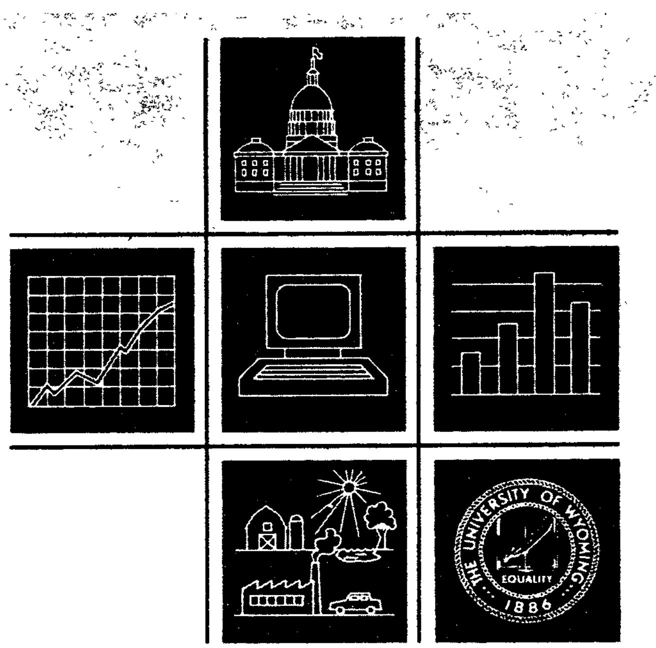
The Institute for Policy Research



. . . addressing public policy issues for the '80's.

Volume II

EXPERIMENTAL APPROACHES FOR VALUING ENVIRONMENTAL COMMODITIES

DISCLAIMER

CONTENTS

LIST OF FIGURES

LIST OF TABLES

Page

Page

CHAPTER I

OVERVIEW

A. INTRODUCTION

This study is a final report for research conducted under a grant from the U.S. Environmental Protection Agency (EPA)[1] concerning "Methods Development in Measuring Benefits of Environmental Improvements." This study replaces and extends earlier draft reports submitted to the EPA as a part of the Methods Development research project.[2]

The Methods Development project was intended to focus primarily on the development and assessment of the Contingent Valuation Method, referred to hereafter as CVM (or CV for contingent valuation), as a means for estimating social benefits attributable to environmental improvements. The CVM involves a process whereby individuals--study participants--are asked to place values on specific environmental improvements within the context of a contingent market. Valuations offered by study participants are referred to as a "bid" for the environmental improvement; the specified environmental improvement is referred to as an environmental "commodity," or the CV commodity. The study participant "sees"--has described to him/her--a particular good or service and is asked to offer a bid for this commodity which represents his/her maximum willingness to pay for that commodity; in some cases, a process of continuous bidding takes place as a part of the CVM.

Interest in the CVM as a means for valuing environmental commodities arises from the nature of such commodities: actual markets do not exist for these commodities and, therefore, market values which reflect social values do not exist for these commodities. The essence of the CVM is that of simulating market conditions, thereby deriving measures that are akin to those observed in actual markets.

Inasmuch as values derived from the CVM are for contingent claims in a hypothetically specified state of the world to a specific environmental commodity, and given that bids are not in fact "paid"--payments of CV bids are hypothetical in nature--a number of questions arise as to how meaningful or reliable CV measures can be vis-a-vis "true" social values attributable to environmental improvements. Of course, these questions, which are discussed below in some detail, provide the raison d'etre for this study. Before turning attention to the purposes of this study, however, brief mention is warranted of two issues: the relationship of this study to earlier, draft reports and, secondly, the authors' intentions for the Overview section of this report.

In a final report, one generally finds little more than a "cleaning up" of the data and presentations given in draft reports. Such is not the case here. Basic to the Methods Development project has been a heuristic process: discovery, learning, efforts intended to provide data and insights which might guide further investigation. This process has continued through the preparation of the final report. Thus, in earlier reports concerning research progress, expositional emphasis was given to the manner in which individuals must search their preferences in arriving at meaningful contingent values. As the authors have attempted to push the discovery process further, it has become evident that experiments related to "preference research" have broader implications of importance for the validation of CV measures: they provide means by which CV responses can be compared with observed, or deduced, market-related responses which reflect the preference research process. In this final report, therefore, concern with market comparisons replaces--subsumes--our earlier studies' concern with preference research per se. As a further example, in earlier progress reports expositional emphasis was given to possible relationships between how a commodity was defined--specified--and the level of aggregation implicit to a given commodity. As the learning/discovery process has continued, considerable progress was made in understanding and clarifying these relationships. The critical importance of distinguishing between many types of aggregation became manifest. The parallel between Lancaster-type "attributes" of goods and ends soughts in specifying CV commodities, and the potential of this parallel for providing criteria for "specificity," became well understood, Thus, this final report includes the authors' "final" efforts to shape and improve the logic underlying hypotheses design and data interpretation.

All of the above is intended to encourage readers of earlier, draft reports concerning the Methods Development project to consider the final report in a different light from the usual: the effects of restructuring data and hypotheses in the final report provide, in many cases, insights as to the workings of the CVM that may be as important for cur understanding of the method as "new" experimental results.

Finally, the Overview section of this report is designed to provide the reader with more than simply a comprehensive summary of results from all experiments in the Methods Development project. In addition to a report of research accomplishments, discussions will be given to non-accomplishments. This is to say that the efforts to respond to a given set of questions/issues concerning the CVM, the authors have encountered still more issues and questions which were unrecognized or obscure at the time that the project was initiated. Thus, for a report on experimental, heuristic research such as this study, an open discussion of unresolved issues which remain as (often, frustrating) challenges to researchers concerned with the CVM will hopefully be of interest to the reader. Therefore, the Overview section is lengthy. It is hoped that the readers patience in this regard will be rewarded by a comprehensive grasp of the lessons learned by the authors as those lessons related to an assessment of the CVM's potential for serving as 2 method for valuing environmental improvements.

A.1 Purpose of the Study

As suggested above, the purpose of the Methods Development project is that of developing and assessing the CVM as a means for estimating benefits attributable to environmental improvements. By "development" reference is made to heuristic inquiry as to methods for obtaining CV values, problems encountered in framing CV instruments, and methods for assessing and validating CV measures as meaningful measures of society's willingness to pay for environmental improvements. To these ends, a group of experiments (described below in sub-section A.2) is designed in efforts to address the following, four sets of issues.

Validation Issues. Three methods which are relevant for efforts to validate CV measures are developed and applied in this study. The first method involves comparisons of CV measures for the value of an environmental improvement (reduced ozone concentrations in the Los Angeles, California area) with those derived by the Hedonic Price (Property Value) method.

The second effort to validate CV measures involves tests of heuristic hypotheses based on individual market behavior deduced from received economic theory as well as from observed behavior in auction settings. Thus, in an auction setting, an individual's valuation for a commodity (or service) to be auctioned may, initially, be imprecisely defined in terms of a maximum willingness to pay. A low, initial bid is offered for at least two reasons: rent (or consumer surplus) is maximized by paying the lowest possible price; secondly, an individual's initial preference search may only define a range of values "appropriate" for the good in question; only as the auction--bidding--proceeds does it become necessary for the process of preference research to focus sharply on a maximum willingness to pay. This is not to deny the possibility that some individuals may initially determine their maximum willingness to pay; however, this value is made manifest only through the bidding process. Thus, one market-like test draws on the analogy between the valuation process observed in the auction setting and that relevant for valuing environmental commodities within the context of a contingent market. At issue in the test are heuristic hypotheses related to the question: is individual behavior in the CVM consistent with behavior observed in auction settings?

It should be noted that the notion of consumer uncertainty as to his/her valuation of any given commodity may not be limited to the auction setting, nor is it new in the economics literature. In 1936 Georgescu-Roegin introduced the concept of a "demand penumbra,"[3] which he more recently defines as "...a stochastic distribution of the quantity demanded at every price."[4] Georgescu-Roegin argues that consumers are imperfect as decision (choice) making instruments--that choices are made stochastically. The existence of thresholds in utility comparisons results in a range of indeterminateness vis-a-vis an individuals choice of the quantity desired of a good, given the goods' price.[5] Thus, the arguments given above represent the "inverse" of Georgescu-Roegins' arguments concerning the demand penumbra: there exists a range of indeterminateness vis-a-vis an individual's price (valuation) of a good, given the "quantity" (extent of environmental change) of the good.

Another market-related test of CV measures draws from the theory of consumer behavior. From received theory, individual valuations of goods and services reflect a consideration of trade-offs imposed by a budget constraint--additional purchases of any one commodity implies, with fixed income-- lesser purchases of some other commodity(s) (or reduced savings). At issue in this market-related test then are hypotheses directed at the question: In offering CV bids, are individual cognizant of reduced expenditures on other, private, market goods implied by the budget constraint?

A third, and final, market-related test of CV measures again draws on received theory of consumer behavior. Given an individuals' allocation of income across a fixed consumption set, axiomatic behavioral responses to a change in the consumption set exist. Thus, given that consumption sets are altered, there also exists a basis for designing testable hypotheses to look for market-consistent behavior of individuals (in offering contingent values for an environmental good). In these regards, experiments are then conducted where consumption sets are altered via the introduction of other environmental and public goods. The effects of such alterations on contingent values provide data for hypothesis testing as to effects which are consistent with market behavior.

The third method used in this study in efforts related to the validation issue involves analyses of preference effects on CV measures. Thus, based on a priori reasoning one can deduce the expected relationship between CV measures and the characteristics of study participants. Characteristics of interest include household income, whether or not children are in the household, education, etc. Hypotheses relating bids to characteristics are tested in efforts to assess the consistency of CV values with preference-related characteristics which are deduce a priori.

Aggregation Issues. The second set of issues considered in this study relate to aggregation. There are many kinds of aggregation which may be relevant for assessments of the CVM; in this regard, the following, four classes of aggregation warrant mention.

(1) Aggregation over "attributes." Following Lancaster,[6] any good X can be described in terms of a vector of utility-satisfying attributes Y_i, $X : (Y_i, \ldots, Y_n)$. Attributes of the commodity "a house" may include: bedrooms, bathrooms, security, prestige, as well as site-specific attributes such as air quality, neighborhood quality (crime rates, etc.) and distance to shopping centers. A second example, which will be of interest in this study, is the commodity: preservation of visibility (via preserved air quality) in the Grand Canyon National Park. Attributes of this commodity and, therefore, values subsumed in a "preservation bid" (an individuals maximum willingness to pay for preserved visibility in the Park), may include: user values, option values, existence values and bequest values.

(2) Aggregation over commodities. As something of an extension of the "attributes" argument, for some purposes it is useful to think about aggregation over commodities. Thus, the budget analyst may work with the commodity "food" which has as its components the commodities bread, milk, fruit, etc. The commodity "air quality in the U.S.," will include the commodity "air quality (visibility) in National Parks" which, in turn, includes the commodity "air quality (visibility) in the Grand Canyon National Park" (which may include a commodity: visibility at Hopi Point in the Grand Canyon National Park).

Before continuing to other types of aggregation, it is important for the reader to fully appreciate the implications of (1) and (2) for assessments of the CVM. These aggregation issues pose an important, and thus far unanswered, question relevant for efforts to derive and interpret CVM measures of social values attributable to environmental improvements, viz., for a public good such as an environmental improvement, what is an "appropriate" commodity for use in CV studies? In other words, how do people think of environmental "goods"--in terms of subjective valuations, can (do) individuals distinguish between (as examples): visibility in the Grand Canyon National Park, visibility in all National Parks or national air quality; reduced environmental risk (to health and safety) from hazardous waste disposal, reduced environmental risk from all possible causes (e.g., air/water pollution) and reduced mortality/morbidity risks per se (from, as examples, cancer, air travel, heart disease, etc.). These questions related to the "mental accounts" notion, discussed below in sub-section A.3, which suggests that individuals may make subjective valuations for groups of commodities (entertainment, food, etc.) rather than for specific commodities (a movie, a loaf of bread, etc.).

The critical importance of this set of aggregation issues for assessments of the CVM is made manifest by the following. Suppose that a CV measure is obtained for the following three commodities: visibility in the Grand Canyon National Park; improved (or preserved) water quality in all of the nation's lakes, rivers and streams; the total containment of hazardous (toxic) wastes; denote the corresponding willingness to pay measures obtained from the CVM as V_G, V_W, and V_H, respectively. If, e.g., V_G is to be used as a measure of social benefits attributable to a policy to improve air quality in the Park--in the sense that it is to be compared with all costs associated with the policy--it must be the case that V_G does indeed measure individual valuations for this specific commodity; similar arguments hold for V_W and V_H. But this implies that V_G, V_W and V_H can be summed--if i = 1, . . ., n denotes all possible kinds of environmental improvements, the sum of derived CV measures for these improvements, $\sum_{i=1}^{n} V_i$, would measure the aggregative social value for improving "the environment." In contrast, suppose that in offering a contingent value for preserved visibility in the Grand Canyon National Park, the individual thinks of this "commodity" in terms of visibility in all Parks, national air quality or environmental quality in the aggregate. In this case, V_G (or, for that matter, perhaps V_W and/or V_H as well) will measure $\sum_{i=1}^{n} V_i$, the aggregate rather than the specific commodity.

The question as to whether CV bids for a specific environmental improvement are disaggregative values or, in fact, are more likely values associated with some broader, environment (or "good cause")-related, aggregative "account" raises an issue of particular concern given that (to our knowledge) no researcher would be willing to defend the summation of CV values that have been obtained in various studies for many types of environmental effects; indeed, the summation of average CV values for public goods thus far available in the literature would exhaust the budget of the average individual. The bottom line then becomes apparent: if one cannot sum--aggregate--commodity-specific CV values, how does one interpret the value? Put another way, if one cannot aggregate over commodity-specific CV values, one must then determine that "commodity" for which the obtained value is relevant--one must determine that minimum level of aggregation at which individuals can meaningfully differentiate (in valuation terms) between commodities.

Given the obvious need for insights as to the commodity-aggregation issue demonstrated above, this issue will be given a great deal of attention in this study. Methods used to study this issue are detailed in subsection C. Attention is now returned to a consideration of still other types of aggregation.

(3) Aggregation over geography. In most cases, the EPA's ultimate interest is in measures of national benefits attributable to environmental standards which are nation-wide in scope; examples include ambient air quality standards and national regulations pertaining to hazardous waste disposal. Benefit estimates for improved water quality in (e.g.) the Rio Puerco in New Mexico are of little relevance in this regard unless one assumes that household benefits for all other lakes, rivers and streams are in some sense identical to those obtained for the Rio Puerco--an assumption that is hardly palatable. Moreover, one would ideally want valuations of improved water quality in the Rio Puerco from all residents in the U.S. as well as the Rio Puerco area residents' valuation of improved water quality in all other areas. Thus, unless one wishes to apply the CVM in every community in the U.S., one's interest is focused on means for generalizing CV measures obtained in one or more geographic areas to the U.S. as a whole. The issue of interest then is the extent to which site-specific variables are significant in explaining individual's formulations of contingent values for given environmental commodities. This issue is examined as a part of this study.

(4) Aggregation over individuals. Related to (3) above, national benefit estimates for environmental improvements requires the aggregation--summation--of individual values for the environmental inprovements, If one accepts, as is common, the appropriately summed,[8] maximum willingness to pay of individuals as a measure of social benefits, one follows established econometric procedures for obtaining significant determinants of CV bids (the most important of which is, generally,

household income), the results of which are used for the process of aggregation, ceteris paribus.

The importance of aggregation over individuals lies not in methods for such aggregation, but in the interpretation of average bids which result from aggregation, however accomplished. In virtually all studies based on the CVM, average values for the CV commodity in question have associated with them variances which are typically quite large. The variance in CV measures is most often as large, or larger, than the mean itself--it is not unusual to find variances in mean CV values that are 200 percent to 300 percent of the mean. Some scholars are troubled by experimental results which produce large variances such as those that typify results from CV studies.[9] The rationale for this concern with large variances is puzzling to the authors of this report for the simple reason that, in aggregating over individuals, one would expect large variances except in cases where one has reason to believe that individuals will have identical (or similar) preferences/tastes for the commodity in question. If, for any commodity, individuals have different tastes vis-a-vis the commodity, these differences will be reflected in large variations around a mean value. If one were studying the consumption of green beans, one would surely expect considerable variance reflecting differing tastes for the commodity; the same logic, and therefore expectations, would seem to apply to individual valuations reflecting tastes for environmental commodities.

Perceptions of CV Commodities. The third set of issues which are examined in this study concern the manner in which individuals perceive the CV commodity. The commodities used in CV studies are not tangible commodities, rather, the CV "commodity" is actually a description of a posited change in the study participants environment. Therefore, it becomes most important that individuals have the same perception of the commodity which is offered in the contingent market--all study participants must "see"--bid for--the same commodity.

The perception issue is considered in this study within the context of two classes of environmental commodities. The first class consists of an environmental commodity which is strongly associated with risk and uncertainty, viz, and EPA regulation on the disposal of hazardous wastes. If hazardous wastes are not contained--i.e., they are allowed to enter the environment--a potential risk/threat to public health and safety exists. There is considerable uncertainty as to the nature of the risk, however. Indeed, in considering, e.g., any hazardous waste containment policy imposed by the EPA, risk/uncertainty, expressed interms of probabilities, enter the problem in at least three related ways: the probability of containment; the probability that health or other environmental damages will occur given non-containment; and, perhaps subsumed in the above, the probability that a given containment is, in fact, effective.[10]

More is involved here, however. Ideally, the relevant environmental improvement--our CV commodity--would be the change in environmental risk associated with an EPA policy. Given the present state of knowledge, one can define neither risks associated with current waste disposal policies nor, obviously then, changes in risk associated with an EPA policy. In the latter regard, a possible exception would be a "total containment" policy which, ceteris paribus, would eliminate (subject to the third probability cited above) all existing risks, whatever those risks might be. Since one cannot define those environmental risks, changes in risk cannot serve as the commodity in a CV study.

One way around this problem might be to use the EPA policy itself--couched in terms of a hedge against uncertain risks--as the CV commodity; experiments with this approach are conducted in this study. This approach cannot be totally satisfactory for an obvious reason, however. Given individual bids for a total containment policy, for example, and ignoring for the moment the "effectiveness" problem, such bids will measure the desired valuation for a hedge against risk as well as (undesirable) individual perceptions of the risk level against which the policy "hedge" is to operate. If the CV commodity is a hedge, the relevant question becomes: a hedge against what? With "what"--current risk levels--unspecified, bids must vary according to individual perceptions of "what" the hedge is to affect.

Acknowledging this weakness in using the EPA policy as a CV commodity--discussions of conceptual issues related to this problem are extended below in subsection A.4--the "policy bid" approach serves as a basis for a number of what the authors regard as interesting experiments in terms of providing insights to guide future research. Of particular interest in these experiments is the manner in which the policy commodity is perceived by study participants. Two sets of experiments are conducted in this regard. The first set will involve efforts to test hypotheses which relate CV bids to changes in the probability of containment as well as to changes in the probability of damages in the non-containment case. The second set of experiments will involve the structuring of individual "bid curves" which are then compared with the structure of bid curves drawn from axiomatic propositions (see Appendix A for discussions of these theoretical propositions).

The second class of commodities which are examined in terms of individual perceptions consist of environmental improvements for which risk and uncertainty are not major characteristics, viz., preserved visibility in the Grand Canyon Rational Park, and air quality improvements (reduced ozone levels) in the Los Angeles area. For this class of commodities, the "bid curve" analysis referred to above is used in efforts to speak to the perception issue.

We must acknowledge that this second class of goods is not necessarily free of uncertainties or risk considerations. In the case of the national parks visibility experiments, Desvousges and Smith[11] argue that the relevant CV commodity is not a particular level of visibility, but a probability of encountering a given level of visibility such time as an individual visits an area. Thus, bids for a "certain" change in visibility may be, in fact, a bid for an individuals perception of a change in the probability of access to a particular environmental condition (visibility level); in such cases, one encounters the problem of distinguishing between valuations and perceived probabilities reflected in contingent values, noted above in the hazardous waste problem.

While Desvousges and Smith's (D-S) "access" argument has pedagogical appeal, one must wonder if it does not impute to individuals a mental, valuation process that is extraordinarily unwieldly. When asked to choose between two average levels of visibility, would, in fact, an individual translate this choice into the probability of encountering one or the other visibility level on his/her future visits, or would he/she accept that one or the other levels would be encountered with certainty? The authors are unaware of data that would establish either position. If on nothing more than eclectic grounds, however, the authors find the latter position intuitively appealing and adopt its use in this study. To the extent that individuals do indeed base their offered, contingent values on the numerative, "access" model of D-S, the CV values will be subject to the weaknesses ascribed to them by D-S.

There is still another potential source for risk and uncertainty to enter valuations for our second class of commodities. Related somewhat to the attribute-aggregation issue described above, as well as to the mental accounts notion discussed below in subsection A.3, we do not understand precisely how individuals perceive questions related to specific kinds of (or effects from) environmental quality improvements. It may be the case, for example, that individuals, when asked to value preserved visibility, think of air quality as a gestalt which includes many effects: visibility, as well as mortality and morbidity. Similarly, the ozone experiment, described below, stated effects are related to morbidity, but mortality and visibility effects may be reflected in the bid. Thus, perceptions of effects and relevant probabilities of effects, that individuals may attach to posited environmental changes may underlie contingent values.

Other Experimental Issues. The final set of issues addressed in this study include the following. First, experiments are designed to determine the effects of cost information on contingent values. Related to the commodity-aggregation issue, an individuals offered bid for an environmental improvement is, theoretically, made within a context which includes consideration of current outlays for environmental goods. In other words, the contingent valuation must be an expenditure for a marginal change in the existing environmental state. The extent to which CV measures are appropriately "marginal" in this sense is the topic of this set of experiments.

A final issue considered relates to solicitation modes for acquiring CV measures. In this regard, CV results from mail, door-to-door, and pre-arranged interview modes are compared. Motivation for this set of experiments is provided by the markedly different costs of administering the CV study by these modes: mail is much cheaper than door-to-door which, in turn, is much cheaper than the pre-arranged interview mode.

In summary, the purpose of this study is to examine four, broad sets of issues which the authors regard as being particularly important for efforts to develop and assess the CVM as a means for valuing environmental changes. The vehicle for these examinations is a set of experiments which is described in the following subsection. The discussion of experiment designs in subsection A.2 is followed (subsection A.3) by a discussion of the relationships between these experiments and those reported in other works. Conceptual and sampling issues which are relevant for the study's experiments are discussed in subsection 8.4, after which (subsection A.5) the plan of the study (and the balance of Chapter I) is described.

A.2 Design of Study Experiments

In this sub-section, attention is focused on the design of experiments used in this study as a means for accomplishing the study purposes described above in A.1. We begin by setting out criteria used in selecting CV commodities to be used in the study; after which the specific experiments are described. To avoid unnecessary clutter in this Overview section, only the essential elements of each experiments' design is described here; greater detail is given in later sections of the report. This sub-section concludes with a summary wherein each experiments' contributions to study purposes are reviewed.

Choosing the CV Commodities. The authors' choice of CV commodities reflects, a one might expect, the major ends (purposes) sought in the study. The greatest challenge in terms of commodity selections was posed by Purposes 2 and 3: Aggregation Issues and Perceptions of CV commodities. For these purposes, it was necessary to have a mix of commodities consisting of: differing levels of aggregation over attributes and commodities; differing mixes of risk and uncertainty; differing standards by which individual perceptions of the CV commodity might be assessed.

For obvious reasons, it would be most difficult to design a single commodity which would allow for comprehensive analyses of all issues included in the study purposes, thus the need for a mix of commodities. Consideration of these purposes lead to the selection of the following commodities to be used in the study.

The first commodity is: preservation of visibility in the Grand Canyon National Park. Bids for this commodity can be argued a priori as an aggregation of values associated with four, specific commodity attributes: option, user, existence, and bequest values. Further, this commodity is readily amenable to extensions to higher levels of aggregation; other regional National Parks--all National Parks--national air quality levels.

The second commodity is: Improvements in National Water Quality. Choice of this commodity reflects three considerations. First, it serves as an example of a commodity which represents three levels of aggregation; aggregation over attributes (swimming, fishing, boating, etc.) commodities (site specific lakes, rivers and streams), and geography. Secondly, it is amenable to still further aggregation; national water and air quality. Thirdly, its use as a commodity in an earlier study[12] provides useful data for comparative and validation analysis.

The third commodity is: an EPA-imposed "total containment" policy (regulation) for (on) hazardous waste disposal. This commodity is included for two major reasons.[13] First, it is representative of a broad range of potential environmental changes which involve indirect and uncertain environmental risks; other examples include policies which affect air quality-related mortality, nuclear power plant siting, nuclear waste management and CO_2 accumulations in the upper atmosphere. Secondly, it represents a commodity which is amenable to aggregation with other commodities and over geography.

The fourth and final commodity used in the study is: reduced ozone levels in the Los Angeles area. This commodity was chosen based on the following considerations. First, air quality in general is a reasonably well understood "commodity" in the Los Angeles area--residents are well aware of differences in air quality in different parts of the Los Angeles area. Effects of one component of "air quality"--ozone levels--can be differentiated and defined with a considerable degree of clarity. Further, reasonably good historical data exists for ozone levels in this area. Secondly, use of this commodity provides an exceptional opportunity for testing the consistency of contingent values with relevant, individual behavior as such behavior relates to the "perception" issue. If individuals do, in fact, perceive the effects of ozone levels as they are described in the CV study, measures for an individuals' elasticity of substitution of income for reduced ozone levels should be consistent with individual choices of residence: one would expect a concentration of individuals with small (large) elasticities in areas with high (low ozone concentrations. Finally, the authors' earlier property value studies in the Los Angeles area provided a relatively inexpensive data base which could be used for <u>one</u> aspect of the studys' validation purposes; viz., the derivation of hedoic (property value) prices for reduced ozone concentrations which can be compared with values drawn from the CVM.

With the above described choices for CV commodities, attention can now be turned to an overview of the studys' experiments. For each experiment, a sketch will be given for the following for characteristics of the experiment design; the experiments are described in greater detail in section II - V of the report.

(a) Description of the commodity: how the commodity is described to study participants.

(b) Payment Vehicle: the method by which contingent payments are to be "paid" in the experiment.

(c) Method for obtaining initial bids.

(d) Values obtained: "willingness to pay" questions asked and values obtained in the experiments. Within each major experiment, sub-experiments make use of differing combinations of these questions. All average values are income-adjusted.

(e) Location of the CV study(s).

The National Parks Visibility Experiment (Visibility Experiment).

(a) Describing the commodity: study participants were shown a rather elaborate set of photographs depicting differing visibility levels (levels A, B, C and D) at selected vantage points in the Grand Canyon National Park (GCNP; see Figure 2.1 in section II). Referring to the photographs, individuals are asked willingness to pay questions for preserving current visibility conditions (Level C in the photographs) rather than allow them to deteriorate to the next worst level, Level B in the photograph.

(b) Payment Vehicle: higher electric utility bills. This vehicle was chosen given participants general familiarity with (i) the fact that their major source for electricity is power plants in the Four Corners area, in close proximity to the GCNP; (ii) the publicized fact that pollution abatement equipment for power plants adds to electric bills.

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB: initial, "starting" bid from Payment Card for preserving air quality in the GCNP.

MB: "maximum" bid obtained via a bidding process ("would you pay $1.00 more, etc.")

SBY: starting bid for the commodity when individuals are asked, prior to the bid, to indicate their monthly take-home income, its allocation over expenditure categories, and which expenditure category will be reduced in order to facilitate payment of the bid. The letter Y indicates bids obtained within the context of this budget information.

MBY: the "maximum bid" obtained within the context of the individuals budget, as above.

AMB: an "adjusted" maximum bid (MB). The individual is asked if he/she wishes to change--adjust--the MB value given that he/she might wish to pay some amount for a different environmental change: air quality improvements in the Denver area (the location for the experiment).

SBG(Y); MBG(Y): "starting" and "maximum" bids (SB, MB) (with and without use of the budget context, Y) for preserved air quality in the GCNP (identified by G) when the participant is asked to simultaneously give his/her maximum willingness to pay for preserved air quality in five other National Parks in the Rocky Mountain region (Zion, Bryce, Mesa Verde, Glen Canyon and Canyonlands National Parks); i.e., the study participant offers a contingent value for preserved visibility in the GCNP (SBG(Y), MBG(Y) values) and a separate contingent value for preserved visibility in the other five National Parks.

SBR(Y); MBR(Y): From the above, starting and maximum bids (with and without use of budget context) for preserved visibility in the five, regional (denoted R) National Parks.

AMBG(Y), AMBR(Y): Maximum bids (MB, with and without use of budget context, Y) for preserved visibility in the GCNP (G) and in the five Regional (R) parks which are "adjusted" (denoted A) by the individuals' consideration that he/she might wish to pay some amount to preserve visibility in all other National Parks in the U.S.

SB-C (UV, OV, EV, BV): SB-C is the starting bids for preserving visibility in the GCNP--obtained in the "component" experiment (C); this value is identical to the SB; referred to above in other experiments. Individuals are asked to indicate that part of this SB-C value that is seen by him/her as appropriate for a user value (UV), option value (OV), existence value (EV) and bequest value (BV).

(e) Location of experiments: Denver, Colorado.

The National Water Quality Experiment.

(a) Description of the commodity: after a brief discussion of water quality problems in the U.S., the individual is shown a "Water Quality Ladder" (Figure 3.1 in section III), which shows five alternative levels of water quality. Water quality ranges from a best level, which may serve drinking water, swimming, game fish habitat and boating purposes, to a worst level which can serve none of these purposes. Willingness to pay questions relate to an improvement in national water quality from current levels (Level C, which serves boating and game fish habitat purposes only) to the next highest level (Level B, which serves boating, game fish habitat and swimming purposes).

(b) Payment Vehicle: higher taxes and/or higher prices for goods and services.

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB: initial, "starting" bid from payment card.

MB: "maximum" bid, which results from the bidding process.

SBY: starting bid obtained with the budget context described above.

SBY-W; SBY-A: individuals are shown an "Air Quality Ladder" (Figure 3.3 in section III) identical inform to the above-described "Water Quality Ladder," along with the Water Quality Ladder. Starting bids, using the budget context (SBY), are simultaneously obtained for a Level C to B improvement in national water quality (as above, denoted SBY-W) and a Level C to B improvement in national air quality (SBY-A).

SB(Y)-WA: A single starting bid (with (SBY) and without (SB) use of the budget context) is obtained for the combined (aggregated) commodity: Level C to B improvements in national water and air quality.

(e) Location of experiment: Denver, Colorado.

The Hazardous Waste Experiment (Policy Bid Experiment).

(a) Description of the commodity: Following a discussion of problems associated with the disposal of hazardous wastes, the nature of uncertainties surrounding risks associated with hazardous waste disposal is explained to the study participant. The following "horns of the dilemma" is stressed. We can impose more stringent regulations today, and accept the associated costs, and later find that: (i) the action was justified, real risks associated with hazardous waste disposal warranted the costs, or (ii) the action was not justified, the severity of the problem did not warrant the costs paid. Alternatively, we can not regulate "today," and later find that: (i) the action (no regulation) was justified, real risks were not serious enough to have warranted the costs, or (ii) the action was not justified--we should have regulated--the lack of regulation has exacerbated risks. Thus, regulation "today" in the face of existing uncertainties takes the form of a "hedge" against potential health threats. The willingness to pay questions relate to the imposition of a "total containment" policy (regulation) by the EPA.

(b) Payment Vehicle: higher taxes and/or higher prices for goods and services.

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB(Y): starting bid for a totally (100%) effective containment policy, with (Y) and without use of the budget context.

MB(Y): "maximum" bid for a totally effective containment policy derived via the bidding process, with (Y) and without use of the budget context.

FB: the maximum bid (MB) for a containment policy that is but 50% effective in containing hazardous wastes (as imposed to 100% effective for all other values).

SB_I, SB_{II}: SB_I is identical to SB; starting bids are obtained for the totally effective containment policy where, as a part of the discussion of hazardous waste problems (part a above), potential threats to the environment are described, but examples of actual occurrences of cases where hazardous wastes have eaten the environment (and resulting effects) are not given to the study participant. In a sub-experiment, a group of participants are given examples of such cases; SB_{II} denotes this groups' starting bid.

AMB: the "adjusted" maximum bid. After obtaining MB, individuals are allowed to adjust--change--their own bid in light of the fact that there are other sources of environmental risk (5 are discussed), more stringent regulations for which would require that they "pay" more in the form of higher taxes and/or higher prices for goods and services.

AMB-1: the adjusted maximum bid as above; in discussing other "goods," however, discussions focus on the 5 environmental goods (as for AMB) and 2, non-environmental public goods: improved national defense and improved highway safety.

SB-A: for one major sub-experiment, the discussion of other environment goods, which in other experiments follows the elicitation of MB, takes place prior to the elicitation of the starting bid--the "other goods" discussion precedes willingness to pay questions rather than occurring at the end of the valuation sequence whereby one obtains SB, the MB, then AMB. Starting bids obtained within the context of discussing other goods is denoted SB-A. One should note that all SB-A values are obtained with the use of the budget context.

SB-AC: for this sub-set of the study participants from which SB-A values are elicited, prior to obtaining the SB-A valuation, individuals are told the average amount that households in their income class now pay, in taxes and higher prices for goods and services, for the existing state of EPA regulations (air, water quality standards, as well as existing regulations on hazardous waste disposal).

(e) Location of experiments: Albuquerque, New Mexico; Houston, Texas and New Haven, Connecticut.

The Ozone Experiment - CVM.

(a) Description of the commodity: the potential sub-clinical health effects of various levels of ozone concentrations are discussed with study participants --individuals are reminded of a "memorable day" when Los Angeles residents experienced a peculiarity in ozone levels: just before and during the 1982 Labor Day Weekend (which received widespread news average given its coincidence with the U.S. Festival, a major outdoor concert). Participants are then shown a graph (Figure 4.1 in section IV) depicting actual, daily ozone concentrations in their area during selected weeks in August and September, 1982. Four concentration levels (Good, Fair, Poor, Very Poor) are identified on a "ladder" along with possible morbidity and "discomfort" effects associated with each concentration level. Willingness to pay questions relate to reducing ozone concentrations, on a day at which "peak" ozone concentrations might (have) occurred in the individuals' community, from Poor (or Very Poor, depending on the individuals neighborhood) to Fair (or to Good).

(b) Payment Vehicle: higher prices (with emphasis on higher operating costs for vehicles due to pollution abatement equipment).

(c) Method for obtaining initial bids: Payment Card.

(d) Values obtained:

SB-(•)(•): Denoting ozone concentration levels as A (Good), B (Fair), C (Poor) and D (Very Poor). Starting bids are obtained for various changes in ozone concentrations, e.g., from D to B or from D to A, which are then denoted SB-DB and SB-DA, respectively.

ACT: An index of level of participation in outdoor activities.

TEN-R: length of time (tenure) that the individual has lived at present residence.

TEN-LA: length of time (tenure) that the individual has lived in the Los Angeles area.

(e) Location of experiment: two communities in each of the San Gabriel Valley, San Fernando Valley, and Coastal Orange County areas of the Los Angeles Basin.

The Ozone Experiment-Hedonic Property Value Study

Along with the contingent valuation experiment, a hedonic property value study was conducted. The principle objective was to attempt to isolate the effect of ozone on property values as opposed to a general effect of air pollution which has been obtained in several previous studies. Thus, the objective was to regress home sale price against home attributes (e.g., square feet, bathrooms, fireplaces, and swimming pools), community attributes (e.g., school quality, crime and distance to work and beach) and air pollution variables (TSP or extinction coefficient and ozone) to determine the impact of each attribute with special emphasis on ozone. This would conceptually allow a comparison of the value of reduced ozone concentrations as capitalized in home sale price with survey bids obtained from the CVM method. The location of the study incorporated home sales in the entire Los Angeles Basin.

For reasons outlined earlier, each of the four major experiments sketched above are used in efforts to analyze various sets of the issues which relate to the intended purposes of the Methods Development project. By way of a summary of this sub-section, Table 1.1 sets out the intended contribution of each major experiment to each of the sets of issues that form the study purposes.

TABLE 1.1

OVERVIEW OF THE CONTRIBUTION OF STUDY EXPERIMENTS TO STUDY PURPOSES

Experiment	Validation Issues	Aggregation Issues	Perceptions of CV Commodities	Other Experimental Issues
The National Parks Visibility Experiment	X	X	X	
National Water Quality Experiment	X	X		
The Hazardous Waste Experiment	X	X	X	X
Ozone Experiment	X		X	X

A.3 Relationship to Other Studies

The Methods Development project draws, in one way or another, on a number of earlier works that relate to assessments of the CVM. No attempt is made here to review all of these earlier works. Three of these are of particular importance for the present study and warrant mention, however.

The first work that should be mentioned is that by Kahneman and Tversky.[14] In that work it is suggested that, in making assessments of valuations, individuals' think of goods and services in terms of "groups" or accounts" of goods and/or services; i.e., individual "mental accounts" are relevant entities in valuation decisions. As an example, rather than allocating $100.00 to a movie and $20.00 to a night of bar-hopping, the individual would allocate $30.00 to an "entertainment account.

Other than noting that observations of individual behavior suggest decision-making processes within a mental account framework, Kahneman and Tversky do not pursue this notion further. Unanswered are a number of critical questions if the mental accounts notion is to be tested empirically to the end of developing meaningful axioms concerning individual behavior. As examples of these questions: what determines the composition of any one account--are accounts hedonic in nature (pleasure, pain, safety, etc.), or perhaps, functional (housing, transportation, food, etc.)? Is the structure of accounts more or less the same for all individuals? Are "account" lines more or less rigid--i.e., with but $10.00 in the entertainment account, and faced with the desirable opportunity to attend a concert costing $20.00, may not the individual reallocate income <u>across</u> account lines and, if so, what is the <u>meaning</u> of an account?

Given that the mental accounts notion is just that--a notion, an intuitive argument--at this point in time, it could be tempting to dismiss the notion as a curiosity. There are, however, a number of perplexing problems encountered in efforts to assess results from the CVM which <u>could</u> be explained by the mental accounts notion. Moreover, the implications of the mental accounts notion for the CVM, should the "notion" turn out to be substantive, are of such a large order of magnitude that one should be hesitant in dismissing it out of hand. These two arguments are briefly developed in the following.

In terms of earlier CV studies, one of the most serious problems with the CVM which begs for resolution concerns the <u>additivity</u> of CV measures. Thus, let $V_1, \ldots, V_n$ be CV measures from a n-different CV studies focusing on n-different commodities (clean air, lower ozone levels, cleaner water, preserved wilderness areas, hazardous waste management, preserved visibility in the Grand Canyon National Park, enhanced emergency cardiac treatment facilities, etc.). If, <u>as is usual</u>, the V_i's are attributed to all households (segregated or adjusted, perhaps, by such things as household income, household size, etc.), one acts as if the "representative" household might be willing to pay $\sum_{i=1}^{n} V_i$ for these n-public goods. Something akin to this additive process is implied when the EPA uses the value V_j as a measure for social benefits attributable to some policy j (and another division of EPA use V_k for evaluating policy k). Virtually no investigator would argue that one can add the V_j's, however--indeed in some cases the sum of the V_i's could equal or exceed household income.

While the fact that the V_i's are not additive may be attributed to a number of possible causes (e.g., the V_i's may be additive if the individual places a value on each the commodity j, j = 1, . . ., n, when faced with all options), a lingering suspicion exists that study participants in the CVM may be "willing to pay" for virtually any "good cause"--a "good cause" account? Thus, despite the fact that V_A is "offered" for cleaner air, one must be hesitant in using V_A as a measure of social value inasmuch as the individual might offer the value V_A for any other public good.

One must be aware of the danger of masking instrument design and other theoretical issues with the "mental accounts" rubric in addressing the "good cause" problem. The problem may be more usefully addressed via concentration on: extensions of separable utility theory, instrument design wherein wider ranges of options are presented, etc. Efforts to at least partially address some of these issues are made in the present study. Thus, one sees in the above discussions of Aggregation Issues (sub-section A.1) the relationships between this studys' objectives and the works of Kahneman and Tversky.

A second, major set of earlier works of particular relevance for the present study are those by Slovic et al. (1977) and others.[15] Slovic et al.'s focus on perceptions of risk relate to this study's the Hazardous Waste Experiment which involves reductions in uncertain risks associated with the disposal of hazardous wastes. A finding by Slovic et al. which is especially relevant for, and is used in, this Experiment concerns the role of information in the forming of risk perceptions: frequency of news coverage (information) of a risky event is seemingly associated with higher risk preceptions of the event.

Still another finding by Slovic et al., supported by results reported by other authors, is relevant for the perceived risk issue. In this regard, a particularly important finding is that individuals, when faced with low probability, high consequence alternatives, tend to ignore probabilities (perceived risk is 1.0?) and base decisions solely on the magnitude of consequence.[16] Thus, to the extent that health threats from hazardous waste disposal are viewed as low risk-high consequence events, contingent values for hazardous waste containment may be insensitive to posited changes in containment probabilities--a phenomenon that would contrast sharply with axioms drawn from expected utility theory where from contingent values are shown to increase with increases in containment probabilities.[17] The Hazardous Waste Experiment will attempt to address some dimensions of this issue.

The third set of earlier works of importance to the present study is the work reported in Schulze et al.[18] This work, which focuses directly on the CVM, provides a survey of research results relating to traditional biases commonly attributed to CV measures: strategic bias, starting point bias, information bias and payment vehicle bias. Referring to this set of biases, the authors conclude that "Biases do not appear to be an overriding problem.[19] Strategic bias was not found in any of the reviewed studies. Vehicle and starting point biases were found in but one of the six reviewed studies. The authors suggest that these "traditional" biases may generally be avoided with the establishment of precise contingent markets and well defined environmental commodities.[20]

While the study by Schulze et al. cannot be viewed as having irrevocably dismissed as irrelevant the above set of biases, the evidence presented therein is viewed by the authors of the present study as sufficiently compelling to warrant this study's shift in focus away from concern with "traditional" biases. Thus, this study moves beyond concern with such things as strategic bias in its focus on validation, aggregation and perception issues.

A.4 Conceptual and Sampling Issues

Somewhat related to the above, there are a number of more theoretical and sampling issues which deserved mention prior to our discussion of experimental results derived in the present study.[21] The first of these concerns the "state dependent" utility function (SDUF). Basic to the SDUF argument is that, especially in cases where uncertainty is involved, the individuals' utility function and, therefore, his/her valuation of any (e.g., environmental state) will depend upon the state at which an individual finds him/herself; as a crude but stark example, an individuals' valuation of a Cancer Clinic when he/she is in good health will differ from that obtained if he/she had cancer. The notion that preference structures may change as states of the world change surely has appeal on intuitive grounds. The implications of the SDUF argument for CVM are not clear, however. One can read into the SDUF argument the (obvious, it would seem) conclusion that ex ante valuations of an environmental improvement <u>may</u> be biased vis-a-vis an ex post valuation. But this would seem to be simply a more elegant, in terms of simplicity, restatement of the ongoing--and unresolved--issue concerning the optimality of competitive equilibrium under uncertainty set out by Radner[22] and expanded by, as examples, Starr[23] and Svensson.[24] In the few cases amenable to analysis, optimal, ex ante equilibrium that is also an optimal, ex post equilibrium is shown to obtain under only the most restrictive assumptions; e.g., in the case of a "spot market" economies, such equilibrium requires: <u>unanimous</u> agreement among consumers as to the spot market vector (which is in fact realized) that will occur <u>with</u> <u>certainty</u> in any state of the environment[25] (i.e., under conditions of <u>perfect certainty</u>). Under conditions of uncertainty, an optimal, competitive equilibrium (and, therefore, equilibrium market prices) is different than that equilibrium (and its associated prices) which is optimal ex post. This axiomatic potential bias in using any current (supposedly equilibrium and optimal) value (CV <u>or</u> market) as a measure of values relevant for different states (ex post) is well known; means for equilibrating these values are <u>not</u> understood. If the intended contribution of the SDUF argument goes beyond this observation, that contribution is simply not understood by the authors of this report.

A second conceptual issue of relevance for this study concerns, once again, the notion of individual perceptions. It was argued above that, particularly in the case of the Hazardous Waste Experiment, individual perceptions of risk (and/or, more generally, uncertainty) will underlie CV values; thus, variations in CV values reflect differing risk perceptions as well as differing preference-related values. As stated above, no attempt is made in this study to measure individual perceptions of risk. While the potential importance of such measures is recognized by the authors, the focus of this study is on heuristic inquiry designed to provide the insights and data requisite for the formulation of informed questions and hypotheses that will be important in later efforts to measure and explain risk perceptions that are relevant for applications of the CVM.

Notwithstanding the fact that perceptions per se are not directly measured in this study, the authors of this study have considered the implications of risk perceptions at some length.[26] From these considerations, two observations may be of passing interest. First, one must not be sanguine in terms of expectations from research focused on risk perceptions. Earlier works[27] point to the rapidity of changes in risk perceptions and the confounding ways in which they may be affected by myriad variables. Somewhat related to the SDUF argument sketched above, risk perceptions may be particularly state dependent,[28] thereby introducing complex problems as to the relevance of ex post vs. ex ante valuations. All of this is to suggest the critical importance of efforts to measure risk perceptions with careful thought as to the proposed end use of such perceptions once measured.

Inextricably related to this "use" question is the following issue which warrants early concern by social science researchers at the EPA. Suppose that risk perceptions associated with, as examples, air quality or hazardous waste disposal, are obtained; they are "good" measures. In most, if not all, cases, "actual" risks are not known (hazardous waste disposal) or existing, "scientific" estimates for risk will be shrouded with uncertainty and controversy (health effects from air pollution, nuclear waste disposal).[29] "Actual" risk estimates will virtually always be orders of magnitude smaller than perceptions of these risks, and the social scientist must anticipate the frustrated physical scientists' question: What is the meaning, and relevance, of perceived risks if such perceptions are "wrong"? In responding to this question, appeal to a basis for "education" vis-a-vis the relevance of risk perceptions must be cautious: to "educate," one must have the "truth," and, in many case, "truths" regarding these risks will not exist.[30] Nor can the social scientist look for solice in providing alternative benefit estimates based on actual and perceived risk estimates to "bound" social values given the extraordinarily large range which can be anticipated to result. Thus, risk perceptions exist, they surely affect CV measures, and are a source for legitimate interest and concern for the social scientist. Their use in analyses of social benefits assessments, may be fraught with problems that the wary scientist must anticipate and deal with early on.

