1	.3	.3	.1	.1	.3	.2	--	.1	.1	.4	1.8	.5	.9	.1	.2	.1	41.9	13.0
Southern	20	17.1	3.3	.2	.6	.4	.1	· ·	--	--	--	--	.6	1.6	1.0	.6	.2	.1	--	14.1	Isa

TABLE AS

City Data Set
(73 Cities in 6 County Area)

Variable	Units	Description	Source
POP70	thousands	Total 1970 population	1977 City and County Data Book (U.S. Census Bureau)
POP75	thousands	Total 1975 population	1975 Statistical Abstract (Calif. Dept. of Finance)
POP75A	thousands	Total 1975 population	ABAG[1]
POP78	thousands	Total 1978 population	1978 Statistical Abstract (Calif. Dept of Finance)
GR78	percentage * 100	Percentage rate of growth of population (1970-1978)	calculated
LAND	sq. miles	1975 land area	1977 City and County Data hook (U.S. Census Bureau)
DENS	1000's of people per Sq. mile	Population density in 1975 (POP75/LAND)	calculated
TAX	$/$100 of assessed value	1977-1978 representative total tax rate	Individual County Assessor or Controller's Office
CTAX	$/$100 of assessed value	1977-78 city tax rate	1977-78 financial Transactions-Cities (Calif. Dept. of Finance)
SCHTAX	$/$100 of assessed	1977-78 representative school tax rate	Individual County Assessor or Controller's Office

1 Association of Bay Area Governments. City information from ABAG does not pertain to official city boundaries but to city boundaries with the potentially annexable areas (defined as sphere of influence).

Table A5 (continued)

Variable	Units	Description	Source
PUBEXP	thousands	1977-78 city expenditures on police, fire, civil defense and public regulation	1977-78 Financial Transactions-Cities (Calif. Dept. of Finance)
CITEXP	thousands	1977-78 total city expenditures	1977-78 Financial Transactions-Cities (Calif. Dept. of Finance)
FIRE	scale from 1-1o	1979 quality rating of fire protection based on local department and adequacy of water supply (low rating indicates better protection)	Insurance Services Office
CRIME	number	Total number of 7 major crimes reported in 1977	Calif. Dept of Justice
CRIMRA	crime per 1000 people	Crime rate (CRIME/POP78)	calculated
SCORES	percentage *100	Composite school scores (the sum of 6th and 12th grade math and reading scores from California Achievement Tests)	Calif. Dept. of Education
ENPLOY	number	Total 1975 employment	ABAG
LOCAL	number	The portion of total employment working in retail trade, professional, business services and other local serving industries	ABAG
EMPRES	number	Employed persons at place of residence	ABAG
EMR STR	percentage *100	Percentage of work trips (private vehicle and transit trips) generated and attracted to the same area	MTC
ENPOP		Employment in City divided by population (EMPLOY/POP75)	calculated
EMPRESP		Employed residents divided city residents (EMPRES/POP75)	calculated

Table A5 (continued)

Variable	Units	Description	Source
PROFP		Local serving employment divided by total employment (LOCAL/EMPLOY)	calculated
ETHNIC	percentage* 100	percentage white population in 1970	1970 Census[2]
NONWH	percentage* 100	percentage spanish and black population in 1970	1970 Census
MEDAGE	number	median age of population in 1970	1970 Census
AGE55	percentage* 100	percentage of population 65 and over	1970 Census
CHILD	percentage* 100	Percentage of families with children ages 0-19	1970 Census
HSGRDP	percentage* 100	Percentage of persons 25 and over graduated from high school	1970 Census
MEDSCH	number	Median school years completed of persons 25 and older	1970 Census
MEDINC	number	Median income of families and unrelated individuals in 1969	1970 Census
POVP	percentage* 100	Percentage of families below the poverty level in 1969	1970 Census

2 City data from the 1970 Census is derived from the aggregation of data from census tracts associated with each city. The assignment of census tracts to cities is based on the sphere of influence of the city (the city boundaries plus the potentially annexable areas) as used by the Association of Bay Area Governments (ABAG)

Table A5 (continued)

Variable	Units	Description	Source
BLUEP	percentage* 100	Percentage of employed persons 16 years and older in blue collar occupations	1970 Census
MEDOCC	percentage* 100	median number of occupants in owner occupied units	1970 Census
NEWHSP	percentage* 100	Percentage of housing units built between 1960-1970	1970 Census
UNIT1P	percentage* 100	Percentage of all occupied year round housing units which are single unit structures	1970 Census
PLUMBP	percentage* 100	Percentage of all occupied year-round housing units which are lacking some or all plumbing facilities	1970 Census
OWNOCC	percentage* 100	Percentage of all occupied units which are owner occupied	1970 Census
VAC	percentage* 100	Vacancy rate (1978)	Federal Home Loan (San Francisco) and U.S. Postal Service
TEMP	degrees	Mean daily maximum July temperature (1951-1960)	U.S. Weather Bureau and San Jose State Department of Meteorology . .