A third issue of particular importance for the CVM concerns the "commodity" which is to be valued in the CVM's contingent market. As noted above, it seems apparent on intuitive grounds that this commodity be well-defined--that it be described to study participants with a higher degree of specificity. A problem which has defied resolution by the authors is that of defining criteria for specificity: what are the measurable characteristics, or manifestations of a "specific" commodity, or what sorts of CV bid characteristics are indicative of a specific commodity? In the quest for specificity criteria, one might begin (as did the authors) with Lancasters' "attributes" argument,[31] where a commodity Y is described by the vector of attributes $(Y_1, . . ., Y_n)$ and describe "specificity" by, for example, the percent of attributes given to an individual. Two, interrelated and perplexing issues arise, however. First, attributes may be unknown or, more seriously, may involve judgments--one chooses to include Y_i as an attribute--which then removes objectivity form the choice of n (and, therefore, any percentage measure). As examples, are (and to what extent) reductions in mortality rates an attribute of reduced ozone levels; is "more federal regulations" logically included as an attribute to the hazardous waste commodity; are types of damages potentially caused by, for example, hazardous wastes an attribute of a policy to contain wastes (and, if so, can one enumerate all potential types)? Secondly, if m is the number of described attributes, we have no a priori basis for relating the specificity measure m/n, however, n is defined, to individual valuations of Y. Consider an automobile, for example. The automobile mechanic or engineer may define n characteristics for a given automobile, only n of which are "known" by the lay buyer--n is orders of magnitude less than n. Our problem is made manifest by the question: is the buyers valuation of the automobile somehow faulty given n/n "small"? Here again the perception issue arises in its most robust form. In virtually any CV study, one can expect that individual perceptions of n may vary substantially, regardless of the number of attributes described to him/her by the investigator. Some efforts to speak to the elusive specificity issue are made in this study but the authors acknowledge at the outset that the issue of defining criteria for measures of specificity remains in the author's view, as a conundrum.

The final set of issues to be addressed in this sub-section concern sampling techniques used in this studys' CV experiments. As suggested by above descriptions of the intended scope for this study, it is hoped that one of the studys' strengths will be the breadth and comprehensiveness of issues considered which are of importance in efforts to assess the CVM. The study, by design, is exploratory and heuristic in character; further, it is free-wheeling in the sense that as the authors encountered new ideas, issues and/or methods of relevance for CVM assessment, efforts were made to develop these ideas/methods via experiments. To the extent that new insights as to the structure of CVM studies provided in this study are a part of its strengths, requisite methods for obtaining them gave rise to its major weaknesses. Thus, in this regard, sample sizes will vary substantially across the studys' many sub-experiments. In efforts to tentatively probe one issue or another, sample sizes will be small and, in such cases, "conclusions" must be accepted in the sense that they are offered: observations that are indicative of the potential existence of behavioral responses that warrant further development in efforts to bring the CVM to full flower as an effective tool in benefits assessments.

Further, in the studys' drive to develop and test new hypotheses, limited resources and time, as well as the intended thrust of the study, made impractical the structuring of sample designs that one would expect in non-experimental applications of the CVM which have as their central purpose the derivation of "final," or perfected, measures of social value. Thus, as implied in sub-section A.3, for many sub-experiments we eschew extensive pre-tests of CV instruments designed to address questions related to information/interviewer biases--the substance of earlier works by Schulze et al. (1981) discussed in A.3.[32] Little attention is allocated to correcting samples for possible stratification and/or non-respondent biases. Thus, the studys' experimental results must be interpreted within the context of experiments concerning economic behavior of study participants; obviously, extentions of the CVM to applications designed to estimate values for use in policy formulations will require considerably more attention to issues related to survey design.

A.5 Plan of the Study

The purposes of the Methods Development project are now understood as those of developing and testing hypotheses concerning four, broad sets of issues: validation issues, aggregation issues, issues concerning individual perceptions of CV commodities, and "other" issues. Hopefully, at this point the reader has some feel for the substance of experiments which this study uses in addressing these issues--the National Parks Visibility Experiment, the National Water Quality Experiment, the Hazardous Waste Experiment and the Ozone Experiment--as well as for the relationship between this studys' purposes and experiments to earlier works by other authors. Finally, earlier discussions have established the experimental context of this study and have alerted the reader to conceptual and sampling issues which form the basis for caveats which one must keep in mind in interpreting the studys' results.

Attention is now turned to an overview of these results. In sub-section B, results from all study experiments which pertain to validation issues are summarized. Similarly, sub-sections C, D and E include summaries of experimental results which pertain to aggregation, perception and "other" issues, respectively. This Overview section concludes with sub-section F wherein the authors' conclusions as to the implications of study results for assessing the viability of the CVM as a useful tool in evaluating benefits attributable to environmental change are offered.

B. VALIDATING CV MEASURES

B.1 Comparing Hedonic and Contingent Valuation Measures of Benefits Attributable to Environmental Changes

Two sets of issues complicate the comparison of a CVM measure of the benefits of reducing ozone levels in the Los Angeles area with measures derived from property values.

First the CV instrument obtains bids for reducing ozone on a daily basis. To develop an annual bid for an improvement in the ozone air quality distribution over an entire year raises questions both of perception (see Section D below) and requires the assumption that utility functions are additive and separable over time in ozone air pollution (see Chapter V Section B) if daily bids are to be simply added up linearly over the change in air quality distribution. One a priori point in favor of simply adding up daily bids is that there is little evidence either of cumulative health problems or of health tolerance for the known sub-clinical health effects of ozone. Thus, from the perspective of a household health technology, there is little reason to reject additivity of bids. However, preferences over the sub-clinical health effects might show some non-separable effects over time.

Second, the property value study (reported in detail in Chapter V, Section D) showed severe multicollinearity problems arising from the high correlation between the distance to beach, ozone and visibility (as measured by extinction or TSP) variables. Note that this collinearity problem is likely not accidental, but may well result from the air chemistry in the basin, wherein, hydrocarbons and nitrogen oxides are exposed to sunlight. Distance to beach is a good proxy for time of exposure to sunlight creating a simultaneous equation system leading to collinearity in our single equation property value model. Unfortunately, no one has yet successfully specified a basin wide air chemistry model nor is hydrocarbon data available at the current time. The most stable and plausible estimates made, to date, rely on an instrumental variable approach using principal components. This approach has poorly understood economic and statistical implications as an estimation procedure, so our results should be interpreted with caution. However, as an example, an average annual bid for an improvement of ozone air quality from that typical of the San Gabriel Valley (Poor) to that typical of the San Fernando Valley (Fair) is $502 ($1,166) from the interview survey analysis and $397 ($231) to $1,340 ($794) from the property value analysis depending on whether TSP or extinction, respectively, is used as the variable representing visibility in the estimated equation (standard errors are given in parenthesis). These values are also roughly consistent with previous hedonic and CVM research done in the Los Angeles Basin.

B.2 Market Criteria for CV Responses

In this sub-section attention is focused on hypotheses that relate CV measures (bids, responses) to criteria deduced from markets. Three sets of hypotheses are tested: those deduced from auction settings, those related to budget constraints and those related to altered consumption sets.

The Auction Process

(i) Motivation and Hypotheses. An issue of some concern for the CVM is the extent to which bids offered in the CV process are indicative of attitudes or intended behavior.[33] Ceteris paribus, use of CV measures for benefits assessments purposes presupposes the latter: individuals will in fact be willing to pay the proffered bid for proposed environmental commodities. The attitude vs. behavior problem may be restated as inquiry as to whether or not individual participants in the CV study consider the commodity in terms of monetary values--what they will pay for the commodity. One method for responding to this question involves moving beyond a single valuation question (what is your maximum willingness to pay . . .) to an auction-like process--if the commodity cannot be provided at "price" p, will you pay $1.00 more? The auction, or bidding, process may serve at least two purposes. First, it emphasizes monetary, payment, behavioral requirements for obtaining the commodity. Secondly, to those familiar with auction settings, it places the contingent market in a more familiar context. If initially offered bids--referred to as "starting bids," SB--are simply expressions of attitudes, there is no a priori reason to expect that individuals would significantly alter their attitudinal expression in response to the simulated auction. On the other hand, if the individual considers the commodity within the context of intended behavior--how much will he/she in fact pay for the commodity--we would expect SB to be significantly affected by the bidding process for the two reasons discussed in section A.1: initial (SB) values are low to maximize rents; considerable introspective search of preferences are required to arrive at a maximum willingness to pay. Denoting MB as the individuals' "maximum" bid resulting from the bidding process, the null hypothesis of interest then becomes

$$H_o : SB < MB, \qquad (1.1)$$

and the alternative hypothesis is

$$H_A : SB = MB. \qquad (1.2)$$

(ii) Study Results. SB and MB values from the National Parks Visibility, National Water Quality and the Hazardous Waste Experiments are given in Table 1.2. Differences in SB and MB values across experiments are expected, of course, due to differences in commodities to which they apply. In terms of the hypothesis of interest, we fail to reject--we "accept"[34] --the hypothesis SB < MB in the National Parks Visibility and the Hazardous Waste Experiments; we reject the hypothesis in the National Water Quality Experiment. Thus, in two of our experiments the bidding, auction-like process results in contingent values that are significantly higher than initial, starting (payment card) bids.

All else equal, from this we might infer the consistency of the valuation process in the CVM with that process observed in behavioral, auction-like process. This inference is weakened, of course, by results from the National Water Quality Experiment. For this experiment, the bidding process results in average bids which are higher, in absolute terms, than initial, starting bids, but bid differences are not

TABLE 1.2

TESTS OF AUCTION HYPOTHESES

Experiment	Average Value For: (Standard Deviation) SB	MB	Accept (Reject) Hypothesis: SB < MB	Sample Size
	($ per month)			
The National Parks Visibility Experiment	$5.69 (7.21)	$9.20 (11.54)	"Accept"	64
National Water Quality Experiment	$6.50 (8.48)	$8.71 (11.11)	Reject	56
The Hazardous Waste Experiment[1]	$16.02 (20.78)	$25.85 (36.43)	"Accept"	163

[1]Values are those obtained from pooling (intensive) experiment data from Houston and Albuquerque components.

statistically significant at 90 percent and 95 percent levels (the relevant t-statistic is 1.3, lower than the critical value of 1.65).

(iii) Caveats/Comments. Obviously, a demonstration that the valuation process in CV studies is consistent with other valuation processes which actually culminate in behavioral responses (actual payment) does not, in itself, establish that behavioral intent underlies CV measures. Little imagination is required to conjure alternative, and perhaps conflicting, implications of the inequality between SB and MB. This demonstration, however partial, is, however, on a piece of what will be shown to be a larger picture which, taken together, has interesting implications for the potential behavioristic character of CV responses.

Budget Constrained Bids

(i) Motivation and Hypotheses. From received economic theory, individual valuations of goods/services entails the introspective process of sorting through ones' preferences and allocating a fixed budget across the consumption set. The equilibrium, "equi-marginal" allocation of that fixed budget such that the ratio of marginal utility to price is the same for all goods/services purchased implies individual awareness of trade-offs between goods/services implied by their price and the fixed budget. As an extension of the argument set out above in discussion of the auction process, if CV bids are indeed considered in value--intended payment behavior-- terms as opposed to attitudinal terms, it must be true that, in offering the valuation, individuals are cognizant of opportunity costs, vis-a-vis foregone purchases of goods/services (or savings), implied by the bid. In other words, the budget constraint must be effective in the individuals determination of his/her bid.

In subsection A.2 a method was described for inquiring as to the effectiveness of budget constraints on bids offered by participants in CV studies. SB values are elicited from one group of participants. A second group is asked to reveal their monthly, take-home income and how that income is expended or saved prior to the willingness to pay (WTP) question. The WTP question is then posed, along with the request that the participant indicate that (those) current expenditure item(s) that will be reduced in order to facilitate payment of the offered contingent value. The resulting "budget constrained" bid is denoted SBY. If contingent values are considered with a value context wherein budget constraint-related trade-offs are considered, one would expect no difference between SB and SBY. Thus the hypothesis of interest here:

$$H_O : SB = SBY \qquad (1.3)$$
$$H_A : SB \neq SBY. \qquad (1.4)$$

(ii) Study Results. Values for SB and SBY obtained in the National Parks Visibility, National Water Quality and the Hazardous Waste Experiments are given in Table 1.3, along with results from tests of the hypothesis SE = SBY. The null hypothesis is "accepted" in all three experiments-- those participants given explicit budget information have

TABLE 1.3

TESTS OF BUDGET CONSTRAINT HYPOTHESES

Experiment	Average Value For: (Standard Deviation) SB	SBY	Accept (Reject) Hypothesis: SB = SBY	Sample Size
	($ per month)			
The National Parks Visibility Experiment	$5.69 (7.21)	$6.77 (6.16)	"Accept"	64
National Water Quality Experiment	$6.50 (8.48)	$13.40 (13.65)	"Accept"	89
The Hazardpus Waste Experiment	$16.67 (22.91)	$17.93 (21.03)	"Accept"	88

[1]Data are for pooled Albuquerque-Houston, intensive data.

differing, income adjusted bids than those not given such information, but bid-differences are <u>not</u> statistically significant.

(iii) Caveats/Comments. Failure to reject the hypothesis SB = SBY lends credence to the notion that CV measures are couched in terms of values which, in turn, gives support to their interpretation as indicative of intended behavior.

<u>Altering the Consumption Set</u>

(i) Motivation and Hypothesis. Received economic theory suggests that, analogous to a fall in the price of 2 substitute good, the introduction of a substitute good (along with its price) into the individuals' feasible consumption set will result in ex post consumption levels of previously consumed goods (for which the "new" good(s) is (are) a substitute) that are less than or equal to ex ante levels. Let P_1, q_1 and P_2, q_2 refer to price/value and consumption levels of the ex ante-consumed and "new" commodities, respectively. By implication, if, with the introduction of the substitute good q_2, the quantity q_1 is fixed, equilibrium can be obtained only if P_1 (ex post) is less than or equal to P_1 (ex ante).

For the moment, hold P_i, q_i constant for all goods and services presently consumed by the individual other than goods 1 and 2, with q_1 and q_2 fixed; superscripts a and b denote ex ante and ex post values, respectively. A much stranger axiom is implied by the above, viz., $P_1^a > P_1^b$ if $MUq_1/P_1^a < MUq_2/P_2$. Thus, the ex post (after introduction of the "new," substitute good) valuation of q_1 must be strictly less than the ex ante value if, given the new good q_2 and the individuals valuation of q_2, P_2, the new good is "worth" as much or more of the "old" good (and, therefore, the new good is purchased).

All else equal, this axiom suggests an interesting, testable hypothesis for efforts to contrast the valuation process in the CVM with theoretical axioms based on market behavior. Consider a CV commodity, Q_1, for which an MB value (P_1^a above) has been obtained. Let a <u>new</u> environmental commodity (or other public good), Q_2, that potentially substitutable for Q_1 be introduced to the study participant. The participant is asked if he/she remains willing to pay MB for Q_1 in light of his/her valuation of Q_2. If the response is negative, acquire the individuals "adjusted" bid for Q_1, denoted AMB ("adjusted maximum bid" analogous to P_1^b above). We would then posit: AMB < MB if Q_2 is consumed, AMB = MB otherwise.

When the assumption $q_i^a = q_i^b$ for all other goods i is relaxed, however--i.e., consumption of goods other than good 1 can be substituted for Q_2--the proposition becomes weaker: AMB < MB if Q_2 is consumed--AMB < MB when Q_1 is traded off for Q_2 and AMB = MB when Q_2 is consumed exclusively at the expense of goods other than Q_1.

The hypothesis AMB < MB remains interesting, particularly in cases where Q_2 is a reasonably close substitute for Q_1, and is used in this work.

As described in sub-section A.2, following the MB bid, groups of study participants are introduced to environmental goods that may be close substitutes for the primary CV commodity and are asked if they wish to revise--or "adjust"--their MB bid. We then test the hypothesis:

$$H_o : AMB < MB \quad (1.4)$$
$$H_A : AMB = MB. \quad (1.5)$$

(ii) Study Results. The effects of altered consumption sets of contingent values for primary CV commodities are examined in the National Parks Visibility and the Hazardous Waste Experiments; results are given in Table 1.4. In both Experiments, the effect of altering the consumption set is to lower the average bid for the primary CV commodity--the absolute value of AMB is lower than MB, reflecting downward adjustments in bids as study participants consider the primary CV commodity within a broader context which includes other substitute, environmental goods. Given the large variances surrounding mean values, however, tests for differences between mean values for AMB and MB in the Hazardous Waste Experiment but <u>not</u> so in the case of the National Parks Visibility Experiment.

(iii) Caveats/Comments. In our continuing search for manifestations that are indicative of CV measures as reflecting valuation processes, results given in Table 1.4 are somewhat encouraging. In a valuation process (as contrasted to an attitudinal, "I like" statement), altered consumption sets <u>via</u> the introduction of substitute goods would lead to downward adjustments in values as seen in results from the National Parks Visibility and the Hazardous Waste Experiments. The fact that the lower (<u>50 percent</u> lower) AMB value does not differ from MB in the "statistically significant" sense weakens any effort to draw definitive conclusions from the experiments. As is shown below, however, when viewed within the context of the totality of experimental results from the Methods Development Project, these results prove to be most useful in assessing the potential of the CVM.

B.3 Indirect Indicators of Intended Behavior in CV Responses

(i) Motivation and Hypotheses. For completeness, we conclude our efforts to validate CV measures by examining hypotheses which relate CV values to value-related characteristics of study participants. Thus, <u>if</u> CV values are indicative of intended behavior, if study participants are viewing the CV commodity in <u>value</u> terms, we would expect preference-related determinants of value to be reflected in CV bids.

Consider the following regression equation.

$$SB = \alpha_0 + \alpha_1 Y + \alpha_2 E + \alpha_3 S + \alpha_4 N + \alpha_5 A, \quad (1.6)$$

where:

Y: household income
E: education of respondent
S: sex of respondent

TABLE 1.4

TESTS OF HYPOTHESES CONCERNING ALTERED CONSUMPTION SETS

Experiment (Primary CV Commodity)	Other Substitute Good(s)	Average Value For (Standard Deviation): AMB	MB	"Accept" (Reject) Hypothesis AMB < MB	Sample Size
The National Parks Visibility Experiment (Visibility in Grand Canyon National Park)	Improved air Quality in Denver	\$6.03 (7.58)	\$9.20 (11.54)	Reject	64
The Hazardous Waste Experiment (Total Containment Policy for Hazardous Waste Disposal)	EPA Regulations for Five Sources of Environmental Risk	\$16.07[1] (20.78)	\$25.85[1] (36.43)	"Accept"	88

[1] Pooled data from Albuquerque and Houston components.

TABLE 1.5

TESTS OF HYPOTHESES CONCERNING INDIRECT INDICATORS OF VALUE

Experiment	Accept/Reject Hypothesis: SB-effects from Y: $\alpha_1 > 0$	SB-effects from N: $\alpha_4 > 0$	SB-effects from S: $\alpha_3 \neq 0$
The National Parks Visibility Experiment	Reject	Reject	Reject
The Hazardous Waste Experiment			
Combined Data	Accept	Reject	Reject
Albuquerque Study	Accept	Reject	Reject
Houston Study	Accept	Reject	Accept
New Haven Study	Reject	Accept	Reject
National Water Quality Experiment	Reject (marginal)	Reject	Reject

TABLE 1.5(A)

POPULATION CHARACTERISTICS OF STUDY PARTICIPANTS

Experiment	Average Education (Years)	Average Annual Income (000)	Average Age (Years)	Average Household Size
The National Parks Visibility Experiment[1]	15.09 (2.20)	$37.14 (16.14)	41.89 (12.91)	3.28 (1.34)
National Water Quality Experiment[2]	14.86 ( )	1.3[4] (.8)	37.22 ( )	3.26 ( )
The Hazardous Waste Experiment[3]	14.74	36.95 (2.4)	41.83 (24.30)	40.6%[5] (14.0)

[1] Table 2.2
[2] Table 3.2
[3] Table 4.2--pooled Houston, Albuquerque data.
[4] Data are for monthly take-home incomes.
[5] Data are for percent of households with children under 18.

N: household size (number of children in household)
A: age of respondent
SB: initial, "starting" bid from CV studies

The five independent variables included in (1.6) are those commonly used for characterizations of CV respondents in terms of delineating groups of individuals with differing tastes or preferences for a given commodity. In most instances--in <u>all</u> instances in this study--multiple collinearity between Y, E and A (those with higher incomes are older and are those with more education), in which case the three variables are collapsed into one, Y. For individuals with identical preferences, higher incomes would be expected to be associated with higher values for SB. In most cases, there is no a priori basis for assigning values to α_4 and especially, α_3 (associated with household size and sex, respectively). When environmental preservation is implicit to the CV commodity, larger household sizes (number of children in households) <u>may</u> be expected to influence bids as a result of "bequest" types of motives. In cases where environmental risk is directly at issue, as in the Hazardous Waste Experiment, ones expectations for a significant influence of α_4 and, one might argue, α_3 on SB may be greater. Thus, for all experiments the following hypothesis would seem to be relevant for the ends sought in this section:

$$H_o : \alpha_1 > 0 \quad (1.7)$$
$$H_A : \alpha_1 \leq 0 \quad (1.8)$$

Additionally, particularly in the case of the Hazardous Waste Experiment, the following hypotheses are of interest.

$$H_o : \alpha_4 > 0 \quad (1.9)$$
$$H_A : \alpha_4 \leq 0 \quad (1.10)$$
$$H_o : \alpha_3 \neq 0 \quad (1.11)$$
$$H_A : \alpha_3 = 0 \quad (1.12)$$

(ii) Study results. Results from tests of the hypotheses (1.7) - (1.12) in the National Parks Visibility, National Water Quality and the Hazardous Waste Experiments are summarized in Table 1.5. Referring to the Hazardous Waste Experiment, as expected in data reflecting <u>valuation</u> processes, income is shown to have a significant effect on bids offered in the CVM--on the average, higher bids are associated with higher incomes.

Results are quite different for the National Parks Visibility and National Water Quality Experiments, however. For these experiments, we "accept" $\alpha_i = 0$ for <u>all</u> demographic variables; this "acceptance" is marginal for α_1 (income) in the case of the National Water Quality Experiment (the t-statistic is 1.60 compared with a critical t-value of 1.65).

(iii) Caveats/Comments. A notable exception from the results described above for the Hazardous Waste Experiment is the relationship between SB and income in the New Haven component of the study. In the New Haven study, the variable "respondents' sex" was dominant in "explaining" the CV bid--bids from female respondents were significantly higher than bids from male respondents. This result _may_ be consistent with the result observed in the Houston component of this study wherein, in addition to income, the variable N--existence of children in households--was significant in "explaining" bids. Taken together, these results suggest the potential influence of maternal concern for health threats to children on CV bids which, it must be acknowledged, _could_ reflect attitudinal as well as behavioral responses. However, as shown below, bids obtained in Albuquerque, Houston and New Haven are not different in the statistically significant sense, and when data are pooled the influences of N and S disappear, leaving income as the only variable which significantly affects the CV bids. In any case, these results should alert the researcher to the potential importance of N and S for determining contingent values for environmental commodities which affect risks to public health and safety.

One can only speculate as to the possible explanations for the lack of significance of demographic variables--particularly, income-in determining bids observed for the National Parks Visibility and National Water Quality Experiments. Referring to data in Table 1.5(A), there are no dramatic differences in population characteristics between, e.g., the Hazardous Waste sample and the National Parks Visibility Experiment sample---particularly in terms of incomes--that would account for the differing results. Marked differences in preferences/tastes within income classes between the two samples _could_ account for the differing influences of incomes on bids, but similarities between bid and bid variances (e.g., Table 1.2) would belie that conjecture. The most probable conjecture is that omitted variables lie at the root of the non-determinateness of variables on bids obtained in the National Parks Visibility and National Water Quality Experiments. Attention is returned to this issue in later sections.

C. AGGREGATION ISSUES

In this subsection attention is turned to experimental results of relevance for the aggregation issues discussed above in A.2. In what follows, tests of hypotheses are discussed which relate to: aggregation over attributes, aggregation over commodities and aggregation over geography.

C.1 Aggregation over Attributes

Relatively little attention is given to the attributes issue per se in this study given that virtually _any_ commodity will consist of many attributes. Extensions of the "aggregation over attributes" issue as it related to aggregating over commodities _is_ given considerable attention below. We have acknowledged above (subsection A.4) the potential relevance of the attributes issues for a related issue: establishing criteria for the specificity of CV commodities. However, in this subsection inquiry as to aggregation over attributes is limited to a very narrow question, interest in which is admittedly pedagogic. The inquiry of interest here is the following. Earlier works have posited, as attributes to an environmental preservation commodity, commodities related to user, option, existence and bequest preferences of individuals. Further, these studies have offered the counterintuitive conclusions that values, subsumed in preservation values, attributable to the bequest motive will account for a large proportion (more than 50 percent) of the preservation bid. Thus, as a part of this study an effort is made to provide one more test of the relationship between the bequest value (BV) and a preservation value.

The preservation value used for this inquiry is the SE value for preserving visibility in the Grand Canyon National Park obtained in the National Parks Visibility Experiment. A sub-set of study participants are asked to disaggregate, when appropriate vis-a-vis their preferences, the SB value to user, option, existence and bequest commodities; associated values are denoted UV, OV, EV and BV, respectively. We then test the hypothesis:

$$BV \geq SB/2 \qquad (1.13)$$

The value obtained for SB (sample size: 75) is $5.09; average attribute values are (standard deviation):

UV = $0.45 ($1.04)
OV = 0.67 (1.66)
EV = 1.42 (3.63)
BV = 2.54 (5.25)

Tests of the hypothesis (1.13) result in our failure to reject the hypothesis $BV \geq SB/2$--we "Accept" the hypothesis that values attributable to the bequest attribute of the preservation commodity account for more than half of the aggregate value for the preservation commodity.

C.2 Aggregation over Commodities

(i) Motivation and Hypotheses. As noted above, the commodity aggregation issue is an extension of the attributes issue inasmuch as if, analogous to the "mental accounts" notion, bids for any one commodity (e.g., air quality in the Grand Canyon National Park) are attributable to a more aggregate commodity (e.g., air quality in the U.S.), the former, more disaggregated "commodity" is an attribute of the more aggregate commodity.

Given the importance of this issue, discussed above in A.2, six hypotheses are tested which relate to the various, potential dimensions of the commodity aggregation issue. These hypotheses, and their respective notations, are described as follows.

We begin with the question: Is the CV bid for a specific, disaggregated CV commodity applicable, in fact, to a more aggregated commodity of which the specific commodity might be considered a priori as a substitute? This question might also be posed as: Is the CV value for a disaggregated commodity attributable to something akin to a "mental account," a component of which is the specific commodity? Five hypothesis, for which use data drawn from the National Parks Visibility and National Water quality Experiments, are designed to speak to this (these) question(s).

1. Define VG as the CV bid for preserving visibility in the Grand Canyon National Park; VG(R) is the bid for the same commodity when individuals simultaneous bid for preserved visibility in the Grand Canyon National Park and preserved visibility in five other "regional" national Parks (the bid for which is VR). If the Grand Canyon National Park visibility "commodity" is distinct from that associated with visibility in other parks, the following null hypothesis would hold.

$$H_o : VG = VG(R) \quad (1.14)$$
$$H_A : VG \neq VG(R) \quad (1.15)$$

Define VG (all parks) as the contingent value for the Grand Canyon National Park visibility commodity formulated when the individual considers the preservation of visibility in all National Parks. Again, if the Grand Canyon National Park commodity is distinct from the more aggregate, "all parks" commodity, the following null hypothesis would hold (assuming 1.14).

$$H_o : VG(R) = VG(\text{all parks}) \quad (1.16)$$
$$H_A : VG(R) \neq VC(\text{all parks}) \quad (1.17)$$

Let NWQ be the contingent value for improvements in national water quality, NW(A)Q is the same value when individuals consider improvements in national air quality in bidding for improvements in national water quality. If one's value for improvements in national water quality is distinct from his/her value of the more aggregate commodity: air and water quality, the following hypothesis is implied.

$$H_o : NWQ = NW(A)Q \quad (1.20)$$
$$H_A : NWQ \neq NW(A)Q \quad (1.21)$$

Let NWAQ be the contingent value for improvements in water and air quality, a commodity which includes water quality and its associated value NWQ. The following hypothesis is implied

$$H_o : NWQ < NWAQ \quad (1.22)$$
$$H_A : NWQ \geq NWAQ \quad (1.23)$$

The sixth and final hypothesis tested as a part of the commodities aggregation inquiry speaks more directly to the mental accounts issue. From the Hazardous Waste Experiment, let AMB be the "adjusted" maximum bid for the total containment policy, such adjustments reflect the individuals' consideration of other environmental goods which are a priori substitutes. AMB(PG) is the adjusted bid when individuals consider other, substitute, environmental goods (as for AMB) as well as other "Public Goods" that are not environmental in nature, viz., improved highway safety and national defense. All else equal, since AMB (PG) involves consideration of an expanded consumption set vis-a-vis AMB, we would expect AMB(PG) > AMB, if improved highway safety and/or national defense are "consumed." If, on the other hand, non-environmental goods are ignored in the process of valuing environmental goods, a la an "environmental safety account," we would expect AMB = AMB(PG)--the introduction of non-environmental "PG" goods leaves unaffected the valuation of the environmental good. Therefore, the last hypothesis of interest here is:

$$H_o : AMB = AMB(PG) \qquad (1.24)$$
$$H_A : AMB \neq AMB(PG). \qquad (1.25)$$

(ii) Study Results. Results from tests of the hypotheses (1.14) - (1.25) are summarized in Table 1.6. Beginning with the more disaggregate good, preserved visibility in the Grand Canyon National Park, "acceptance" of hypotheses 1 and 2 (Table 1.6) suggest the distinctness of the environment commodity: valuations of five other regional parks and valuations of all other national parks does not affect the individuals' valuation of the specific commodity: preserved visibility in the Grand Canyon National Park.

Results from hypothesis 3 (Table 1.6) are troublesome, however. The sum of CV values for preserved visibility in the Grand Canyon National Park (VG(R)) and for preserved visibility in five other regional national parks (VR) is not less than the CV value for improvements in national air quality (NAQ). Indeed, we accept the hypothesis VG(R) + VR = NAQ--CV values for national improvements in air quality are captured in bids for preserved visibility in six national parks.

A similar pattern is found when attention focuses on more aggregate commodities. The bid for improved national water quality is unaffected by introducing improved national air quality as a commodity (hypothesis 4 in Table 1.6). However, the bid for improved national water quality (NWQ) is not less than the bid for improvements in national water and air quality (NWAQ). Indeed, NWQ = NWAQ is accepted--the value for improvements in water and air quality is captured by the bid for improved water quality alone.

Finally, in an earlier experiment (Table 1.4) it was shown that the introduction of other environmental goods significantly lowered the bill for the Hazardous Waste Commodity, i.e., MB > AMB. From hypothesis 6 (Table 1.6), however, the further introduction of non-environmental goods (AMB(PG)) does not affect the bid--we "accept" the hypothesis AMB = AMB(PG). Seemingly, individuals ignore non-environmental goods in their valuation of an environmental good (or a set of environmental goods.

(iii) Caveats/Comments. One might explain away the results of hypotheses 3 and 5 (Table 1.6) by appealing to such things as problems associated with individuals' ability to grasp the meaning of aggregate commodities such as national environmental quality improvements. The authors are inclined to view these results at face value. The implications are that real problems may exist in the attribution of CV measure to specific, disaggregated commodities--bids for a specific commodity may in fact measure maximum willingness to pay for a broader, more aggregate commodity. The notion that individuals may view environmental improvements in aggregative, "gestalt" (or "mental account") terms is supported by results from hypothesis 6 in Table 1.6: individuals seemingly ignore non-environmental goods in their valuations of an environmental good.

Our finding of evidence which suggests the potential for commodity bids that apply to broader commodity classes is not altogether negative vis-a-vis the ultimate potential of the CVM for use in benefits assessments. One sees in these results an interesting parallel with Bishop and Heberlien's attitude-behavior dichotomy. If, in the introspective valuation process, individuals do indeed tend to think in terms of classes of general environmental goods--or the environment as a whole--this need not relegate CV measures to a role of simply indicating attitudes. Values used in hypotheses 3, 5 and 6 were used in hypotheses tested in subsection B.l above wherein reasonably persuasive conclusions are suggested as to the argument that individuals do view offered CV bids within the context of values, rather than attitudes, Thus, CV measures may remain as values for classes, or accounts, of (relevant to) environmental improvements.

Moreover, results from hypotheses 1, 2 and 4 (Table 1.6) are relevant for efforts to deduce implications from hypotheses 3, 5 and 6. Results from hypotheses 4 and, particularly 1 and 2 suggest that at relatively disaggregate levels, individuals can and do differentiate between environmental commodities: the introduction of "new" commodities that are defined at (approximately) the same level of aggregation does not effect individual valuations of a specific commodity.

It is the authors view that this mix of results concerning the commodity aggregation issues defines a clear challenge for future research designed to further the development of the CVM. Much more work is required in efforts to design the CV instrument in such a way that individual attention is focused on environmental commodity of interest within a context which includes the more general commodity-class within which the specific commodity may be a component. As an example, it may be necessary in the elicitation of bids for a commodity X to present to and discuss with the study participant a large class of other environmental goods; it may be necessary to seek simultaneous valuations of components in this reasonably exhaustive menu of environmental goods (and other public goods?). We recognize the implications of these conclusions for potential size of the CV instrument as well as the costs of implementing the CVM. In light of this subsections findings, taken together with subsection A.1's discussion of the importance of the commodity-aggregation issue (particularly with regards to the question: can one sum CV values), these costs may be unavoidable if the CVM is to generate values which can be defensibly used as benefit measures attributable to a specific commodity.

C.3 Aggregating over Geography

(i) Motivation and Hypotheses. The final set of aggregation issues to be addressed in this subsection relates to aggregation over geography. Interest in this issue is motivated by the ultimate need to aggregate geography-specific CV values to national values in cases where CV measures are to be used for comparisons of national benefits and costs associated with a particular policy. In such cases, one must be concerned with the extent to which commodity values vary across regions of the U.S. and the determinants of such variations. Thus, if $D_1, \ldots, D_n$ are variables which serve as proxies for preference-related population

TABLE 1.6

TESTS OF HYPOTHESES RELATED TO AGGREGATION OVER COMMODITIES

Hypothesis	Accept/Reject
1. VG = VG(R)	Accept
2. VG(R) = VG(All Parks)	Accept
3. VG(R) + VR < NAQ	Reject
4. NWQ = NW(A)Q	Accept
5. NWQ < NWAQ	Reject
6. AMB < AMB(PG)	Reject

characteristics which are established a priori (e.g., income, education, etc.), one is concerned with the influence of the D_i's on commodity valuations. Problems can arise as different sets of the D_i's are found to be of importance in explaining bids or each of a few sites in which the CVM is applied. Such findings could necessitate potentially large, costly expansions in the number of site-applications of the CVM for national aggregation purposes. Thus, ideally the same set of (hopefully, a few) D_i's are found to be of consequence across regions of the U.S.

The geography-aggregation issue is addressed in this study via the one experiment which involves multi-locational applications of the CVM, viz., in the Hazardous Waste Experiment which involves application of the CVM in three metropolitan areas: Albuquerque, New Mexico (ABQ); Houston, Texas (HT); and New Haven, Connecticut (NH). The results are therefore limited inasmuch as no basis exists for extrapolating findings of this experiment to all other CVM applications which involve different CV commodities. The experiment does serve as an interesting case study, however, and provides, at a minimum, a basis for reference in future experiments concerning the geography-aggregation issue.

As discussed above (see Table 1.5), tests of the influence on bids of selected variables demonstrated the dominance of income as a determinant of bids. The remaining issue is the relationship between income-adjusted bids obtained in the three cities/regions; i.e., are these geography-specific bids different and, if they are, what explains the differences. Defining MB_A, MB_H and MB_N as "maximum" bids for Hazardous Waste commodity of the Hazardous Waste Experiment obtained in Albuquerque, Houston and New Haven, respectively, the hypothesis of interest is then expressed in the following

$$H_o : MB_A = MB_H = MB_N \tag{1.26}$$
$$H_A : MB_A \neq MB_H \neq MB_N \tag{1.27}$$

(ii) Study Results. Results from tests of the hypotheses (1.26) and (1.27) are described below in subsection IV's Table 4.13 and 4.17. The null hypothesis 1.27 is "accepted"-- there is no statistically significant difference between CV values for the Hazardous Waste commodity obtained in the three regions.

(iii) Caveats/Comments. Aside from the implicit caveat mentioned above concerning generalizing these results to other CV studies with different CV commodities, an additional observation warrants mention.[35] We have acknowledged the lack of a theoretical basis for necessarily expecting bid-differences across studies other than those attributable to variables included in regression analyses described above in subsection B.3. Indeed, hypothesis (1.26) and (1.27) represent heuristic inquiry as to the possible existence of unexplained bid-differences that would then necessitate additional theoretical and empirical attention. In this regard, one must recognize the potential importance for CV values attributable to the Hazardous Waste commodity that can be seen as obviously relevant on theoretical as well as a priori grounds, viz., proximity to a waste disposal site. Close proximity to a known disposal site for hazardous wastes is not an issue in any of the three sites used in the Hazardous

Waste Experiment. Differences in the nature of public concern for the general hazardous waste disposal issue exists in the samples and, from the above, such differences seemingly do not affect bids. For example, concern in Albuquerque focuses on city wells in the South Valley which were recently found to have been contaminated by "improper" dumping of hazardous industrial wastes; potential dangers from the disposal of wastes from petrochemical industries were of concern to Houston residents. But in none of the areas was a well-defined waste disposal site per se an issue of concern.[36]

D. INDIVIDUAL PERCEPTIONS OF CV COMMODITIES

A better title for this section might well be "problems in perceiving CV commodities." Clearly if an individual does not understand what he or she is bidding for (the nature of the commodity itself, or how useful that commodity might be at the moment or over time to the individual, then the contingent valuation method will produce biased or meaningless results. Although closely related to the aggregation issue in several respects--one could reinterpret most of the preceding section along perception lines--the focus in this section will be placed on three examples drawn from the experiments of potential or actual perception problems.

The first example is drawn from the National Parks Visibility Experiment. Two separate estimates of user values for improved visibility at the Grand Canyon can be made from the CV results of this study. First, an estimate of this value can be made from daily bids collected through increased entrance fees on the day of a hypothetical visit. Taking the number of visitor days per year times the average bid per day for an increase in visibility gives a rough estimate of annual total user benefits. A second approach is to use CV estimates of the total value of preserving visibility at the Grand Canyon collected through increased electric utility bills, where individuals are asked to then disaggregate this bid into components consisting of user, option, existence and bequest values. Individuals were able to ascertain that user value "should" be the smallest of the component values, giving average values of about $.45 per month versus a total preservation value (sum of the components) of $5.09/month. If this ratio of .0884 to 1 obtained from a Denver sub-sample were to hold for the nation, it would imply a national user value bid for preserving visibility at the Grand Canyon of $309 million per year (based on annual total preservation value of $3.5 billion as described in Chapter II). The daily bid estimates, on the other hand, imply a national bid of only $10 million dollars per year. This inconsistency suggests the possibility of a fairly severe perception problem possibly associated either with radically different payment methods, or with an inability to break down an aggregate bid into components where one of those components is very small. For example if the component user bid were to agree with the daily entrance fee bid, the former would have to have averaged 1½¢ broken out of a total preservation value averaging over $5! The "scaling" of the component bid approach is, in retrospect, almost ridiculous and obviously likely to induce a perception problem as compared to the daily entrance fee approach.

The second example of a perception problem occurred in the Hazardous Waste Experiment. A large fraction of respondents bid the same amount for a policy which provided a 50 percent probability of hazardous waste containment as for a policy which provided a 100 percent probability of containment. One explanation for this result is the simple fact that a large fraction of the adult population in the United States has no formal concept of what a probability is. Thus, the specification of the commodity could have been meaningless to a large fraction of the respondents. Political scientists often employ filter questions to remove meaningless answers to survey questions. In the case of the Hazardous Waste Experiment, a few questions to determine if the respondent understood the meaning of a simple probability would have improved the interpretation of the results dramatically.

Finally, the Ozone Experiment provides a more positive example relating to perceptions. Daily CV bids for reduced ozone levels do appear to be roughly consistent both with previous CV studies using monthly bids and with capitalized air quality values revealed through analysis of property values. In contrast to the National Parks Visibility Experiment, no scaling problem appeared to be present since daily bids fell in the range of a few dollars, monthly bids in the range of tens of dollars, and annual capitalized values in a range of hundreds of dollars.

E. OTHER EXPERIMENTAL ISSUES

The final set of issues addressed in the Methods Development project are methodological in nature. Two sets of issues are addressed: the "marginal" nature of CV values and the nature of differences in CV values obtained from alternative solicitation modes.

E.1 CV Values as Measures of Marginal Values

(i) Motivation and Hypotheses. Related to the attitude vs. intended behavior as well as the commodity aggregation issues which has appeared repeatedly in our earlier discussions, if the CV measure is indeed couched in value terms (as opposed to an indication of "I like a clean environment") the CV measure must be a marginal valuation. This is to say that there now exists an environmental "state" and an existing "state" of EPA regulations. The existing state of environmental quality is a good for which people now pay a "price" in terms of higher taxes (compared with, e.g., pre-EPA days; such taxes pay for research, policy formulation and enforcement activities by the EPA and other agencies) and higher prices for current purchases of goods and services (e.g., pollution abatement costs passed on, in whole or part depending on demand/supply elasticities, to consumers). An environmental improvement--the substance of CV commodities--represents a (usually) small change in the environmental state. Obviously then the CV measure must be attributable to the appropriate margin rather than to the environmental state per se.

As stated above, this "marginal" issue is an alternative way of stating the commodity aggregation issue: does the CV measure apply to the specific commodity (a marginal change in the environmental state) or to a more aggregate commodity (the environmental state per se). There is one important difference, however, which accounts for the authors distinct treatment of the "marginal" issue. This difference lies in viewing the commodity aggregation with a precise value context: basic to this line of inquiry is the individuals' cognizance of the existing environment state and their costs for maintaining that state in offering values for improvements--changes--in environmental quality.

The following procedure is used in addressing the "marginal" issue. In the New Haven component of the Hazardous Waste Experiment, a discussion of the existing state of environmental regulations and environmental quality (air, water quality, etc.) preceded willingness to pay questions. Half (44) of the New Haven respondents were given additional information, viz., an estimate of the monthly amount now paid by similar (to the respondents') households for the existing environmental state via higher prices and taxes. Questions expressed by two hypotheses are of interest for this experiment. First, are individuals cognizant of the existing environmental state in offering bids for marginal changes (environmental improvements)? Evidence suggestive of such cognizance would follow from a demonstration that bids obtained without explicit discussions of the environmental state (the SB values obtained in Albuquerque and Houston) are not significantly different from those obtained with such discussions (the SB value obtained from 44 New Haven respondents); i.e., with SB_N the New Haven starting bid and SB_{AH} the Albuquerque (or Houston) starting bid, cognizance of the existing environmental state is suggested by "acceptance" of the hypothesis $SB_N = SB_{AH}$. Of course, this hypothesis was tested above in subsection C.3 and the hypothesis was "accepted." We then have evidence suggestive of individual awareness of the existing environmental state in their formulation of CV bids.

Secondly, are individuals' cognizant of their present expenditures for the existing environmental state in their formulation of a CV bid? Defining SB_1 (SB_2) as the average starting bid by individuals who are (are not) given estimates of their current expenditures for the environmental state, an affirmative answer to this question is suggested by the following hypothesis:

$$H_o : SB_1 = SB_2 \quad (1.28)$$
$$H_A : SB_1 \neq SB_2 \quad (1.29)$$

(ii) Study Results. Results from tests of hypotheses (1.27) and (1.29) are summarized in Table 1.7. The null hypothesis is "accepted": CV bids are seemingly unaffected by explicit information as to current outlays for the existing environmental state.

(iii) Caveats/Comments. Results from the Hazardous Waste Experiment are consistent with the proposition that CV values are appropriately "marginal" in nature--in offering CV bids, individuals are cognizant of the existing environmental state and the income sacrifice required to maintain that state. However much encouragement one might draw from this observation, it must be recognized that a demonstration that CV values are

TABLE 1.7

TEST OF THE MARGINAL BID

Experiment	Average Value For (Standard Deviation) SB_1	SB_2	Accept/Reject Hypothesis $SB_1 = SB_2$	Sample Size
The Hazardous Waste Experiment	\$13.34 (17.22)	\$17.52 (20.55)	Accept	88

appropriately marginal does not necessarily diminish the commodity-aggregation problem. Thus, while 2 bid for an environmental improvement may be a marginal valuation, the issue as to how individuals view the marginal environmental change--a marginal change in aggregative "environmental quality" or the change represented by the CV commodity--remains as an open question.

E.2 Solicitation Modes for Obtaining CV Measures

(i) Motivation and Hypotheses. An important methodological, or logistical, issue for implementation of the CVM concerns the solicitation mode to be used in administering the CV instrument. Three obvious alternatives exist: administering the CV instrument by mail, by going door-to-door in selected neighborhoods (or to selected houses) and by the intensive process by which pre-arranged appointments are established with selected households; these methods are referred to as mail, extensive and intensive methods (or solicitation modes), respectively. Ones motivation for interest in solicitation modes is a practical one: cost; costs per completed instrument are most often much lower for the mail method than for the extensive method and most expensive is the intensive method.

The central issue here is the question as to the existence of rationale which would lead one to prefer one solicitation mode over another; in other words, does one get different, or "better," results using one method over another and, if so, what might explain the differences?

The following method is used in this study in efforts to address these questions concerning solicitation modes. In the Houston component of the Hazardous Waste Experiment, CV values for the Hazardous Waste commodity are obtained using both the intensive and extensive methods. Defining PB_E and PB_I as CV values obtained from extensive and intensive methods, respectively, we then test the hypotheses:

$$H_o : PB_E = PB_I \qquad (1.30)$$
$$H_A : PB_E \neq PB_I \qquad (1.31)$$

In the Ozone Experiment, CV measures for the Ozone commodity are obtained using both the extensive and mail methods. Defining Z_E and Z_m as Ozone bids obtained from extensive and mail methods, respectively, the following hypotheses are tested:

$$H_o : Z_E = Z_m \qquad (1.32)$$
$$H_A : Z_E \neq Z_m \qquad (1.33)$$

(ii) Study Results. Results from tests of hypotheses (1.30) - (1.33) are given in Table 1.8. The null hypotheses (1.30) and (1.32) are "accepted"-- there is no statistically significant difference between CV values obtained from mail, extensive and intensive solicitation modes.

(iii) Caveats/Comments. Some potential for a fallacy of composition--a deductive "leap"--exists in any conclusion that the three solicitation modes yield identical results. All three modes were not used

TABLE 1.8

TESTS OF HYPOTHESES CONCERNING SOLICITATION MODES

Experiment	Mean Value of Bid (Standard Deviation) PB_I	PB_E	Z_E	Z_m	Accept/Reject Hypothesis $PB_I = PB_E$	$Z_E =$	Sample Size
The Hazardous Waste Experiment	\$17.06 (22.40)	\$7.05 (8.44)			Accept		113
Ozone Experiment			See Chapter 5			Accept	___

in a single experiment, in which case appeal to some form of transitivity is required if one is to "conclude": I = E, E = M, ergo I = M. Obviously, the link $PP_E = Z_E$ is missing for the appropriate deduction: $PB_i = PB_E$, $PB_E = Z_E$, $Z_E = Z_m$. Nonetheless, the results of hypotheses (1.30) - (1.33) can be viewed as encouraging in their potential promise for considerable flexibility in the investigators' choice of a solicitation mode.

Finally, results reported in Table 1.9 must be viewed within the context of data concerning response/contact ratios which are given in Table 1.7. These data suggest the potential for respondent biases in our CV results as discussed above in A.4. The large percent of individuals contacted by mail/telephone that did not participate in the study raises questions not addressed in this study as systematisation biases in terms of characteristics of individuals who do and do not participate. While the response/contact ratio for the Hazardous Wastes' extensive (door-to-door) study is relatively higher--33 percent--underlying this ratio is the fact that, in many of the socio-economic neighborhoods included in the study, the response rate is zero (see Table 4.3 in subsection IV).

F. CONCLUSIONS

F.1 Review of Study Results

Having discussed the nature of, and results from, the multi-facited experiments included in the Methods Development Project, it is now desirable to bring these many results together in an effort to describe what has been learned about the CVM and the implications of this knowledge for assessments of the CVM in terms of its potential as a method for estimating benefits attributable to environmental inprovements. Before giving attention to these important issues, it will be useful to briefly review what has been learned in the Project; thus, a brief statement of these "lessons" follows.

1. Are CV values for environmental improvements consistent with those derived from the Hedonic Property Value Method?

- Both the CV Method and the Hedonic Property Value Method produce order of magnitude estimates, not precise estimates, due to the uncertainties inherent in each technique.

- Within this order of magnitude range CV and Hedonic Property Value Methods give consistent benefit estimates.

2. Are CV responses couched within the context of value as opposed to attitudes?

- CV measures are consistent with values formulated within a budget-constrained process of preference research.

TABLE 1.9

RESPONSE/CONTACT RATIOS FOR EXPERIMENTS

Experiment	Number of Contacts	Number of Responses	Response/Contact Ratio
The Hazardous Waste Experiment			
Extensive[1]	75	25	.33
Intensive[2]	1,147	92	.08
Ozone Experiment			
Mail Method	--	--	.03-.10[3]
Extensive	--	--	.24-.56[3]

[1] Door-to-door contacts in Houston.
[2] Telephone contacts in Houston.
[3] Range of ratios in communities surveyed.

- in 2 out of 3 experiments, bid formulation in CV studies is consistent with auction-like (demand penudrum) processes wherein individuals focus on maximum willingness to pay only as market-entry costs rise.

- lower CV bids resulting from altered consumption sets are consistent with axioms from received theory; however, questions remain as to the extent that altering the consumption set will significantly effect CV bids.

- household income, and other household characteristics, are not shown to be significant determinants of CV values.

- CV bids are seemingly formulated within a context where individuals are cognizant of the existing environmental state as well as present expenditures for maintaining that state; thus, contingent values are seemingly "marginal" in nature.

3. Are contingent values appropriately commodity-specific or may they be attributable to some more aggregative commodity?

- Commodity-specific bids for relatively disaggregated commodities are seemingly unaffected by the introduction of substitute goods which are at the same level of disaggregation.
- However, bids for aggregate commodities (e.g., improvements in national air quality or air and water quality) are not significantly different from bids for disaggregate commodities, which suggests that commodity-specific bids may be attributable to more aggregative goods. This result is consistent with the "mental accounts" notion.

- Again supportive of the mental accounts notion, individuals seemingly ignore non-environmental goods in their formulation of values for an environmental good.

4. Are bid changes in response to changes in environmental risk consistent with those derived from Expected Utility Theory?

- Lower probabilities of hazardous waste containment are not associated with lower CV values, which is inconsistent with axioms derived from Expected Utility Theory.

- Higher (implicit) damage probabilities are not associated with higher CV values, which is inconsistent with axioms derived from Expected Utility Theory.

- However, the credibility of these results is seriously weakened by weakness in the design of CV instruments used in deriving data for testing these hypotheses as well as by a myriad issues related to individual perceptions of risk which are not addressed in this study.

5. Are individual perceptions of, and offered value for, CV commodities consistent?

- o Perception of values may be affected by scaling problems.

- o Perception of values under uncertainty may be poor when individuals fail to understand concepts of probability.

6. Are included variables sufficient for explaining bid-differences across regions of the U.S.?

- o Income-adjusted bids for the Hazardous Waste commodity are shown to be invariant with respect to study locations.

7. Are CV measures affected by choice of solicitation mode?

- o Significant differences in bids are not identified between those derived by intensive and extensive modes and by extensive and mail modes.

F.2 Conclusions: The Substance of the Contingent Valuation Method

Based on study results summarized above, one immediately obvious conclusion is suggested in terms of the viability of CV values as measures of social benefits attributable to environmental improvements: considerably more developmental research is required if the state of the arts for the CVM is to advance to the level where it may produce defensible benefit estimates. However, while this conclusion follows from the problems associated with CV values identified in this work, these problems should not overshadow the positive findings reported in the study.

Looking to the positive side, results from validation studies (groups 1 and 2 above) provide a reasonably sound basis for concluding that CV measures are couched within the context of value. The juxtaposition of offered CV values to budget-related trade-offs, their responsiveness to altered consumption sets and the auction-like process by which CV values are re-defined and re-formulated in response to increasingly stringent market-entry conditions combine to suggest that in formulating CV bids, individuals follow the process of preference research indicative of, or at worst consistent with, intended behavior. All else equal, these results should increase the palatability of ones' acceptance of a CV value as a meaningful measure of maximum willingness to pay. While of interest in their own right, conclusions as to the equality of CV bids across regions and their insensitivity of solicitation modes buttresses these arguments as to the value-content of CV measures.

However, if one accepts the value content of the CV measure, unanswered is the starkly critical question posed by study results as to what is being valued in the CV study. Study results provide good reason to question the applicability of a studys' CV measure of "value" to the studys' specific commodity. Rather, the valuation may well apply to some more aggregate commodity--some aggregate Commodity "account." To the extent that this commodity-aggregation issue is real--and, however casual, the research community's general reluctance to <u>add</u> commodity-specific values would suggest that it <u>is</u> real--implications for questions requiring research are immediately apparent. First, we must understand, define and delineate the aggregate commodity (or mental account) relevant for any specific environmental improvement. Secondly, experiments are required for testing means by which values which are appropriately attributed to the aggregate commodity can be allocated to the disaggregated commodities which are the "attributes" of the aggregate commodity.

A final problem of substantial substance identified in the study is the perplexing role of individual perceptions in their formulation of CV values.

REFERENCES

1. Grant No. CR808-893-01.

2. Brookshire, D. S., et al., "Experimental Approaches for Valuing Environmental Commodities," Vol. 1 (April, 1982) and Vol. 2 (April, 1983), U.S. Environmental Protection Agency, Washington, D.C.

3. Georgescu-Roegin, N., "Pure Theory of Consumer Behavior," Quarterly Journal of Economics (August, 1936).

4. Georgescu-Roegin, N., "Threshold in Choice and The Theory of Demand," Econometrica, Vol. 26 (1958): 157-168.

5. Georgescu-Roegin (19361, Op. Cit., p. 587.

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

7. See, as but a few examples,

8. Here we simply acknowledge the existence of the debate as to the appropriateness of summing indicators of individual utilities; for discussions of this topic, see Goldman and Uzawa (1964) and Katzner (1970).

9. See, e.g., Bishop and Heberlein (1979), Hammack and Brown (1974).

10. The authors express their appreciation to Dr. William Desvousges, Research Triangle Institute, for useful remarks in these regard.

11. Desvousges, W. H. and Smith, V. K. The Basis for Measuring the Benefits of Hazardous Waste Disposal Regulation (Raleigh, Research Triangle Institue (1982).

12. Mitchell, Robert, et al. (1981).

13. The CV study for hazardous waste disposal was, initially, a case specific study required for compliance with an EPA Cooperative Agreement. Its later extensions and inclusion as a part of the Methods Development project were based on the following considerations.

14. Kahneman and Tversky, Science, January, 1982.

15. Slovic, et al. (1977).

16. *Ibid*; see, also, Kahneman and Tversky (1979), Starr, Rudman and Whipple (1976) and Fairley (1975).

17. See Section IV.B.

18. Schulze et al., *Land Economics* (1981); see, also, Randall, A., et al., "Contingent Valuation Survey for Evaluating Environmental Assets," *Natural Resources Journal* (June. 1983).

19. *Ibid*, p. 170.

20. *Ibid*

21. See Graham, D., "Estimating the State Dependent Utility Function," *Natural Resources Journal* (June 1983); particularly, see Desvousges and Smith (1983) and Gallagher, D.R. and V. K. Smith, "Measuring Values for Environmental Resources Under Uncertainty," mimeo, Department of Economics, University of North Carolina, Chapel Hill (January 24, 1983).

22. Radner, R., "Problems in the Theory of Market Under Uncertainty," *American Economic Review* 60 (May 1970): 454-460.

23. Starr, R., "Optimal Production an Allocation Under Uncertainty," *Quarterly Journal of Economics* 87 (January 1973): 84-85.

24. Svensson, L., "Sequences of Temporary Equilibria, Stationary Point Expectations and Pareto Efficiency," *Journal of Economic Theory* 13 (1976): 169-183.

25. Burness, H. Stuart, et al., "Ex Ante Optimality and Spot Market Economics," Chapter 7 in *Water Management Strategies in Arid Regions,* Report to the National Science Foundation, Grant No. DAR 7909933, Washington, D.C. (February 1982): 7.25.

26. See, for example, Chapter 8 in Cummings, R.G., et al., "The Proposed Waste Isolation Pilot Project and Impacts in the State of New Mexico," EMD 2-6-1139, New Mexico Energy Research and Development Institute, Santa Fe (April 1981).

27. For example, Slovic et al. (1977), Op. Cit.

28. See, for example, the "risk denial" notion developed in Slovic et al., (1977), Op. Cit.

29. Cummings et al., 1981, Op. Cit., Chapter 8.

30. *Ibid*

31. Lancaster, K. (1966).

32. Schulze, et al., 1981 (Land) Op. Cit. 33. Bishop and Heberlein (1974), see, also, Hoehn and Randall and Randall et al. (1983), Op. Cit.

34. We use the "loose" expression of accepting H_o for expositional simplicity for use in the following tables.

35. The authors are grateful for comments offered by Dr. W. H. Desvousges in this regard.

36. The obvious question which arises in this regard is why the study design did not include areas in close proximity to disposal sites. During the design stage of the Policy Bid experiment, the researchers included such sites. For reasons not totally clear to the authors, these choices were rejected by the grant monitor; the Albuquerque, Houston and New Haven sites were those approved by the monitor.

CHAPTER II

THE NATIONAL PARKS VISIBILITY EXPERIMENT

A. VARIATIONS IN FRAMING

A.1 Introduction

The credibility of the contingent valuation approach hinges upon the stability of bids offered for a nonmarket good. Stability, in turn, depends on the extent to which the respondents are induced to research their preferences. The depth of a respondents research into his/her preferences depends on two critical factors: (1) how well the nonmarket good is specified; and (2) the quality of the survey design.

As suggested previously, recently completed research implies that results between benefit estimates for public goods derived from hedonic methods and those derived from contingent valuation methods (Brookshire, et al., 1982; Cummings, et al., 1978) are approximately equivalent. Two criticisms of the contingent valuation technique have been raised. First, that respondents could casually bid any amount, without weighing the opportunity costs implicit in their bids; and second, the bids obtained may possess an upward bias because contingent valuation surveys heretofore have sought bids for individual or single public goods in isolation, rather than within an environment in which other public goods may, realistically, have to be purchased as well.

A third issue which has been raised is Randall's prediction that the individual's initial bid, taken from a payment chart, may not fully capture his maximum willingness to pay.

The goal of the experiment outlined in this section is investigation of the relationship between bid stability and good specification, as well as effectiveness of alternative methods for inducing "preference research".

An outline for the remainder of this section is as follows: sub-section A.2 presents the survey design, sub-section A.3 reports on the results of the survey, and finally, conclusions are given in sub-section A.4.

A.2 Survey Design

The survey instrument is employed to address a multiple set of issues in the problem of valuing nonmarket goods. The survey was structured into four sub-experiments. In each of these, bids were solicited for the same well-defined public good, visibility at the Grand

Canyon National Park. Specification of this good was assured by presenting all respondents with the same set of photographs of known visibility levels at particular sites as well as identical supplementary information. Variable across the four sub-experiments were: (1) the presence of budget constraints, (2) introduction of other well-defined public goods, (3) addition of a vaguely defined public good, and (4) use of an iterative procedure to elicit any differential between initial bid and the maximum willingness to pay.

Common to all four surveys were the following steps. The surveys were initiated with interviewers introducing themselves and presenting the purpose of the study. After an introduction, a brief explanation of the causes of poor visibility was given. Next, photographs of the sites were shown to the respondents. These photographs were arranged in five columns representing visual air quality ranging from very poor in Column A to very good in Column E with Column C depicting the average level of air quality. At this stage of the interview, data gathering began. All four surveys began with questions concerning frequency of the household's past and future park visitation. Beyond this point, divergence between the four surveys occurs.

The First Experiment began by asking people how much they would be willing to pay per month as an increase in their electric utility bills to preserve the average level of air quality (Column C) rather than having it deteriorate to the level shown in Column B. This initial bid was obtained by handing the respondents a payment chart with different dollar amounts listed and asking him/her to select one of the figures. This bid is called the initial willingness to pay bid. Now, to test Randall's hypothesis that the initial bid does not fully capture Maximum willingness to pay, participants were asked the following question. "Suppose that with all households paying your initial bid, this amount of money was insufficient to permit preservation of visibility level C at the Grand Canyon, would you be willing to pay one dollar more?" If the answer was positive, the question was repeated. This process is iterated until the participant will pay no more, and the total bid thus obtained is termed the "maximum willingness to pay". To test whether the individual's true preferences have been captured, we introduced into the consumer's opportunity set, the option of buying another familiar, hence well-defined, public good and observed whether the tendency to buy quantities of this newly introduced good modifies the respondents maximum willingness to pay for visibility in the Grand Canyon. Since this survey took place in the relatively smoggy-city of Denver, Colorado, we chose to introduce an improvement in air quality in Denver as the other, familiar, well-defined public good. This was accomplished by asking the respondents the following question. "Suppose that another surveyor came tomorrow and asked how much you would be willing to pay to see air quality improved in Denver, would you still be willing to pay the maximum amount you have indicated for the Grand Canyon?" If the respondent did not alter his previous bid, that fact may be taken as evidence that his true preferences have been revealed. If, on the other hand, the individual's bid changes when this other public good (air quality in Denver) is introduced, then this would imply that the dollar amount obtained through the Bidding Game fails to correspond with his/her true willingness to pay, i.e., the respondent's true preferences.

The Second Experiment differed from the First in two respects. First, the question regarding the other well-defined public good, local air quality, was deleted from the survey. Second, before the bidding process began, the individual was confronted with his budget constraint. This was accomplished by (1) asking the household to reveal its monthly net income and (2) requiring this figure to be allocated between five categories: housing/utilities, food, recreation/entertainment, transportation, savings, and finally other expenses. Only after giving this budget information was the respondent handed the payment chart and asked to select his willingness to pay to preserve the average level of visibility in the Grand Canyon through increases in his monthly electric utility bill. Once this figure was obtained the iterative procedure was employed to elicit his maximum willingness to pay. At this point the individual was requested to indicate which of the expenditure categories would be decreased in order to finance his contribution to the maintenance of present air quality at the Grand Canyon. This introduction of a budget constraint was designed to confront the individual with the opportunity costs entailed by his bid, and thus to stimulate preference research. The latter is desirable because when the individual undertakes substitution out of other commodities and into air quality at the Grand Canyon, he is brought to focus in a concrete way upon his actual valuation of the public good.

The Third Experiment differs from the Second in several ways. First, the budget constraint analysis was eliminated. Second, rather than introducing visibility at the Grand Canyon by itself as the public good to be purchased, in this experiment the good offered consisted of the well-defined composite commodity made up, simultaneously, of visibility at the Grand Canyon together with visibility at five other national parks in the region, Zion, Bryce, Mesa Verde, Glen Canyon, and Canyonlands National Parks. Photographs of the various parks as well as of different pollution levels were used to assure that this composite public commodity was well-defined in the mind of the bidder. The third difference was in the introduction of an ill-defined public good, in addition to the Grand Canyon which included "all 36 of the 77 national parks in the U.S. which are threatened with significant visibility deterioration". The simultaneous other public good was introduced to observe whether the bid for preserving visibility at the Grand Canyon would be affected by the concurrent presence of other well-defined public goods. The survey question was phrased as follows: "how much extra would you be willing to pay, at most, per month as an increase in your electric utility bill to preserve current average visibility as represented by the photographs in Column C rather than have the average deteriorate to that shown in Column B. Please give two separate bids, one for the Grand Canyon and one for the other regional parklands combined". As before, the iterative procedure was employed to elicit the individual's maximum willingness to pay. The inclusion of all other threatened parks in the nation was aimed at focusing the respondent's attention on the presence of the other vaguely defined public goods present in his choice set with the goal of discovering what effects this might have on bids given for the Grand Canyon. This question was phrased: "assuming you are willing to pay to see air quality preserved in all these other areas, would you still be willing to pay the same amounts for the Grand Canyon and for the regional parks you initially indicated?"

The Fourth Experiment was identical in all respects to the Third, with one exception. It included initial bids simultaneously for the Grand Canyon and for other well specified public goods, followed by a procedure to elicit the respondent's maximum willingness to pay, and finally it offered a chance to revise these bids after the participant's attention had been focused on the presence of air quality problems at remaining national parks for which he might want to expend some portion of his budget as well. The one difference in this experiment was the addition of the budget constraint. As in the Second Experiment, the procedure here was to solicit budget data before the bidding process was begun.

Each of the four experiments concluded by seeking the following set of socioeconomic data: home zip code, place of residence (rural, suburban, urban), education, age group, sex, size of household, whether the respondent was the primary income earner, and finally a note was made if additional information was used.

The survey was conducted in Denver, Colorado, during the summer of 1982. 172 interviews were completed, by five male/female teams, each equipped with identical picture boards. Two census tracts were chosen randomly from middle income tracts in the 1970 census data, and every household in these tracts were approached (see Table 2.1). The survey was restricted to middle income families for two reasons. First, because time and financial resources were constrained, and second, due to the limited sample size, it was necessary to hold the income variable constant, which permitted comparison of results across all four sub-surveys conducted. This restriction to middle income strata only requires qualification of any experimental conclusions. Extension of the experiment across lower and higher income brackets as well as the expansion of the sample size may permit generalization of our conclusions.

A.3 Survey Results

This sub-section presents in summarized form, the information collected in the surveys described in the preceding section. All values are means with their standard deviations in parentheses. Past and future visitation for the different sites are shown in Table 2.2. Table 2.3 presents monthly income and its allocation into the six expenditure categories mentioned above, which together with the bids are used to derive income, cross, and own price elasticities. Presented in Table 2.4 are initial and maximum bids for visibility in the Grand Canyon, with and without budget constraint, in the various contexts of the different combinations of other public goods. Included here are (1) the introduction of well defined, simultaneous other public goods as represented by preservation of visibility at the four regional national parks, (2) improvement of air quality in the Denver metropolitan area, and (3) the vaguely defined other public good, preservation of air quality throughout the entire national park system. Finally, Table 2.5 presents socioeconomic

TABLE 2.1

DESCRIPTION OF THE AREA SAMPLED FOR THE NATIONAL PARK SURVEY
DENVER METROPOLITAN AREA

community/ Area	Boundaries of the Sample	Census Tract Number[a]	% Black[b]	Mean Income[c]
Denver	West: Monaco North: Yale Ave. South: Hampton Ave. East: Syracuse	68.01	1%	17,774
Denver	West: I-25 North: Evans South: Yale Ave. East: Quebec	69.01	.05%	14,405

[a]Defined in the maps of, Census tracts Denver, Colorado Standard Metropolitan statistical Area: 1970 census of Population and Housing, U.S. Department of Commerce, Bureau of the Census Publication PHC(1.)-56.

[b]From Table P-4 "Income Characteristics of the Population: 1970," ibid.

[c]From Table P-1 "General Characteristics of the Population: 1970," ibid.

TABLE 2.2

PAST AND FUTURE VISITATION DAYS

	PAST GRAND CANYON	FUTURE GRAND CANYON	PAST ZION	FUTURE ZION	PAST MESA VERDE	FUTURE MESA VERDE	PAST BRYCE	FUTURE BRYCE	PAST CANYON	FUTURE CANYON
Experiment 1	1.02 (2.40)	2.70 (2.81)								
Experiment 2	2.17 (3.31)	4.37 (4.40)								
Experiment 3	.94 (2.68)	2.94 (3.83)	.31 (1.08)	2.26 (3.69)	1.69 (3.09)	2.94 (4.04)	.31 (1.11)	1.69 (2.35)	.49 (1.34)	1.40 (2.40)
Experiment 4	1.78 (3.36)	3.25 (2.97)	.67 (1.59)	1.50 (2.16)	1.69 (2.12)	3.08 (3.77)	.36 (1.27)	1.69 (2.55)	.49 (2.68)	1.04 (3.53)

Experiment 1 = Base survey + Maximum Willingness to Pay + Denver

Experiment 2 = Base survey with budget constraint + Maximum Willingness to Pay

Experiment 3 = Base survey with other regional national parks + Maximum Willingness to Pay + all remaining national parks

Experiment 4 = Base survey with other regional national parks with budget constraint t Maximum Willingness to Pay + all remaining national parks

TABLE 2.3

MONTHLY EXPENDITURES ($)

	INCOME* (MONTHLY)	HOUSING	FOOD	REC.	TRANSPORT	SAVINGS	OTHER
Experiment 2	1866.00 (682.72)	514.85 (310.74)	298.28 (146.19)	127.41 (111.49)	127.14 (150.45)	219.00 (202.74)	580.42 (486.61)
Experiment 4	2372.50 (1034.15)	573.97 (267.43)	306.95 (141.59)	172.50 (144.99)	129.16 (89.98)	430.69 (605.31)	765.05 (710.65)

Experiment 2 = Base survey with Budget Constraint + Maximum Willingness to Pay

Experiment 4 = Base survey with other regional national parks with budget constraint + Maximum Willingness to pay + all remaining national parks

* numbers in parentheses are standard deviations

TABLE 2.4

BIDS ($)

	INITIAL* GRAND CANYON	INITIAL REGIONAL	MAXIMUM GRAND CANYON	MAXIMUM REGIONAL	DENVER	NEW BID GRAND CANYON	NEW BID REGION
Experiment 1	5.69 (7.21)		9.20 (11.54)		6.03 (7.58)		
Experiment 2	6.77 (6.16)		10.39 (10.02)				
Experiment 3	5.21 (6.18)	5.53 (6.94)	8.31. (10.43)	9.60 (13.36)		8.03 (10.43)	9.25 (13.43)
Experiment 4	6.40 (9.07)	8.14 (11.29)	8.06 (9.61)	10.51 (13.40)		7.57 (9.19)	9.98 (13.00)

Experiment 1 = Base survey + Maximum Willingness to Pay + Denver

Experiment 2 = Base survey with budget constraint + Maximum Willingness to Pay

Experiment 3 = Base survey with other regional national parks + Maximum Willingness to Pay + all remaining national parks

Experiment 4 = Base survey with other regional national parks with budget constraint + Maximum Willingness to Pay + all remaining national parks

*numbers in parentheses are standard deviations data which includes the number of respondents in each sub-survey, education, age, family size, income, and monthly electric utility bills.

This subsection provides statistical answers to the questions which motivated the study. Primary among our objectives was to test the credibility of the Bidding Game technique through testing the stability of people's hypothetical valuations of a public good in differing opportunity environments. Variable across these environments were both choice set and budget constraint. A further question investigated was Randall's hypothesis that initial bid will always fail to fully capture maximum willingness to pay. The appropriate statistical test for hypotheses in which the dependent variable is influenced simultaneously by several independent variables is the f-test. In the present instance we wish to determine whether the bids are influenced by different combinations of variables, including budget constraint, well-defined simultaneous other public good, vaguely defined other public goods, and iterative elicitation of maximum willingness to pay, thus the f-test is employed.

The f-test procedure is as follows: (1) formulate H_o, the null hypothesis, that the means of two different experiments are equal; (2) formulate H_1, the alternative hypothesis that the means of two experiments are unequal; (3) assuming H_o is true, the data for the two experiments are pooled. The pooled bid data becomes the independent variable in the restricted model; (4) assuming H_1 is true, the data for the two experiments should remain separate, the unrestricted model is thus formed; (5) using sums of squared errors, numbers of observations, and the degrees of freedom in both the restricted and unrestricted models, the f-statistics can be calculated; (6) finally, if this f-statistic is smaller than the critical f-value associated with the pre-selected level of significance, then the null hypothesis cannot be rejected, otherwise the alternative hypothesis is accepted.

The first test inquires into whether there existed any significant differences among initial bids obtained in the four experiments. The f-statistic in this case was .217, f-critical was 2.60 with 95% confidence. Thus, the null hypotheses (initial bids are equal) cannot be rejected.

The second test compares maximum bids across the four experiments. The calculated f-statistic was .479 and the f-critical with 95% confidence is 2.60. Thus, the null hypothesis again cannot be rejected: there is no significant difference among maximum bids across survey types.

Using the results of the first two tests, initial bids across the four experiments are pooled, as can be the maximum bids. These two aggregate quantities are now tested for significant differences. Formulate H_o the pooled initial bid is equal to the pooled maximum bid. The alternative hypothesis then is that these two quantities are unequal. The f-statistic in this case was 9.646 and the f-critical with 95% confidence was 3.84. Thus, the null hypothesis is rejected: the initial bid is not equal to the maximum bid.

TABLE 2.5

SOCIOECONOMIC DATA

	# OF RESPON.	YEARS EDUC.	ACE	HH SIZE	(X-1000) INCOME	ELEC. BILL ($)
Experiment 1	64	15.09 (2.20)	41.89 (12.91)	3.38 (1.34)	37.38 (16.14)	57.34 (29.02)
Experiment 2	35	15.60 (1.99)	37.34 (11.96)	3.09 (1.42)	22.39	47.86 (18.12)
Experiment 3	35	14.91 (2.13)	43.89 (10.98)	3.31 (1.43)	31.43 (13.68)	57.93 (27.39)
Experiment 4	36	15.83 (1.81)	38.25 (12.28)	3.00 (1.22)	28.47	53.61 (29.10)

Experiment 1 = Base survey + Maximum Willingness to Pay + Denver

Experiment 2 = Base survey with budget constraint + Maximum Willingness to Pay

Experiment 3 = Base survey with other regional national parks + Maximum Willingness to Pay + all remaining national parks

Experiment 4 = Base survey with other regional national parks with budget constraint + Maximum Willingness to Pay + all remaining national parks

* numbers in parentheses are standard deviations

The fourth test inquires whether the bids obtained for the Grand Canyon under the introduction of the vaguely defined public good is influenced by the presence of a budget constraint. The f-statistic in this case was .044, f-critical was 3.84 with 95% confidence. Thus, the null hypothesis cannot be rejected indicating that there exist no differences between bids obtained with and without budget constraint. Using the result of the fourth test we may pool bids for the Grand Canyon obtained with and without budget constraints. These bids were both made in the presence of vaguely defined other public goods. The fifth test compares this pooled bid against the previously pooled maximum bid. The f-statistic here was .912 and f-critical was 3.84 with 95% confidence. Thus the null hypothesis cannot be rejected, and we conclude that the introduction of a vaguely defined other public good had no significant effect on the bids.

The sixth and final test investigates whether the previously pooled bid for the Grand Canyon was significantly affected by the introduction of a well-defined public good, namely air quality in Denver. The f-statistic in this case was 2.59 and the f-critical was 3.84 with 95% confidence. Again, the null hypothesis could not be rejected, and we conclude that the introduction of this well-defined public good had no significant effect on the bids.

In summary the bid was not affected by the introduction of simultaneous other well-defined public goods, vaguely defined other public goods, or the budget constraint. The only variable which significantly affected the bid was the iterative procedure to elicit the <u>maximum</u> willingness to pay. In other words, the initial bid was not equal to the maximum bid.

A.4 Conclusion

This experiment addressed three issues. The first of which was the criticism that due to the hypothetical nature of the bidding transaction respondents could casually bid any amount without having to weigh the opportunity cost implicit in their bids. This question was tested by comparing the results obtained from two sub-surveys. One of which sought bids without a budget constraint, the other first confronted respondents with the limitations implicit in their budgets, and only then solicited bids. The results: "no statistically significant difference was observed in this case. This stability of bids, i.e., invariance with respect to the budget constraint has been rationalized as being due to the fact that the public good, visibility at the Grand Canyon, is <u>well-defined</u>."[2]

The contingent valuation technique has also been criticized for seeking bids for public goods singly, in isolation from an environment in which the individual would realistically have to purchase many other public goods at the same time. This criticism was tested for validity. Combinations of two familiar, hence well-defined, public goods, and one vaguely defined public good were introduced in an effort to perturb the bid offered. Statistical testing showed no significant difference in these additional goods. Again, this stability has been rationalized as stemming from the fact that visibility at the Grand Canyon was well-defined in the minds of the participants.

The third issue tested in this experiment was Randall's hypothesis that the initial bid will fail to capture full maximum willingness to pay. Initial bids were solicited, then an iterative procedure was employed to elicit maximum bids. Statistical testing of these two bids showed that the maximum bid was significantly greater than the initial bid in all cases.

The Bidding Game technique will be credible, first because the good is well-defined, and secondly because of a sound survey design. These two factors contribute to the inherent stability of all elicited bids. The experiments which we have conducted have statistically borne out that the bid responses were not altered significantly when adding these additional constraints (as explained earlier in experiments 1-4).

B. COMPONENT VALUES

B.1 Introduction

Up to this point we have been using the Contingent Valuation Technique to obtain measures of the value of preserving present visibility levels at the Grand Canyon. The phrase "Preservation Value" has been employed to denote the value placed, via the bids, on the public good. Krutilla (1967) suggested that benefits of preserving an environmental good can be sub-grouped into option benefits, existence benefits, and bequest benefits; in addition to benefits in actual use.

In this chapter the bids obtained for preservation of visibility at the Grand Canyon are broken down into the above categories in an effort to weigh their relative magnitudes. This will provide empirical evidence on the monetary significance of these values to assist in the development of environmental policy. Schulze, et. al. (1981) found that existence value surprisingly swamped the user value. Although this experiment was designed differently from Schulze, et al., but a comparison of the results obtained in these studies is required.

The remainder of this section is structured as follows: The survey design is presented in sub-section B.2. Sub-section B.3 reports the survey results, and finally, some concluding remarks are offered in sub-section B.4.

B.2 Survey Design

The Contingent Valuation Technique was utilized in this experiment as it was throughout this paper. The theoretical construct of this technique was fully explained in Chapters 2 and 4, thus this section concentrates only on explaining the structure of the questionnaire used in this study.

The "commodity" to be considered here is visibility at the Grand Canyon National Park. To collect information through the survey technique, the following steps were taken: the survey[3] was initiated with interviewers introducing themselves and presenting the purpose of the study. After the introduction, a detailed description of the Grand Canyon and the causes of poor visibility was given to each household interviewed. The respondents were shown a display of Grand Canyon photographs. These photographs represent five levels of visibility during morning and afternoon hours looking east and west from Hopi Point at the Grand Canyon. Column A represented poor visibility; B, below average; C, average visibility, D, above average and E, good visibility. in comparing columns respondents could see the variety of air quality conditions and resulting levels of visibility to be observed in the Grand Canyon. The rows represented the different vistas while standing at Hopi Point. The first row represented the different visibility and air quality conditions looking east, in the morning, Hopi Point. The second row represented morning conditions looking west, and the third row represented the view looking west in the afternoon from the same point. Past and future visitation by the household for the site was obtained by asking: how many days have you spent visiting the Grand Canyon National Park in the last 10 years? How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? In the next step, respondents were asked to state their maximum willingness to pay in higher electric utility bills if the extra money collected would be used for air pollution controls to preserve current air quality and visibility levels at the Grand Canyon. We must note, that this constitutes a direct attempt to determine how much preserving visibility at the Grand Canyon is worth to the household. In other words, the household was asked to state willingness to pay by an increase in their electric utility bill to preserve current average visibility as represented in Column C rather than have the average deteriorate to that shown in Column B.

If willingness to pay (WTP) was zero, individuals were asked to check one of the following: (1) the air quality improvements represented in the columns were not significant, (2) the source of air pollution should be required to pay the costs of improving the air quality, or (3) other (please specify). Then the component value questions were deleted and the respondents were only asked a set of socioeconomic questions.

If the WTP was positive, then the interviewers were asked to proceed with the component value questions. This part of the survey was designed to "breakdown" the Preservation Value Bid into its four possible components. Consequently there are four reasons why the individuals might be willing to preserve the environmental quality.

a. The first reason you might be willing to pay for preservation is <u>Actual User Value</u>. That is, when you actually visit the Grand Canyon, you would rather have air quality at "C" rather than at "B". Thus, you should be willing to pay some amount to preserve air quality for each day of their own use if their recreation experience is improved by air quality at "C".

b. The second reason is <u>Option of Use Value</u>. Although you might be uncertain as to whether or not you will ever visit the Grand Canyon, you might be willing to pay to preserve your "Option of Use" to visit the

Grand Canyon under conditions represented by "B". Thus, you may be willing to pay an extra amount above User Value to insure good visibility at the Grand Canyon if you decide to visit.

c. The third reason is called Existence Value. Whether or not you ever visit the Grand Canyon, you are willing to pay solely to ensure the existence of air quality conditions at the Grand Canyon for the benefit of your generation as represented by "C" rather than those represented by "B".

d. The fourth reason is Bequest Value. This category is closely related to Existence Value as defined above, however, in this case, you must be willing to pay to preserve air quality conditions at the Grand Canyon for the benefit of future generations.

In the last part of the Survey every respondent was asked a set of socioeconomic variables in the following order: home zip code, place of residence (rural, suburban, urban), educational level, age, sex, size of household, whether the respondent was the primary income earner, household's yearly income, monthly electric bill, and finally, note if additional information was used.[4]

The Survey was conducted in Denver, Co. in the fall of 1981. 75 interviews were completed by three male/female pairs each equipped with identical picture boards. These were equally divided into high, low, and income families. the sample were chosen in a random fashion where income class variation was an important factor in determining the sample areas. Data from 1970 Census Tracts were used, and Table 2.6 describes, in detail, the areas sampled and provides some relevant Census Tract information.

B.3 Survey Results

This section presents results obtained from information collected in the survey described in the previous section. All values are "means" with "standard deviations" in parentheses. Past and future visitation for the Grand Canyon National Park is shown in Table 2.7. Among all respondents interviewed, 36.9 percent have visited the Grand Canyon, while 67 percent indicated they plan to visit the site sometime in the future. As was the case in previous experiments, past visitation had very little influence on bids, while future visitation plans did have some influence on bids for the Grand Canyon.

Table 2.8 presents the various socioeconomic and demographic characteristics of survey respondents. These variables are, number of observations, level of education, age group, size of household, yearly income (gross), and monthly electricity bill. Additional information not included in Table 2.8 were (1) 64% of the respondents were primary income earners, and (2) that 55% of the respondents were male.

Survey respondents were asked how much they would be willing to pay as an increase in electric utility bills to prevent average visibility deteriorating from situation "C" to situation "B". This "preservation value" bid is paid whether or not the respondent actually uses the Grand

TABLE 2.6

DESCRIPTION OF THE AREA SAMPLED FOR THE NATIONAL PARK SURVEY
DENVER METROPOLITAN AREA

Community/ Area	Boundaries of the Sample	Census Tract Number[a]	%Black[b]	Mean Income[c]
Denver	West: University Blvd. North: Alameda South: Mississippi East: Colorado Blvd.	39.01	.1	25,892
Denver	West: Holly North: 23rd Street South: Colfax East: Quebec	40.02	.1	21,000
Denver	West: Federal North: 19th Street South: 6th Street East: River	8	9	4,142

[a]Defined in the maps of, Census Tracts Denver, Colorado Standard Metropolitan Statistical Area: 1970 Census of Population and Housing U.S. Department of Commerce, Bureau of the Census, Publication PHC(1.) -56.

[b]From Table P-4, "Income Characteristics of the Population:1970," ibid.

[c]From Table P-1, "General Characteristics of the Population:1970," ibid.

TABLE 2.7

MEAN NUMBER OF DAYS FOR PAST AND FUTURE VISITATION

	Grand Canyon*
Past 10 years	2.41 (11.40)
Next 10 years	4.35 (11.57)

* numbers in parentheses are standard deviations

TABLE 2.8

SOCIOECONOMIC CHARACTERISTICS

	Number of Obs.	Education (years)	Age (years)	Household size	Income (yearly) x$1000	Electricity (monthly)
Denver	75	14.95 (2.37)	43.5 (14.62)	2.32 (1.05)	32.695 (21.74)	55.33 (42.30)

* numbers in parentheses are standard deviations

Canyon. The preservation value bid and its break down into: (1) user value, (2) pure existence value, (3) option value, and (4) bequest value is shown in Table 2.9. Of the respondents 67 percent are classified as users, while 33 percent are nonusers. Thus, the user value for the latter group is zero. bequest value is the largest and the user value is the smallest among these values. Schulze, et al. (1981) found that the user value is a small portion of the preservation value. Our experiment resulted in a user value which is approximately 8 percent of the preservation value. Therefore, among all these components, which sum up to the preservation value, for the Grand Canyon, the user value is the least significant.

Finally, if an individual was not willing to pay (i.e., zero bid), he was asked to check one of three reasons for a zero bid. They are: (1) the air quality improvements represented in the columns were not significant, (2) the source of air pollution should be required to pay the costs of improving the air quality, and (3) other (please specify). Table 2.10 illustrates the zero bids by reason for all preservation value respondents. A total of 16 individuals expressed a zero bid, and only two persons indicated "not significant" as their reason for bidding zero. This small number indicates that visibility at the Grand Canyon shown by the photographs is significant to the respondents.

B.4 Conclusion

The purpose of the experiment as developed in this chapter was to develop and apply the contingent valuation techniques in order to measure user, existence, option and bequest values. Schulze, et al., (1981) found that the annual preservation value of the Grand Canyon, nationwide, approaches 3.5 billion dollars, but user value is on the order of tens of millions of dollars. Thus, user value is only a small fraction of preservation value.

The respondents in this survey were divided into two groups: (1) non-users (participants who have never visited the site and have no future plans to do so), and (2) users (respondents who do have future visitation plans).

"User value" for non-users is, of course, zero. "User value" for users is $0.62 for an air quality improvement from "B" to "C". Brookshire, et al. (1982) recorded $1.08 for the same air quality improvement, this amount, however, included user and option value. Thus, in our study, the sum of option and user value would be $1.28.[5] Therefore, the results of this study are very close in comparison to those results determined by Brookshire, et al. (1982).

TABLE 2.9

PRESERVATION VALUE BID AND ITS COMPONENTS

Reason	Bid*
User Value	.45 (1.04)
Option Value	.67 (1.66)
Existence Value	1.42 (3.63)
Bequest Value	2.54 (5.25)
TOTAL Preservation Value Bid	5.09

*numbers in parentheses are standard deviations

TABLE 2.10

ZERO BIDS BY REASON AMONG PRESERVATION VALUE RESPONDENTS

	Not Significant	Source should Pay	Other	Total
Denver	2	5	9	16

REFERENCES

1. Additional information concerning the scientific basis of the photographs, causes of poor visibility, a listing of industrial facilities, and finally a map of the area was supplied upon request.

2. See page 78, paragraphs (a) and (c), of the report (Methods Development in Measuring Benefits of Environmental Improvements, Schulze, W.D., Brookshire, D.S., et al.).

3. The actual survey is given in Appendix C.

4. Additional information concerning the scientific basis of photographs, cause of poor visibility, list of industrial facilities, and finally, a map of the area was supplied upon request.

5. The Grand Canyon had 2,131,700 individual visits in 1979 or about 761,300 household entrances, assuming one household equals one carload. Using $1.08, the average household bid per visit to maintain visibility at level C--the current summer average rather than the poorer condition B, on the day of the visit--then $1.08 times 761,300 = $822,204. Using the $1.28 figure, the average household bid for the same air quality improvement, the result is ($1.28) * (761,300) = $944,012. Here again is another evidence for closeness in the results.

   Also, the aggregate of these values can be obtained:

   Aggregate User Value = (mean user bid) * (number of visits)
   Aggregate Option Value = (mean option bid) * (potential visits)
   Aggregate Existence Value = (mean existence bid) * (number of households)
   Aggregate Bequest Value = (mean bequest bid) * (number of households)

CHAPTER III

THE NATIONAL WATER QUALITY EXPERIMENT

A. INTRODUCTION

The aggregate bid experiment to be discussed below is motivated by both previously discussed experiments and raises the following questions. First, the disaggregate bid experiment focuses upon a specific, well-defined commodity for a small geographic region. Given the difficulties of aggregating such a bid, a question of interest becomes: is it possible to obtain a defensible aggregate, or national, bid for such commodities through the use of contingent valuation (CV)? Second, does the potential for obtaining national, aggregate bids depend on how well the CV commodity is defined? Specifically, can the aggregate commodity, "cleaning up the nation's rivers" (or air) be valued utilizing the contingent valuation method?

Thus, the primary purpose of the aggregate bid experiment is to evaluate the usefulness of applying the contingent valuation method to evaluating programs that are described generally and, additionally, have no unique geographic anchor in the description of the program. For instance, the improvement could be described as an average increase in air or water quality nation-wide. Such an approach is, of course, in direct contrast to the disaggregate experiment whereby as many dimensions of the contingent valuation mechanism as possible are specified. Given that Mitchell et al.[1] introduced the aggregate bid method as a means for estimating social benefits attributable to improving water quality in the <u>nation's</u> freshwater lakes and streams, their work will serve as a point of departure for the aggregate bid experiment reported here.

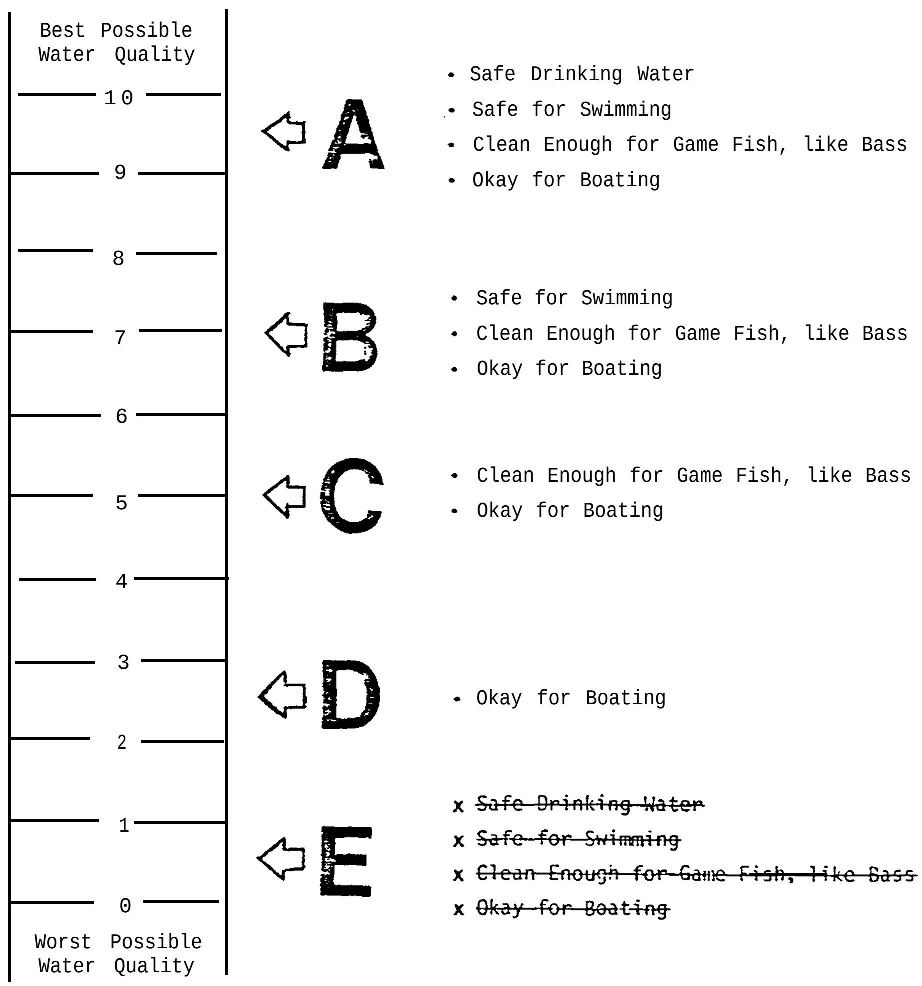
<u>A.1 The Aggregate Bid Experiment and CV Instrument</u>

The aggregate bid experiment involves the administering of a CV instrument, described below, to respondents in Denver, Colorado, during the period March 20-28, 1982. A complete set of CV instruments used in the aggregate bid experiment is given in Appendix E to this report. The basic structure of the CV instrument is as follows.

1. Following introductions and explanations of the purpose of the study, the water quality problem was defined via a water quality ladder (see Figure 3.1). The ladder defines the commodity "water quality" from a level "unsafe for drinking or boating" to a level safe for all activities (the current, average water quality level was described as level C in Figure 3.1). The basic survey format is the

Figure 3.1

Water Quality Ladder



same as that used by Mitchell and Carson except that in their study, the ladder describing water quality utilized pictures whereas water quality is verbally described in this study.[2]

At this point in the CV instrument, the respondent has been introduced to either a single commodity--i.e., water quality--or two different commodities--air and water quality. The CV instruments were further differentiated at this point by pursuing one of the following procedures:

2. An improvement in water quality from C to B is posited, coupled with a willingness to pay question. The respondent was handed a payment card to facilitate bidding.