Table A6

Air Pollution **Data** (1977-78), City **Level**

Variable	Units	Description	Source
PCTOZ 1	Percentage* 100	Percent Moderate Ozone Days	BAAPCD[1]
PCTOZ2	Percentage* 100	Percent Unhealthful Ozone Days	BAAPCD
PCTOZ3	Percentage* 100	Percent Very Unhealthful Ozone Days	BAAPCD
OZHI	PPHM	High Hr. Average Ozone	BAAPCD
OZMAX	PPHM	Ave. of Daily Maximum Ozone Values (July- Sept)	BAAPCD
OZEX	Number	Number of Days with High Hr. Ozone exceeding 8 PPHM	BAAPCD
PCTCO 1	Percentage* 100	Percent Moderate CO Days	EPA[2]
PCTCO2	Percentage* 100	Percent Unhealthful CO Days	EPA
PCTCO3	Percentage* 100	Percent Very Unhealthful Days	EPA
Variable	Units	Description	Source
COHI	PPM	High 8 Hr. CO Value	EPA
PCTTSP	μ/m^3 100	Annual Geometric Mean PSI Days	BAAPCD

1Bay Area Air Pollution Control District. Variable calculated from data in Contaminant and Weather Summary, Technical Services Division.

2Environmental Protection Agency, San Francisco Region 9. Variables calculated from printout provided by EPA.

3Data summarized by the National Climatic Center (Asheville, North Carolina) for BAAPCD.

Table A6 (continued)

Variable	Units	Description	Source
AVENO2	PPHM	Hourly Ave. Concentration	BAAPCD
AVESO2	PPHM	High 24-hr. Ave Value	BAAPCD
PSIMODP	Percentage* 100	Percentage Moderate PSI Days	BAAPCD, EPA
PSIUP	Percentage*	Percentage Unhealthful	BAAPCD, EPA
PSIVUP	Percentage* 100	Percentage Very Unhealthful PSI Days	BAAPCD, EPA
VISMOD	Percentage* 100	Percentage Moderate Visibility Days	National Climatic Center, BAAPCD[3]
VISPOOR	Percentage* 100	Percentage Poor Visibility Days	National Climatic Center, BAAPCD
PS12		defined in text	SRI, based on BAAPCD

Table A7

440 ZONE DATA
(398 zones in six county area)

Variable	Units	Description	Source
DISTANCE	hundreds of miles	Distance from each 440 zone to 20 employment centers	MTC[3]
TIME	hundred of miles	Peak-hour highway times from 440 zones to 20 employment centers	MTC
CENTER	percentage* 100	Percentage of all work trips (private vehicle and transit trips) generated in each zone and attracted to each of 20 major employmentcenters	calculated
ZACRES	acres	Total land area	ABAG
UNUSE	acres	Land area precluded from development	ABAG
STREETS	acres	Land area occupied by streets and highways	ABAG
BASICA	acres	Land area occupied by manufacturing and other industry	ABAG
LOCALA	acres	Land area occupied by retail trade, professional services and other local serving firms	ABAG
RESID	acres	Land area occupied by residential housing units	ABAG
AVAIL	acres	Vacant land in industrial parks and other areas having industrial potential	ABAG
PRIME	acres	Prime available land for residential development	ABAG
SECONDARY	acres	Secondary available land for residential development	ABAG
HOUSE	acres	Total housing units	ABAG

TABLE A8

CENSUS TRACT DATA
(946 census tracts in 6 county area)

Variable	Units	Description	Source
POP	number	Total population	1970 Census
FAMC	number	Total families	1970 Census
LABORC	number	Total civilian labor force 16 and older	1970 Census
PCT65	percentage* 100	Percent of population 65 or over	1970 Census
MEDAGET	number	Median age	1970 Census
HSGRDP	percentage* 100	Percent high school graduates in population 25 and older	1970 Census
PCTPOV	percentage* 100	Percent of all families with income below poverty level	1970 Census
MEDINCT	number	Median family income	1970 Census
WHITEP	percentage* 100	Percent of all employed in white collar occupations	1970 Census
BLUECOL	percentage*	Percent of all employed in blue collar occupations	1970 Census
SERVPT	percentage* 100	Percent of employed in service occupations	1970 Census
FARMPT	percentage* 100	Percent of employed in faming occupations	1970 Census
BLACKT	number	Total black population	1970 Census
SPANT	number	Total spanish population	1970 Census
OWNOCCCT	number	Total owner occupied housing units	1970 Census
MEDOCCT	number	Median persons per unit	1970 Census
RENT	number	Total renter occupied housing units	1970 Census