3. A question is asked as to why the respondent bid zero if in fact they did bid zero.

4. Finally, demographic data was collected for: zip code, rural, suburban or urban, education level, age, sex, and size of household and primary income earner.

A summary of demographic characteristics for participants in the aggregate bid experiment are given in Table 3.1. Years of education average 14.7; average age is 38.9 years and, as expected, there is an inverse relationship between the percent who are female (52 percent) and the percent who are primary income earners (37 percent). Average sample size is 3.4 persons/household, and average monthly, after tax, income is $1,633.50 (standard deviation: $815.64).

The average (standard deviation) bid for the posited improvement in water quality was $6.50/month ($8.48). This value, comparative to bids obtained in the Mitchell study, will serve as our "baseline" bid against which will be compared effects of alternative changes in the CV instrument designed to induce "preference research" as explained above.

B. ADDING A BUDGET CONSTRAINT

In the aggregate bid experiment, the budget constraint is--as in the policy bid experiment--introduced prior to eliciting the individuals bid for improved water quality. The items included in the budget constraint are the same as those used in the policy bid experiment. For reasons that will be come apparent from our analyses of results, however, <u>two</u> different methods for introducing a budget constraint were used in this experiment: a "budget constraint" and an "extended budget constraint." The "budget constraint" method is identical to that used in the disaggregate bid and policy bid experiments. For the extended budget constraint method, a payment card is <u>not</u> used. The respondent is simply asked to rearrange his/her monthly expenditure pattern (information for which is acquired first) to reflect his/her maximum willingness to pay for the posited improvement in water quality--the individual, looking at his <u>current</u>

TABLE 3.1

DEMOGRAPHIC CHARACTERISTICS FOR PARTICIPANTS
IN THE AGGREGATE BID EXPERIMENT

Sample Size:	217
Average Years of Schooling:	14.86
Average Age (years):	37.22
Percent Male:	56.53
Average Household Size:	3.26
Primary Income Earners (percent):	56.04
Average Monthly (after-tax) Income:	$1764.90

pattern of expenditures (Table 3.2a) fills out a new budget (Table 3.2b) payment card is not used. The respondent is simply asked to rearrange his/her monthly expenditure pattern (information for which is acquired first) to reflect his/her maximum willingness to pay for the posited improvement in water quality--the individual, looking at his current pattern of expenditures (Table 3.2a) fills out a new budget (Table 3.2b) where water quality is included as a budget item. Thus, we focus upon the effects of two different budget constraints in understanding the respondents "researching of preferences."

Table 3.3 (discussed later) presents the mean bids and mean income for the surveys divided into two groups for comparison of the effect of a budget constraint. Effects of introducing an additional public good upon a bid for a single commodity will be discussed in Section C. Since we are focusing in this section upon the effects of introducing a budget constraint to a bid elicited in the absence of a budget constraint the following comparisons are relevant.

- Water Bid versus Water Bid with Budget Constraint
- Water Bid versus Water Bid with Extended Budget Constraint
- Water bid with Budget Constraint versus Water Bid with Extended Budget Constraint

Focusing on the comparisons of bids, mean bids range from $6.50 for the national average improvement from C to B as described by the ladder in sub-section A.1, to $26.00 for a water quality bid obtained utilizing the extended budget constraint (Table 3.3). Thus from a rank ordering perspective, introduction of either type of budget constraint into the survey format in order to induce respondents to research their preferences would appear to increase the bids. Table 3.4 gives the deviations from the mean of water bids.

Examining Table 3.5, the water quality bid is statistically different utilizing a means t-test from the bid obtained utilizing either alternative budget constraint. Further, in comparing the results of the different type budget constraints a statistical difference is also found.

Thus in focusing individuals on trade-offs through the use of two different budget constraints the stability of the original water bid is in question except in one case. However, note that the bids did not decrease but in fact increased. This is in contrast to the policy bid experiment. where the introduction of a budget constraint lowered the unconstrained original bids. A possible explanation for the case at hand is that the introduction of the budget constraints only further confused respondents who did not view the commodity as being well defined. However, at this point no evidence is available to support this contention. The role of the commodity in these results, however, will be discussed in more detail in later sections.

C. ADDING OTHER PUBLIC GOODS

TABLE 3.2

BUDGET SHEETS COMPLETED BY RESPONDENTS IN THE AGGREGATE BID EXPERIMENT: EXPANDED BUDGET CONSTRAINT METHOD

-a-

FIRST BUDGET INFORMATION REQUESTED

Monthly After-Tax Income $______________

Allocation To:

Shelter (includes utilities)	$______________
Food	$______________
Recreation/Entertainment	$______________
Savings	$______________
Other	$______________

-b-

BUDGET INFORMATION REQUESTED WITH WILLINGNESS TO PAY QUESTION

Monthly After-Tax Income $______________

Allocation To:

Shelter (includes utilities)	$______________
Food	$______________
/ Improved Water Quality /	$______________
Recreation/Entertainment	$______________
Savings	$______________
Other	$______________

TABLE 3.3

MEANS AND STANDARD DEVIATIONS (IN PARENTHESES) FOR THE WATER BIDS BY TYPE OF CV INSTRUMENT

Type of CV Instrument (Sample Size)	Mean Bid	Mean Income
Water (56)	6.50 (8.48)	1633.50 (815.64)
Water; Budget Constraint (25)	13.40 (13.65)	1646.20 (667.97)
Water; Extended Budget Constraint (28)	26.00 (26.29)	2070.00 (1116.91)

TABLE 3.4

DEVIATIONS FROM THE MEAN BY CV INSTRUMENT
(Mean = 13.38)

Type of CV Instrument	N	Deviation from the Comparison Group Mean
Water	54	-6.88
Water; Budget Constraint	25	0
Water; Extended Budget Constraint	28	12.62

TABLE 3.5

t-STATISTICS, DEGREES OF FREEDOM AND RESULTS OF THE HYPOTHESES TESTS CONCERNING THE EQUALITY OF ALL POSSIBLE PRICE OF MEAN WATER BIDS OBTAINED BY THE VARIOUS CV INSTRUMENTS
(t-statistics are given in absolute values)*

Type of CV Instrument	Water	Water; Budget Constraint	Water; Extended Budget Constraint
Water	-----------	2.77 (79) Reject H_o	5.07 (82) Reject H_o
Water; Budget Constraint	-----------	-----------	2.15 (59) Reject H_o

*Let X_i = mean bid from the i^{th} CV instrument technique.

Then: in each cell we test

$$H_o: \bar{X}_i = \bar{X}_j \ (i \neq j)$$

$$H_a: \bar{X}_i = \bar{X}_j \ (i \neq j)$$

for example, H_o: mean bid obtained from the water only CV instrument are equal to mean bid obtained from the water; budget constraint CV instrument

H_a: they are not equal

The t-statistic is .48, the number of degrees of freedom are 110 and we fail to reject H_o.

The critical values for the t-statistic are:

2.58 - 99% level
1.96 - 95% level
1.65 - 90% level
1.29 - 80% level

$$Z = \frac{|\bar{X}_i - \bar{X}_j|}{S \quad \frac{1}{n_i} + \frac{1}{n_j}}$$

$i \neq j$; where: n_i = the size of sample i, i=1, ..., 6
X = pooled sample standard deviation

For the aggregate bid experiment, the "other" public good introduced as an alternative method for inducing "preference research" is air quality. To examine the effects of introducing air quality as a commodity on a bid for water quality, an air quality ladder (Figure 3.2) is introduced in conjunction with the water quality ladder (see CV instrument in Appendix E). Thus, in the policy bid experiment, the individuals maximum willingness to pay for the public good of interest (improved water quality) is elicited within a context wherein the individual's attention is focused on other environmental problems, the mitigation of which could also involve costs.

Table 3.6 presents the mean bid and income. Examining the mean bids and income for the effects of focusing individuals on other environmental problems, we see that all appear relatively equal; in applying a test of means this result holds statistically. That is, whether air quality is introduced into a water only or water; budget constraint or water; extended budget constraint we fail to reject the null hypothesis that the bid for water quality obtained without consideration of all other environmental problems is equal to a bid obtained in the context of an air quality bid.[3] The critical value for 90 percent confidence level is 1.65 while the t-values in order of the comparison in Table 3.6 are respectively .48, 1.33, and .13. Thus adding a public good does not affect the bid.

Figure 3.2

Air Quality Ladder

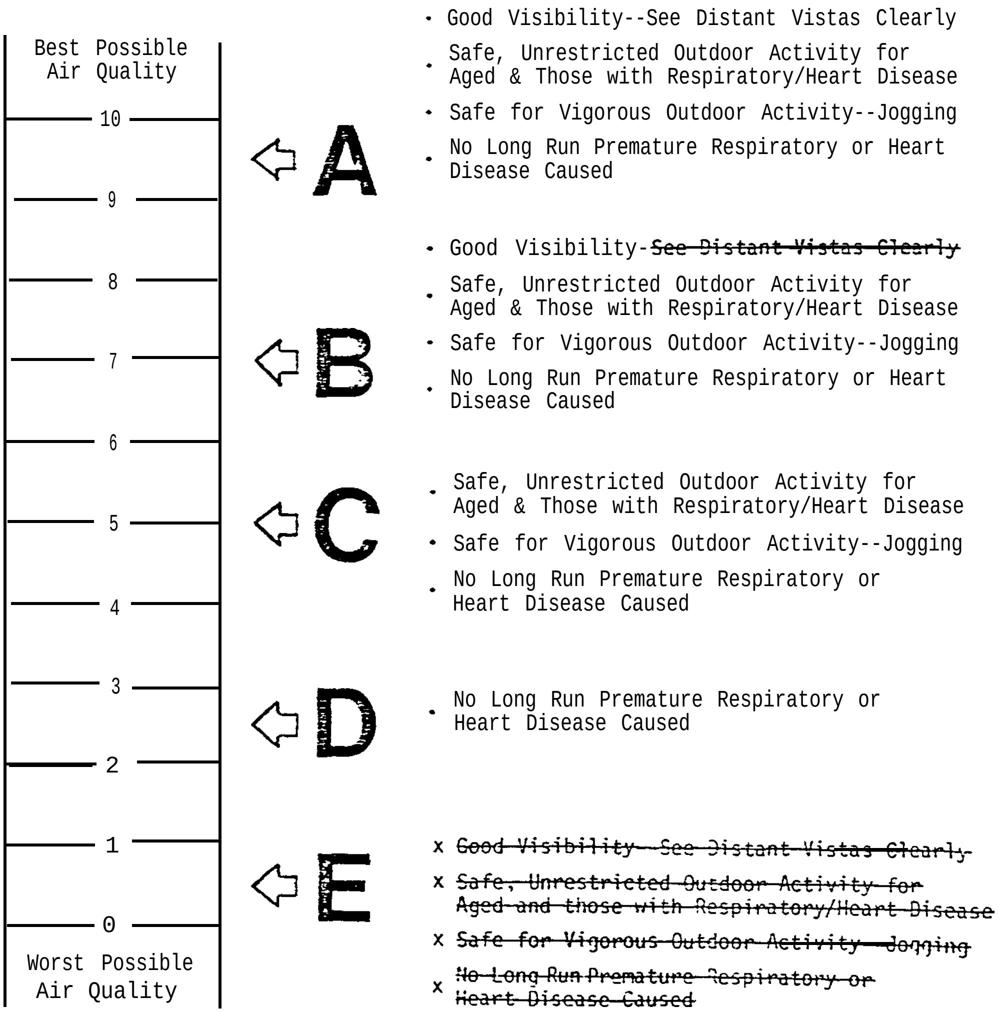


TABLE 3.6

MEAN AND STANDARD DEVIATIONS (IN PARENTHESES) FOR THE WATER BIDS BY TYPE OF CV INSTRUMENT

Type of CV Instrument (Sample Size)	Mean Bid	Mean Income
Water (56)	6.5 (8.48)	1633.5 (815.64)
Water and Air (56)	7.29 (8.29)	1623.8 (728.54)
Water; Budget Constraint (25)	13.2 (13.65)	1646.2 (667.97)
Water; Extended Budget Constraint (28)	26.00 (26.29)	2070.0 (1116.91)
Water and Air; Extended Budget Constraint (27)	24.9 (36.48)	2198.3 (1284.76)

REFERENCES

1. R. C. Mitchell and R. T. Carson, An Experiment in Determining Willingness to Pay for National Water Quality Improvements, Report submitted to the Office of Strategic Assessment and Special Studies, U.S.E.P.A. Contract #R-806906010.

2. The use of verbal descriptions was adopted to facilitate consistency with and "air quality ladder" discussed below.

3. For the structure of the test, see Table 3.5.

CHAPTER IV

TEE HAZARDOUS WASTE EXPERIMENT

A. INTRODUCTION

In the ozone experiment, reported on in Chapter V, as well as in the disaggregate bid experiments (Chapter II), the commodity used in the contingent valuation studies was relatively well defined. In the case where environmental risk was directly at issue (the ozone experiment), individual exposure to ozone and the effects of such exposure could be spelled out in considerable detail. In these instances where exposure and exposure effects were well defined, changes in contingent values attributable to changes in environmental risk (ozone levels) were consistent, in qualitative terms, with those that would be predicted from expected utility theory. Thus, while individual perceptions of risk associated with exposure to ozone are not, per se, measured in the ozone experiment--derivation of such measures is argued repeatedly in this volume as a vitally important next step in contingent valuation research--the framing of questions and information in the CV instrument seem to affect risk perceptions in a manner consistent with received expected utility theory. This observation may be important for future efforts to measure and explain risk perceptions as they relate to environmental risk.

There are many sources of environmental risk subject to regulation by the EPA which involve considerable uncertainty as to both exposure and exposure effects. One such source arises in the disposal of hazardous wastes. In the case of hazardous waste disposal, we know of cases where stored wastes have entered the environment; we know of cases where individuals have been exposed to uncontained wastes; and we know of instances where damages from such exposure have occurred (damages from ingested wastes by animals are documented; debate remains as to actual damages to humans, an area which we do not explore here). Notwithstanding these observations, we can specify with any degree of conclusiveness neither the nature, or probability of human exposure to hazardous waste nor the probability of damages that night attend such exposure. Thus, unlike the case with the ozone experiment, changes in environmental risk cannot be used as a commodity in a contingent valuation study of regulations on hazardous waste disposal.[1]

If one wishes to use the contingent valuation method as a means to estimate benefits attributable to more stringent EPA regulations on hazardous waste disposal (e.g., a total containment policy), one must then look to a CV commodity other than changes in environmental risk. One way of defining such a commodity is suggested in a recent work by Dr. Talbot Page.[2] Page poses the following dilemma facing society when uncertainty exists as to exposure and exposure effects associated with toxic substances:

a. In the face of this uncertainty, we (the EPA) can regulate "today" and accept the associated costs. In the future, as more information and knowledge develops, we can find: (i) we were justified in imposing the regulation--the "dangers" in fact warranted the regulation and it's associated costs, or (ii) we were wrong, we overregulated, the "dangers" to public health and safety were <u>not</u> of an order of magnitude to justify the costs incurred as a result of the regulation.

b. We <u>cannot</u> regulate today, rather, we wait for more information. In this case, we can later find that: (i) we were justified in waiting--the dangers were overstated and we correctly <u>avoided</u> the (ex-post) unnecessary costs associated with regulation, or (ii) we were wrong, our waiting has exacerbated the threat to health and safety.

Page's dilemma may be interpreted in the following way for our purposes. The CV commodity is an <u>action</u> (or policy) which has the effect of a hedge against uncertain risks to health and safety. In valuing this action, an individual must weigh certain costs against uncertain benefits (avoided health/safety risks). Of course, an EPA regulation on hazardous waste disposal is such an action or policy; in what follows we then refer to a "policy commodity" the contingent valuation for which is called a "policy bid".

Whether or not the use of an EPA policy can serve as a viable commodity in a CV study is a question to be addressed in this chapter. The CV commodity aside, what is really at issue here, of course, is the viability of the CV method per se as a means for deriving credible values for an environmental good which cannot be defined with any degree of specificness. Our experiences with the CV method to date have almost always involved commodities amenable to specific definitions. These experiences lead us to anticipate the potential for framing-types of problems (see chapters V and II) in attempts to apply the CV method to commodities such as hazardous waste disposal which are lacking in specificity. Of course, questions as to the extent to which the specificity of the CV commodity might limit application of the CV method provide the raison d'etre for the experiments conducted in this chapter.

In this chapter, our concern with experimental approaches for valuing environmental commodities is extended to that class of commodities involving uncertain environmental risks, where regulations on hazardous waste disposal are used as a case study. The specific objective of this inquiry is that of addressing the following related questions. In cases where the nature of environmental risk is uncertain, and, therefore, individual perceptions of such risk are of paramount importance, can framing of the CV instrument affect risk perceptions (subjective probabilities)? Further, with changes in risk perceptions, are resulting changes in policy bids consistent, in qualitative terms, with those predicted by established models of expected utility theory. Finally, do changes in the framing of the CV instrument result in policy bid changes that are consistent with changes deduced from received theory of value?

As in our earlier contingent valuation experiments with other environmental commodities, we do not attempt in this chapter to measure individual perceptions of risk associated with exposure and/or damages. We recognize the importance of such measures. However, we also recognize the importance of heuristic inquiries designed to provide the insights and data requisite for the formulation of informed questions and hypotheses that will be important in efforts to measure and explain risk perceptions as they are relevant for valuing changes in environmental risk. Thus, our study as to the potential viability of the policy bid approach proceeds within this exploratory context wherein insights and data are acquired via heuristic inquiry.

To the ends described above, the plan of our policy bid experiment and, therefore, the balance of this chapter, is as follows. In Section B we develop and motivate hypotheses which are to be tested from data obtained via a contingent valuation study based on the policy bid approach. Hypotheses related to these sets of issues are discussed. First, based on an expected utility model, we derive hypotheses as to changes in policy bids that should attend changes in subjective (perceived) probabilities related to exposure to and exposure damage from hazardous wastes (i.e., the subjective probability of hazardous waste containment and the subjective probability of damage from released, noncontained, wastes). Secondly, we develop hypotheses related to other aspects of individual preference structures, concerning environmental risk. As in our other experiments, primary concern here is with the framing of willingness to pay (WTP) questions and information as they might affect an individuals' process of preference research in arriving at contingent values. Third, and finally, hypotheses concerning interviewing and aggregation problems are discussed.

In Section C, our hypotheses are summarized and a contingent valuation instrument is designed for obtaining data required for testing the hypotheses. Results from the CV study and their applications to tests of hypotheses, are given in Section D. Conclusions are offered in Section E.

B. CONCEPTUAL AND METHODOLOGICAL ISSUES RELEVANT FOR EXPLORATORY ASSESSMENTS OF THE POLICY BID APPROACH

B.1 Hypotheses Drawn from the Expected Utility Model

Concern in the policy bid experiment is with a contingent valuation study wherein an EPA containment policy for hazardous waste disposal serves as the CV commodity. Given the above-described uncertainties surrounding the effects of such a policy, individual perceptions of two types of risks (their subjective probabilities) must underlie contingent values obtained in the CV study: subjective probabilities of waste containment with and without the EPA policy; and subjective probabilities of damages from noncontained wastes. Our a priori expectations as to the behavior of policy bids as changes occur in these subjective probabilities may be derived from the following expected utility model of decisionmaking under conditions of uncertainty. (For an excellent discussion of the expected utility theoretical framework and its application to hazardous waste disposal, see Desvousges and Smith, 1982).

We define our notation as follows:

Let P = the subjective probability of containment of toxic wastes;

Π = the subjective probability of health damage if toxic wastes are not contained;

Y = consumer income;

D = level of health damage which the consumer believes will occur to him or herself if exposed to toxic wastes;.

U(Y,D) = consumer utility, an increasing function of income ($U_Y > 0$) and a decreasing function of the level of health damage ($U_D < 0$);

and B = consumers bid (willingness to pay) for a government policy to contain toxic wastes.

Presumably a consumer will have a subjective probability for containment of toxic wastes even with no government policy, which we denote P°. A government policy to contain toxic wastes should raise this perceived probability to a higher level P^I. The willingness to pay for a waste containment program is in actuality a bid to raise P from P° to P^I. In the survey described below we obtain two bids for two levels of P^I which are given to respondents by the interviewer as 50% and 100%. We now develop a model to predict the determinants of the bid, B.

The expected utility of a consumer where no government policy for containment of toxic wastes has been undertaken is

$$P^\circ U(Y,O) + (1-P^\circ)[\Pi U(Y,\overline{D}) + (1-\Pi)U(U,O)]. \qquad (4.1)$$

The term $P^\circ U(Y,O)$ is the probability of containment with no program times the utility in a state where health damage is zero (D=0). This is the expected utility derived from the state wherein no release occurs and consequently no health damage occurs. The term on the right-hand-side weighted by $(1-P^\circ)$, the probability of a release, is the expected utility in the state of the world where a release does occur.

However, it is not certain in this state that health damage must occur. Rather, consumers believe that if a release occurs, health damage of level $\overline{D}$ will occur only with odds Π. Health damage may be zero (D=0) with odds $(1-\Pi)$ even though a release has occurred. Components of expected utility in these two compound states are $(1-P^\circ)\Pi U(Y,\overline{D})$, expected utility where a release has occurred and health damages result, and $(1-P^{\circ})(1-\Pi)U(Y,0)$, expected utility where a release has also occurred but health damages do not result.

Expected utility where a government toxics containment policy has been undertaken is identical to (4.1) above, except P^1 replaces P° and income is reduced from Y to Y-B so the consumer is paying $B to achieve P^1 rather than P°. Thus we have

$$P^1U(Y-B,0) + (1-P^1)[\Pi U(Y-B,\overline{D}) + (1-\Pi)U(Y-B,0)] \qquad (4.2)$$

as a measure of a consumer's welfare where a toxics program has been undertaken. If we set (4.2) equal to (4.1) and solve for B, we have the maximum willingness to pay of a consumer for a containment policy which the consumer believes will increase the odds of containment from P° to P^1. Further, if we totally differentiate the resulting equation we can solve for

$$\partial B/\partial P^1 = \frac{U(Y-B,0) - [\Pi U(Y-B,\overline{D}) + (1-\Pi)U(Y-B,0)]}{P^1U_Y(Y-B,0) + (1-P^1)[\Pi U_Y(Y-B,\overline{D}) + (1-\Pi)U_Y(Y-B,0)]}, \qquad (4.3)$$

the rate of increase of the bid with an increase in probability of containment. The denominator is simply the expected marginal utility of money, $E(U_Y)$, i.e., the probability weighted marginal utility of money in different states, which is clearly positive. The numerator is the difference between the utility in the state wherein no release occurs and the expected utility wherein a release does occur. Clearly the individual is better off in the state wherein no release occurs so the numerator is positive. Thus, $\partial B/\partial P^1 > 0$ and the bid should be larger for policies which have a higher probability of containment.

Again, by totally differentiating the equation obtained by setting (4.2) equal to (4.1) we can solve for

$$\partial B/\partial \Pi = \frac{(1-P^1)[U(Y-B,\overline{D}) - U(Y-B,0)] - (1-P^{\circ})[U(Y,D) - U(Y,0)]}{P^1U_Y(Y-B,0) + (1-P^1)[\Pi U_Y(Y-B,\overline{D}) + (1-\Pi)U_Y(Y-B,0)]}, \qquad (4.4)$$

the change in the toxics policy bid resulting from an increase in the perceived probability of health damage. Again the denominator is the expected marginal utility of money and is positive. However, the numerator defies easy interpretation. If the utility function is well behaved, a technique for approximating $\partial B/\partial \Pi$ is to approximate the utility function with a first order Taylor series expansion about Y and D=0 so

$$U(Y-B,D) \sim U(Y,0) - U_Y(Y,0)B + U_D(Y,0)D \qquad (4.5)$$

and

$$U_Y(Y-B,D) \sim U_Y(Y,0). \qquad (4.6)$$

Substituting (4.5) and (4.6) into (4.4), we obtain

$$\partial B/\partial \Pi \sim \frac{(P^{\circ} - P^{1})\, U_{D} \cdot D}{U_{Y}} .$$

Thus, as an approximation $\partial B/\partial \Pi > 0$ since $P^{1} > P^{\circ}$, $U_{D} < 0$, $D > 0$ and $U_{Y} > 0$. This approximation is correct if D and B are sufficiently small so that (4.5) and (4.6) are in fact good approximations. In other words, an increase in the perceived probability of health damage if a release has occurred should raise the bid for a containment policy according to the expected utility model of consumer behavior.

Given the broad, exploratory scope intended for this study, we wish to test the two qualitative hypotheses suggested by the analyses given above, viz. that contingent values for the policy commodity rise as (i) the perceived probability of containment, (P) rises and/or as (ii) the probability of damages (Π) rises. Means for testing these hypotheses are sketched as follows (greater detail is given below in Section III).

Before continuing, a major point raised in Section I must be stressed. An effort is not made in this study to measure individual perceptions of risk per se. Prior to initiating the study, the authors were well aware of the importance of risk perceptions for studies of behavioral responses to events involving risk.[3] What was (and, to some extent, remains) not well understood is how such perceptions, along with other preference-structure-related behavior discussed below, might influence (in a qualitative sense) contingent valuations offered by individuals. Thus, as repeatedly stressed throughout this report, the primary intent of this study is that of exploring these issues--of amassing data which can provide a basis for hypotheses formulations in later phase efforts to directly address the difficult problem of deriving quantitative measures for perceived risk.

Returning now to the hypotheses stated above, the hypothesis $\partial B/\partial P > 0$ is examined in the following manner. In eliciting the WTP measure, individuals are told that the EPA containment policy will totally contain (100% containment) hazardous wastes; i.e., $P^{1} = 1$. So long as individual perceptions of P with current disposal practices, P°, are less than 1 ($P^{\circ} < 1$), then we would expect a positive bid (call this bid MB for "maximum bid"). The individual is then asked to assume that the EPA policy is but 50% effective in assuring the containment of hazardous wastes--i.e., $P^{2} = .5$. The resulting bid, FB ("fifty percent" bid) can be expected to have the following relationship to MB depending on the individuals perception of P°:

$$P^{\circ} \geqq .5 \rightarrow FB = 0;$$
$$P^{\circ} < .5 \rightarrow MB > FB > 0.$$

Thus, if individuals perceive the probability of containment without the regulation as 50% or better, nothing is gained by the regulation and a zero value would obtain for FB. If perception of this probability are less than 50%, a positive value for FB would be expected; with $\partial B/\partial P > 0$, FB would be less than MB (associated with $P^1 = 1$).

In terms of the second hypothesis, $\partial B/\partial \Pi > 0$, the following test is used. We assume that one's perceptions of the probability of damage from hazardous wastes that are not contained is influenced by--determined by--information (examples) as to incidents wherein such damages have in fact occurred. Thus, one set of study participants (set I) are given very little information in this regard. A second set of participants (set II) are given numerous examples of damage instances. Denoting SB as an individuals' "starting bid" (initial contingent valuation), we then compare SB_I with SB_{II}. Given our hypothesis drawn from expected utility theory wherein we assume $\Pi_I < \Pi_{II}$, we would expect $SB_{II} > SB_I$.

Thus, our inquiry as to the influence of perceived risk on contingent values focuses on questions with one common theme: can risk perceptions be "moved" by information--is information as to such things as containment and damage probabilities an effective determinant of perceived risks?[4]

B.2 Other Issues Concerning Preference Structures

There are three sets of issues/questions concerning the structure of individual preferences for environmental risk which are considered in this study; given the nature of these issues, our approach is necessarily heuristic. These issues concern instrument framing and preference research, environmental safety costs and contingent values, and demographic variables.

B.3 Instrument Framing and Preference Research

As in our disaggregate bid experiment (Chapter II), we wish to address issues concerning the framing of WTP questions in the CV instrument and the extent to which "framing" can affect the necessary process of an individuals' "preference research" if offered contingent values are to be meaningful. Following received theory of value, an individual, in choosing an optimal, budget-constrained comsumption set of goods and services, will examine all possible goods/services and their prices in arriving at an "equi-marginal" position where the ratio of marginal utility (MU) to price (P) is equaled for all goods/services which are consumed, This is to say that the trade-offs for MU/P for all goods in the feasible set are considered.

The context of the CV study, when the policy commodity is explained to the individual, the effect may be that of introducing to the individuals' feasible set of goods and services a new good--the individual has not previously considered hazardous waste regulations as a "good" in his/her consumption set. If the WTP question is framed simply as willingness to pay for the described commodity, one may well inquire as to the extent to which the individual has, in fact, considered the trade-offs implied by his/her offered valuation of the policy commodity; i.e., the individual may not, with this frame, consider the changes in his/her present consumption/savings pattern implied by the contingent valuation, when one assumes (as the CV methods supposes that they do) that the offered valuation is in fact paid. Therefore, we wish to inquire as to the effect of different frames for the WTP question which relate to this preference research process involving the examination of trade-offs.

An issue which is inextricably related to the above concerns the question as to how individuals view any one, specific commodity. Received theory suggests that individuals view, and value, each individual commodity in their feasible consumption set. Thus, if an additional commodity is added to this set, that commodity is valued in its own right. However, recent work by psychologists,[5] suggest that individuals may view some commodity groups as a gestalt; i.e., individuals have "mental accounts" wherein similar commodities are grouped. Thus, as a simplification, in allocating income, rather than allocating $4.00 to a movie, $10.00 to a night at the bar, etc., an individual may simply allocate $14.00 to an "entertainment account".

The mental accounts notion has important implications for our study. If individuals do indeed view goods within a mental account context, the possibility exists that WTP measures for our policy commodity may well be more appropriately interpreted as a value attributable to a broader commodity (account): the individuals' "environmental safety account". The framing issue would then be most important--care must be taken to frame the WTP question in such a way as to focus attention one that one element in the environmental safety account of interest, viz., hazardous waste disposal (as differentiated form health/safety risks from air pollution, water pollution, etc.).

Before continuing, one should note that the mental accounts notion need not be necessarily at odds with the standard theory of value. The mental accounts notion may describe no more than a convenient process by which an individual thinks of goods/services at one level of abstraction--one sets aside, roughly, this amount of money for food, recreation, etc. When making actual expenditures, however, the account-level suballocation process may well cross account lines. Of course, this is pure conjecture and the relevance of the mental account notion remains as an open empirical question at this point.

Three alternative framing experiments are conducted in this study in an effort to gain insights as to the issues described above. These experiments are described as follows.

(i) We inquire as to the effect of framing the WTP question within a context wherein trade-offs between the policy commodity and goods/services in the individuals present consumption/savings pattern are made explicit. To this end, one set of participants (group A) are asked the WTP question in the usual way--explicit trade-off information is not given. For a second set (group B), prior to the WTP question, individuals are asked to reveal their monthly income and how this income is now spent in various expenditure/saving categories. The WTP question is then asked, along with the request that the individual indicate which expenditure category is to be reduced in order to facilitate the offered bid. With SB as the initial (starting) bid, we then test the heuristic hypothesis $SB_A = SB_B$ in inquiring as to the effect of this type of framing.

(ii) When asked the WTP question, individuals offer a WTP from a payment card (described below). In an effort to induce individuals to give depth to their consideration of this offered bid, a "bidding process" is then used. Thus, given an initial, "starting" bid SB, the individual is asked to suppose that, with all households paying SB, resulting income would be insufficient to implement the proposed regulation; under these circumstances, the individual is asked if he/she would be willing to pay $1 more, then $2 more, etc., until a maximum willingness to pay is obtained. Denoting this latter, "maximum" value (bid) as MB, we then test the heuristic hypothesis MB = SB in examining the effects of an instrument frame which involves the bidding process.

(iii) Finally, we inquire as to the effects on contingent values for our hazardous waste policy commodity of making explicit the <u>potential</u> trade-offs with other environmental goods. Thus, cleaner air, cleaner water, etc., might be obtained if individuals were willing to pay more for these items. An offer to "pay" for the hazardous waste policy must then be considered in this context. In obtaining MB, we assume, as one typically does in a CV study, that these trade-offs are considered. This assumption is tested by framing the WTP question within a context where these "other environmental goods" trade-offs are made explicit. After obtaining MB, these trade-offs are described for the five environmental goods (including our hazardous waste disposal good) given in List 1, Table 4.1. Following this description, the individual is asked if he/she is still willing to pay MB; if not, an adjusted bid OG ("other goods") is obtained. The effect of framing the WTP question with explicit consideration of other goods is then tested with the heuristic hypothesis MB = OG.

The OG question has implications that extend hazard commodity trade-offs, however. It relates to the mental accounts notion: is MB a contingent value for our specific EPA policy on hazardous waste disposal or one for (for example) an "environmental safety account"? Suppose that MB > OG, i.e., when presented with other goods, the individual lowers his/her WTP for our specific policy commodity. This observation could be consistent with <u>either</u> standard value theory (more commodities over which to allocate income results in less income allocated to our specific commodity) or the mental accounts notion (with attention focused on the entire account, WTP for one component--our policy commodity--is smaller). Therefore, we examine the following, three heuristic hypotheses which are relevant in these regards.

First, we inquire as to whether or not OG is somewhat "mechanically" derived by simply dividing MB by 5 (the number of other goods in List 1, Table 4.1), i.e., $OG = \frac{MB}{5}$. If equality holds, the result would be weakly suggestive of the mental account notion. Most importantly, equality in $OG = \frac{MB}{5}$ might raise serious questions as to

TABLE 4.1

LISTS OF "OTHER PUBLIC GOODS" USED IN PRE-TEST PHASE

Goods Included In List 1	Goods Included In List 2	Other Public Goods
X	X	Regulating facilities for permanent disposal of non-nuclear hazardous works
X	X	Regulating facilities for temporary storage of non-nuclear hazardous works
X	X	Regulating transportation of non-nuclear hazardous works
X	X	Regulating sites for nuclear waste disposal
X	X	Regulating transportation of nuclear works
	X	National Defense
	X	Improving Highway Safety

the extent to which OG is a thoughtful, reflective valuation, which is an important issue.

Secondly, in deriving OG, one set of participants (group 1) are given in List 1, Table 4.1, which includes only environmental goods. Another set of participants is given in List 2, Table 4.1, which includes List 1's environmental goods <u>and</u> the nonenvironmental public goods: national defense and improved highway safety.[6] <u>Ceteris</u> <u>paribus</u>, standard utility theory would suggest $OG_1 > OG_2$ inasmuch as List 2 involves more goods which are introduced into the consumption set. The mental accounts notion may imply $OG_1 = OG_2$, inasmuch as national defense and highway safety are excluded from the environmental safety account. Thus, the heuristic hypothesis of interest here is $OG_1 = OG_2$.

Third, and finally, as was the case in a recent study by Tolley and Randall, the sequence of obtaining contingent values--SB then MB then OG--may bias the OG value. To test for such bias, the OG value is obtained from one group of participants in the sequenced manner described above--OG is obtained <u>after</u> SB and MB. For a second group of participants, the <u>initial</u> SB value is framed within the "other goods" context. Prior to eliciting the WTP, List 1 (Table 4.1) is discussed at some length and the point is stressed that the WTP applies to <u>but one</u> of many EPA regulations related to environmental safety: a regulation on hazardous waste disposal. Denote the initial and maximum contingent values derived with this question-frame as SB(OG) and MB(OG), respectively. We test the heuristic hypothesis MB(OG) = OG. Equality can be taken to belie the existence of a sequencing bias. MB(OG) < OG may imply (i) the potential for a sequencing bias and/or (ii) consistent with the mental accounts notion: the MB(OG) frame better assists individuals in "getting inside" the environmental risk account.

<u>B.4 Environmental Safety Costs and Contingent Values</u>

A second set of issues related to preference structures concerns the information set within which contingent values are derived. By this reference is made to the fact that many EPA regulations on environmental quality are now in place (including existing regulation on hazardous waste disposal) and that individuals are now paying for the existing state of environmental safety via higher taxes and higher prices for goods and services. The EPA regulations on hazardous waste disposal of interest here represents a <u>marginal</u> change in EPA-provided safety vis-a-vis these many. existing regulations. At issue is the question: is our CV measure marginal in this sense?

One method for gaining insights to this question is to inquire as to the extent that individuals are cognizant of the existing state of environmental safety regulations and the "price" that they are in fact now paying for this state. If such cognizance exists, or contingent value for the total containment policy of interest here is appropriately "marginal". Thus, in experiments wherein measures for SB(OG) and MB(OG) are derived, estimates for the amount that households in the participants' income class now pay for environmental safety are given to one set of participants (and not given to another set) prior to eliciting SE(OG)--denote this value $SB(OG)^{COST}$. We then test the heuristic hypothesis $SB(OG) = SB(OG)^{COST}$ as a means for addressing this issue.

B.5 Demographic Variables

In looking to the determinants of contingent values for our policy commodity, we follow established practice in looking to the potential effects on preferences manifested in such values of demographic characteristics: income, age, sex, education, race and family size. In passing, we intuitively note the potential importance of family size (in this study, whether or not children under 18 are in the household) given the potential health threats associated with the hazardous waste disposal issue.

B.6 Methodological Issues

Two sets of methodological issues are considered in the policy bid experiment. The first concerns the choice of interviewing methods. The primary interview method used in this study is "intensive" in nature. Appointments for in-home interviews are prearranged by telephone some days before the interviewer visits the study participants home; typical interviews last 1½ to 2½ hours. This method is time consuming and costly. Given the necessary use of many visual aids (described in Section C) and the length of the CV instrument, however, the intensive method was considered desirable at the design stage of this project.

In one such study area (Houston, Texas), however, we experimented with the less expensive "extensive" method. Interviewers simply went door-to-door in preselected areas and requested individuals' participation as a CV study interviewee. Using the subscripts T and D to denote values drawn from the intensive, telephone-managed interviews and the extensive, door-to-door interviews, respectively, we then test for any differences in contingent values drawn form the two methods.

Thus, we test:

$$SB_T = SB_D$$
$$MB_T = MB_D$$
$$OG_T = OG_D$$

Secondly, we examine a methodological issue of considerable importance for efforts to derive national benefits estimates by aggregating over samples drawn from a few regions in the U.S. Here our interest is in the extent to which variables included in regression equations are sufficient to explain any differences in contingent values drawn from different cities (regions). The question as to comparability of contingent values drawn from three cities--Albuquerque, New Mexico, Houston, Texas, and New Haven, Connecticut --will be developed below.

C. STRUCTURE OF THE POLICY BID CV STUDY

C.1 Focus of the CV Study: Summary of Hypotheses

In assessing the potential viability of the policy bid approach as a means for obtaining contingent values for EPA regulations on hazardous waste disposal, arguments related to questions of particular importance for this assessment were developed above in Section B. These arguments suggested testable hypotheses, tests of which constitute the primary focus of this study. These hypotheses are summarized as follows (see notation, Table 4.2).

C.2 Hypotheses Concerning Perceived Risks

1. Is the policy bid for an EPA policy that is 100% effective in containing wastes (MB) the same as that for a policy that is posited to be only 50% effective (FB)?
Hypothesis 1: MB = FB

2. Is the policy bid for a 100%-effective containment policy with "small" information-related perceptions as to the probability of damages from uncontained wastes (SB) the same as that obtained with "larger" information-related perceptions of such probabilities (SB_{II})?
Hypothesis 2: $SB_I = SB_{II}$

C.3 Hypotheses Concerning Preference Structures

3. Does framing the WTP question within the context of explicit budget trade-offs affect the policy bid? (Subscripts A and B denote values from groups without and with budget information, respectively).
Hypothesis 3: $SB_A = SB_B$

4. Does framing the WTP question within a "bidding" process elicit focus on trade-offs, thereby resulting in adjusted policy bids?
Hypothesis 4: SE = MB

5. Does the explicit considerations of other (environmental) goods affect the policy bid?
Hypothesis 5: MB + OG

6. Is the "other goods" bid, OG, simply the maximum bid (MB) divided by 5?

Hypothesis 6: $OG = \frac{MB}{5}$

7. Is the "other goods" bid with only environmental goods (OG_1) the same as that obtained when environmental <u>and</u> nonenvironmental goods are considered (OG_2)?
Hypothesis 7: $OG_1 = OG_2$

8. Does the sequence of introducing other goods affect the

TABLE 4.2

NOTATION

SB = initial starting bids taken from payment card--100% containment policy

MB = "maximum" bid obtained from the bidding process--100% containment policy

FB = value obtained when EPA policy is posited as but 50% effective in containing hazardous wastes

OG = contingent value for 100% effective containment policy when "other goods" are introduced

OG_1: only environmental goods introduced (list 2, Table 6.1)

OG_2: environmental non-environmental goods introduced (list 2, Table 6.1)

MB(OG), SB(OG) = MB and SB values obtained when "other goods" are introduced prior to the WTP question

$SB(OG)^{COST}$ = the SB(OG) bid when participant is given estimate of how much he/she now pays for environmental safety

AI: = average annual household income

AG: = participants use

RC: = race (white anglo-saxon, hispanic, black)

SX: = sex (male, female)

CN: = children under 18 in household (yes, no)

EN: = education (years of school)

Subscripts: (a) I. II: denotes values drawn from participant groups who are not (I) and are (II) given information related to probabilities of damages from un-contained hazardous wastes

(b) A. B: denotes groups who are not (A) and who are (B) given explicit budget information

policy bid?
Hypothesis 8: $MB(OG) = OG$

9. Is the policy bid a "marginal" valuation; does cost information affect the policy bid?
Hypothesis 9: $SB(OG) = SB(OG)_{COST}$

10. What demographic variables (average annual income, age, race, sex, children and education) significantly affect the policy bid?

For the equation:

$$MB = \alpha_o + \alpha_1 AI + \alpha_2 AG + \alpha_3 RC + \alpha_4 SX + \alpha_5 CN + \alpha_6 EN$$

Hypothesis 10: $\alpha_i = 0, \quad i = 0, 1, \ldots, 6$

C.4 Hypotheses Concerning Methodological Issues

11. Is there a difference between policy bids obtained from the intensive, prearranged interview method (SB_T, MB_T, OG_T) and those obtained with the extensive, door-to-door method (SB_D, MB_D, OG_D)
Hypothesis 11: $SB_D = SB_T$
$MB_D = MB_T$
$OG_D = OG_T$

12. Is there a significant difference between policy bids obtained in Albuquerque (Q), Houston (H), and New Haven (N)?
Hypothesis 12: $SB_Q = SB_N$
$MB_Q = MB_N$
$OG_Q = OG_N$

$SB(OG)_N = SB_Q$
$SB(OG)_N = SB_H$

Hypotheses 1 - 12 are to be tested using regression techniques. For hypothesis 3, for example, the regression equation takes the form

$$SB = \alpha_o + \alpha_1 D + \alpha Y + U \qquad (4.7)$$

where the dependent variable SB is represented by an (n+m) x 1 vector containing the n starting bids for group A and the m starting bids for group B, D is a dummy variable represented by an (n+m) x 1 vector of n zeros and m ones denoting whether the observation was drawn from group A or group B, Y is the respondents income, U is a random disturbance, and the α_1 are parameters. The parameter α_1 is interpreted as the income adjusted "group effect" on SB. That is, if the least squares estimate, α_1. If a_1 is <u>not</u> statistically different from zero, then one accepts the hypothesis $SB_A = SB_B$. If α_1 <u>is</u> significantly different from zero, D significantly affects the average bid and one <u>rejects</u> the hypothesis $SB_A = SB_B$.

Thus, for each hypothesis which compares one WTP value (W_1: e.g., SB, MB or OG) with another (W_2), the hypothesis that is statistically tested is $H_o: \alpha_1 = 0$. If t^* is the t-statistic for α_1, t_c is the critical value for t^*, then, for each hypothesis:

$$t^* \geq t_c \rightarrow \text{reject } H_o \rightarrow \text{reject } W_1 = W_2,$$
$$t^* < t_c \rightarrow \text{accept } H_o \rightarrow \text{accept } W_1 = W_2.$$

C.5 The CV Instrument

The structure of the CV instrument used in this study is described as follows. Given the length of the interview, a number of exhibits are used as visual aids to assist the interviewee's understanding of conversations (exhibits and figures used and referred to below are given in Appendix D).

1. Following introductions and explanation of the purpose of the study, hazardous wastes are defined (exhibit 1).

2. The pervasiveness of processes which generate hazardous wastes is explained (such wastes result from the production of many of the goods that we commonly consume, (exhibit 2).

3. The volume of wastes generated each year is mentioned (exhibit 3).

4. The disposition of these hazardous wastes is described, with emphasis on those wastes that are permanently disposed (exhibit 4); for group II, pictures of these disposal methods are also shown (figures 1-4).

5. Attention is narrowed to the issue of the permanent land disposal of hazardous wastes; in what follows, we ignore problems associated with treatment, temporary storage, transportation and, particularly, nuclear wastes (exhibits 5 and 6).

6. We then describe potential threats to public health and safety associated with the disposal of hazardous wastes (exhibit 7). Group II is given a description of such hazards accompanied by examples (exhibits 7-A through 7-F).

7. Attention is then focused on the uncertainty surrounding the hazardous waste disposal issue; uncertainty as to the kinds of wastes that can safely be allowed to enter the environment as well as quantities that can be released without toxic accumulations is described (exhibit 8).

8. Given these uncertainties, the regulate-don't regulate dichotomy is presented (exhibits 9 and 10).

9. The possible effects associated with the regulate-don't

regulate dichotomy--Page's "horns of the dilemma"--are then described (exhibit 11).

10. Given this context for uncertainty surrounding the need for and effects from the regulation of waste disposal, a total containment policy (to be in effect for 10 years) is explained and the individual is asked for a maximum willingness to pay to have the EPA policy initiated; the initial valuation or "bid" is chosen from a payment chart (exhibits 12 and 13).

11. Following the initial bid, we posit the case where, with all households paying this amount, the payments are insufficient to accommodate the regulation--"would you be willing to pay $1.00 more per month?" This bidding process is continued until a maximum willingness to pay is determined.

12. Uncertainty as to the effectiveness of the containment policy per se is then introduced. A maximum willingness to pay (following the procedure in 11) is then elicited under the assumption that the probability is but 50 percent that the containment policy will in fact prevent hazardous wastes from entering the environment (exhibit 14).

13. Attention is then returned to the containment policy that is 100 percent effective (exhibit 12), and the individual is reminded of his/her bid of $X to see this policy implemented. We then discuss other similar sources of environmental risk (exhibit 15), EPA regulations which could result in higher costs to the individual (via, e.g., passed on higher costs for goods and services). Given that willingness to pay questions similar to those asked here could well be raised concerning regulations related to items such as those in exhibit 15, the individual is asked if he/she would still be willing to pay the $X bid; if not, a maximum willingness to pay for the containment policy for hazardous waste disposal is elicited.

14. The interview terminates with responses to demographic questions:

    Annual household income
    Sex
    Age
    Race
    Education
    Children living at home (18 and under)

These 14 steps given above, along with the exhibits in Appendix D, describe the basic CV instrument given to group A study participants in Albuquerque and Houston (roughly, half of the participants in these cities). For group B participants in these cities, the following information and questions are added to the basic CV instrument. Prior to eliciting the WTP measure in step 10, the individual is asked his/her monthly, after-tax income and how this income is allocated among the following categories (see exhibit 16).

Annual after-tax income	$________
a. Shelter (including utilities)	$________
b. Food	$________
c. Recreation/entertainment	$________
d. Savings	$________
e. Other	$________

The individual's bid is then elicited (step 10), along with the question: from which category, a-e, would you reduce expenditures in order to pay for the proposed EPA policy?

For reasons detailed in Section B, the CV instrument used in New Haven was modified vis-a-vis those described above. These modifications are described as follows.

(1) prior to step 10 (the WTP question), other environmental goods/regulations are discussed (exhibit 16)--we now pay for these existing environmental regulations.

(2) for half of the participants, stress is given to the fact that we are interested in making more restrictive only one of these many environmental regulations: hazardous waste disposal (exhibit 19). Step 10--the WTP question--is then used.

(3) for the other half of the participants, prior to (2), above, the participant is given an estimate of how much he/she now pays for environmental regulations (exhibit 17).

Referring to the basic CV instrument (steps 1-14, exhibits 1-15), this instrument represents the end product of pretests conducted in Albuquerque, N.M., during the period September 1-November 31, 1981. Major findings from the pretest, reflected in the basic CV instrument, were as follows.

1. Initially, "starting bids" of $1.00 and $5.00 per month were given individuals at step 10--the WTP question. Seemingly individuals associated starting bids with the actual cost of implementing a containment policy and final WTP valuations tended to cluster around the starting bid (either $1.00 or $5.00)--i.e., we encountered obvious "starting point bias".[8] This problem is corrected with the use of the payment card, exhibit 13, wherein individuals choose their own initial valuation.

2. Concern with nuclear waste disposal was pervasive in pretest interviews. Therefore, the exclusion of nuclear waste issues in this study is stressed in exhibit 6.

3. The regulation was posited as being in effect (exhibit 12) for 5

and 10 years. Resulting WTP valuations were found to be invariant to 5 or 10 years. Therefore, the 10-year horizon was uniformly adopted.

C.6 Implementing the CV Instrument

As the reader can now appreciate, the CV instrument is lengthy and considerable information must be communicated to the study participant. If the interviewee is to comprehend the WTP questions, time is required for the interviewee to ask clarifying questions, repetitions, etc., and the interviewer must be sensitive to whether or not the interviewee is following the conversation. As an aside, participants were generally very interested in the discussion and interviews averaged some 1½ to 2½ hours.

Reflecting these considerations, the decision was made to conduct interviews on a prearranged, appointment basis. This is the say that individuals were called at their homes and asked to participate in the study (see telephone script, exhibit 20). For those who agree to participate in the study, specific appointments were made and a "reminder" call was made at a later time. In Albuquerque and New Haven, phone numbers were taken from area phone books via a standard random number generator.

The technique used for drawing telephone numbers in Houston differed from the above. For Houston, the Research Triangle Institute, (RTI) selected survey areas which, based on census data, were to provide a stratified, representative sample of the Houston population (see Appendix E). The telephone exchanges for these areas were then used to form the pool of telephone numbers from which numbers to be called were selected via the random number generator. It must be recognized that for any particular demographic/economic area identified by RTI, its telephone exchange will in most cases include populations <u>outside</u> of the RTI area.

Finally, after completion of the appointment-arranged CV study in Houston, an effort was made to elicit participation in the CV study in 75 households on a door-to-door basis. In other words, if λ_i is the percent of the Houston sample which, according to the RTI sampling method, should come from area i, interviewers would enter area i and go from house to house for $\lambda_i(75)$ houses, conducting the CV study in those households which were willing to participate.

Success ratios for telephone-arranged appointments as well as for participation rates in the Houston door-to-door studies are given in Table 4.3; demographic characteristics of study participants are given in Table 4.4.

D. STUDY RESULTS

D.1 The Data

As described above, the policy bid experiment was conducted in three locations: Albuquerque, New Mexico (December 1, 1981 to March 1, 1982); Houston, Texas (September 15, 1982 to December 15, 1982)[9]; and New Haven, Connecticut (January 1, 1983 to March 15, 1983); data from

TABLE 4.3

CONTACTS AND PARTICIPATION RATES IN THREE STUDY AREAS

A. Albuquerque

Telephone Exchange	Number of Telephone Contacts	Number of Contacts Agreeing to Participate in study
24X	69	3
25X	81	9
26X	132	15
28X - 29X	258	21
34X	66	6
76X	15	0
82X	78	7
84X - 86X	33	4
87X	42	2
88X	72	6
89X	57	3
Total	903	76

B. New Haven

28X	201	21
24X	133	7
39X	257	23
38X	110	8
4XX	244	10
56X	24	1
78X	116	9
77X	166	10
86X	12	1
93X	18	0
Total	1,281	90

(Table 4.3 continued)

Table 4.3 (continued)

C. HOUSTON

RTI AREA	telephone prefix*	Door-to-Door: Number of Door-to-Door visits	Door-to-Door: Number of Households Willing to Participate in CV Study	Telephone Appointments: Number of Calls	Telephone Appointments: Appointments Made
21-04064	22X 465	2	0	35	02
21-11396	69X	3	0	63	4
21-12782	92X	2	0	47	4
21-15498	52X	2	0	31	3
21-18159	64X	3	0	39	5
21-27619	73X	3	0	49	3
21-45424	78X 72X	3	0	63	1
21-47548	77X	30	16	397	38
21-55790	86X	2	0	55	4
21-67008	462	3	2	60	4
22-15010	469	5	4	70	0
22-17395	472	2	1	59	5
22-22272	471	1	0	34	0
22-27095	498	6	1	50	5
22-34099	336	3	0	42	6
22-34570	258	6	0	53	8
Total		75	24	1,147	92

* The letter X indicates all 3rd-digit numbers

TABLE 4.4

DEMOGRAPHIC CHARACTERISTIC OF POLICY BID EXPERIMENT PARTICIPANTS

AREA	Sample Size	Average Annual Income* (000)	Average Education* (Years)	Average Age* (Years)	Percent of Participants: Non-White	Female	With Children In Household
Albuquerque	74	$27.4	15.5	42.1	26%	35%	28%
		(14.8)	(2.4)	(15.8)			
Houston							
Intensive	89	44.9	14.1	41.6	9	33	51
		(32.2)	(2.4)	(12.5)			
Extensive	24	23.5	14.8	32.0	4	54	25
		(13.0)	(2.5)	(8.4)			
New Haven							
Set 1	44	30.2	15.0	45.0	5	41	50
		(15.9)	(2.8)	(15.6)			
Set 2	44	30.8	15.7	39.1	7	48	59
		(17.2)	(2.2)	(11.6)			

* Standard deviations given in parentheses.

interviews in these areas are given in Appendix F. The number of households that ultimately participated in the CV study is: Albuquerque, 76; Houston (prearranged interviews), 90; Houston (door-to-door), 27; New Haven, 90.

As with most studies of this type, results may be influenced by "outliers"--i.e., a few extremely high or low values which, if included in the data set, may bias analyses. One method for eliminating outliers is suggested in recent works by Desvousges, Smith and others.[16] essence of this method is to eliminate any observation from the sample that has a disproportionately large effect on the estimated values $\hat{\alpha}_1$, $\hat{\alpha}_1$, or $\hat{\alpha}_3$. As applied in the present setting, the term "disproportionately large" was defined to be 30%. In other words, if after eliminating the ith observation from the regression, either $\hat{\alpha}_1$, $\hat{\alpha}_2$, or $\hat{\alpha}_3$ changed by 30% or more as compared with the values obtained in the sample, the ith observation was discarded. As shown, in the following table, however, few observations were treated as outliers.

AREA	ORIGINAL SAMPLE SIZE	ADJUSTED SAMPLE SIZE
Albuquerque, total		
Group A	44	42
Group B	32	32
Houston, total		
Group A	46	45
Group B	43	43
Houston, door-to-door, total	27	27
New Haven, total		
Group 1	45	44
Group 2	45	44

D.2 Average Measure for WTP

Average, income-adjusted measures for WTP drawn from the 3-city study are given in Table 4.5. Values given are for: the initial 'starting (or payment card) bid", SB; the "maximum bid" (which results from the bidding process), MB; the 'fifty-percent bid" (WTP when the EPA policy is posited as being but 50% effective), FB; and the "other goods bid" (WTP when other public goods are discussed), OG. Sets 1 and 2, for New Haven, refer to groups of participants who are not (set 1) and who are (set 2) given information as to their present outlays for environmental quality. All New Haven participants are given budget information. For Houston, "intensive" and "extensive" refers to prearranged appointment and door-to-door interviewing methods, respectively. Attention is now turned to an analysis of these data.

D.3 Affecting Risk Percentions in Contingent Valuations

Data in Tables 4.5 and 4.6 are relevant for hypotheses 1 and 2 concerning risk perceptions. In Table 4.6, the relevant t-statistic is less than the critical t for all cities in which case we fail to reject the hypothesis $\alpha_1 = 0$, which implies that we accept (fail to reject) the hypothesis MB = FB in all cases. Thus, contrary to the result consistent with hypotheses drawn from our expected utility model (MB > FB), the posited reduction from 100% to 50%) in the probability of containment does not result in a significantly lower bid--MB = FB, i.e., the bid is unaffected, in a statistical sense.

This apparent inconsistency between axioms drawn from expected utility theory and our survey results extends to perceptions regarding probability of damage as seen from data in Table 4.7. Again, we fail to reject the hypothesis $SB_I = SB_{II}$. An increase in information-related perceptions of the probability of damages does not, in contrast to hypotheses drawn from an expected utility theory model, result in an increase in the bid for 100% containment.

Obviously, one must interpret these results with caution. These findings may be viewed as indicative of any one or combination of the following explanations. First, the expected utility theory model (EU) fails in explaining behavior under conditions of uncertainty in this case. Secondly, our CV instrument fails in accomplishing its' intended purpose: affecting individual risk perceptions. In terms of containment probabilities (P in the EU model), the fact the MB is significantly greater than zero--that individuals are willing to pay for a 100% containment policy--supports the EU hypothesis $\partial B/\partial P > 0$. In asking individuals to assume that the policy is but 50% effective, the MB = FB finding may reflect things other than $\partial B/\partial P = 0$. For example, individuals may have perceived our 100% effectiveness statement as incorrect--around 50% is the best that one would expect. In the case of damage probabilities, it could well be the case that such perceptions are independent of information and/or simply that our framing of information failed to affect perceptions of damage probabilities.

In any of these cases, results in Tables 4.6-4.7 raise questions which require consideration as to the power of our EU models for situations involving environmental risk and, most importantly, the framing of questions/information used to affect perceptions of environmental risk. However, although not statistically significant, the sign of each of the relevant α coefficients is consistent with EU hypotheses developed earlier.

D.4 Instrument Framing and Preference Structures

Data in Tables 4.8, 4.9 and 4.10 are relevant for our efforts to examine the effects of changes in the framework of WTP questions on contingent values, as the framework might affect the individual's focus on trade-offs. Consistent with results in the disaggregate bid experiment (Chapter II), data in Table 4.8 supports the hypothesis that framing the WTP question within the context of explicit budget information does not affect the contingent valuation; it would seem that, in offering the contingent valuation, individuals are cognizant of implied private

TABLE 4.5

AVERAGE INCOME-ADJUSTED VALUES FOR POLICY BIDS
IN THE THREE-CITY EXPERIMENT

AREA	AVERAGE VALUE (standard deviation) FOR: (dollars per month) SB	MB	FB	OG
Albuquerque	$13.90 (17.23)	$21.32 (26.37)	$16.78 (24.69)	$14.20 (23.01)
Houston				
Intensive	17.06 (22.40)	29.62 (42.84)	20.37 (40.97)	17.15 (23.78)
Extensive	7.05 (8.44)	10.92 (14.50)	9.70 (14.20)	8.63 (14.14)
New Haven				
Set 1	13.34 (17.22)	25.84 (31.34)	22.09 (31.96)	n.a.
Set 2	17.52 (20.55)	31.85 (36.36)	25.16 (35.94)	n.a.

TABLE 4.6

TEST OF HYPOTHESIS MB = FB

For Regression Bid = $\alpha_0 + \alpha_1 D + \alpha_2 Y$:

AREA	Coefficient Value for α_1	t-statistic	Critical to (90%)
Albuquerque	-4.55	-1.092	± 1.645
Houston	-9.36	-1.622	± 1.645
New Haven	-5.22	-1.043	± 1.645

TABLE 4.7

TEST OF HYPOTHESIS $SB_I = SB_{II}$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque (N=24)	2.18	0.23	± 1.721

TABLE 4.8

TEST OF HYPOTHESIS $SB_A = SB_B$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	0.60	0.146	± 1.668
Houston	6.47	1.607	± 1.665

TABLE 4.9

TEST OF HYPOTHESIS SB = MB

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	7.43	2.058	± 1.645
Houston	12.70	2.790	± 1.645
New Haven	13.42	3.297	± 1.645

TABLE 4.10

TEST OF HYPOTHESIS MB = OG

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	-7.13	-1.779	± 1.645
Houston	-12.92	-2.718	± 1.645

goods/savings trade-offs (or, one might with to argue, they do not reflect on such trade-offs with or without explicit consideration of budget information).

The bidding process significantly affects contingent values as is seen from data in Table 4.9. This result is in contrast to that found in Chapter II's disaggregate bid experiment. Of course, a different CV commodity is involved in the disaggregate bid experiment and conflicting results may reflect differences in the specificity of the commodities. Further, one must be cautious in attributing the finding that the bidding process affects contingent values to the asserted cause: individuals' are induced to focus on relevant trade-offs. The finding may be indicative of other behavioral responses; e.g., the interviewee, when asked ". . . would you pay x-dollars more . . ." (see step 11 in the CV instrument), may feel that an adjusted bid is somehow "expected" from him or her.

From Table 4.10, we find that framing the WTP question within the context of other (environmental) goods results in a significant reduction in the contingent valuation--when attention is focused on trade-offs between our policy commodity (hazardous waste regulations) and other possible regulations affecting environmental safety, the contingent valuation for hazardous waste regulations is adjusted downward. Of course, this result is consistent with standard value theory as well as with the notion of mental accounts.

For reasons developed in Section B, we extend our analysis of how consideration of other goods affects the contingent valuation of one, specific good. First, we ask if the other goods-adjusted bid is simply a mechanical adjustment of the MB value; i.e., is OG simply MB divided by the number of other goods discussed in the CV instrument (5, see Table 4.1, List 1). That such is _not_ the case is suggested by data in Table 4.11. The average value for OG is significantly lower than MB/5, a finding that is consistent with the argument that, in considering trade-offs between the hazardous waste commodity and other environmental commodities, the individuals mental preference research process vis-a-vis these trade-offs is discerning process.

Results given in Table 4.12 are striking in their _possible_ inconsistency with value theory and their consistency with the mental accounts notion. Data described above suggests that the introduction of other environmental goods affects the contingent valuation (Table 4.10) and that such efforts reflect some degree of thoughtful differentiation between several environmental goods (Table 4.11). When still more "other goods" are introduced, but goods which are _not_ related to environmental safety, the contingent valuation _for the environmental good_ is unaffected. All else equal, value theory would lead us to expect a change in the contingent valuation as income is to be allocated over an expanded consumption set, in contrast to the result given in Table 4.12. The result is consistent either with the mental accounts notion, or with a rather extreme separability for environmental from other goods in consumers utility functions.

TABLE 4.11

TEST OF HYPOTHESIS $OG = \frac{MB}{5}$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	-9.93	-3.657	± 1.645
Houston	-11.05	-4.375	± 1.645

TABLE 4.12

TEST OF HYPOTHESIS $OG_1 = OG_2$

AREA	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque (N=50)	5.67	0.741	± 1.684

There are, of course, a number of possible explanations for the apparent inconsistency between Table 4.12 results and value theory. Individuals may be sated in these non-environmental goods at present, fixed outlays for the goods (equilibrium, equi-marginal conditions would be at issue here, however). They may feel that they can affect environmental goods but not the other goods. A weakness in the CV instrument in terms of affecting perceptions of the "other goods" may be an issue. At worst, we must conclude that Table 4.12 results raise questions as to how individuals assess values across heterogeneous groups of goods and that this issue warrants attention in future research. In this latter regard, it would be useful to extend this type of experiment to include many different types of goods-classes (possible mental accounts) in efforts to define the limits of "account" items (if, indeed, they are relevant) or further explore separability issues.

We next inquire as to the potential for a 'sequence bias" in obtaining other goods-adjusted contingent values. In the New Haven experiment, other environmental goods are introduced <u>prior</u> to the initial WTP question as opposed to being introduced after the derivation of SB and MB values in Albuquerque and Houston. At issue is the question: is the maximum bid obtained within the cost of other goods derived in New Haven (MB(OG)) the same as the "sequenced", other goods bid derived in Albuquerque and Houston (OG values)? Data in Table 4.13 present mixed results. As the 90% confidence level, the hypothesis $MB(OG) = OG$ ($\alpha_1 = 0$) is accepted (one fails to reject the hypothesis) for the Albuquerque experiment but is rejected in the Houston experiment. However, the failure to reject the hypothesis in the Albuquerque is marginal: one rejects the hypothesis at a slightly lower, 87.5% confidence level. Thus, the results supportive of the possibility of something of a sequencing bias in the OG contingent value.

Acceptance of the hypothesis that new Haven-type bids are significantly different (lower) than OG bids obtained in Albuquerque and Houston need not necessarily imply a "bias", however. Assume that individuals do, in fact, consider goods within the context of something like a mental account. From our earlier analyses, we would interpret MB (in Albuquerque and Houston) as a value relevant for an 'environmental safety" account and we then later, ask the individual to consider MB within the context of other environmental (we later "remind" the individual--call to his/her attention--of (to) these trade-offs). The individual must perceive the <u>implicit</u> emphasis on the fact that the hazardous waste regulation is one of many existing and potentially altered environmental regulations. While a "different" contingent valuation for the hazardous-waste regulation results, this relevant perception may be very different from that obtained in the New Haven experiment. In the New Haven experiment, the <u>interviewer</u> makes this emphasis explicit (see exhibits 16 and 19 used in New Haven). Thus, it <u>may</u> be the case that bid differences between the two experiments reflect differences in the individuals' preference research process relevant for getting "inside" the environmental safety account as opposed to a Randall-type sequencing bias per se.

The next issue related to preference structures addressed in this work concerns the extent to which contingent values for our policy commodity

TABLE 4.13

TEST OF HYPOTHESIS MB(OG) = OG

MB(OG) in New Haven Compared With OG Value In:	Coefficient Value for α_1	t-statistic	critical-t
Albuquerque	-8.82	-1.596	± 1.645 ± 1.554 (87.5%)
Houston	-16.28	-3.697	± 1.645

reflect an individuals' general awareness of what he/she is actually paying for environmental quality/safety at the present time. As discussed above, this issue is important for several reasons. In homey terms, if, in offering a contingent valuation, an individual fails to consider the wide range of existing regulations in place and what he/she now pays for the present environmental safety "state", the offered value may be meaningless at that later moment when he/she does consider the existing state. More formally, our interest is in valuing what is in fact a marginal change in the state of environmental safety and contingent values must be correspondingly "marginal" in nature.

In the New Haven experiment, half of the study participants (45) were given an estimate for the amount that similar (in terms of gross annual income) households now pay, in terms of taxes and higher prices for purchased goods and services, for the existing state of environmental regulations; the other half, of course, do not receive this information. The resulting contingent values are compared in Table 4.14: contingent values are seemingly unaffected by cost information. It would then appear that, in offering contingent values for our policy Commodity, individuals may be, in general terms, cognizant of the existing state of environmental regulations and the cost of maintaining this state.

In closing our analyses of issues related to preference structures and their implications for contingent valuations of environmental safety, we inquire as to the effects of demographic characteristics of individuals on this contingent valuation of our policy commodity. Results relevant for this issue are given in Table 4.15. As noted above, in the equation used for testing hypotheses involving bid comparison (equation 4.7), income is the only demographic variable included. Further, in all cases the coefficient on the income variable (α_2) is statistically significant (the t-statistic is well above the critical t at a 90% confidence level). When an additional five demographic variables are included in our equation, mixed results are obtained (Table 4.15). Income remains as a significant determinant of the MB contingent value in the Albuquerque and Houston experiments. In the Albuquerque experiment, contingent values are not significantly determined by other demographic variables. However, in the Houston experiment, the participants sex as well as their income is a significant determinant of the contingent valuation. Since the variable for sex in Table 4.15 is zero-one--zero for females, 1 for males--contingent valuations for the hazardous waste regulation are significantly higher for females than for males.

When Albuquerque and Houston data are pooled, two results are of interest. First, in the test as to differences between the regression equation with and without the pooled date, the f-statistic (99% confidence level) is $f_{6,126}$ = 2.8; the calculated f-statistic is F = 1.97, in which case one fails to reject the hypothesis that the equations are different. This implies that the MB value drawn in Houston is not significantly different from the MB value drawn in Albuquerque. Secondly, and of relevance to our discussion above, income and sex are significant determinants of the contingent valuation of the hazardous waste regulation with the pooled Albuquerque/Houston data set.

TABLE 4.14

TEST OF HYPOTHESIS $SB(OG) = SB(OG)^{cost}$

AREA	Coefficient Value for α_1	t-statistic	critical-t
New Haven	4.04	1.013	± 1.665

TABLE 4.15

TEST OF HYPOTHESES OF DEMOGRAPHIC VARIABLE EFFECTS ON CONTINGENT VALUES (MB-values)

AREA (critical-t)	Coefficient Value (t-statistic) for Variables: Income	Age	Race	sex	Children	Education
Albuquerque (1.684)	.7(1.943)	-.4(-1.400)	-9.6(-1.015)	-3.4(-0.354)	-6.7(-0.733)	2.9(1.512)
Houston (1.66)	.7(4.851)	-.2(-0.446)	5.2(0.363)	-16.0(1.845)	-0.2(-0.022)	.2(0.131)
New Haven (1.665)	.1(0.432)	-.1(-0.208)	4.0(0.248)	-3.4(-0.486)	22.4(2.836)	.8(0.529)
Pooled Albuquerque-Houston (1.665)	.7(5.765)	-.3(-1.223)	-6.2(-.790)	-11.5(-1.779)	-2.6(-.413)	1.6(1.286)
Pooled Albuquerque-New Haven (1.665)	.3(1.779)	.03(.188)	1.2(.174)	.05(.011)	5.2(1.000)	1.3(1.245)
Pooled Houston-New Haven (1.665)	.3(2.813)	.1(.301)	11.7(1.271)	-1.7(-.305)	4.5(.830)	-.4(-.435)

In the New Haven experiment, income is <u>not</u> a significant determinant of the bid when other demographic variables are added to equation (4.7)--the existence of children in the participants household is the only variable that is statistically significant in explaining the contingent valuation. With the zero-one variable D gives zero's for no children, 1 for the existence of children in the household, the positive coefficient on the "children" variable indicates that contingent values for the hazardous waste regulation are significantly higher in households with children than in no-children households.

As in the case of pooled Albuquerque/Houston data, f-tests for regression equations with and without pooled data suggest no significant difference between data sets. The f-statistic (99% confidence level) relevant for comparing the New Haven/Albuquerque (Houston) regression is $f_{6,125} = 2.96$ ($f_{6,164} = 2.925$); the calculated f-statistic is $F = 1.8726$ ($F = 0.959$). With pooled data, only income is significant in determing the policy bid in Albuquerque/New Haven and Houston/New Haven. Thus, the case for treating sex as an important determinant of the policy bid is weakened when pooled data are considered.

All of the above points to the potential importance of income, sex and children in determining individual preferences related to regulations which affect environmental risk.

D.5 Results Concerning Methodological Issues

The final set of issues considered in this chapter concern interviewing methods and aggregation issues. Results from the Houston experiment which compares contingent values obtained from intensive and extensive (door-to-door) interviewing methods are reported in Table 4.16. In terms of starting, maximum and other goods bids for the hazardous waste regulation there is no statistical difference in bids obtained form the two interviewing methods. This result is particularly interesting within the context of experiments with data gathering methods conducted as a part of the ozone study reported in Chapter V. In that experiment, little statistical difference was found between contingent values derived from mail surveys and those derived form extensive, door-to-door interviews. In terms of costs per CV response, those from mail surveys are less costly than those from extensive methods which, in turn, are less costly than those derived from intensive methods. Thus, to the extent that results from the hazardous waste and ozone experiments are in some sense "transitive", lower-cost mail survey techniques may be viable for future CV studies concerning hazardous waste regulations. At this point, however, our data limit conclusions to the finding that, in the case of hazardous waste regulations, the lower cost extensive method yields results comparable to those derived form the intensive method.

In terms of the aggregation issue, results form tests of hypotheses concerning the comparability of contingent values obtained in our 3-city study are given in Table 4.17. As seen in Table 4.17, there is no statistical difference between income-adjusted bids obtained in Albuquerque and Houston (comparisons with New Haven values were discussed above; see

TABLE 4.16

TEST OF HYPOTHESES RELATED TO VALUES FROM INTENSIVE AND EXTENSIVE INTERVIEWING METHODS

AREA	Value of α_1 Coefficient (t-statistic) For Hypothesis:		
	$SB_D = SB_T$	$MB_D = MB_T$	$OG_D = OG_T$
		(critical-t = 1.661)	
Houston	-2.24(-0.535)	-5.48(-0.661)	-2.39(-0.479)

TABLE 4.17

TEST OF HYPOTHESES RELATED TO BID DIFFERENCES BETWEEN CITIES

HYPOTHESIS	Coefficient Value for α_1	T-statistic	critical-t
$SB_Q = SB_H$	-3.04	-1.005	1.645
$MB_Q = MD_H$	-2.04	-0.369	1.645
$OG_Q = OG_H$	-2.04	-0.545	1.645

Table 4.13). This conclusion is supported by analyses described above wherein, using pooled Albuquerque/Houston data, bids adjusted for income and sex were not found to differ between the two cities.

E. CONCLUSIONS

The central questions addressed in the policy bid experiment concern the viability of the policy bid approach to measuring benefits associated with nonspecific, highly uncertain environmental risk, the effects of instrument framing on risk perceptions and other ideas related to preference structures and, more generally, the structure of major research problems which must be resolved in future research if the policy bid approach is to be used to generate estimates of national/regional benefits attributable to EPA regulations on hazardous waste disposal.

Subject to the caveats discussed below, results from this initial, explanatory research concerning the policy bid approach suggest, in the authors' view, considerable promise for the viability of this approach in applying the contingent valuation method. Lack of specificity in the CV commodity per se does not appear to introduce the magnitude of distortions that one might have expected a priori--although specificity-related problems exist as noted below. In this regard, the stability and comparability of policy bids across different regions and across different instruments, is encouraging (Tables 4.15 and 4.17). Study-participants seemingly grasp the substance of the policy commodity as well as the "marginal" nature of the commodity vis-a-vis the existing state of environmental regulations (Table 4.14). Further, the effects of changes in instrument framing are, in some cases, consistent with axiomatic behavior predicted by received theory as well as with results obtained from CV studies involving more specific environmental commodities (Table 4.8). Finally, lack of specificity in the policy commodity seemingly does not imply the need, as initially expected, for extensive, time-consuming, intensive interviewing methods.

A number of issues remain for further research, however. The most important of these, as we know at the outset, of course, is the need for measures of risk perception and changes in risk perceptions that are elicited in contingent valuation settings. This is to say that we need the capability of measuring perceptions of risk in the pre-commodity state as well as the perceptions that attend the policy bid offer. One conclusion from this experiment is made forcibly: we must understand the determinants of risk perceptions if the policy bid approach is to be made operational. The framing of risk changes used in this study, was not affective. Neither variations in the probability of containment nor (indirectly, via information) in the probability of damages resulted in significant changes in policy bids predicted by our expected utility model. These results could suggest problems with the expected utility framework. More likely, however, is the possibility that our a priori hypotheses as to determinants of perceived risk were faulty and/or or instrument frame failed to adequately communicate changes in risk. Thus, since individuals' perceptions of the "50% effectiveness" assumption may have been something other than a ΔP; considerable attention in further research must be given to how one communicates incremental changes in risk; policy bids for 100% containment were, of course, consistent with expected utility theory.

Aside from, but relevant for, the risk perception issue, the question as to how individuals perceive the non-specific commodity in the contingent valuation process remains as an important issue. Here reference is made to the "mental accounts" notion: does the policy bid apply, as intended, to the specific policy commodity or to something like an environmental safety account? Our results show that individuals adjust their bids downward when the policy commodity is valued within the context of other environmental goods (Table 4.10) and that such adjustments are seemingly discerning in nature (Table 4.11); our results are mixed in terms of the potential for a sequencing bias in this adjustment (Table 4.13). However, policy bids adjusted for trade-offs with other environmental goods are the same as those adjusted for trade-offs with environmental and non-environmental goods--individuals seemingly ignore non-environmental public goods in adjusting their contingent valuation for an environmental good (Table 4.12). Obviously, results from one experiment in this regard does not make the case for the mental accounts notion; the case is made, however, for the need for further inquiry in this area. If bids reflect an individuals' "dumping" of an entire "account", we must understand why. Potentially troublesome framing questions would then arise as to how one induces individuals to consider one component in this account. Our efforts in this regard (Table 4.13) produce mixed results: emphasis on the marginal change in the environmental safety state represented by our specific policy commodity resulted in bids that were similar to those obtained without this emphasis.

Finally, the effects of our commodity's lack of specificity is seen in the sensitivity of bids to instrument framing. Similar to results obtained in the Disaggregate Bid Experiment, couching the WTP question within the context of explicit budget information, thereby calling explicit attention to trade-offs between the policy commodity and other private goods/savings, does not affect the policy bid (Table 4.8). Unlike the disaggregate bid experiment involving a more specific good, however, both the bidding process and the introduction of other goods results in significant changes in the policy bid (Tables 4.9 and 4.10). When the bid changes with each change in framing, one simply does not have a value which can be interpreted as a preference researched bid: still more changes in framing may result in still more adjustments in the bid. Further research is clearly required which focuses on the development of CV instrument the results in bids which are reasonably insensitive to changes in framing. In closing this chapter, we note a curious result from the research relevant for this framing issue. While bids do indeed change as the frame of the contingent valuation changes, bid changes are affectively similar in each of the three cities studied in this experiment.

REFERENCES

1. In the ozone experiment, changes in environmental risk are directly related to an EPA policy on ozone levels: lower ozone levels directly imply lesser exposure (risk) and, therefore, exposure damages.

2. See T. Page, 1981.

3. See our earlier work in Cummings, et al., April, 1981, Chapter 8; see also, Slovic, et al., 1983.

4. That such _is_ the case is suggested by Slovic, et al., 1983.

5. See Kahneman and Tversky, 1982.

6. $OG_1 = OG_2$ could obtain in cases where individuals choose to allocate no more income to national defense and highway safety.

7. See Tolley and Randall, 1983.

8. See Schulze, et al., May, 1981.

9. Funding for initiating the Houston/New Haven phase of the study was delayed from March to September, 1982.

10. Desvousges, et al., 1982; their method draws on work reported in Belsley, et al., 1980.

CHAPTER V

THE OZONE EXPERIMENT

A. INTRODUCTION

The ozone experiment developed in this chapter was undertaken to satisfy a variety of objectives.

First, benefits of reducing ambient ozone concentrations are poorly understood apart from the overall value of reducing photochemical air pollution. Thus, development of a methodology for using the contingent valuation technique for valuing reductions in ozone exposure to households was one objective.

Second, the contingent valuation approach has been applied using mail surveys in some instances and interview surveying in other instances. However, the comparability of the two approaches has never been established. We accomplish that objective by employing both mail and interview surveying in valuing ozone reductions in six sample communities in the Los Angeles area. Overall, although response rates are substantially lower for the mail surveys, the two approaches give very similar results. This is quite surprising since we deliberately did no follow ups to increase the response rate for the mail surveys because we were interested in detecting non-response bias. This possible lack of apparent bias has a number of important implications. For example, the Bishop and Heberlein study (1979) used mail surveys, but included actual dollar payments for obtaining some bids. This study is important because it includes actual, as well as hypothetical attempts to repurchase hunting permits. However, the applicability of the results of this study have been limited because mail surveys might have differed substantially in bidding outcomes from interview surveys. Also, if mail surveys are valid, surveying for benefits of national environmental programs could be undertaken at a greatly reduced cost compared to in person interviews. Our results as presented in Section C suggest that further research in this area is warranted. We originally expected to reject mail surveying for bidding games as complex as the one used in this study.

The third objective was to obtain a better understanding of environmental preferences and how those preferences might affect the location decisions of individuals. As we show in Sections B and C, respectively, the theoretical and empirical linkages between survey responses and hedonic property values have not been explored, yet, this is a rich area for future research.

The fourth objective was to explore the consistency of daily bids for air quality levels with annual bids for a positively desired change in the frequency distribution of occurrence of those air quality levels. If annual bids (as perhaps capitalized in the property value study discussed below) are consistent with daily bids, as we show in Section E, then people are plausibly perceiving both the impact of daily changes in air quality on annual air quality, and of daily bids on annual bids, correctly. Also, this consistency, as shown in Section B, implies that individuals' utility functions are roughly separable over time in air quality.

Finally, the fifth objective was to attempt to validate the contingent valuation approach for ozone by comparison with a property value study, which we present in Section D. The property value study has been plagued by problems of multicollinearity. Distance to beach and the air quality variables of interest, ozone proxying for sub-clinical health effects and TSP (or extinction coefficient) proxying for aesthetic-visibility effects, are all highly collinear in the Los Angeles area. A variety of techniques were employed to attempt to solve this problem. The technique which appears to give the most stable results is the principal components approach. The precise economic-statistical implications of this approach are not well understood, so our results should be interpreted with caution. However, the objective of obtaining a health vs. aesthetics valuation split using a hedonic property value study is extremely important both for policy, since existing regulations are primarily health based, and to allow a comparison with the survey approach for valuing ozone. This comparison, which is quite favorable, is made in Section E.

B. THEORETICAL ISSUES IN INTERPRETING DAILY BIDS FOR AIR POLLUTION CONTROL

Two issues are of concern in analyzing individual daily bids for ozone reduction.

First, individuals will likely have very different tastes with respect to air pollution control. In a previous study (see Brookshire, Schulze, et al., 1982; and Schulze, et al., 1983) where individuals were allowed to bid for differing levels of pollution abatement for the Grand Canyon, some individuals had concave bid functions for reductions in air pollution willingness to pay increased at a decreasing rate for better air quality) while others had convex bid functions (willingness to pay increased at an increasing rate for better air quality). The latter.case is usually considered to be "pathological" in that nonconvex indifference curves are implied for individuals with convex bid functions. However, this case is not entirely implausible for environmental commodities. If individuals value a pristine environment very highly, but feel that a somewhat polluted environment is just as bad as a very polluted environment, then they will bid little for improvements in air quality to levels below pristine, but bid relatively large amounts to achieve pristine air quality. We analyze this type of behavior below, focusing on developing a simple measure of tastes to reflect the convexity of bid and indifference curves for analyzing the frequency of occurrence of individuals with what we will term "nonconvex environmental preferences" after the shape of the implied indifference curve. In addition, we show that with a well defined hedonic property value market for air quality, individuals with nonconvex preferences should cluster in the least and most polluted areas available and not be found in moderately polluted areas, Later, we examine this prediction in terms of the occurrence of nonconvex preferences as estimated from our surveys conducted in a highly polluted versus a moderately polluted area of Los Angeles County. We also compare the frequency of occurrence of nonconvex preferences as obtained from mail versus interview surveys to test for relative bias in sampling between the two approaches.

The second issue is the validity of obtaining daily bids for air quality improvements. Daily bids greatly simplify survey design, clarity and specificity, but imply a degree of separability over time which may not be entirely realistic. For example, an individual may wish to have clean air mostly on the day of a planned tennis game and care less if other days during the week are polluted. The validity of employing uniform daily bids for air quality improvements is evaluated below with a theoretical model specifying the degree of separability of utility functions which would be necessary to justify this approach.

To explore these issues, the following notation will be used:

Let

t = time in days (t=1, 2, 3, ...);
P_t = level of air pollution on day t;
R_t = reduction in pollution on day t;
Y = consumer income;
y_t = consumption on day t;
and B_t = daily bid for air pollution reduction.

To evaluate nonconvex preferences, time will initially be deleted from the analysis. Thus, consumer utility is taken to be a function of income and pollution.

$$U(y,P) \qquad (5.1)$$

where the partial derivative U_y is positive and U_P is negative. If the initial pollution level is $P°$, the observed pollution level is given by

$$P = P° - R \qquad (5.2)$$

where R is the reduction in air pollution associated with the policy or standard to be valued. The bid, or willingness to pay for pollution reduction, denoted B, can then be defined using a compensating variation-measure by the following equation

$$U(y°,P°) = U(y°- B, P°- R). \qquad (5.3)$$

The initial income and pollution levels $y°$ and $P°$ respectively give utility on the left-hand-side of (5.3) which is set equal to the utility on the right-hand-side determined by the new income level (which is reduced by the bid for pollution control to $y°$-B) and the new pollution level (which is lowered by the reduction in pollution to $P°$-R). Thus the maximum willingness to pay for pollution control is B.

Marginal willingness to pay can be obtained by totally differentiating (5.3) and solving for $\partial B/\partial R$ which yields:

$$\partial B/\partial R = -U_p/U_y > 0. \qquad (5.4)$$

This expression is strictly positive given our assumptions on the signs of U_p and U_y. To obtain the curvature of the bid function implied by (5.4) with respect to pollution reduction, R, we take $\partial(\partial B/\partial R)/\partial R$ to obtain

$$\frac{\partial^2 B}{\partial R^2} = \frac{U_{pp}}{U_y} - \frac{U_p}{(U_y)^2} U_{yp}. \qquad (5.5)$$

The usual assumption would be that the bid curve would increase at a decreasing rate in R so the expression in (5.5) would be negative. This would be true if $U_{pp} < 0$ and $U_{yp} < 0$ (or $U_{yp} > 0$ and sufficiently small) given that $U_p > 0$ and $U_p < 0$. Under these assumptions the indifference curve between y and R has the usual shape for positively desired commodities as shown in Figure 5.1 and the bid curve appears as shown in Figure 5.2. However, as indicated above, there is some evidence that bid curves for some individuals may increase at an increasing rate. This will occur if $U_{pp} > 0$ and $U_{yp} > 0$ for $U_{yp} < 0$ and $|U_{yp}|$ sufficiently small). Figures 5.3 and 5.4 show the indifference and bid curves respectively for the case of nonconvex preferences. Note also that the arrow in Figure 5.3 denotes the direction of preference, i.e., that y and R are desired commodities.

To test for nonconvex preferences among our respondents, we estimate individual bid curves as a function of pollution reduction using the following functional form

$$B = kR^{\eta} \qquad (5.6)$$

where k and n are estimated as separate parameters for each respondent. Given this functional form, $\partial^2 R/\partial R^2$ takes the form

$$\partial^2 B/\partial R^2 = k\eta(\eta-1)R^{\eta-2} \quad \begin{matrix} < 0 \text{ if } \eta < 1 \\ = 0 \text{ if } \eta = 0 \\ > 0 \text{ if } \eta > 1. \end{matrix}$$

Thus, if the estimated parameter n is larger than unity for an individual respondent, we have an indication that the individual has nonconvex preferences as defined above. Further, we can treat n as a taste parameter reflecting the shape of respondents' indifference curves and plot frequency distributions of n among subsamples to see how tastes are distributed between our mail versus door-to-door surveys and how tastes are distributed spatially as well.

This last point deserves further elaboration. Our previous research suggests that a well defined property value gradient for air pollution exists in the Los Angeles area. This implies that the cost of a home or

Figure 5.1: Convex Indifference Curve

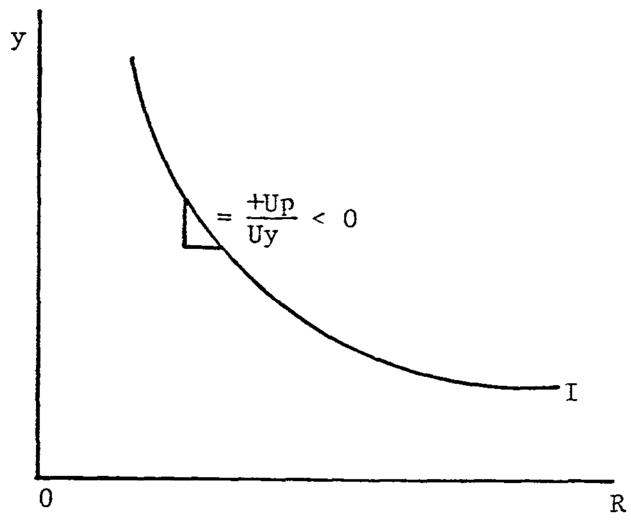


Figure 5.2: Concave Bid Function

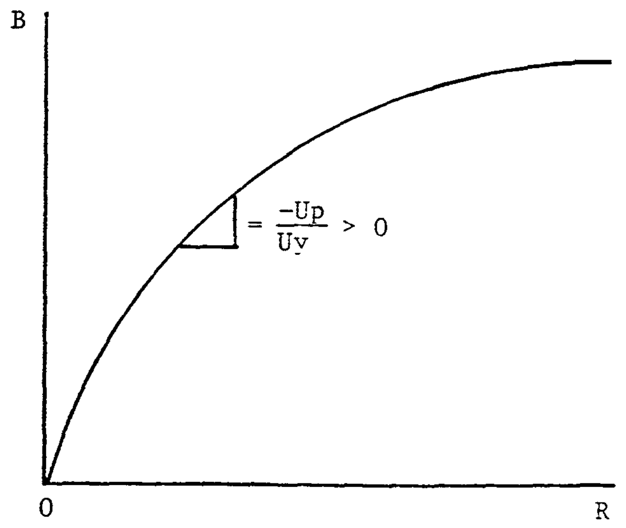


Figure 5.3: Concave Indifference Curve

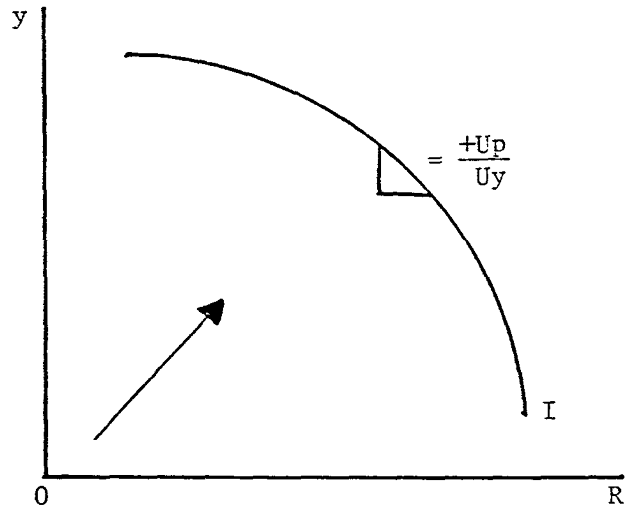
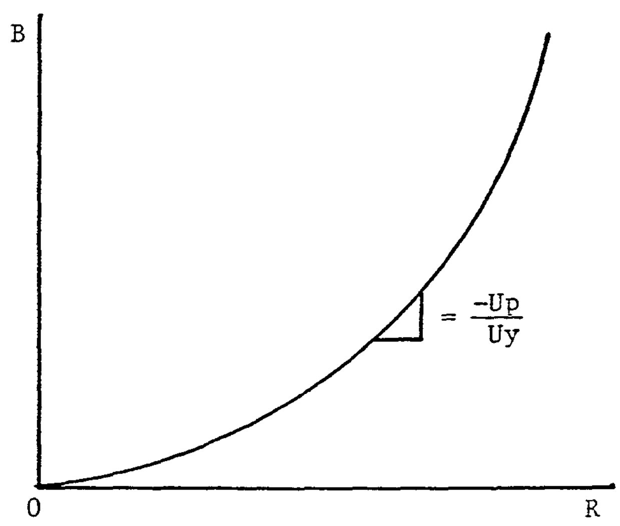


Figure 5.4: Convex Benefit Function



apartment varies with air pollution level. Where we denote this cost as C(P) where $C'(P) < 0$, consumers will choose a pollution "location" where they maximize utility,

$$U(y^\circ - C(P), P), \tag{5.8}$$

over choice of P. The first order condition for maximization of (5.8) implies

$$\frac{U_p}{U_y} = C'(P) \tag{5.9}$$

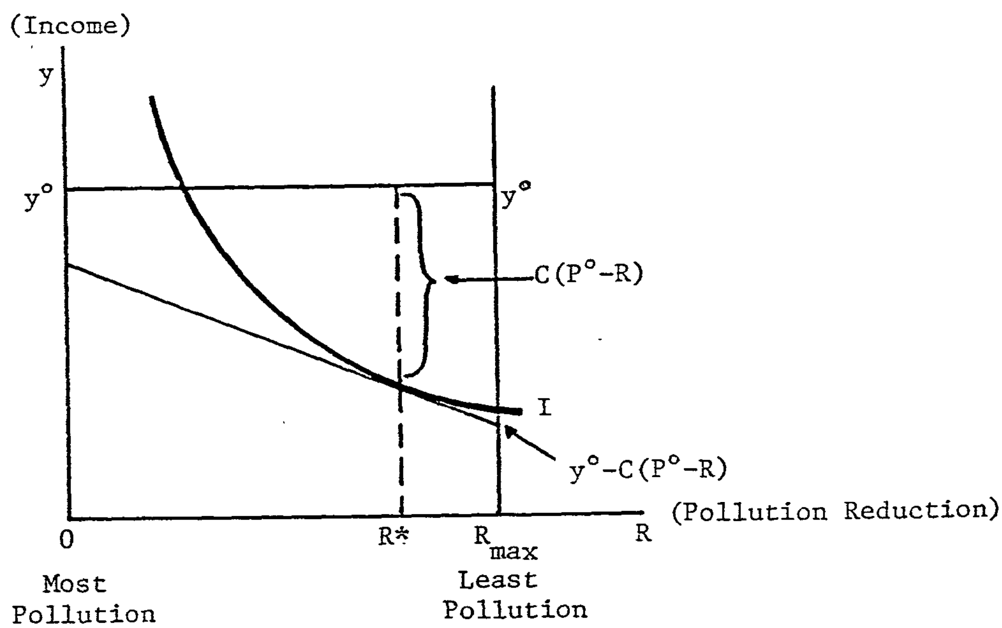
or that the slope of the indifference curve as shown in Figure 5.1 should lie tangent to the rent gradient which has a slope of C'(P). The solution to this problem is shown graphically in Figure 5.5 for the case of normal preferences where $P = P^\circ - R$ is substituted into (9) above yielding

$$\frac{U_p}{U_y} = C'(P^\circ - R). \tag{5.10}$$

In Figure 5.5, R = 0 represents the worst air quality available in the region, where the air pollution reduction is zero. The vertical line at R_{max} denotes the best air quality available in the region, where the air pollution is reduced to the maximum extent possible. The cost of housing, $C(P^\circ - R)$, is subtracted from the horizontal line $y^\circ - y^\circ$, representing initial income before housing cost is subtracted, yielding the net income curve, $y^\circ - C(P^\circ - R)$. The indifference curve denoted I is tangent to the net income curve where pollution reduction is R* and the individual chooses to live at a pollution level $P = P^\circ - R^*$. The individual has chosen to reduce pollution by living in a less polluted area, but to pay a higher cost for housing than would have obtained in the most polluted area. Individuals with convex preferences would presumably have solutions like that shown in Figure 5.5 with tangencies distributed between R = 0 and R_{max} However, individuals with nonconvex preferences will likely locate only at R = 0 or at R_{max} as shown in Figure 5.6. Thus, for example, an individual with a preference direction A (and associated nonconvex indifference curves) would have a corner solution and locate at point a, an area of maximum pollution. An individual with preference direction B would also have a corner solution but locate at point b, an area of least pollution.