Table A8 (continued)

Variable	Units	Description	Source
UNIT1PT	percentage* 100	Percent single unit structures	1970 Census
NEWHSPT	percentage* 100	Percent owner occupied housing units built between 1960-1970	1970 Census
PLUMBPT	percentage* 100	Percent occupied housing units lacking some or all plumbing facilities	1970 Census
ALLUNITS	number	Total year-round housing units	1970 Census
UNITSLT	number	Total year-round housing units for sale	1970 Census
UNITRTT	number	Total year-round housing units for rent	1970 Census
OWNOCC	number	Total occupied housing units	1970 Census
NEWHS68	number	Occupied housing units moved into from 1968 to March 1970	1970 Census
ACRES	hectares	Total tract land area	ABAG
QUAKE	hectares	Tract area in each of six earthquake zones	ABAG
NOISE	hectares	Tract area in airport noise zone	ABAG
ELEV	meters	Average tract elevation	ABAG
SLOPE	percentage* 100	Average tract slope	ABAG

TABLE A9

HOUSEHOLD DATA
(47,214 Individual Transactions)

SOURCE: SREA Market Data Center

Variable	Units	Description
TRACT	number	Census Tract Code
SALES	hundreds of dollars	Sales price
MORT	hundreds of dollars	Amount of first mortgage
SALEDATE		Sale date
LOT	Acres or Sq. ft.	Lot size
BED	number	Bedroom
BATH	number	Full and one-half baths
LIVING	Sq. ft.	Living area
AGEMOC		Year built (xx before 1900)
OTHERRM		Other rooms
	A	Den
	B	Family Room
	C	Dining Room
	D	Enclosed Porch
	E	Bonus Room
	F	Lanai
	G	Attic
	H	Florida room
	I	Atrium
	J	Other rooms
SITE		Site amenities
	A	Scenic View
	B	Ocean nearby
	C	Bay nearby
	D	Canal nearby
	E	River nearby
	F	Lake nearby
	G	Wooded area nearby
	H	Golf course nearby

Table A9 Continued

TYPE		Housing Type
	A	Single family residence
	B	Row house
	C	End row house
	D	Flat
	E	Townhouse
	F	High-rise
	G	Garden
CONS		Quality of Construction
	P	Poor
	F	Fair
	A	Average
	G	Good
	E	Excellent
	L	Luxury
COND		Quality of Condition
	P	Poor
	F	Fair
	A	Average
	G	Good
	E	Excellent
	L	Luxury
Pool		Presence of pool
	P	Unheated pool
	H	Heated pool
	E	Enclosed pool
	I	Indoor pool
Parking		Type of parking
	A	Attached parking
	B	Built-in parking
	C	Carport
	D	Detached parking
	E	Subterranean parking
	F	Off-site parking
	G	Open parking
	H	No parking
FIRE	number	Fireplaces

Table A1O

HOUSEHOLD DATA
(37,384 Individual Transactions)

SOURCE: California Department of Savings and Loan “

Variable	Units	Description
YEAR	number	Year loan closed
QUAR	1-4	Quarter loan closed
COUNTY		County Code
	6	Santa Clara
	10	Alameda
	11	Contra Costa
	12	Marin
	13	San Francisco
	14	San Mateo
TRACTSL		Census tract identifier
TYPESL		Housing Type
	1,4	Single Family Residence
	6A	Condominium with 3 or less stories
	6B	Condominium with 3 or more stories
LOAN	S	Loan amount
SALE%	S	Sales price
INTRST	percentage*	Annual percent interest rate
TERM	years	Term of loan
AGESL	years	Year built
LIVINGSL	sg. ft.	Living area
FAMINC	$	Total family monthly income
BORETH		Borrower Ethnicity
	I	American Indian
	A	Asian
	B	Black
	S	Hispanic
	W	White
	O	Other
	N	Not a person

Table A10 continued

BORSEX		Borrower sex
	F	female
	M	Male
BORAGE	years	Borrower age
BORINC	$	Borrower monthly income