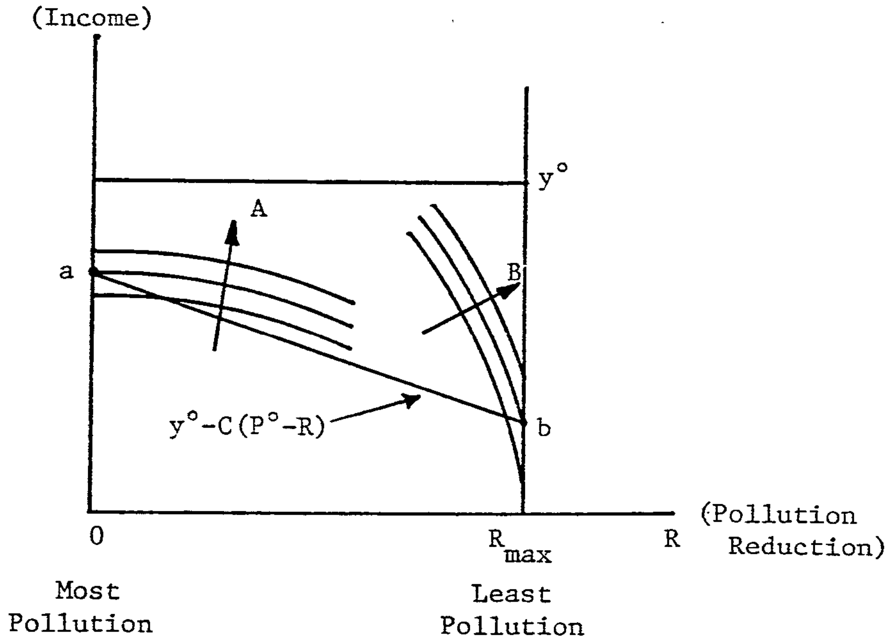
Thus, we have as a theoretical prediction that individuals with nonconvex preferences for air quality should cluster in the most and least polluted areas and that such individuals should be poorly represented in moderately polluted area. We test this prediction by examining the relative frequency of occurrence of nonconvex preferences (as indicated by n's greater than unity) in heavily versus moderately polluted areas in and around Los Angeles. Our empirical results presented in a following section show remarkable consistency with this prediction.

Figure 5.5



(Income)
y
y°
y°
C(P°-R)
I
y°-C(P°-R)
(Pollution Reduction)
0
R*
R
max
R
Most
Pollution
Least
Pollution

Figure 5.6



(Income)
y°
A
a
B
y°-C(P°-R)
b
0
R$_{max}$
R
(Pollution Reduction)
Most Pollution
Least Pollution

The second theoretical consideration is that of uniform daily bids. In general, utility over time can be specified as

$$U(y_1, y_2, \ldots, y_T; P_1, P_2, \ldots, P_T) \tag{5.11}$$

a function of expenditures on day t, y_t, and pollution on day t, P_t, for all days over the planning horizon from t = 1 to t = T. If individuals could hypothetically purchase a reduction in air pollution on day t equal to Rt by paying a cost $c_t(R_t)$ then the budget constraint would be

$$y - \sum_{t=1}^{T} y_t - \Sigma\, c_t(R_t) \tag{5.12}$$

where we ignore the role of compound interest or assume the planning horizon is very short. Substituting $P_t = P^\circ_t - R_t$ into (5.11) where P°_t is the initial pollution level before reductions R_t are purchased, the consumer optimization problem is to choose y_t and R_t to maximize (5.11) subject to (5.12). Where λ is the Lagrange multiplier on (5.12) and L denotes the relevant Lagrangian, first order conditions are:

$$\partial L/\partial y_t = U_{y_t} - \lambda \leq 0 \tag{5.13}$$

and

$$\partial L/\partial R_t = - U_{P_t} - \lambda c_t' \leq 0. \tag{5.14}$$

Combining these we obtain (for noncorner solutions)

$$\frac{-U_{P_t}}{\lambda} = c_t'. \tag{5.15}$$

The left-hand-side of (5.15) is effectively identical to the marginal bid B/∂R defined earlier as $\partial B/\partial R = - U_P/U_y$ in (5.4) above. In both versions, the numerator is the marginal disutility of pollution while the denominator is the marginal utility of money (λ here is the shadow price on the budget constraint (5.12)). However, in this case ∂B/∂R is a fairly complicated expression since

$$\frac{\partial B}{\partial R} = \frac{-U_{P_t}(y_1, \ldots, y_T; P_1, \ldots, P_T)}{\lambda} \tag{5.16}$$

and as can readily be seen, the marginal disutility of pollution depends on expenditure levels over time, the date t, and on pollution levels over time. In terms of daily bids, λ is, most likely, practically fixed. However, daily marginal bids may well depend on whether the particular day is one on which high expenditures are planned, a long weekend occurs, or neighboring days are polluted or clear. This level of complexity would make surveying for bids difficult if not infeasible.

Thus, the approach taken has been to ask for an average daily bid. Another justification would be to assume that the utility function is separable as follows:

$$U = u(y_1, \ldots, y_T) - \sum_{t=1}^{T} D(P_t) \qquad (5.17)$$

so utility derived from daily expenditures, $u(y_1, \ldots, y_T)$, is separable from the disutility derived on any day from pollution, $D(P_t)$. Further, disutility from pollution on day t, $D(P_t)$ is separable from disutility on any other day t', $D(P_{t'})$, but the disutility function D(P) is the same for every day. In this case, marginal daily bids are of the form

$$\partial B/\partial R = \frac{D'(P_t)}{\lambda} \qquad (5.18)$$

where $P_t = P^\circ_t - R_t$. Except for some minor interdependence through effects on the marginal utility of money, λ, this implies separability of daily bid functions for air pollution control. This simplicity is of great use in survey design and also eases the task of calculating total benefits of changing the frequency distribution of occurrence of air pollution levels, which is the actual effect of air pollution control programs. However, as we have tried to point out above, the assumptions to allow this simplification are extreme indeed.

C. THE CONTINGENT VALUATION APPROACH

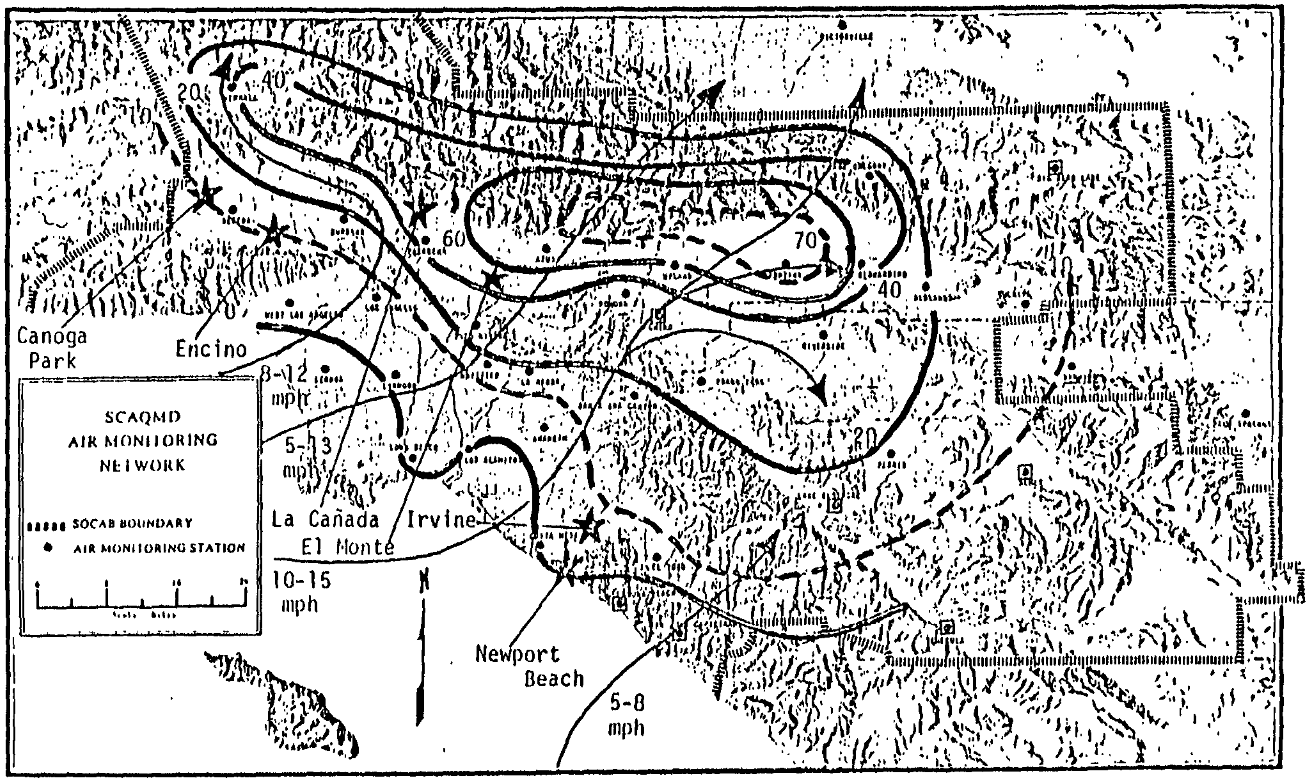
C.1 The Sample Plan

To provide a broad range of values for potentially relevant variables, six survey areas were selected that varied in peak ozone concentrations as well as in demographic characteristics.

The survey areas are in: La Canada and El Monte (in the West San Gabriel Valley); Canoga Park and Encino (in the San Fernando Valley); and Irvine and Newport Beach (in North Coastal Orange County). Figure 5.7 shows the location of the survey areas in the South Coast Air Basin (SOCAB). The illustration also shows the number of Stage I Ozone Episodes during 1981 in the SOCAB.

It can be seen that La Canada and El Monte had approximately 50 such episodes during 1981, the San Fernando Valley communities had about 10 such days and in Orange County, Irvine had 5 and Newport Beach 0 Stage One Episodes. There is year-to-year variation in air quality measures apart from long-run trends but these figures provide a rough measure to indicate the diversity of ozone levels in the survey areas. Also shown on Figure 5.7 are typical daytime wind patterns. These winds are largely responsible for the intra-basin movement of airborne emissions.

Figure 5.7: Sample Areas, Number of State One Ozone Episodes in 1981 and Daytime Summer Wind Patterns in the South Coast Air Basin



Air monitoring discontinued at this site.

Typical Summer Daytime Ocean Winds

Communities Surveyed

In 10-day intervals.

In 20-day Intervals.

* Source: "Season and Diurnal Variation in Air Quality in California's South Coast Air Basin" "1981 Summary of Air Quality in the South Coast Air Basin of California" Both published by South Coast Air Quality Management District

Various demographic traits of the survey areas are presented in Table 5.1.

When reviewing these traits, it should be kept in mind that no attempt was made to select a random sample of SOCAB residents. Rather, the intent was to provide sample communities which would provide the wide range of values sought in air quality and demographic measures.

This sampling technique is appropriate since the experiment was not an attempt to estimate aggregate benefits of ozone reduction across the SOCAB.

As can be seen, there is considerable variation among the sample areas in most characteristics. Mean household income (in 1979) ranged from $14,213 to $65,738. Further, within each air quality area there was variation in 1979 mean income: $14,213 and $65,738 in San Gabriel Valley; $16,028 and $58,675 in San Fernando Valley and $32,096 and $43,528 in Orange County. The desirability of low ozone levels made it virtually impossible to identify a neighborhood with high air quality and low incomes.

There was similar variation in other demographic variables: average number of persons per household varied within each air quality area although the variation was less in the San Fernando Valley.

The San Fernando Valley survey areas also showed relatively little variation in the fraction of the population that was more than 64 years old. In both these cases in which the San Fernando Valley showed relatively little variation, though, the values were intermediate. That is, there was no indication that the communities selected for any air quality area were extreme (except for the areas selected for extreme high or low ozone levels).

Within these broadly varied communities it might be possible to discern meaningful patterns in response rates or values of responses. The results are discussed in sub-sections C.3 and C.4 of this chapter.

C.2 Survey Design

Design Considerations

Survey-based bidding to estimate the value of nonmarket goods has been shown (Brookshire, et al., 1982) to be capable of producing estimates consistent with alternative evaluation techniques. Reliability in such estimates requires, however, that the object of the bid be a well-defined and understandable good and that the payment vehicle be plausible.

These are not trivial requirements in the case of basin-wide reduction of ozone concentrations.

Ozone is known to be among the most lethal of gases (National Research Council of the Rational Academy of Sciences, 1977) Even at the very low

TABLE 5.1

U.S. CENSUS INFORMATION FOR SAMPLE AREAS*

Community	Census Tract No.	Population	Avg. Persons	No. of Households	Mean Income	% > 64 Years	% White	Mean Travel Time to Work
La Cañada	4607	4903	3.03	1616	65,738	1.1	96.2	21 min.
El Monte	4334	9175	3.43	2673	14,213	7.1	72.7	21 min.
Canoga Park	1345	5645	2.40	2352	16,028	8.7	72.9	20 min.
Encino	1396	4319	2.60	1681	58,675	9.3	94.4	30 min.
Irvine	525.04	4340	3.16	1375	32,096	2.3	82.2	23 min.
Newport Beach	630.01	7528	2.25	3347	43,528	11.4	97.0	19 min.

*Source: 1980 Census.

concentrations (0 - 50 parts per hundred million) seen in SOCAB ozone has been shown to have significant effects on human health and comfort.

Ozone, however, exists as one of many irritants in photochemical smog. The effects of ozone in combination with these other pollutants is poorly understood. Even the effects of pure ozone have been difficult to examine: ethical and logistical difficulties inhibit the study of long-term intermittent exposure on human subjects while effects on experimental animals vary considerably among species.

The easily-identified effects of ozone exposure appear to be reversible, but are not always easily explained. In addition, some of the most common effects of smog (such as eye irritation) are typically caused by components other than ozone.

Ozone is produced when certain emissions (ozone precursors) are exposed to sunlight. In SOCAB daytime on-shore breezes move these compounds inland during the exposure period, resulting in higher ozone concentrations further inland (see Figure 5.7) with peak concentrations during late morning and afternoon (Hoggan et al.) Because of more intense solar radiation ozone, concentration tends to be higher in summer than winter.

The distribution of ozone concentrations within SOCAB varies with daily wind patterns, other meteorological phenomena and the level of human activity which produces ozone precursors. The issue of ozone reduction then is the issue of a probabilistic reduction of exposure to an agent with probabilistic effects.

Early consideration was given to the use of a downward shift in the annual distribution of daily maximum ozone concentrations as a bid object. While such a shift has the advantage of being the likely result of any feasible ozone reduction policy, it could not be presented in a manner suitable for a mail survey to the general population.

A specified ozone reduction on a specific day is more easily comprehensible but gives the choice of the day special significance. People might reasonably have very different preferences among weekends, holidays and other days and might even feel strongly about different weekends during any summer month.

A bid object was finally selected which was intended to be fully enough specified to elicit comparable responses from a wide range of individuals, but which avoided arbitrary specification of detail.

Identification of the good to be bid upon was accomplished by referring to a memorable day and using ozone levels on that day to define the base level for bids to reduce ozone concentration on an unspecified summer day.

Selection of the "memorable" day was straightforward: the summer of 1982 was one of generally low ozone levels, with a sharp increase just before and during the Labor Day weekend (see Figures 5.8-5.10). This last major holiday of the summer was also the time of a major outdoor concert (the US Festival). The coincidence of a severe deterioration in air quality and an entertainment spectacle caused widespread news coverage of both.

No such fortuitous event presented itself to aid in the designation of a payment vehicle.

A fee placed on the emission of ozone precursors would involve at least moderately intrusive monitoring of private vehicle use. A payment vehicle with substantial inconvenience would cause respondents' desire to avoid the inconvenience to mask their willingness to pay for ozone reduction.

The most workable payment mechanism seemed to be a generalized price increase with special attention drawn to increased operating costs for vehicles.

The specification of a good to be bid upon and the designation of a payment mechanism constitute the core of the experiment. The bid questions were supplemented with a number of other questions designed to provide information about the respondent.

<u>The Survey Instrument</u>

Separate (but similar) instruments were designed for each air quality area surveyed (San Gabriel Valley, San Fernando Valley, North Coastal Orange County).

Mail and Interview surveys differed only in that the Interview instrument included mechanical instructions to the interviewer to ensure a uniform survey procedure. The survey instruments are included in Appendix A.

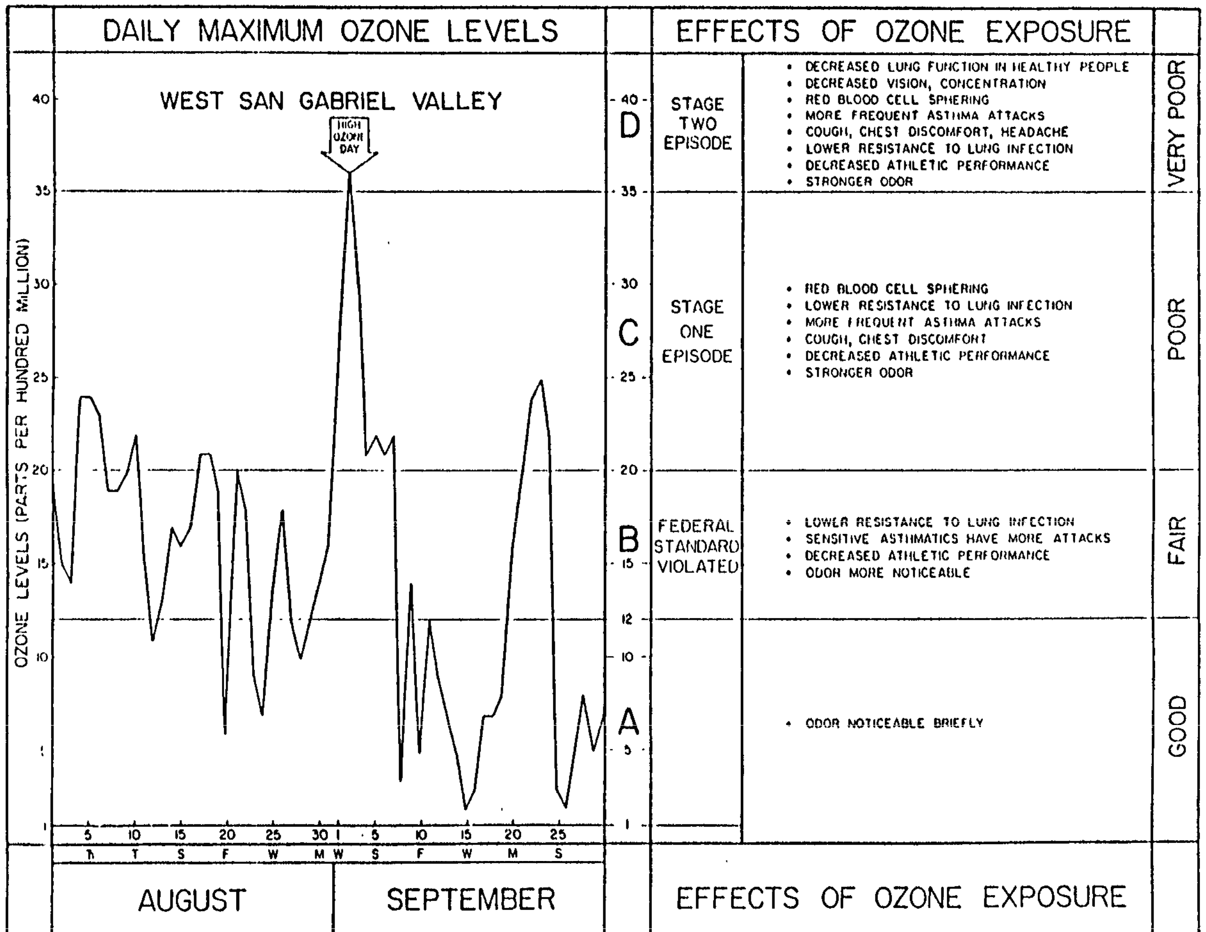
Each survey instrument begins with a prologue which identifies the research team but not the sponsor. This is followed by a review of ozone effects and recent conditions in the survey area. After focusing attention on Labor Day weekend, 1982 (see sub-section C.2) the respondent is asked whether he (or she) or any family member experienced any of the described effects of ozone exposure. For each survey area the reference day is different because the ozone peak occurred on different days in different parts of the SOCAB. The questions for the San Gabriel Valley are:

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Thursday, September 2?

_____ Yes _____ No (Please Check)

2. If you answered yes, which of these symptoms did you notice?

Figure 5.8



DAILY MAXIMUM OZONE LEVELS
EFFECTS OF OZONE EXPOSURE
WEST SAN GABRIEL VALLEY
HIGH OZONE DAY
OZONE LEVELS (PARTS PER HUNDRED MILLION)
40
35
30
25
20
15
12
10
5
1
D
C
B
A
STAGE TWO EPISODE
• DECREASED LUNG FUNCTION IN HEALTHY PEOPLE
• DECREASED VISION, CONCENTRATION
• RED BLOOD CELL SPHERING
• MORE FREQUENT ASTHMA ATTACKS
• COUGH, CHEST DISCOMFORT, HEADACHE
• LOWER RESISTANCE TO LUNG INFECTION
• DECREASED ATHLETIC PERFORMANCE
• STRONGER ODOR
VERY POOR
STAGE ONE EPISODE
• RED BLOOD CELL SPHERING
• LOWER RESISTANCE TO LUNG INFECTION
• MORE FREQUENT ASTHMA ATTACKS
• COUGH, CHEST DISCOMFORT
• DECREASED ATHLETIC PERFORMANCE
• STRONGER ODOR
POOR
FEDERAL STANDARD VIOLATED
• LOWER RESISTANCE TO LUNG INFECTION
• SENSITIVE ASTHMATICS HAVE MORE ATTACKS
• DECREASED ATHLETIC PERFORMANCE
• ODOR MORE NOTICEABLE
FAIR
• ODOR NOTICEABLE BRIEFLY
GOOD
5 10 15 20 25 30 1 5 10 15 20 25
T T S F W M W S F W M S
AUGUST
SEPTEMBER
EFFECTS OF OZONE EXPOSURE

Figure 5.9

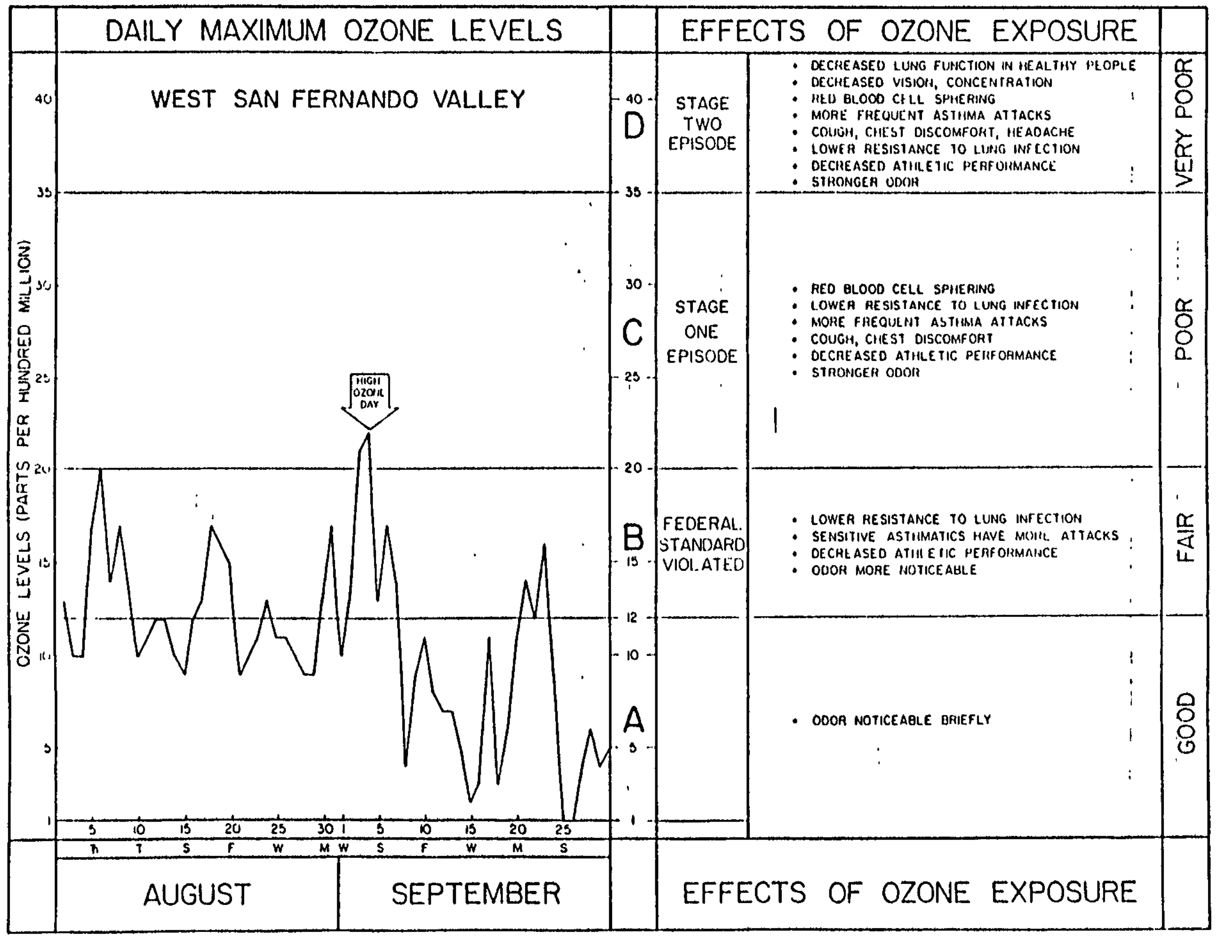
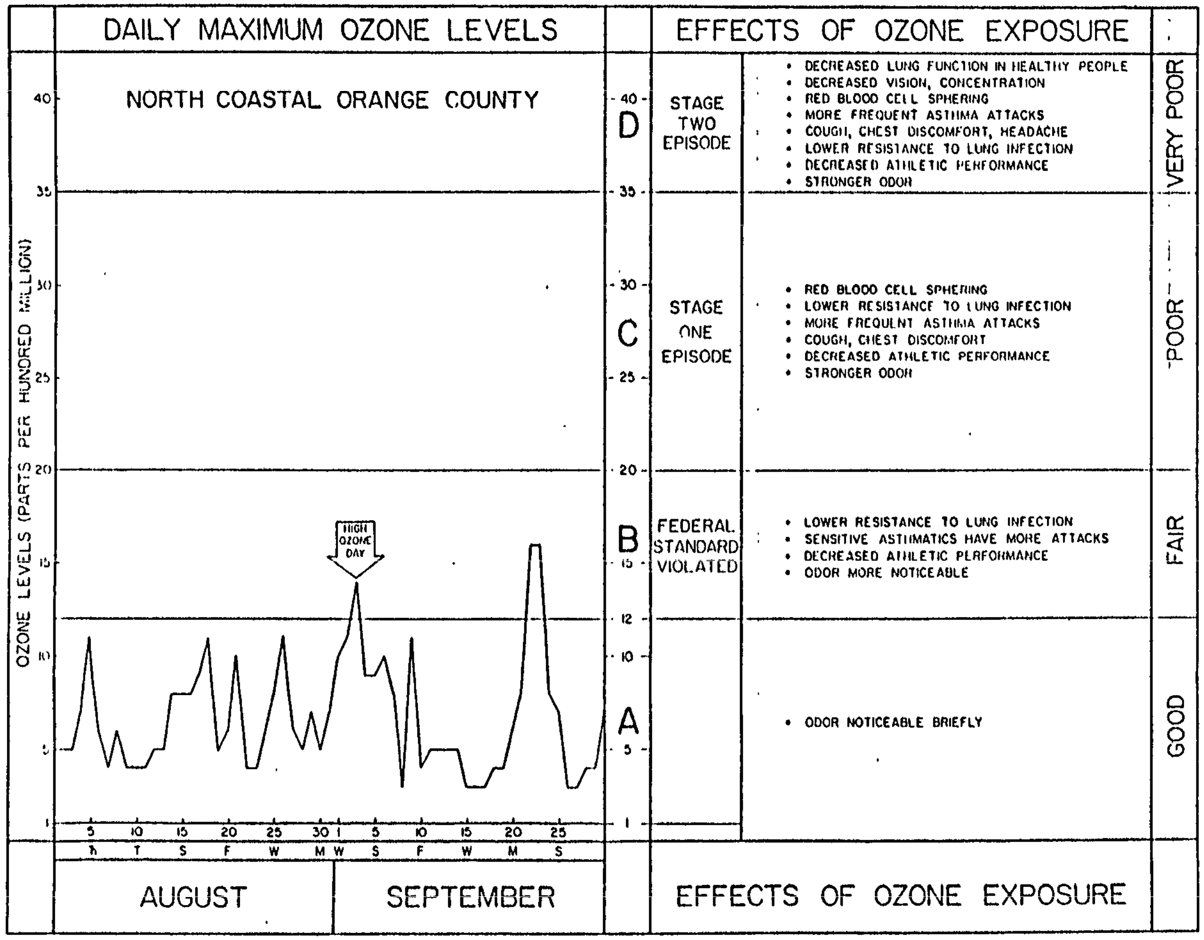

DAILY MAXIMUM OZONE LEVELS
WEST SAN FERNANDO VALLEY
OZONE LEVELS (PARTS PER HUNDRED MILLION)
HIGH OZONE DAY
AUGUST
SEPTEMBER
D
C
B
A
EFFECTS OF OZONE EXPOSURE
STAGE TWO EPISODE
• DECREASED LUNG FUNCTION IN HEALTHY PEOPLE
• DECREASED VISION, CONCENTRATION
• RED BLOOD CELL SPHERING
• MORE FREQUENT ASTHMA ATTACKS
• COUGH, CHEST DISCOMFORT, HEADACHE
• LOWER RESISTANCE TO LUNG INFECTION
• DECREASED ATHLETIC PERFORMANCE
• STRONGER ODOR
VERY POOR
STAGE ONE EPISODE
• RED BLOOD CELL SPHERING
• LOWER RESISTANCE TO LUNG INFECTION
• MORE FREQUENT ASTHMA ATTACKS
• COUGH, CHEST DISCOMFORT
• DECREASED ATHLETIC PERFORMANCE
• STRONGER ODOR
POOR
FEDERAL STANDARD VIOLATED
• LOWER RESISTANCE TO LUNG INFECTION
• SENSITIVE ASTHMATICS HAVE MORE ATTACKS
• DECREASED ATHLETIC PERFORMANCE
• ODOR MORE NOTICEABLE
FAIR
• ODOR NOTICEABLE BRIEFLY
GOOD
EFFECTS OF OZONE EXPOSURE

Figure 5.10



DAILY MAXIMUM OZONE LEVELS
NORTH COASTAL ORANGE COUNTY
OZONE LEVELS (PARTS PER HUNDRED MILLION)
HIGH OZONE DAY
AUGUST
SEPTEMBER
D
C
B
A
EFFECTS OF OZONE EXPOSURE
STAGE TWO EPISODE
• DECREASED LUNG FUNCTION IN HEALTHY PEOPLE
• DECREASED VISION, CONCENTRATION
• RED BLOOD CELL SPHERING
• MORE FREQUENT ASTHMA ATTACKS
• COUGH, CHEST DISCOMFORT, HEADACHE
• LOWER RESISTANCE TO LUNG INFECTION
• DECREASED ATHLETIC PERFORMANCE
• STRONGER ODOR
STAGE ONE EPISODE
• RED BLOOD CELL SPHERING
• LOWER RESISTANCE TO LUNG INFECTION
• MORE FREQUENT ASTHMA ATTACKS
• COUGH, CHEST DISCOMFORT
• DECREASED ATHLETIC PERFORMANCE
• STRONGER ODOR
FEDERAL STANDARD VIOLATED
• LOWER RESISTANCE TO LUNG INFECTION
• SENSITIVE ASTHMATICS HAVE MORE ATTACKS
• DECREASED ATHLETIC PERFORMANCE
• ODOR MORE NOTICEABLE
• ODOR NOTICEABLE BRIEFLY
VERY POOR
POOR
FAIR
GOOD
EFFECTS OF OZONE EXPOSURE

Symptom	Yourself	Family Member
Decreased Vision	________	__________
More frequent asthma attacks	________	__________
Cough, Chest discomfort	________	__________

Other (please name)______________________________

Following this, the payment mechanism is introduced and a bid is solicited for specified reductions in ozone levels from the designated peak. Three bids are solicited in the San Gabriel Valley, two in the San Fernando Valley and one in Orange County. Questions from the San Gabriel Valley are:

3. What is the most your household would be willing to pay to reduce the daily high ozone reading on that day from VERY POOR to POOR? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

4. What is the most your household would be willing to pay to reduce the daily high ozone level on that day from VERY POOR to FAIR? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

5. What is the most your household would be willing to pay to reduce the daily high ozone level on that day from VERY POOR to GOOD? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

Immediately following the bid(s), the respondent is asked why they bid zero if they did.

The respondents are then asked the extent of their outdoor activities and how or if they change their behavior when ozone levels rise.

The survey is concluded with a series of demographic questions. Included in the series is a question asking whether or not air quality was considered in residential choice.

Survey Procedures - Mail

Execution of the mail survey was accomplished obtaining current street address telephone directories for each survey area. These documents, available from the local telephone utility, contain listed telephone service customers arranged by street address rather than alphabetically in each service area. From these were taken residential addresses within the preselected survey area. An initial goal of 500 mailings in each area was modified to accommodate somewhat fewer than anticipated customers with listed numbers in some of the areas.

The surveys were mailed during the first week of December, 1982. All responses received before January 15, 1983 were included in the sample if they were completed. Four responses not included in the sample were received between January 15 and February 15, 1983.

A series of mechanical and procedural errors resulted in a very small mailing to El Monte in December, 1982. To remedy this two additional mailings were required. The response rates were nearly identical in all three mailings. The results are treated as one group because of the small numbers in each mailing response.

No follow-up mailings or telephone calls were attempted. This strategy was adopted to examine the potential of a low-cost contingent valuation of environmental amenities. Such a device, if workable, would be useful in the conduct of policy research regarding national or regional rather than local amenities.

A possible extension of this approach could include a second mailing to increase response rates. Such an effort would have to be very carefully structured, though, since it would involve either the sacrifice of respondent anonymity or the possibility of dual responses from some respondents.

Survey Procedures - Interview

A field supervisor was retained in Los Angeles to recruit and manage interviewers and to review completed interview forms prior to their shipment to Laramie. The supervisor is an individual experienced in, among other things, hiring and training interviewers and managing fieldwork. He has considerable experience and has successfully completed similar assignments for other research groups. Interviewers were selected principally on the basis of successful experience in similar survey efforts. Other relevant criteria were availability of dependable transportation, perceived ability to deal effectively with at least one of the sample populations and interviewing skills.

A member of the project team traveled to Los Angeles to conduct a training session with the field supervisor and interviewers. The training session provided an opportunity for personal interaction with the interviewers as well as describing project objectives.

The session provided information to interviewers regarding the concept of benefit measurement, a review of previous related efforts and mock interviews. The interviewers were reminded not to provide additional information to respondents about the research sponsors or its applications.

The training session was a valuable part of the survey effort with interviewers gaining an understanding of the significance of the interview process as a part of benefits assessment.

Interviews were conducted during December 7-18, 1982, during the late morning and afternoon. Interviews were conducted on weekends, as well as weekdays to provide a full range of potential respondents.

Each interviewer was provided with a list of residents who had been sent mail surveys and a street map of the survey area. They were instructed to include all portions of the survey area in their attempts while avoiding residences to which a survey form had been mailed. In two of the survey areas (Canoga Park and Newport Beach) the interviewers were obliged to survey in adjacent areas of similar appearance to complete the desired number of interviews.

C.3 Survey Results

There was considerable variation in response rates among the five survey areas. Table 5.2 presents response information for both interview and mail survey efforts.

The interview response rate for resident contacts (those attempts when an adult-resident came to the door) varied from 24% in Canoga Park to 56% in La Canada. There is of course no comparable rate for the mail survey.

Survey response rates are plotted against mean household income in Figure 5.11. The most obvious pattern that emerges is that the contact response rate for interviews was in all cases higher than the mail response rate. This is hardly surprising. There is no consistent pattern within either the mail or interview groups. The Orange County communities had the highest mail response rates but were in the middle of the income range for the communities.

Within air quality areas, the higher income communities had lower mail response rates in Orange County and the San Fernando Valley, but higher in the San Gabriel Valley. The San Fernando Valley interview effort reversed this, with the higher income community having a higher response rate. The San Gabriel Valley communities had the highest response rates.

TABLE 5.2: RESPONSE RATES AND RELATED INFORMATION

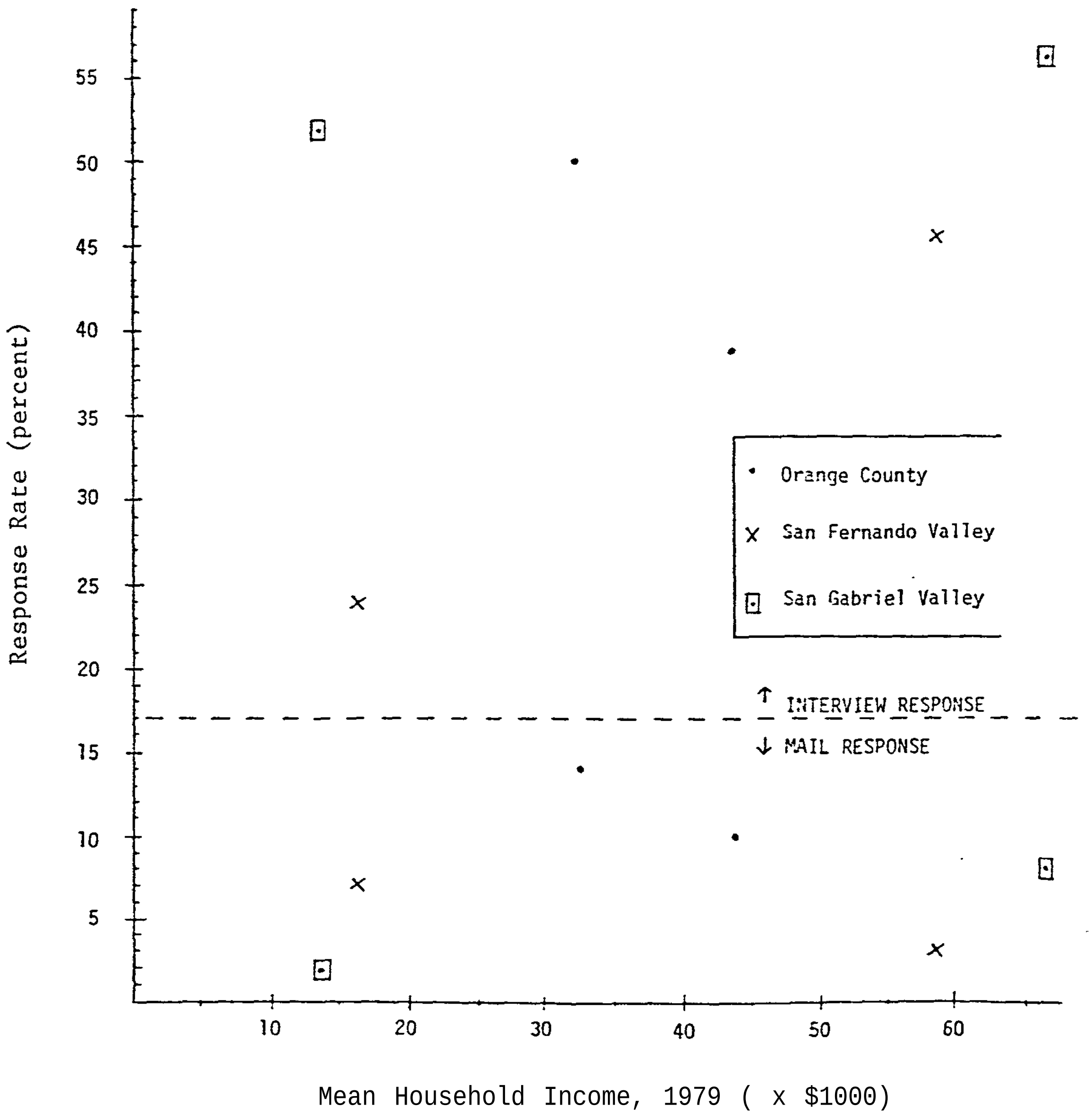
		A	B	C	D	E	F	G
					Reason for Refusal			
		Total Attempts	Resident Answered Door	Refusals	Do Not Consider Ozone to be a Problem	Too Busy	Other	No Reason Given
Communities Surveyed by Interview	El Monte	54	44	14	2	4	7	1
	La Cañada	58	32	8		5	2	1
	Canoga Park	175	90	65	6	26	29	4
	Encino	80	33	14		6	7	1
	Irvine	55	36	11	1	7	1	2
	Newport Beach	94	46	20		14	2	4
Communities Surveyed by Mail	El Monte	519						
	La Cañada	401						
	Canoga Park	295						
	Encino	616						
	Irvine	383						
	Newport Beach	408						

(Table 5.2, continued)

Table 5.2 (continued)

		H	I	J	K	I	M
		Flawed Surveys	Completed Surveys	Cross Response Rate (I÷A)	Non-Protest Surveys	Net Response Rate (K÷A)	Contact Response Rate (K÷B)
Communities Surveyed by Interview	El Monte	2	28	.52	23	.43	.52
	La Cañada	4	20	.34	18	.31	.56
	Canoga Park	1	24	.14	22	.13	.24
	Encino	5	19	.24	15	.19	.45
	Irvine	1	24	.43	18	.32	.50
	Newport Beach	1	25	.27	18	.19	.39
Communities Surveyed by Mail	El Monte	1	15	.03	11	.02	
	La Cañada	6	37	.09	32	.08	
	Canoga Park	15	22	.07	20	.07	
	Encino		23	.04	19	.03	
	Irvine		60	.16	53	.14	
	Newport Beach	18	52	.13	42	.10	

Figure 5.11: Response Rates and Income
for Survey Areas



In short, neither mean household income nor air quality within a survey area has an obvious relationship to response rates for either mail or interview surveys.

The net response rate (percentage of survey attempts resulting in completed surveys that did not protest the fairness of a pollution-reduction charge) was as might be expected, higher for the interview survey than for the mail survey.

Responses to survey questions are summarized in Table 5.3. The responses are grouped by air quality area.

The responses to question 7 are scaled as 1, 2, and 3 respectively for Rarely, Occasionally and Often and summed for each respondent. This produces an index of outdoor activity with a potential range of 0-24.

Apart from the bids (which are examined more closely below) there appears to be a remarkable similarity between mail and interview respondents in each air quality area. Mean years in current residence (#9) and mean years in the Los Angeles area (#10) are very close for both mail and interview samples. Mail respondents tend to he somewhat older (#15) and more educated (#14) than interview respondents and are much more likely to be male (#16). This difference presumably reflects the fact that interviews were conducted on weekday afternoons as well as evenings and weekends.

Apart from these responses, no clear pattern emerges to differentiate mail and interview respondents across air quality areas: San Gabriel Valley (SG) mail respondents noticed ozone-induced symptoms more often but had lower mean bids; in the San Fernando Valley (SF) mail respondents in Encino noticed ozone-induced effects less often and bad higher mean bids while Canoga Park residents noticed the effects more often and had higher mean bids. Orange County (OR) mail respondents noticed the effects less often and had lower mean bids. Mean income was lower for mail respondents in SG, higher in SF and OR.

C.4 Analysis of the Data

The survey results are examined through three different techniques in an attempt to discern meaningful patterns in respondents' bids.

Tables 5.4-5.6 report the results of linear regression models of each bid level. That is, the bid of each specified ozone reduction is entered as the dependent variable in the regression. The bid is "explained" by the selection of independent variables: household income (INC), education (ED), an index of outdoor activities (ACT), and either years in current residence (YH) or years in the Los Angeles area (YLA). A separate equation is calculated for interview and mail respondents in each air quality area. While these equations have limited explanatory power, as measured by each equation's R^2, some of the results do warrant comment.

TABLE 5.3

Question #.	1	3	4	5	7	9	10	11
Community	Symptom % Yes (SD)	CBID ($) Mean (SD)	BBID ($) Mean (SD)	ABID ($) Mean (SD)	Activity (Index) Mean (SD)	Years in House (Yrs) Mean (SD)	Years in L.A (Yrs) Mean (SD)	Consider Air Quality (% Yes)
La Cañada Interview N=18	16.7	15.92 (31.18)	16.92 (31.05)	24.75 (36.08)	8.06 (5.05)	11.83 (9.62)	27.56 (16.92)	55.6
Mail N-32	46.9	9.70 (18.59	13.66 (19.83)	20.97 (26.24)	7.00 (4.33)	12.03 (10.09)	28.56 (19.45)	40.6
El Monte Interview N=23	21.7	3.61 (7.32)	5.17 (9.50)	11.30 (25.24)	3.09 (3.41)	10.00 (9.72)	26.17 (17.74)	17.4
Mail N=11	63.6	1 82 (2.05)	3.73 (2.90)	15.86 (28.71)	6.36 (4.99)	11.82 (12.67)	23.82 (15.32)	9.1
Canoga Park Interview N=22	27.3		4.82 (6.40)	8.59 (14.01)	7.77 (6.18)	5.64 (5.63)	18.77 (10.18)	13.6
Mail N=20	30.0		7.53 (22.15)	7.75 (22.10)	5.40 (2.52)	4.45 (3.36)	19.75 (16.28)	40.0
Encino Interview N=15	60.0		2.57 (4.17)	3.23 (4.79)	4.27 (3.86)	8.27 (8.07)	21.73 (14.34)	6.7
Mail N=19	31.6		8.18 (12.84)	12.21 (22.48)	7.21 (4.10)	10.37 (8.04)	24.11 (18.19)	26.3
Irvine Interview N=18	38.9			16.08 (31.37)	4.22 (3.19)	4.67 (2.97)	24.28 (17.75)	94.4
Mail N=53	22.6			4.46 (5.58)	9.04 (4.00)	4.79 (3.23)	14.02 (13.26)	71.7
Newport Beach Interview N=18	38.9			9.83 (25.63)	7.22 (4.49)	12.33 (6.61)	20.50 (11.76)	72.2
Mail N=42	19.0			4.77 (15.41)	6.55 (3.62)	12.81 (8.79)	31.67 (19.74)	73.8

(Table 5.3, continued)

Table 5.3 (continued)

Question #:	12	14	15	16	17	18	19	20	21
Community	Info Index Mean (SD)	Education (Years) Mean (SD)	Age (Years) Mean (SD)	Gender % Male	Household Size (Persons) Mean (SD)	Primary Earner %	Residence (% Detached) (SD)	Own or Rent (% Own) (SD)	Income ($000) (SD)
La Canada									
Interview N=18	1.28 (.83)	15.44 (2.26)	41.72 (14.64)	22.2	3.78 (1.52)	16.7	100.0	94.4	68.72 (20.29)
Mail N=32	1.53 (.80)	16.63 (1.56)	48.75 (10.85)	81.3	3.72 (1.55)	87.5	100.0	93.8	54.84 (18.67)
El Monte									
interview N=	1.44 (.90)	12.17 (2.08)	44.30 (13.53)	43.5	3.35 (1.70)	65.2	87.0	56.5	14.83 (9.44)
Mail N=	1.73 (.79)	13.27 (1.62)	35.46 (21.02)	36.4	2.73 (2.01)	63.6	72.7	63.6	18.09 (11.53)
Canoga Park									
Interview N=22	1.82 (.91)	13.64 (1.92)	31.32 (10.15)	54.5	3.32 (1.56)	40.9	77.3	31.8	23.68 (14.82)
Mail N=20	1.35 (.88)	15.00 (2.29)	36.70 (11.24)	90.0	2.10 (1.45)	75.0	25.0	25.0	28.30 (20.26)
Encino									
Interview N=15	1.00 (.66)	13.20 (1.66)	43.13 (16.61)	40.0	2.47 (1.30)	26.7	66.7	73.3	36.20 (20.55)
Mail N=19	1.63 (.68)	(1.66) (1.41)	41.47 (13.45)	68.4	2.53 (1.31)	63.2	42.1	52.6	52.68 (21.91)
Irvine									
Interview N=18	1.44 (.71)	13.89 (1.45)	35.11 (12.62)	38.9	3.33 (1.09)	38.9	100.	88.9	35.33 (11.11)
Mail N=53	1.40 (.91)	16.26 (1.76)	39.49 (9.68)	77.4	3.26 (1.24)	86.8	98.1	86.8	46.89 (16.80)
Newport Beach									
Interview N=18	1.22 (.65)	15.78 (1.80)	40.06 (13.67)	33.3	3.56 (1.20)	16.7	100.	94.4	53.17 (16.39)
Mail N=	1.60 (.89)	16.00 (1.71)	51.19 (11.00)	85.7	2.48 (1.04)	92.9	81.0	85.7	54.05 (.)

TABLE 5.4

REGRESSION RESULTS FOR BID ESTIMATES
SAN GABRIEL VALLEY SURVEY

Mean (Standard Deviation)	R^2	CONST	INC	YH	YLA	ED	ACT
	Beta Coefficients (t-Statistic)						
CBID							
INTERVIEWER RESPONSES:							
9.01 (21.93)	.30	-40.23 (-2.13)	-.23 (-1.57)	.05 (.16)		3.48 (2.18)	1.93 (2.41)
9.01 (21.93)	.31	-43.82 (-2.28)	-.24 (-1.64)		.12 (.66)	3.55 (2.24)	1.98 (2.51)
MAIL RESPONSES:							
7.69 (16.38)	.30	-27.32 (-1.55)	.19 (1.57)	.65 (2.98)		.62 (.47)	1.29 (2.38)
7.69 (16.38)	.25	-37.57 (-1.95)	.08 (.62)		.31 (2.37)	1.64 (1.20)	1.08 (1.96)
BBID							
INTERVIEW RESPONSES:							
10.33 (22.23)	.33	-37.52 (-2.00)	-.26 (-1.82)	.03 (.10)		3.36 (2.13)	2.27 (2.86)
10.33 (22.23)	.34	-41.28 (-2.15)	-.27 (-1.89)		.12 (.65)	3.43 (2.18)	2.33 (2.99)
MAIL RESPONSES:							
11.12 (17.64)	.31	-23.83 (-1.26)	-30 (2.30)	.66 (2.83)		.37 (.26)	1.12 (1.93)
11.12 (17.64)	.21	-29.04 (-1.36)	.20 (1.45)		.21 (1.44)	1.25 (.82)	.84 (1.38)
ABID							
INTERVIEW RESPONSES:							
17.21 (30.81)	.24	-.29 (-.01)	-.12 (-.56)	-.17 (-.36)		.47 (.20)	3.32 (2.83)
17.21 (30.81)	.24	-.26 (-.01)	-.12 (-.56)		-.06 (-.24)	.45 (.19)	3.36 (2.89)
MAIL RESPONSES:							
19.66 (26.64)	.15	-5.21 (-.16)	.42 (1.93)	.52 (1.34)		-.19 (-.08)	.34 (.36)
19.66 (26.64)	.12	-8.50 (-.25)	.35 (1.56)		.15 (.64)	.48 (.20)	.11 (.12)

TABLE 5.5

REGRESSION RESULTS FOR BID ESTIMATES
SAN FERNANDO VALLEY SURVEY

Mean (Standard Deviation)	R^2	CONST	INC	YH	YLA	ED	ACT
	Beta Coefficients (t-Statistic)						
BBID							
INTERVIEW RESPONSES:							
3.90 (5.65)	.12	.29 (.04)	-.01 (-.19)	-.04 -.31		.16 (.26)	.32 (1.76)
3.90 (5.65)	.13	1.12 (.15)	-.02 (0.33)		-.05 (-.64)	.17 (.27)	.33 (1.83)
MAIL RESPONSES:							
7.26 (17.85)	.04	-7.84 (-.32)	-.02 (-.11)	.42 (.85)		.69 (.42)	.31 (.33)
7.43 (18.07)	.06	16.92 (-.63)	-.04 (-.26)		.23 (1.79)	1.09 (.62)	.59 (.62)
ABID							
INTERVIEW RESPONSES:							
6.42 (11.43)	.11	-2.37 (-.16)	-.10 (-.84)	-.12 (-.42)		.70 (.55)	.49 (1.32)
6.42 (11.43)	.11	-1.76 (-.11)	-.11 (-.96)		-.06 (-.37)	.71 (.56)	.50 (1.35)
MAIL RESPONSES:							
9.66 (22.34)	.06	-21.02 (-.69)	.04 (.23)	.45 (.72)		1.55 (.75)	.29 (.24)
9.86 (22.61)	.08	-31.82 (-.951	.01 (.06)		.27 (1.15)	2.02 (.93)	.56 (.47)

TABLE 5.6

REGRESSION RESULTS FOR BID ESTIMATES
ORANGE COUNTY SURVEY

	R^2	CONST	INC	YH	YLA	ED	ACT
Mean (Standard Deviation)	Beta Coefficients (t-Statistic)						
<u>ABID</u>							
INTERVIEW RESPONSES:							
10.83 (25.49)	.26	24.30 (.57)	-.22 (-.78)	-.88 (-1.14)		-.19 (-.37)	3.43 (2.61)
13.53 (29.50)	.19	92.95 (2.01)	.009 (.03)		.20 (.56)	-7.09 (-2.22)	3.35 (2.09)
MAIL RESPONSES:							
4.60 (10.99)	.01	-5.35 (-.47)	.03 (.49)	.0009 (.006)		.52 (.72)	-.02 (-.06)
4.60 (10.99)	.02	-8.94 (-.77)	.02 (.33)		.06 (.86)	.67 (.91)	.05 (.15)

The outdoor activity index (ACT) is the only variable that has even modest statistical significance in most of the equations. This finding is not startling; it even provides modest comfort that a variable so closely tied to outdoor air quality is not generally irrelevant. A noteworthy feature of ACT's pattern is that the sign of the coefficient is positive wherever it has even modest significance (the exception in fact has t = -.06).

In each air quality area the t-statistic is higher for ACT in the interview sample than for the mail sample. This difference is most extreme in Orange County.

The Orange County samples also show the most extreme difference in magnitude for the estimated coefficient of ACT. In SG the mail and interview ACT coefficients diverge with the degree of ozone reduction. That is, the ACT coefficients for CBID are comparable in both forms of the equation. The differences are greater for BBID and extreme for ABID.

The coefficients for ACT are all roughly comparable in the SF samples.

The Orange County mail and interview equations differ to an extent that is disturbing. This is especially so since the two Orange County communities were more similar than those in other air quality areas and had much higher mail response rates.

The most extreme difference between the mail and interview responses (Table 5.3) were in ABID (with mail lower) and percentage of respondents who were household primary earners (mail lower). This latter difference was seen in SG and SF also, but mail respondent bids were generally higher.

This consistency, with typical expectations, is not shown in other variables. ED, for instance, shows moderate statistical significance with positive coefficients in SG, but in SF has statistical significance in only one equation, when the coefficient is negative.

This general inconsistency of sign and statistical significance suggests that considerable subtlety will be necessary to provide explanation of ozone reduction bids.

To determine the influence of "outliers" on the regression estimates, a technique developed by Belsley, Kuh and Welsch (1980) (B-K-W) and previously applied by Desvousges, Smith and McGivney (1982) (D-S-M) was adopted. The B-K-W statistic, DFBETA, measures the effect of an individual observation on the estimated coefficients in a regression model.

It is estimated by Equation:

$$DFBETA \equiv b - b(i) = \frac{(X^T X)^{-1} x_i^T e_i}{1-h_i}$$

where h_i is $x_i\ (X^TX)^{-1}x_i^T$ and the e_i's are the ordinary least squares residuals.

Following D-S-M, ±30 percent in any coefficient was taken as the standard for defining an outlier. The number of outliers detected was quite small: 1 each in 2 of the 12 SG equations; 1 each in 2 of the eight SF equations; and 1, 3 and 4 in 3 of the four OR equations. The re-estimated equations, with outliers removed, are presented in Tables 5.7-5.9. These revised equations differ substantially only in the constant term ,which was in all cases the term associated with a large DFBETA.

An examination of the difference between the mail and interview samples is presented in Table 5.10. The mean and standard deviation of each sample bid is presented for the complete sample and for the sample with outliers removed from each of the two regressions. For each pair of mail and interview bid samples, Student's t is calculated. This statistic tests the hypothesis that the two samples are drawn from the same population, with the difference in the means being a result of variation in the population.

In no case can this hypothesis be rejected at the .05 level, and even at the .10 level the hypothesis can be rejected only in Orange County.

This result is remarkable for a number of reasons. The large difference in response rates might have been suspected of being an indication of mail respondent self-selection and thereby causing sample bias. This possibility seemed especially troubling given the inherent complexity of both the substantive material and the survey instrument.

The interview respondents, with interviewers available to explain the material, had a less rigorous experience. This complexity may have substantially contributed to the self-selection of mail respondents with higher mean education than interview respondents. The mail respondents had mean years of education at least one year higher than interview respondents in all communities except Newport Beach, which had the highest interview respondent education level, 15.78 years.

The mean bids have a large standard deviation in all communities at all levels. This is to be expected for valuation of a public good.

Private goods, the benefits of which can be appropriated exclusively by one user, have large variations in quantity purchased at a price that is uniform for all buyers. Demand estimation is accomplished by estimating intended, desired or potential purchases by different individuals at varying prices.

Public goods cannot, by definition, be made available in different amounts to separate users; they are available in the same amount to all users, as is air quality in a given area.

The estimation of "demand" in this case is accomplished by estimating the prices different users would be willing to pay for a given amount of

TABLE 5.7

REGRESSION RESULTS FOR BID ESTIMATES
(With Outliers Removed)
SAN GABRIEL VALLEY SURVEY

Mean (Standard Deviation)	R^2	CONST	INC	YH	YLA	ED	ACT
	Beta Coefficients (t-Statistic)						
CBID							
INTERVIEWER RESPONSES:							
11.25	.29	-46.77	-.24	.05		3.90	2.04
(24.41)		(-1.98)	(-1.41)	(.09)		(2.02)	(1.99)
10.31	.31	-50.39	-.25		.15	3.88	2.18
(23.52)		(-2.24)	(-1.59)		(.74)	(2.17)	(2.33)
MAIL RESPONSES:							
8.15	.33	-29.10	.19	.73		.73	1.22
(16.90)		(-1.60)	(1.56)	(3.16)		(.52)	(2.05)
7.90	.26	-43.62	.05		.33	2.12	.99
(16.94)		(-2.01)	(.37)		(2.32)	(1.34)	(1.62)
BBID							
INTERVIEW RESPONSES:							
12.86	.32	-43.16	-.28	.02		3.72	2.38
(24.63)		(-1.84)	(-1.62)	(.05)		(1.95)	(2.35)
11.80	.34	-47.44	-.29		.15	3.71	2.54
(23.78)		(-2.13)	(-1.82)		(.73)	(2.10)	(2.74)
MAIL RESPONSES:							
11.33	.36	-24.83	.30	.79		.33	1.16
(18.14)		(-1.30)	(2.33)	(3.27)		(.23)	(1.85)
11.08	.23	-31.28	.19		.26	1.34	.83
(18.23)		(-1.31)	(1.25)		(1.64)	(.77)	(1.23)
ABID							
INTERVIEW RESPONSES:							
21.59	.19	2.10	-.12	-.31		.44	3.25
(33.67)		(.06)	(-.47)	(-.42)		(.15)	(2.16)
19.81	-21	-.19	-.12		-.06	.40	3.41
(32.68)		(-.01)	(-.50)		(-.21)	(.15)	(2.45)
MAIL RESPONSES:							
20.33	.19	-10.66	.42	.67		.26	.08
(27.37)		(-.33)	1.90)	(1.61)		(.10)	(.08)
20.08	.15	-4.58	.39		.21	.21	-.21
(27.51)		(-.12)	(1.63)		(.87)	(.07)	(-.20)

TABLE 5.8

REGRESSION RESULTS FOR BID ESTIMATES
(With Outliers Removed)
SAN FERNANDO VALLEY SURVEY

Mean (Standard Deviation)	R^2	CONST	INC	YH	YLA	ED	ACT
	Beta Coefficients (t-Statistic)						
BBID							
INTERVIEW RESPONSES:							
3.90 (5.65)	.12	.29 (.04)	-.01 (-.19)	-.04 (-.31)		.16 (.26)	.32 (1.76)
3.90 (5.65)	.13	1.12 (.15)	-.02 (-.33)		-.05 (.64)	.17 (.27)	.33 (1.83)
MAIL RESPONSES:							
7.26 (17.85)	.04	-7.84 (-.32)	-.02 (-.11)	.42 (.85)		.69 (.42)	.31 (.33)
7.43 (18.07)	.06	16.92 (-.63)	-.04 (-.26)		.23 (1.19)	1.09 (.62)	.59 (.62)
ABID							
INTERVIEW RESPONSES:							
6.42 (11.43)	.11	-2.37 (-.16)	-.10 (-.84)	-.12 (-.42)		.70 (.55)	.49 (1.32)
6.42 111.43)	-11	-1.76 (-.11)	0.11 (-.96)		-.06 (-.37)	.71 (.56)	-50 (1.35)
MAIL RESPONSES:							
9.66 (22.34)	-06	-21.02 (-.69)	.04 (.23)	.45 (.72)		1.55 (.75)	.29 (.24)
9.86 (22.61)	.08	-31.82 (-.95)	.01 (.06)		.27 (1.15)	2.02 (.93)	.56 (.47)

TABLE 5.9

REGRESSION RESULTS FOR BID ESTIMATES
(With Outliers Removed)
ORANGE COUNTY SURVEY

Mean (Standard Deviation)	R^2	CONST	INC	YH	YLA	ED	ACT
	Beta Coefficients (t-Statistic)						
<u>ABID</u>							
INTERVIEW RESPONSES:							
10.83 (25.49)	.26	24.30 (.57)	-.22 (-.78)	-.88 (-1.14)		-.19 (-.37)	3.43 (2.61)
13.53 (29.50)	.19	92.95 (2.01)	.009 (.03)		.20 (.56)	-7.09 (-2.22)	3.35 (2.09)
MAIL RESPONSES:							
4.60 (10.99)	.01	-5.35 (-.47)	.03 (.49)	.009 (.006)		.52 (.72)	-.02 (-.06)
4.60 (10.99)	.02	-8.94 (-.77)	.02 (.33)		.06 (.86)	.67 (.91)	.05 (.15)

TABLE 5.10

t-TESTS FOR DIFFERENCES BETWEEN MAIL AND INTERVIEW SAMPLES

				Years in House Outliers Removed			Years in L.A. Outliers Removed		
San Gabriel	N	Mean (Stan. Dev.)	t-Stat	N	Mean (Stan. Dev.)	t-Stat	N	Mean (Stan. Dev.)	t-Stat
CBID									
Interview	41	9.01 (21.93)		34	10.60 (23.81)		32	11.25 (24.41)	
Mail	43	7.69 (16.38)	.31	41	7.76 (16.76)	.59	41	8.00 (16.71)	.64
BBID									
Interview	41	10.33 (22.23)		34	12.13 (24.05)		32	12.86 (24.63)	
Mail	43	11.17 (17.65)	-.18	41	11.29 (18:05)	.17	41	11.54 (17.96)	.26
<u>ABID</u>									
Interview	41	17.21 (30.81)		34	20.37 (33.01)		32	21.59 (33.67)	
Mail	43	19.67 (26.65)	-.39	41	20.20 (27.18)	.02	41	20.44 (27.04)	.16
San Fernando									
BBID									
Interview	37	3.91 (5.65)		37	3.91 (5.65)		37	3.91 (5.65)	
Mail	39	7.85 (17.99)	-1.30	38	8.03 (18.19)	-1.33	39	7.84 (17.99)	-1.30
ABID									
Interview	37	6.42 (11.43)		37	6.42 (11.43)		37	6.42 (11.43)	
Mail	39	9.92 (22.10)	-.87	38	10.13 (22.36)	-.91	39	9.92 (22.10)	-.87
Orange County									
ABID									
Interview	36	12.96 (28.41)		33	13.53 (29.50)		32	10.83 (25.49)	
Mail	95	4.66 (10.99)	-1.72*	95	4.60 (10.99)	-1.70*	94	4.65 (11.04)	1.33

*Reject H_o at .10 level

$H_o : \mu_1 = \mu_2$

$H_1 : \mu_1 \neq \mu_2$

the good. Since there is variation in individual preferences, one would expect large variation in this bid estimate just as one would expect large variation in quantity estimates for a private good at a particular price.

The third technique applied to the data examines changes in individual bids over ozone-reduction intervals rather than aggregating individual bids for a specific reduction.

In this effort an equation of the form

$$B_i = kR_i^{\eta}$$

is estimated, where B_i is a household's bid for the ith ozone-reduction interval, R_i is the reduction and A and n are coefficients to be estimated. (See Section B for an examination of theoretical aspects of this bid equation).

For each respondent there are three observations in the San Gabriel Valley (from D to C, from D to B and from D to A) and two in the San Fernando Valley (from C to B and from C to A). With only one bid per respondent, an estimate of the equations in Orange County would be meaningless.

To estimate the equations, the ozone reductions were taken to be from the midpoint of the reference interval to the midpoint of succeeding intervals. That is, R_1 in SG is from 38.75 pphm (the midpoint of D as depicted), to 27.5 pphm (the midpoint of C), or a reduction of 11.25. Similarly R_2 in SG is 17.75 (from D to the midpoint of B, 14.5) and R_3 is 32.25 (38.75 to 6.5).

In SF, bids begin at the midpoint of C (27.5) so that R_1 is a reduction of 6.5 and R_2 is 21.

The results of these efforts are presented in Figures 5.12-5.13. The vertical axis is number of respondents in each category. The bar to the left of the origin shows the number of respondents who bid zero at all levels (This does not include "protest zeroes").

The numbers to the right of the origin are values of n.

The distribution of values for n of respondents has a pronounced pattern: In the intermediate ozone level area sampled (SF) the range stops at approximately 1.0 except for one observation. All three observation in the 1.0-1.1 range actually have estimated values for n of 1.026. In the high ozone level area sampled (SG) estimated values for n continue beyond unity ranging beyond 15.

The termination, at approximately 1.0 exists in both interview and mail samples in the San Fernando Valley (with the one exception); the continuation of the range in the San Gabriel Valley likewise exists in both samples.

Figure 5.12: Individual Bid Elasticity Estimates and Zero Bids

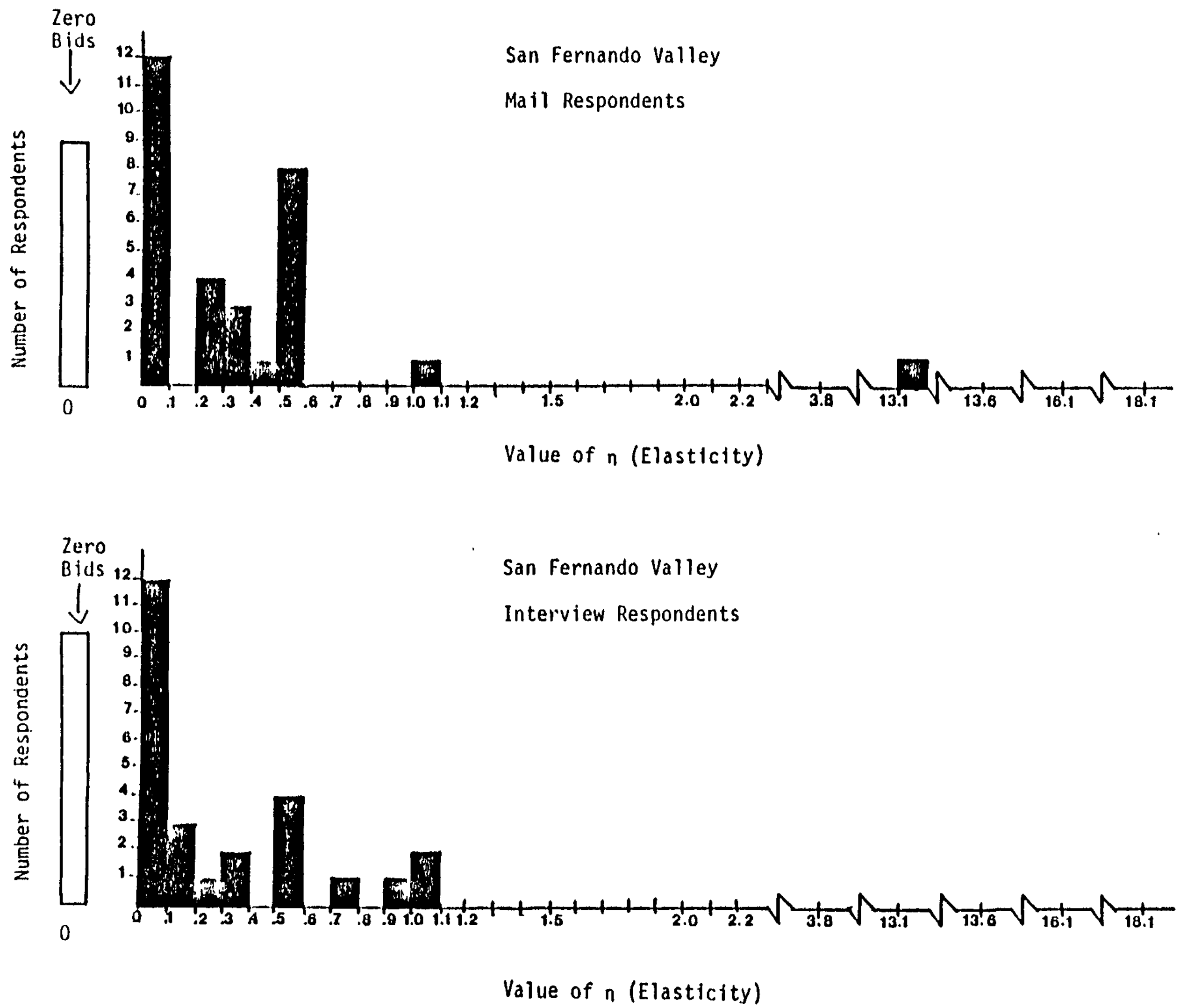
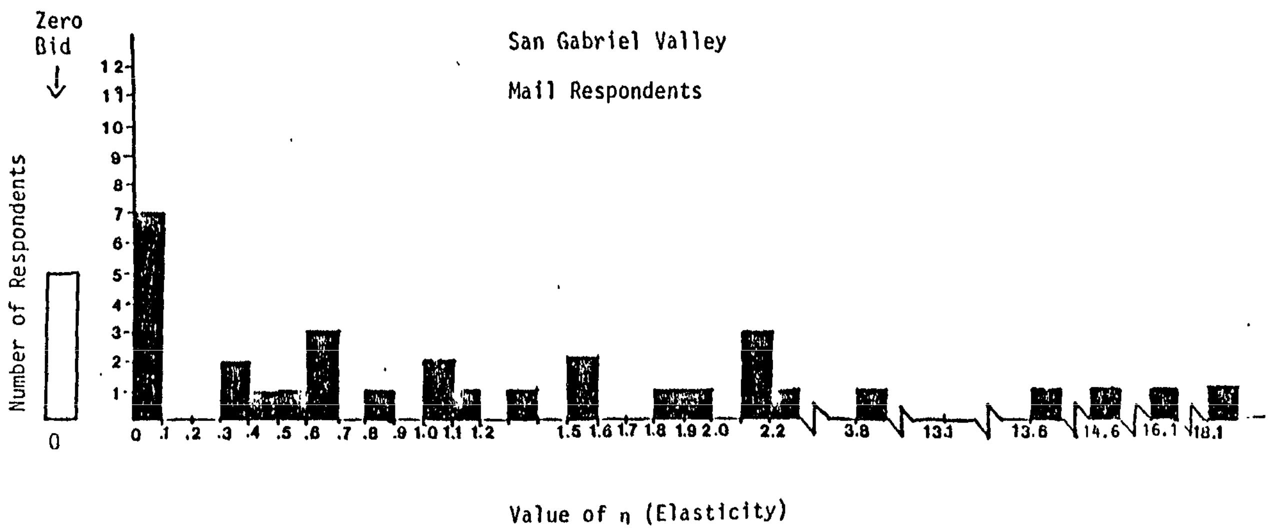
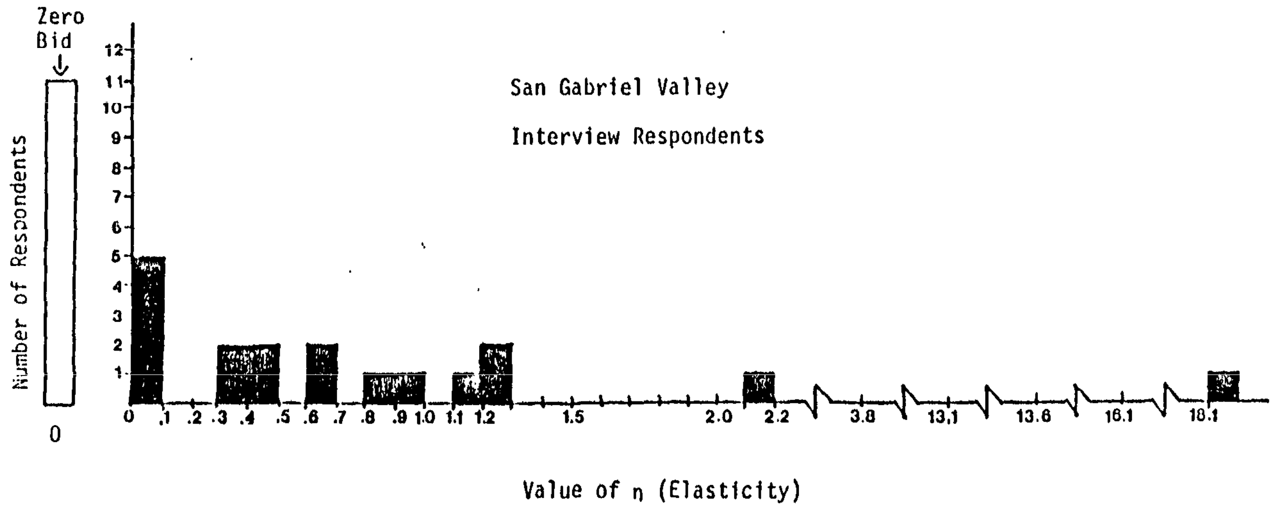


Figure 5.13: Individual Bid Elasticity Estimates and Zero Bids





As shown in Section B, values for this coefficient less than unity are consistent with the concave preference functions typically assumed by economists to exist. Values greater than unity indicate increasing marginal utility of ozone reduction. Individuals for whom $n > 1$ would be expected to locate themselves in areas of extreme air quality (whether high or low) unless there were a compelling preference unrelated to price and ozone levels in residential choice (a desire to be near one's job or one's childhood neighborhood for example).

This statement warrants some further elaboration, since it seems to suggest the existence of "extremists" who are little concerned with which extreme they choose.

A coherent description of the preferences of an individual with $n > 1$ would include the observation that such an individual places a relatively high value on preservation of air purity at a very high level. This person would place a lesser value on preservation of air purity if air quality had already been significantly degraded.

Conversely, a relatively low value would be placed on an incremental improvement in air quality unless the increment would "restore" pristine air. Each succeeding increment would have higher value. The final increment would have a higher value than any preceding improvement.

This person, with non-convex preferences, is to be contrasted with the typical person found in economic analysis who places ever smaller value on succeeding increments in availability of any good. The improvement that brings air quality to a pristine state from a slightly impaired condition would be valued less than a similar improvement in seriously degraded air. This parallels the expectation that a given ration of food would be valued more if a person had been deprived of food than if the same person were near full satiation.

Individuals with convex (i.e., "normal") preferences may have very different tastes regarding air quality. Some may place very high values on cleaner air and others may regard air quality as insignificant relative to all other considerations in residential location. The convex indifference curve shown as Figure 5.1 implies only that successive improvements in air quality have values that are less than earlier improvements. These early improvements may have very high as well as very low values.

These "normal" individuals can "purchase" a combination of air quality and other goods by choosing a location along the pollution-rent gradient depicted in Figure 5.5.

Individuals with non-convex preferences, though, would not be inclined to choose any intermediate level of air quality.

If, from a location with lowest air quality, such person were willing to "purchase" a small improvement (by moving to an area with slightly higher air quality), he or she would be willing to purchase more since each successive improvement has higher value.

With such a preference system, a person would be inclined to choose the highest possible air quality. If the premium for this level, though, were deemed to exceed the value, the second choice would not be some intermediate air quality location, but an area with low air quality.

These individuals differ from those with convex preferences not (necessarily) in the strength of their preferences for clean air as opposed to other goods but in the relative assessment of the value of improvements in air quality.

Thus we might find as neighbors in a low-pollution area one person with convex preferences who places a very high value on a small initial improvement and very small value on succeeding improvements and another person who places very small values on any improvement in air quality unless it brings pristine air.

The former would be little inconvenienced if local air were slightly degraded. The latter would protest vigorously or move.

Similarly, a high pollution area might contain some people who would make substantial sacrifices for a small improvement in air quality (but less than the housing-cost differential of such an area) and others who would make essentially no sacrifice unless it would bring pristine air.

These are of course the extreme cases. The important point is that persons with non-convex preferences would not generally locate in areas of intermediate air quality. The individuals are, of course, concerned with which extreme they choose.

San Fernando Valley respondents had, with one exception, convex preferences. San Gabriel Valley respondents included a number of people with non-convex preferences.

This distribution of preferences is that implied by the theoretical development in Section B. A very small number of individuals with non-convex preferences would be expected in intermediate air quality areas of other communities to exist with similar amenities differing only in air quality.

The Los Angeles area, with its very diverse mix of neighborhoods would be expected to offer very high or very low air quality locations with amenities similar to the San Fernando Valley communities in this study. Indeed, one suspects almost any conceivable amenity mix could be found.

The agreement between the pattern implied by a theoretical consideration of location choice and the estimated values of n in high and intermediate ozone level communities is rather dramatic.

The coefficient n can be thought of as a variable reflecting tastes. That it appears to be significant in residential choice suggests that examination of other variables reflecting tastes might be fruitful.

The activity index, ACT, used in regression models can also plausibly be interpreted as a taste variable. Given the broader range of "tastes", as measured by n, extent in the San Gabriel Valley than in the San Fernando Valley, one might expect a taste variable to have more significance in SG than in SF. This is so in the mail sample, but not in the interview sample. In fact, in SF and OR regressions ACT carries substantially more significance in interview than mail samples.

A greater relative importance of taste in explaining bids is, however, suggested by the much larger coefficients for ACT in SG and OR than in SF in cases where the coefficient has even a low level of statistical significance.

Opportunities for further research are indicated by the apparent complexity of the patterns involving survey response, respondent location decisions and other characteristics and bid levels.

D. THE PROPERTY VALUE APPROACH

D.1 Introduction

Previous research efforts have found survey results to be generally consistent with the hedonic housing value approach (Brookshire, et al., 1982), a hedonic wage analysis (Cummings, et al., 1982) and the recreation-based travel cost method (Desvousges, et al., 1982). In addition, surveys have been found to be internally consistent and compatible with demand theory (Schulze, et al., 1981). However, the debate over the validity of survey results continues in spite of these previous successes.

The purpose of the research reported in this section is to add to the literature concerning the validity of surveys designed to ascertain the value of environmental goods. This is accomplished by undertaking a detailed analysis of the relationship between housing values and ozone concentrations in the South Coast Air Basin. The objective was to develop an ozone based rent differential to compare to the survey results presented in the previous section. This is in accord with the theoretical treatment in Brookshire, et al. (1982).

The research described herein encompasses two separate but related housing value studies. First, the housing value analysis was conducted in Los Angeles County. Second, the study area was expanded to include the remainder of the South Coast Air Basin (Orange County, Riverside County, San Bernardino County). This was done to overcome empirical difficulties. The research was directed at determining whether housebolds actually pay for cleaner air in the form of higher housing values for homes in clean air communities and if this willingness to pay was comparable to the hypothetical willingness to pay expressed in the survey instrument.

Valuation of reductions in urban air pollution concentrations based upon housing value differentials is the most common form of the hedonic price procedure as developed by Rosen (1974), the basis of which is Lancaster's (1966) consumption theory. This procedure assumes that access to environmental (dis)amenities is capitalized in property values. This assumption is based on the premise that households are willing to pay a premium for an otherwise identical home located in a clean air area versus that located in a polluted area.

Among public goods which have been valued using the hedonic housing approach are air pollution (Anderson and Crocker, 1971; Harrison and Rubinfeld, 1978), social infrastructure (Cummings, 1978) and other community characteristics such as noise level (Nelson, 1979) and ethnic composition (Schnare, 1976).

The hedonic approach for assessing the benefits of environmental improvement is generally viewed as a multistage procedure (see Rosen, 1974; Freeman, 1979). The initial step is to estimate the hedonic price gradient which explains home sale price as a function of the house's structural characteristics as well as the characteristics of the community and neighborhood in which it is located, The second step is to determine'the implicit price of environmental change by differentiating the hedonic rent gradient with respect to the variable of interest. Subsequent steps include estimation of the inverse demand curve and integration to obtain benefit estimates.

The hedonic procedure as outlined above was generally well-received by the economics profession until just recently. However, a number of authors, including Brown and Rosen (1982), Mendelsohn (1981), and Palmquist (1982) have criticized the approach as not possessing sufficient information to identify the (inverse) demand curve in the subsequent steps. For this reason the methodology employed here is to follow Brookshire, et al. (1982) and conduct the validation test using the rent differential (second step) rather than actual benefit estimates.

Elimination of the theoretical problem of direct benefit estimation in the hedonic format does not, however, eliminate all potential difficulties. Estimation of the hedonic price gradient must be completed within the confines of the data. Problems which generally arise in housing value studies are misspecification and multicollinearity. The latter is especially problematical in this study. So much so that a large portion of the research reported herein is directed at attempting to solve this problem.

The central point is that the completion of a housing value study is not without theoretical and empirical difficulties. In this case the estimation problems are such that it is difficult to delineate explicitly the relationship between ozone concentrations and housing values. However, an estimated relationship between ozone and home sale price is obtained through the use of principal components analysis. In the next section this relationship is used to test the validity of the survey results. Preliminary indications are that surveys provide reasonable values for ozone reductions.

This section is organized as follows. In the following sub-section a discussion of the characteristics of the data is presented. Sub-section D.3 describes the empirical procedure and the base empirical results for Los Angeles County. As is described these results are beset with multicollinearity. Thus, a variety of solutions to this problem, with associated results, are presented in sub-section D.4. None of the solutions described in this section provide a satisfactory outcome. However, in sub-sections D.5 and D.6, two solutions which yield the expected relationship between home sale price and ozone concentrations are described. Sub-section D.7 offers summary remarks.

D.2 Data Specifics

The hypothesis to be tested is whether or not ozone concentrations are a significant determinant of housing sale price. The study area is first Los Angeles County and then the entire South Coast Air Basin, and is specifically confined to single family residences. Thus, not considered is the impact of ozone concentrations upon other structures (multiple family dwellings, mobile homes, commercial, etc.) or other ownership types (rental leasing, etc.). Therefore, within our sample, this research asks if households will pay a premium in the form of higher housing values for homes located in clean air areas and what is the magnitude of that willingness to pay.

The data base was constructed to enable the testing of hypotheses concerning the impact of ozone differences on housing sale price. The dependent variable in the entire analysis is the sale price of owner occupied single family residences.[1] The independent variable set consists of variables which correspond to three levels of aggregation: house, neighborhood, and community. Table 5.11 describes further the data employed in the study.

The housing characteristic data, obtained from the Market Data Center (a computerized appraisal service centered in Los Angeles), pertains to homes sold in the 1978-79 time period and contains information on nearly every important structural and/or quality attribute.[2] It should be emphasized that housing data of such quality (e.g., micro level of detail and over time) is rarely available for studies of this nature. Usually outdated data which are overly aggregate and not collected on a regular basis (for instance census tract averages only in census years) are employed. These data yield functions relevant for the "census tract" household but are only marginally relevant at the household (micro) level. Further, it is imperative that the rent differential is calculated at the household level for comparison with the survey results.

The initial empirical analysis was confined to Los Angeles County for the 1978-79 period. The Market Data Center provided computer data tapes

TABLE 5.11

VARIABLES USED IN ANALYSIS OF HOUSING MARKET FOR 1978-79

Variable	Definition (assumed effect on housing sale price)	Units	Source
Dependent:			
Sale Price	Sale price of owner occupied single family residences	($100)	Market Data Center
Independent-Housing:			
Sale Date	Month the home was sold (positive)	January 1978 = 1 December 1979 = 24	Market Data Center
Age	Age of home (negative)	Years	Market Data Center
Bathrooms	Number of bathrooms (positive)	Number	Market Data Center
Living Area	Square Feet of Living Area (positive)	Square Feet	Market Data Center
Pool	1 if pool, 0 if no pool (positive)	0 = no pool 1 = pool	Market Data Center
Fireplaces	Number of fireplaces (positive)	Number	Market Data Center
Independent-Neighborhood:			
Distance to Beach	Miles to nearest beach (negative)	Miles	Calculated
Age Composition	Percent Greater than 62 in Census Tract (positive)	Percent	1980 Census
Ethnic Composition	Percent White in Census Tract (positive)	Percent	1980 Census
Time to Work	Average time to Employment from Census Tract (negative)	Minutes	1980 Census
View	1 if view present, 0 if not (positive)	0 = no view 1 = view	Market Data Center
Independent-Community:			
School Quality	Community's 12th grade math score (positive)	Percent	California Assessment Program (1979)
Population Density	Population per square mile in surrounding community (negative)	Persons/square mile	1980 Census, Thomas Brothers Grid Maps
Pollution (TSP)	Total Suspended Particulates (negative)	$\mu g/m^3$, Annual Geometric Average	California Air Resources Board
Pollution (O_3)	Ozone Concentrations (negative)	PPHM, Annual Arithmetic Average of daily maximum	

listing all homes sold in Los Angeles County during this period. The number of entries was unmanageably large (approximately 50,000 observations) so the data set was reduced in size using a random number matching system, Thus, for the basic econometric work the number of randomly chosen observations was 5,921. Subsequent empirical analysis examined a region extended to include the other South Coast Air Basin counties. Again, a sample of approximately 5,000 observations was used.

In addition to the immediate characteristics of a home, other variables which could significantly affect its sale price are those that reflect the condition of the neighborhood and community in which it is located. Such variables include, school quality, ethnic composition, proximity to employment, distance to the beach, and measures of local population density. In order to capture these impacts and to isolate the independent influence of location vis-a-vis ozone differences, these variables were included in the econometric modeling.

The data base assembled for the housing value study is appropriate to test the hypothesis outlined above for two reasons. First, the housing characteristic data is extremely detailed at the household level of aggregation and extensive in that a relatively large number of observations are considered. Second, a variety of neighborhood and community variables which enable the isolation of ozone variation on housing values have been included.

D.3 Empirical Results - Single Equation Model for Los Angeles County

The underlying structure of the initial hypothesis test is a single equation empirical model which attempts to explain the variation in sale prices of homes located in Los Angeles County for the years 1978, 1979.[3] The estimated coefficients of these hedonic equations specify the effect a change in a particular independent variable has on sale price. In reference to the ozone variable, this procedure allows one to focus on its significance while separating out the influence of other extraneous variables. Therefore, this analysis yields two outputs concerning the relationship of ozone differentials to housing price. The relative significance of location variations is determined and the estimated coefficient pertaining to location implicitly measures its monetary value at the margin.

The estimated hedonic price gradient that best fits the data is presented in Table 5.12. A number of aspects of the equation are worth noting. First, both ozone and suspended particulate concentrations are included in the equation. The particulate measure is used as a proxy for the aesthetic component of air quality while ozone concentrations implicitly measure the health effects. Second, the nonlinear specification utilized is a significant improvement over linear forms. As Rosen (1974) pointed out, this is to be expected since consumers cannot always arbitrage by dividing and repackaging bundles of housing attributes. Third, approximately .82 of the variation in home sale price is explained by the variation in the independent variable set. Fourth, with the exception of the time to work and percent old variables, all coefficients are

TABLE 5.12

ESTIMATED HEDONIC EQUATION (SEMI-LOG) FOR LOS ANGELES COUNTY.
DEPENDENT VARIABLE = in (HOME SALE PRICE IN HUNDREDS OF 1978 DOLLARS

Variables	Coefficient	t-statistic
Site Specific Characteristics:		
Sales Date	$.1664 * 10^{-1}$	30.91
Age of Home	$-.22998 * 10^{-2}$	-12.01
Square Feet of Living Area	$.3221 * 10^{-3}$	42.77
Number of Bathrooms	$.9720 * 10^{-1}$	14.43
Number of Fireplaces	$.8774 * 10^{-1}$	15.61
Pool	$.9977 * 10^{-1}$	12.02
View	.1390	14.26
Community Characteristics:		
School Quality	$.1674 * 10^{-3}$	2.28
Population Density	$-.1192 * 10^{-4}$	-7.75
% White	$.8583 * 10^{-2}$	46.41
% Greater THan 62 Years Old	$-.2182 * 10^{-3}$	-.36
Pollution (TSP)	$-.1148 * 10^{-1}$	-32.67
Pollution (Ozone)	$.1011 * 10^{-1}$	7.30
Location Characteristics:		
Time to Employment	$-.5349 * 10^{-3}$	-.53
Distance to the Beach	$-.1475 * 10^{-1}$	-15.84
Constant	6.4380	147.45
R-Squared	.82	
Number of Observations	5921	

significantly different from zero at the one percent level and possess the expected relationship to home sale price. However, the most noteworthy aspect of the hedonic equation is that the ozone variable is positively related to home sale price.

The explanation for this unexpected result is found through examination of the correlation coefficient matrix. This indicates that ozone concentrations and distance to beach are highly collinear, with a simple correlation coefficient of .896. Whereas a high simple correlation coefficient warrants concern, it is not sufficient to claim collinearity as the cause of the problem with the ozone variable. However, the degree of harmful collinearity can be somewhat determined through a rule of thumb suggested by Klein. This rule indicates that multicollinearity would be regarded as a problem only if $R^2_{HSP} < R^2_{x_i}$ where R^2_{HSP} is the multiple correlation of home sale price versus the independent variable set and $R^2_{x_i}$ is the multiple correlation between ozone and the rest of the independent variables. In this case the Klein criterion is satisfied since $R^2_{HSP} = .82$ and $R^2_{x_i} = .83$. Thus, the degree of collinearity in the data is indeed harmful, preventing the estimation of an accurate relationship between ozone and home sale price.

In Los Angeles County the collinearity is especially problematical for the variables distance to beach and ozone for two reasons. First, the prevailing daytime wind patterns are essentially perpendicular to the beach meaning as one moves inland air pollution in general increases.[4] Secondly, the chemical reaction which causes ozone formation requires time and hence distance from the original discharge locations. Thus, the prevailing wind patterns plus the large stock of upwind pollutants yield significant increases in ozone concentrations as one moves inland from the beach areas. Each variable is then measuring exactly the same impact upon home sale price.

Finally, it should be noted that the collinearity problem in Los Angeles County is stable across both functional form and randomly drawn samples. To justify the former statement a variety of functional forms, which allow for variation in both dependent and independent variables, were estimated. Further, a number of random samples were drawn of varying size, including the limiting case of including all observations. In no instance was the collinearity between distance to beach and ozone concentrations broken. Given then that the collinearity could not be reduced through functional form or random sampling, a variety of other approaches were attempted. These are the subject of the next section.

D.4 Alternative Solutions *to* Multicollinearity

Given the multicollinearity between variables and the associated spurious ozone result as described above, the next task was to search for a reasonable solution. The econometrics literature contains a number of possibilities including: (i) dropping variables; (ii) using extraneous estimates; (iii) ridge regression; (iv) nonrandom sampling; (v) altering the model specification; (vi) increasing the spatial variation by increasing the study area; and, (vii) principal components. Each of these was considered. Most were eliminated either on theoretical grounds, lack of supporting information or statistical insignificance. Only the last two options provided any satisfactory solution.

Consider first the dropping variables solution. The problem with multicollinearity is that there is insufficient information in the sample to permit accurate estimation of the individual parameters. By dropping an independent variable (distance to beach in this case) one can derive estimates of the other parameters. However, these estimates are biased, even though they have smaller mean square errors than the original estimates. But it is precisely the unbiasedness that is desired in this case since the estimates are used to calculate the rent differential for comparison to the survey results. In this instance if distance to beach is excluded from the estimation, then the coefficient on ozone possesses the correct negative relationship to home sale price and is significant at the one percent level. However, the estimate is biased and includes the impact of both distance to beach and ozone concentrations. With no *a priori* method for determining the magnitude of the bias, dropping variables does not meet the criterion of reasonableness.

The use of extraneous estimates represents a means to control the collinearity by (i) using an estimate of the impact of distance to beach on home sale price taken from an exogenous estimation; and (ii) correcting home sale price for this impact and then estimating the independent influences of ozone on the dependent variable. However, to our knowledge, there exists no such truly extraneous estimate of distance to beach on home sale price. Furthermore, this method is somewhat questionable on the basis that the extraneous estimate may indeed be "extraneous" and not measure precisely what was intended (Meyer and Kuh, 1957).

The next solution, ridge regression (as used to solve collinearity) is a purely statistical solution without much basis in economic theory. Further, interpretability is oftentimes a problem with the parameter estimates from this procedure. Thus, this solution was not considered in detail.

The nonrandom sampling solution constitutes an attempt to break the collinearity by choosing the sample so as to control for one of the problem variables. Two separate nonrandom sampling procedures were tried in this study. First, sampling was completed along lines parallel (constant distance) to the beach. This was an attempt to control for beach distance yet allowing variation in the other explanatory variables. The primary problem of this procedure is control of beach distance effectively controlled the variation in other variables. The distance to beach variable is insignificant as is expected since it is being controlled. However, this does not solve the problem of the ozone variable since it too is not significantly different from zero even at the ten percent level. This is also to be expected given the degree of collinearity between the two explanatory variables; that is, controlling for one effectively controls the other.

In response to this problem, the second nonrandom procedure was conducted along lines possessing an approximate forty-five degree angle relationship to both the beach and the predominant wind direction. This constituted an intermediate sampling method by controlling somewhat for beach access yet allowing some variation. The results of this exercise were somewhat more promising in that ozone concentrations possess the correct relationship (negative, but not significantly different from zero) to home sale price. However this approach is beset by other limitations, which are also of concern in the first nonrandom sampling procedure. These limitations include the following.

First, there is insufficient variation in other variables to permit accurate estimation; that is, the sampling procedure reduces the inherent variation in the other variables. Second, there is induced multicollinearity as a result of this insufficient variation. Thus, whereas the simple correlation between ozone and distance to beach is reduced, the simple correlations between ozone and population density, ozone and TSP, TSP and population density, ozone and percent greater than 62 years old and others demonstrate marked increases. The total multicollinearity is therefore not reduced due to the non-random sampling. Third, without a specific sampling plan generalization outside the sample may not be justifiable.

In conclusion, the non-random sample experiments conducted were not completely successful. However, some hope remains, especially in light of the results concerning the second approach. It seems that a non-random sampling method could be devised that counters the arguments presented above. Thus, this solution is not without some merit and may warrant further investigation.

The failure of the previous experiments led these researchers to question the basic model specification. That is, rather than posit a single equation model, a simultaneous equation system was examined. The basis for this model is that ozone is a produced pollutant and is dependent upon its precursors (reactive hydrocarbons, oxides of nitrogen) plus some reaction time. If reaction tine is functionally dependent upon distance travelled then this would explain the high correlation between ozone and distance to beach in Los Angeles County. Note that distance to beach is essentially distance travelled (or reaction time) since the predominate daytime wind direction is perpendicular to the beach.

The structural equations of this simultaneous system can be formally stated as:

$$HSP = \beta_o + \beta_1 \cdot (BD) + \beta_2 \cdot (O_3) + \beta_3 (NO_x) + \sum_{i=1}^{n} \gamma_i X_i \qquad (5.19)$$

$$Ozone = \alpha_o + \alpha_1 \cdot (BD) + \alpha_2 \cdot (NO_x) + \alpha_3 \cdot (HC) \qquad (5.20)$$

where

HSP = home sale price

BD = distance to nearest beach

O_3 = ozone concentrations

NO_x = oxide of nitrogen concentrations

HC = reactive hydrocarbons concentrations

X_i = the rest of the independent variable set usually associated with a hedonic housing equation

$\alpha_i, \beta_i, \gamma_i$ = parameters to be estimated

The first equation is the standard hedonic housing equation. The second equation is the production relationship. Each equation could be specified as above (linear) or some other better fitting functional form. In this model the endogenous variables are home sale price and ozone concentrations. All other variables are exogenously determined. In addition, under the assumption that reactive hydrocarbons are not perceived directly by households (reactive hydrocarbons are omitted from the first equation) then the model is identified; that is, the rank condition for identification is satisfied.

Substituting the second equation into the first the model can be rewritten as:

$$HSP = (\beta_o+\beta_2\alpha_o) + (\beta_1+\beta_2\alpha_1) \cdot BD + (\beta_3+\beta_2\alpha_2) \cdot NO_x + \beta_2\alpha_3 HC + \sum_{i=1}^{N} \gamma_i X_i \qquad (5.21)$$

or where

$$\lambda_o = \beta_o + \beta_2\alpha_o$$

$$\lambda_1 = \beta_1 + \beta_2\alpha_1$$

$$\lambda_2 = \beta_3 + \beta_2\alpha_2$$

$$\lambda_3 = \beta_2\alpha_3$$

$$HSP = \lambda_o + \lambda_1 \cdot BD + \lambda_2 \cdot NO_x + \lambda_3 \cdot HC + \sum_{i=1}^{N} \gamma_i x_i \qquad (5.22)$$

Equations (5.20) and (5.22) are the reduced-form equations. The parameters of the model $(\alpha_i, \lambda_i, \gamma_i)$, can then be estimated using indirect least squares. In this method the reduced-form equations are estimated using ordinary least squares and then the structural equation parameters are obtained from the relationships specified above. Thus,

$$\beta_o = \lambda_o - (\lambda_3/\alpha_3) \cdot \alpha_o$$

$$\beta_1 = \lambda_1 - (\lambda_3/\alpha_3) \cdot \alpha_1$$

$$\beta_2 = \lambda_3/\alpha_3$$

$$\beta_3 = \lambda_2 - (\lambda_3/\alpha_3) \cdot \alpha_2$$

No transformation is required for the α_i and the γ_i.

Considering the ozone equation, estimation was completed as follows. Data at each of the air quality monitoring stations was utilized in the estimation. Ozone, NO_x and HC were specified as annual arithmetic averages of the daily maximum values. Distance to beach was measured in miles. The estimated equation in linear form is presented in Table 5.13.[5] As indicated the only significant variable is distance to beach. This implies that the proposed physical model is somewhat deficient.

Further investigation of the physical relationship between ozone and its constituent pollutants revealed that ozone peaks generally occurred downwind from the hydrocarbon and oxides of nitrogen peaks. Therefore, rather than use HC, NO_x and O_3 measurements from the same monitoring station, ozone concentrations at each station were related to the corresponding farthest upwind station. These results are presented in Table 5.14. Again, distance to beach is the only significant variable indicating rejection of the physical model of ozone formation. In this case the failure of HC and NO_x to appear as significant variables may be traced to the lack of sufficient variation in the upwind data on an annual average basis. A more reasonable approach would employ daily pollution data.

These experiments indicate that the proposed physical model is either incorrectly specified or the data is insufficient for the task. Without an accurate physical model the simultaneous equation approach as developed here lacks sufficient justification. Thus, as a solution to the multicollinearity problem the simultaneous equation method was abandoned. This does not imply that the methodology is inherently incorrect but rather that until further refinements are made the model holds little promise.

This section examined a variety of solutions to multicollinearity in the Los Angeles data set. Essentially, each proposed solution was unsuccessful. In the next two sections empirical results are presented for two solutions which do yield the expected relationship between ozone concentrations and home sale price.

D.5 Empirical Results - Single Equation Model, South Coast Air Basin

As is detailed above, there exists severe collinearity between

TABLE 5.13
ESTIMATED OZONE EQUATION (LINEAR) FOR LOS ANGELES COUNTY.
DEPENDENT VARIABLE = OZONE CONCENTRATIONS IN PARTS PER MILLION

Variables	Coefficient	t-statistic
Beach Distance	.00426	3.10
Oxides of Nitrogen	.5233	1.05
Hydrocarbons	-.00464	-.834
Constant	-.0049	-.067
R-Squared	.60	
Residual Sum Squares	.0115	
Number of Observations	14	

TABLE 5.14

ESTIMATED OZONE EQUATION (LINEAR) FOR LOS ANGELES COUNTY UPWIND DATA. DEPENDENT VARIABLE = OZONE CONCENTRATIONS IN PARTS PER MILLION

Variables	Coefficient	t-statistic
Beach Distance	.0056	4.22
Oxides of Nitrogen	.962	.867
Hydrocarbons	.0021	.109
Constant	-.102	-.853
R-Squared	.55	
Residual Sum Squares	.0124	
Number of Observations	14	

ozone and distance to beach within Los Angeles County. However, in the areas adjacent to Los Angeles County the collinearity between these variables is much less apparent. Therefore, it was decided to increase the spatial variation in the data set through the addition of data from Orange, Riverside and San Bernardino Counties. The data addition was restricted to those areas of each county which borders Los Angeles County on the premise that data from long distances would constitute a separate housing market. The housing data was obtained from the SREA Market Data Center while the associated neighborhood and community data were obtained from the sources outlined in Table 5.1.

The data from the surrounding counties were pooled with the original Los Angeles County data. The new data set had approximately 68,400 observations. The relevant county breakdown was Los Angeles with 50,432, Orange with 12,117, Riverside with 1,452 and San Bernardino with 4,405. Due to this large size the data set was reduced to 4,951 observations using a random number matching system. In order to account for any variation in housing markets across county boundaries a set of zero-one variables for county location were constructed and added to the data set. Before proceeding to a discussion of the empirical results based on the new sample it should be noted that the additional data reduced the simple correlation coefficients between ozone and beach from .896 to approximately .66.

In addition to the data which increased the spatial variation, data which more closely approximates the aesthetic aspect of air quality became available. That is, a measure of actual visibility, or its reciprocal, light extinction was generated by a simultaneous California Air Resources Board project. The variable visibility is measured as median miles and was[6] calculated for grid squares roughly four miles square for the study area. This variable was entered into the data set as another explanatory or independent variable.

Given the data as outlined above, a single equation hedonic housing model was estimated. A particular example is presented in Table 5.15. Note that the Riverside County zero-one variable is the excluded variable so that the zero-one variables for the other counties are interpreted as deviations from Riverside County as depicted by the constant term. As is illustrated, the estimated equation seems to perform quite well on a number of counts. First, approximately 80 percent of the variation in home sale price is explained by the independent data set. Second, with few exceptions, the estimated coefficients possess the expected relationship to home sale price and are significant at the one percent level. Two exceptions are ozone and school quality. However, these variables are significantly different from zero at the ten percent level under the presumption of a priori information; that is, the sign of the variable is known in advance. Therefore, the only variable which is not significantly different from zero at the ten percent level is time to work. However, this is not totally unexpected since this variable is essentially constant, demonstrating a small variance around its mean. The indication is that most people travel about the same time to work. Thus, its insignificance is not particularly troublesome.

TABLE 5.15

ESTIMATED HEDONIC EQUATION (SEMI-LOG) FOR THE SOUTH COAST AIR BASIN.
DEPENDENT VARIABLE = ln(HOME SALE PRICE IN 1978-79 DOLLARS)

Variables	Coefficient	t-statistic
Site Specific Characteristics:		
Sales Date	$.1481 * 10^{-1}$	28.61
Age of Home	$-.1658 * 10^{-2}$	-8.02
Square Feet of Living Area	$.4012 * 10^{-3}$	46.86
Number of Bathrooms	$.6320 * 10^{-1}$	8.66
Number of Fireplaces	$.7606 * 10^{-1}$	12.38
Pool	$.7788 * 10^{-1}$	8.59
View	.1481	12.85
Community Characteristics:		
School Quality	$.1256 * 10^{-3}$	1.36
Population Density	$-.7807 * 10^{-5}$	-4.32
% White	$.8055 * 10^{-2}$	33.53
% Greater Than 62 Years Old	$.1839 * 10^{-2}$	2.54
Pollution (TSP)	$-.7811 * 10^{-2}$	-18.82
Pollution (Ozone)	$-.1973 * 10^{-2}$	-1.58
Location Characteristics:		
Time to Employment	$.1257 * 10^{-2}$	1.25
LN(Distance to the Beach)	$-.6899 * 10^{-1}$	-11.36
Los Angeles County	$.9084 * 10^{-1}$	4.16
Orange County	-.1466	-6.28
San Bernardino	-.2031	-9.01
Constant	5.882	114.77
R-Squared	.80	
Number of Observations	4951	

The central point is that the estimated equation in Table 5.15 looks reasonable in every respect. However, the results are very unstable with the ozone variable demonstrating substantial variation for small changes in either functional form or random samples. For instance, the use of distance to beach rather than $\ln$ (distance to beach) reverses the sign of the ozone variable. Similarly, using the light extinction variable rather than total suspended particulates as a measure of aesthetic air quality alters the ozone coefficient markedly. In fact, the functional form presented is one of only a limited number of forms which produced a negative and significant relationship between ozone concentrations and home sale price. This inherent instability strips the results of any meaning.

Therefore, in an attempt to break the collinearity between distance to beach and ozone the data set was expanded to include outlying areas. This effort reduced the simple correlation between these variables by a significant amount. Further, we were able to estimate an equation which could be perceived as correct. However, the ozone coefficient is inherently unstable, subject to large variation in both magnitude and sign. The conclusion is that harmful collinearity in the data set has not been appropriately solved. In the next section we report on the use of principal components analysis which does produce stable results.

D.6 Empirical Results - Principle Components Analysis

Principle component analysis is a method of transforming a given set of variables into a new set of composite indices or principle components that are orthogonal (uncorrelated) to each other. Because of the severe collinearity in this study a transformation that yields uncorrelated variables is particularly useful. The transformation is accomplished by choosing the best linear combination of the variables. In this context best implies that the combination chosen accounts for more of the variance in the data than any other linear combination of variables. The first principle component is therefore viewed as the single best summary of linear relationships exhibited in the data. The second component is defined as the second best linear combination of variables, given the condition that the second is orthogonal to the first. This continues until all the variation in the data is explained.

The principle component method can be expressed as:

$$X_i = a_{i1}F_1 + a_{i2}F_2 + a_{iK}F_K \qquad (5.23)$$

where

X_i = the variables included in the principle component analysis (i = 1, 2, . . ., m)

F_j = the principle components or factors (j = 1, 2, . . ., K) , $K \leq M$

a_{ij} = estimated coefficients

If the number of factors equals the number of variables (K=M) then the entire variation in the variables is explained by the factors. However, it is the usual case to use fewer factors than variables because if the two are equal then the procedure is identical to not using principal components analysis (Johnston, 1972).

The estimated coefficients are important in that they indicate the relative importance of each factor. The importance of a given factor for a given variable can be expressed in terms of the variance in the variable that is explained by the factor. Mathematically this is the square of the estimated coefficient (a_{ij}^2). The total variation of a variable explained by all factors is obtained by summing the squared coefficients

$(\sum_{j=1}^{K} a_{ij}^2)$.

Given the relationships described in equation (5.23) the original data is transformed into a set of composite scales or factor scores that represent the relative importance of the respective factors or principle components. In order to do this the matrix of a_{ij} is transformed into a factor score coefficient matrix. The composite scales or factor scores are then calculated as:

$$Z_j = b_{1j}(X_1 - \overline{X}_1)/\sigma_1 + b_{2j}(X_2 - \overline{X}_2)/\sigma_2 + \ldots + b_{Mj}(X_m - \overline{X}_m)/\sigma_m \qquad (5.24)$$

where

Z_j = factor score representing the j^{th} factor ($j = 1, 2, \ldots, K$)

b_{ij} = factor score coefficient ($i = 1, 2, \ldots, m$)

X_i = original data ($i = 1, 2, \ldots, M$)

$\overline{X}_i$ = mean of the i^{th} independent variable

σ_i = standard deviation of the i^{th} independent variable.

Note that the original data is standardized as an alternative to measuring all variables in the same units (Johnston, 1972).

The factor scores represent the transformed data set in which orthogonality is preserved. This new data is then input into the home sale price hedonic equation as explanatory variables. In essence, a set of highly correlated variables are replaced by a new set of uncorrelated variables which measure precisely the same information. However, it should be noted that the initial variables have been constrained to a linear relationship. Essentially, the procedure represents the imposition of a linear restriction, where the linear relationship is not based on a priori information but is chosen as the one which best fits the data.

In the semi-log form the hedonic equation can be written as:

$$\ell n(HSP) = \beta_0 + \sum_{j=1}^{K} \beta_j Z_j + \sum_{i=M}^{N} \lambda_i X_i \qquad (5.25)$$

where

HSP = home sale price

Z_j = factor scores representing the principle components ($j = 1, 2, . . . K$)

X_i = remaining explanatory variables not included in the principle component analysis

$\beta_0, \beta_j, \lambda_i$ = estimated coefficients.

Since the principle components are linear combinations of other variables no precise interpretation can be given to the factor score variables. However, one can still determine the relative effect of a change in a variable included in the principle component analysis by differentiating equation (5.25) with respect to that variable. For instance, consider the impact of X_1, a variable included in the principle component analysis. Substituting equation (5.24) into (5.25) and differentiating, we obtain

$$\frac{\partial HSP}{\partial X_1} = \frac{\partial HSP}{\partial Z_1}\frac{\partial Z_1}{\partial X_1} + \dots + \frac{\partial HSP}{\partial Z_K}\frac{\partial Z_K}{\partial X_1}$$

$$= e^{(\beta_0 + \sum_{j=1}^{K} \beta_j Z_j + \sum_{i=m}^{N} \lambda_i X_i)} \left(\frac{\beta_1 b_{11}}{\sigma_1} + \frac{\beta_2 b_{12}}{\sigma_1} + \dots + \frac{\beta_K b_{1K}}{\sigma_1}\right) \qquad (5.26)$$

Thus, although X_1 does not enter the hedonic housing equation directly its relative importance can still be determined.

In the particular situation under study there exists severe collinearity between ozone concentrations and distance to beach. Thus, it was decided to perform principle component analysis on these troublesome variables to transform them into a set of uncorrelated variables. Two different approaches were utilized. In each case distance to beach, ozone and a variable measuring aesthetic air quality were included as variables to be transformed. The first used TSP, the second used light extinction. In each case two factors were used to explain the variables.

The initial factor matrix for beach, ozone and TSP is presented in Table 5.16 (top). The bottom portion of the table presents the distance to beach, ozone, extinction case. As is illustrated the first factor or principle component largely explains distance to beach and ozone concentrations. In both cases the aesthetic measure loads up on the second

TABLE 5.16

FACTOR COEFFICIENT MATRIX

Variable	Factors	
	Factor 1	Factor 2
Distance to Beach	.85105	.30095
Ozone	.90116	.18974
TSP	.2597	.96397
Distance to Beach	.80893	.39651
Ozone	.92789	.14043
Extinction	.23856	.9626

factor. The two factors explain approximately 89 percent of the variation in the variables in each case.

As outlined above the initial factor matrix is transformed into a factor score coefficient matrix. The relevant matrices are presented in Table 5.17. These factor score coefficients are used to compute factor scores or composite scales which represent the relative importance of each factor for each variable. This is accomplished in accordance with equation (5.24). The factor scores are input data (explanatory variables) into the hedonic housing equation. The expected sign of each of the factors is negative since each represents negative influences on home sale price.

The hedonic housing equation using principle components to transform distance to beach, ozone and TSP and estimated on the South Coast Air Basin sample (4,951 observations) is presented in Table 5.18. The hedonic equation which is based on distance to beach, ozone and extinction is sufficiently similar as to not warrant inclusion here.

As is illustrated the estimated log-linear equation performs quite well when considering proportion of explained variation (R^2 = .79) and t-statistics. Note that time to employment has been replaced by distance to the central business district. As a locational indicator the latter seems to outperform the ubiquitous time to work variable. Also, Los Angeles County is the excluded zero-one variable. This has no effect on the results but makes the signs of the zero-one location variables consistently negative.

The estimated equation also appears to be quite stable with respect to experimental functional forms and randomly drawn samples. However, only a preliminary analysis has been conducted.

The non-linear specification presents straightforward analysis of the quantitative impact of a unit change in an independent variable since the effect depends upon the level of all other variables. However, if ozone and all other variables are assigned their mean values then a one unit improvement in ozone (PPHM) is valued at $852.

The estimated equation shown in Table 5.18 yield the marginal willingness to pay for ozone reductions by taking the derivative with respect to ozone. This procedure supplies information on the amount that each household is willing to pay in house price differentials for changes in ozone concentrations. These home sale price differentials are used in the next section for comparison to the survey results.

D.7 Summary

This section reports on an attempt to validate the survey results of the previous section through an analysis of the housing market. The housing value study was conducted initially in Los Angeles County. However, severe collinearity between variables prevented the estimation of an accurate hedonic housing equation. A variety of solutions often cited in the literature were attempted but within Los Angeles the collinear

TABLE 5.17

FACTOR SCORE COEFFICIENT MATRIX

Distance to Beach, Ozone, TSP		Distance to Beach, Ozone, Extinction	
Factor 1	Factor 2	Factor 1	Factor 2
.5628	-.0761	.4897	.0572
.6667	0.2480	.7300	-.3231
-.3069	1.1099	-.3082	1.062

TABLE 5.18

ESTIMATED HEDONIC EQUATION (LOG-LINEAR) FOR THE SOUTH COAST AIR BASIN. DEPENDENT VARIABLE = ln(HOME SALE PRICE IN 1978-79 DOLLARS)

Variables	Coefficient	t-statistic
Site Specific Characteristics:		
ln(Sales Date)	$.98 * 10^{-1}$	23.76
ln(Age of Home)	$.11 * 10^{-1}$	-6.11
ln(Square Feet of Living Area)	.709	46.75
ln(Number of Bathrooms)	$.928 * 10^{-1}$	6.72
Number of Fireplaces	$.738 * 10^{-1}$	11.45
Pool	$.912 * 10^{-1}$	9.68
View	.192	16.30
Community Characteristics:		
ln(School Quality)	$.65 * 10^{-1}$	2.57
ln(Population Density)	$-.456 * 10^{-1}$	-6.24
ln(% White)	.367	34.14
ln(% Greater Than 62 Years Old)	$.201 * 10^{-1}$	3.05
Location Characteristics:		
ln(Distance to Central Business District)	$-.132 * 10^{-1}$	-4.84
Riverside County	$-.906 * 10^{-1}$	-4.03
Orange County	-.247	-27.63
San Bernardino County	-.253	-18.23
Factors		
Factor 1	-.11	-28.39
Factor 2	-.122	-30.76
Constant	-.19	-1.12
R-Squared	.79	
Number of Observations	4951	

relationships could not be broken. Therefore, the study area was expanded to include the other counties of the South Coast Air Basin. In addition, the harmful collinearity was reduced through the use of principle components analysis. In the latter approach a linear restriction is imposed on the problem variables. The end result was a stable estimated hedonic equation that satisfied the usual statistical tests. More extensive work should further refine the model.

The final equation includes both ozone concentrations and another variable which measures the aesthetic aspect of air quality. The relative impact of ozone concentrations can be analyzed by differentiating the equation with respect to ozone. The resulting home sale price change measures the marginal willingness to pay for a marginal ozone change. These figures are not strictly interpretable as benefit measures but can be compared to the survey results as a validation test in accordance with Brookshire et al. (1982). As is described in the next section the home sale price differential closely parallels the survey results.

E. PRELIMINARY COMPARISON BETWEEN SURVEY AND HEDONIC HOUSING VALUE RESULTS

The ozone experiment conducted in the South Coast Air Basin represents an attempt to place a monetary value on ozone concentration reductions. This is accomplished through use of both the survey approach and an analysis of housing values. The survey was undertaken in six communities, spanning three air quality areas. Individual households were asked to value daily ozone improvements consistent with these air quality zones. Variation across income class was an important variable in survey design.

The housing value analysis was not limited to a set of individual communities but rather used data from the four counties (Los Angeles, Orange, Riverside, San Bernardino) in the South Coast Air Basin. This more extensive data base was required to accurately estimate the hedonic price gradient. The objective of the housing value exercise was to determine the hedonic or implicit price of ozone concentrations (annual average) as they impact residential housing values.

In this section these diverse methodologies are brought together so that a preliminary comparison of the values associated with ozone reductions can be completed. The comparison is restricted to the six communities (three air quality areas) in which the survey was conducted. The air quality zones are labelled Poor (West San Gabriel Valley), Fair (West San Fernando Valley), and Good (North Orange County). The comparison is done on an annual basis. Thus, for each methodology a conversion of the basic values obtained is necessary.

Consider first the survey approach. The survey was directed at determination of the value of ozone reductions on a single "memorable" day. However, the theoretical model presented above suggests that utility functions may be daily separable. This implies that daily bids are both separable and additive. Thus, an annual bid may be obtained for a specific air quality change by multiplying the daily bid by the number of days to be altered.

In each air quality region the respective frequency distribution of days that the representative air quality standards (federal standard, stage one alert, stage two alert) are violated are depicted in Table 5.19. As is indicated the Poor air quality region has relatively more high ozone days and less low ozone days than either of the other regions. In a like manner the Fair region has relatively worse air quality than the region labelled good.

The particular air quality change that is analyzed here corresponds to a shift of the frequency distribution from Poor to Fair and from Fair to Good. Thus, the West San Gabriel Valley is assumed to change from the present state to ozone concentrations consistent with the West San Fernando Valley. Further, the West San Fernando Valley is to experience air quality levels that now exist in the North Orange County communities.

Given the number of days to be affected, the final data input necessary to calculate an annual bid from survey responses are the individual bids for each category. The mean bids across individuals are presented in Table 5.20. As is illustrated, West San Gabriel respondents bid for three air quality improvements (D-C, C-B, B-A). On the other hand there are only two bids for West San Fernando respondents since they experience no days with second stage smog alerts. These mean bids represent marginal bids since, for instance, West San Gabriel individuals were asked to bid from D to C, D to B and D to A. Thus, the figures in Table 5.20 are the differences between bids (marginal bids) for the changes D to C, C to B and B to A.

For each individual in an air quality region an annual bid is determined through a simple summation of the daily bids. Each daily bid represents the households daily marginal bid for the air quality change for that day. For instance, if the air quality in the poor region is improved to fair levels then the individual would receive 8 less D days, 77 less C days and 84 less B days. Multiplying the individuals value of the air quality changes by these figures and summing yields the annual bid for a change from Poor to Fair. In a similar manner the value that a West San Fernando household places on a Fair to Good improvement is determined by multiplying daily bids by the number of days changed. For comparison to the housing value results the individual annual values are deflated to reflect 1979 dollar values.

The means and standard deviations of these annual bids are presented in Table 5.21. The range of values represents the basic difference between interview and mail respondents.

For comparison to the calculated values obtained from survey responses, an annual bid was estimated from the hedonic housing value study. The primary output from an estimated hedonic housing equation is the implicit price of each characteristic. If the estimated equation is non-linear then this implicit price is not independent of other variables

TABLE 5.19

OCCURRENCE OF DAILY PEAK OZONE LEVELS BY AIR QUALITY AREA, 1978

	AIR QUALITY AREA		
	West San Gabriel Valley	West San Gernando Valley	North Coastal Orange County
Air Quality (Ozone, pphm)	Number of Days		
D(35-50 pphm)	8	0	0
C(20-35 pphm)	85	16	3
B(12-20 pphm)	59	52	22
A(0-12 pphm)	213	297	340

TABLE 5.20

MEAN AND STANDARD DEVIATION OF MARGINAL BIDS
FOR OZONE REDUCTIONS ($1982)

	AIR QUALITY AREA			
	West San Gabriel Valley		West San Fernando Valley	
	Interview Respondents	Mail Respondents	Interview Respondents	Mail Respondents
D	--	--	--	--
C	9.01 (21.93)	7.72 (16.77)		
B	1.32 (2.24)	3.09 (6.78)	3.91 (5.65)	7.85 (17.95)
A	6.88 (19.58)	8.78 (18.71)	2.51 (6.51)	2.08 (8.37)

TABLE 5.21

ANNUAL VALUES FOR OZONE REDUCTIONS ($1978)

	Means and Standard Deviations (in parentheses) Air Quality Improvement	
	Poor - Fair	Fair - Good
Interview Respondents	502 (1166)	106 (227)
Mail Respondents	692 (1238)	128 (325)
Hedonic Housing Value	346 - 731 (191) - (453)	153 - 371 (76.7) - (162)

in the equation. Such is the case in this study. This implicit price or marginal willingness to pay is given as the home sale price differential for a marginal charge in the characteristic and is, in essence, a marginal bid for the particular characteristic. Thus, for a given change in the attribute this marginal willingness to pay or home sale price differential can be precisely compared to the bids obtained from the survey.

The basic procedure then is to first calculate the home sale price for each individual in the comparison areas for the initial air quality conditions. The next step is to calculate the home sale price for the subsequent air quality. The differential between these two calculations represents the home sale price differential attributable to the air quality change. This is equivalent to differentiating the hedonic housing equation with respect to ozone concentrations and evaluating over the relevant change. Various hedonic equations are used, the primary differences being functional form and the variable used to describe the aesthetic component of air quality (light extinction or total suspended particulates).

The hedonic housing approach uses annual average ozone data to describe ozone concentrations spatially. Thus, the shift downward in the frequency distribution described above is translated into a change in the annual average to calculate the home sale price differential. For instance, the frequency distributions for the three air quality areas imply approximate annual averages of 13.77, 8.8 and 7.17 pphm, respectively. The home sale price differential is calculated for each individual household for these changes (13.77 - 8.8, 8.8 - 7.17).

Home sale price differentials are calculated for each household in the comparison areas. These represent home sale price changes over the life of the home. These values are converted to annual differentials using the standard annualization procedure (interest rate = .095). The means and standard deviations for each proposed air quality change are presented in Table 5.21. The lower portion of the range is based on the log-linear functional form and the use of total suspended particulates to measure the aesthetic aspect of air quality. The upper portion of the estimated range relies on the model which uses the semi-log functional form and the light extinction variable.

It appears from an examination of Table 5.21 that surveys and hedonic housing studies yield comparable values for the proposed ozone reductions. If anything, surveys seem to produce lower valuations than an analysis of. housing values. But this is consistent with the theoretical model in Brookshire et al. (1982). The closeness of the valuations also lend support to the theoretical model specified above that assumes daily separability of the bids. However, this comparison is only preliminary. Only after substantial in-depth statistical examination and comparability checks between the two studies will the researchers be able to state unequivocally how the valuations compare.

REFERENCES

1. The sale price or the discounted value of the flow of rents rather than actual rent is used as the dependent variable. The two are interchangeable given the appropriate discount rate.

2. 1978 was chosen as the year of analysis because that is the last year of data that was available. This makes the comparison to the survey results somewhat tentative but that is all that was possible given the data limitations.

3. See Freeman (1979) and Mäler (1979) for reviews of estimating hedonic housing equations.

4. For a complete discussion of these issues see "Seasonal and Diurnal Variation in California's South Coast Air Basin", by M. Hoggan, A. Davidson and D. Shikiga of the South Coast Air Quality Management District.

5. The results are not affected by functional form.

6. See J. Trijonis et al. "Development of Methods to Estimate the Benefits of Visibility Improvement," California Air Resources Board, on going project, 1983.

BIBLIOGRAPHY

Anderson, R. and T. Crocker. 1971. "Air Pollution and Residential Property Values," Urban Studies, 8 (October).

Belsey, D. A,, E. Huh, and E. Welsch. 1980. Regression Diagnostics (New York: John Wiley and Sons).

Bishop, R. C. and T. A. Heberlein. 1979. "Measuring Values of Extra-Market Goods: Are Indirect Measures Biased?" American Journal of Agricultural Economics 6 (December).

Brookshire, D., M. Thayer, W. Schulze, and R. d'Arge. 1982. "Valuing Public Goods: A Comparison of Survey and Hedonic Approaches," American Economic Review, 72 (March).

Brookshire, D. S., R. Cummings, M. Rahmatian, W. Schulze and M. Thayer. 1982. "Experimental Approaches for Valuing Environmental Commodities: Volume I," Methods Development in Measuring Benefits of Environmental Improvements, U.S. Environmental Protection Agency, Grant #CR808-893-01 (April).

Brown, J. and H. Rosen. 1982. "On the Estimation of Structural Hedonic Price Models," Econometrica (May).

Burness, H. S. et al. 1982. "Ex Ante Optimality and Spot Market Economics," Chapter 7 in Water Management Strategies in Arid Regions, Report to the National Science Foundation, Grant #DAR 7909933, Washington, D.C. (February): 7.25.

Cummings, R. G., H. S. Burness, and R. G. Norton. 1981. "The Proposed Waste Isolation Pilot Project and Impacts in the State of New Mexico," EMD 2-6-1139, New Mexico Energy Research and Development Institute, Albuquerque (April).

Cummings, R. G., W. Schulze, S. Mehr, and D. Brookshire. "Measuring the Elasticity of Substitution of Wages for Municipal Infrastructure: A Comparison of the Survey and Wage Hedonic Approaches," Forthcoming: Journal of Environmental Economics and Management.

Desvousges, W. H. and V. K. Smith. 1982. The Basis for Measuring the Benefits of Hazardous Waste Disposal Regulations, Technical Report, Raleigh, Research Triangle Institute.

Desvousges, W., V. K. Smith, and M. McGivney. 1982. A Comparison of Alternative Approaches for Estimating Recreation and Related Benefits of Water Quality Improvement, Draft, Research Triangle Institute.

Fairley, W. B. 1975. "Criteria for Evaluating the 'Small' Probability of a Catastrophic Accident from the Marine Transportation of Liquefied Natural Gas," in Okrent Edition.

Freeman, A.M., III. 1979. "Hedonic Prices, Property Values and Measuring Environmental Benefits: A Survey of the Issues," Scandinavian Journal of Economics, 81.

Gallagher, D. R. and V. K. Smith. 1983. "Measuring Values for Environmental Resources Under Uncertainty," mimeo, Department of Economics, University of North Carolina, Chapel Hill (January 24).

Georgescu-Roegin, N. 1936. "Pure Theory of Consumer Behavior," Quarterly Journal of Economics (August).

Georgescu-Roegin, N. 1958. "Threshold in Choice and the Theory of Demand," Econometrica 26: 157-168.

Goldman, S. M. and H. Uzawa. 1964. "A Note on Separability in Demand Analysis," Econometrica 32(3) (June): 387-398.

Graham, D. 1983. "Estimating the State Dependent Utility Function," Natural Resources Journal (June).

Hammack, J. and G. Brown. 1974. Waterfowl and Welands: Toward Bioeconomic Analysis, (Baltimore: Johns Hopkins University Press).

Harrison, D., Jr., and D. Rubinfeld. 1978. "Hedonic Housing Prices and the Demand for Clean Air," Journal of Environmental Economics and Management, 5 (March).

Hoehn, J. P. and A. Randall. "Aggregation and Disaggregation of Program Benefits in a Complex Policy Enviornment," unpublished manuscript.

Hoggan, M., A. Davidson and D. Shikiga. "Seasonal and Diuranal Variation in California's South Coast Air Basin," The South Coast Air Basin Management District.

Johnston, J. 1972. Econometric Methods (New York: McGraw-Hill).

Kahneman, D. and A. Tversky. 1979. "Propsect Theory: An Analysis of Decision Under Risk," Econometrica 47 (March): 263-292.

Kahneman, D. and A. Tversky. 1982. "The Psychology of Preferences," Scientific American (January): 160-180.

Katzner, D. W. 1970. Static Demand Theory (New York: MacMillan).

Krutilla, J. V. 1977. "Conservation Reconsidered," *American Economic Review* 57 (September).

Lancaster, K. 1966. "A New Approach to Consumer Theory," *Journal of Political Economy* 74 (April).

Mäler, K. "A Note on the Use of Property Values in Estimating Marginal Willingness to Pay for Environmental Quality," *Journal of Environmental Economics and Management,* 4, December, 1977.

Mendelsohn, R. "The Demand and Supply for Characteristics of Goods," University of Washington, 1980.

Meyer, J. and E. Kuh. 1957. "How Extraneous are Extraneous Estimates," *Review of Economics and Statistics* (November).

Mitchell, R. C. and R. T. Carson. 1981. *An Experiment in Determining Willingness to Pay for National Water Quality Improvement*, report submitted to the Office of Strategic Assessment and Special Studies, U.S. Environmental Protection Agency, Contract #R-806906010 (June).

National Research Council. 1977. Committee on Medical and Biological Effects of Environmental Pollutants. "Ozone and Other Photochemical Oxidants." Division of Medical Sciences, Assembly of Life Sciences. Washington D. C., National Academy of Sciences.

Nelson, J. 1979. "Airport Noise, Location Rent, and the Market for Residential Amenities," *Journal of Environmental Economics and Management,* 6 (December).

Page, T. 1981. "A Framework for Unreasonable Risk in Toxic Substances Control Act," Caltech, SSWS papger No. 368 (February).

Palmquist, R. 1981. "The Demand for Housing Characteristics: Reconciling Theory and Estimation," North Carolina State University.

Radner, R. 1970. "Problems in the Theory of Market Under Uncertainty," *American Economic Review* 60 (May): 454-460.

Randall, A. et al. 1983. "Contingent Valuation Survey for Evaluating Environmental Assets," *Natural Resources Journal* (June).

Rosen, S. "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition," *Journal of Political Economy*, 82, January/ February, 1974.

Schnare, A. "Racial and Ethnic Price Differentials in an Urban Housing Market," *Urban Studies,* 13, June, 1976.

Schulze, W., R. d'Arge, and D. Brookshire. 1981. "Valuing Environmental Commodities: Some Recent Experiments," *Land Economics* (May).

Schulze, W., R. Cummings, D. S. Brookshire, R. Whitworth, M. Thayer, M. Rahmatian, H. S. Burness, J. Murdoch, A. F. Mehr, and M S. Walbert. 1983. "Experimental Approaches for Valuing Environmental Commodities: Volume II," Methods Development in Measuring Benefits of Environmental Improvements, U.S. Environmental Protection Agency, Grant #CR808-893-01 (February).

Slovic, P., B. Fischhoff, S. Lichtenstein, B. Corrigan, and B. Combs. 1977. "Preference for Insuring Against Probable Small Losses: Implications for the Theory and Practice of Insurance," Journal of Risk and Insurance 44: 237-258.

Slovic, P. and S. Lichtenstein. "Preference Reversals: A Broader Perspective," American Economics Review (In press).

Starr, R. 1973. "Optimal Production and Allocation Under Uncertainty," Quarterly Journal of Economics 87 (January): 84-85.

Starr, C., R. Rudman, and C. Whipple. 1976. "Philosophical Basis for Risk Analysis," Annual Reviewe of Energy 1: 629-662.

Svensson, L. 1976. "Sequences of Temporary Equilibria, Stationary Point Expectations and Pareto Efficiency," Journal of Economic Theory 13: 169-183.

Tolley, G. and A. Randall. 1984. "Establishing and Valuing the Effects of Improved Visibility in Eatern United States," Final Report 807768-01-0, U.S. Environmental Protection Agency (In press).

APPENDIX A

SURVEY QUESTIONNAIRES: MAIL AND INTERVIEWER

Dear Californian:

We are a research team at the University of Wyoming conducting a study related to air quality improvements. Air quality is a familiar topic to people who live in the Los Angeles area. Also, many people are interested in the benefits of having cleaner air.

However, cleaning up the air involves certain costs to society in which all people will share in one way or another. We are interested in finding out whether it is worth it for the people in Los Angeles to pay these costs in light of the benefits they receive from cleaner air.

We would appreciate it if you would take the time to answer some questions which will be helpful in discovering whether pollution control is worthwhile. Before answering these questions, please read through the following information on measuring air quality. Your answers will be held in strict confidence. A postage paid return envelope is enclosed to return the questionnaire form.

Thank you for your cooperation.

SAN GABRIEL VALLEY SURVEY

Air pollution in the Los Angeles area consists of a variety of gases and particles. Some of these are emitted directly by pollution sources (cars, trucks, industrial facilities) while others are formed in the air from these directly emitted pollutants.

Ozone, the most important gaseous air problem in the South Coast Air Basin, is created when certain other emissions are exposed to sunlight. Ozone is an important air problem because of its effects on human health and well-being.

Please find and open the enclosed sheet of illustrations.

The left-hand side shows the daily maximum ozone concentrations in your area during August and September of this year.

The right-hand side presents a summary of known effects of breathing ozone on humans and experimental animals. The effects are the result of relatively short-term exposure to ozone concentrations that are possible in the South Coast Air Basin.

Ozone concentrations in the air are measured in parts per hundred million. This is a common way of measuring ozone levels.

On this scale a measure of 5 is very clean air for the Los Angeles area. A rating of 40 is very smoggy.

The Federal Standard for ozone requires an hourly average concentration of ozone less than 12 (all references to ozone concentration will be in parts per hundred million).

A Stage One Ozone Episode is called when ozone concentrations reach 20.

A Stage Two Ozone Episode requires an hourly average of 35. There have been no Stage Three Ozone Episodes, which require a concentration of 50, since 1974.

Some of the effects of ozone levels are:

- Concentrations meeting the Federal Standard (0-12). Ozone levels in this range are identified as Situation A, GOOD air quality, on the illustration.

  • ODOR BRIEFLY NOTICEABLE

  Most people notice the pungent smell of ozone at concentrations around 2. At 5 the "smell" fades in about 5 minutes even if the ozone remains.

- Federal Standard violated (12-20). Ozone levels in this range are identified as Situation B, FAIR air quality, on the illustration.

  - DECREASED ATHLETIC PERFORMANCE

    Athletes performing outdoors show slower speeds in running.

  - LOWER RESISTANCE TO LUNG INFECTION

    Some laboratory animals get lung infections more readily.

  - SENSITIVE ASTHMATICS HAVE MORE FREQUENT ATTACKS

    The people with asthma who are most sensitive to ozone have more frequent coughing spells.

- Stage One Ozone Episode (20-35). Ozone levels in this range are identified as Situation C, POOR air quality, on the illustration.

  - COUGH, CHEST DISCOMFORT, HEADACHE

    Healthy adults notice discomfort in breathing, get headaches, and cough.

  - MORE FREQUENT ASTHMA ATTACKS

    More frequent coughing spells are had by people with asthma.

  - RED BLOOD CELL SPHERING

    Changes in the appearance of red blood cells were noticed in human volunteers.

  - DECREASED VISION, CONCENTRATION

    Human volunteers exposed to ozone had decreased sharpness of vision and had more difficulty concentrating. This may contribute to the higher number of automobile accidents when ozone levels rise.

- Stage Two Ozone Episode (35-50). Ozone levels in this range are identified as Situation D, VERY POOR air quality, on the illustration.

  - DECLINE IN LUNG FUNCTION IN HEALTHY INDIVIDUALS

    Human volunteers exposed to ozone at this level had a noticeable decrease in various lung functions. At this level ozone is certainly more than an inconvenience; it presents a health hazard to people.

All effects of ozone at lower concentrations continue at higher concentrations. In the right-hand-side of the illustration these effects are repeated as ozone levels rise. Ozone, however, is not usually the cause of eye irritation. Other pollutants in smog are responsible for the stinging eyes.

The left-hand side of the illustrations shows the daily high ozone concentration in your area during last August and September.

Please notice the very high readings just before Labor Day Weekend and three weeks later on September 22 and 23. Between these periods of high ozone levels was a period of exceptionally low ozone levels. Earlier in the summer there were rather large day-to-day variations in daily high ozone readings.

Thursday, September 2, was a day with relatively high ozone concentrations in your area. It was the Thursday before Labor Day weekend and is marked on the left-hand-side of the illustration with a solid arrow. This was a day with VERY POOR ozone levels, such as Situation D as shown on the illustration.

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Thursday, September 2?

_____ Yes _____ No (Please Check)

2. If you answered yes, which of these symptoms did you notice?

Symptom	Yourself	Family Member
Decreased Vision	______	______
More frequent asthma attacks	______	______
Cough, Chest discomfort	______	______
Other (please name) ______		

The principle source of emissions which yield ozone is exhaust from cars and trucks. Factories, refineries, and other industrial facilities, also produce a significant amount of emissions.

A reduction in ozone levels will require the use of more costly procedures in manufacturing and in higher operating costs for automobiles and trucks. All of this would be reflected in higher prices for goods and services.

Over the Labor Day weekend, ozone levels dropped some in your area, to Situation C. There were numerous other days in August and September with C, POOR air quality.

Try to imagine a summer day with VERY POOR ozone levels, such as situation D as shown in the illustration.

Ozone levels could be reduced on that day by imposing regulations requiring the use of more expensive procedures as mentioned above. If such regulations were imposed you would be "paying" for an ozone reduction.

3. What is the most your household would be willing to pay to reduce the daily high ozone reading on that day from VERY POOR to POOR? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

4. What is the most your household would be willing to pay to reduce the daily high ozone level on that day from VERY POOR to FAIR? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

5. What is the most your household would be willing to pay to reduce the daily high ozone level on that day from VERY POOR to GOOD? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

6. Answer only if you answered $.00 to questions 3 through 5 above.

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

7. In what outdoor activities do you regularly participate? How often?

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging	_____	_____	_____
Sailing	_____	_____	_____

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Tennis	______	______	______
Surfing	______	______	______
Swimming	______	______	______
__________	______	______	______
__________	______	______	______
__________	______	______	______
__________	______	______	______

8. Do you change your behavior on days with high ozone levels? If so, how?

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
________________________	____	____	____
________________________	____	____	____
________________________	____	____	____
________________________	____	____	____

9. How long have you lived at your present address? ________ years

10. How long have you lived in the Los Angeles area? ________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
__________	__________	__________	__________

13. Home zip code ____________________

14. Your education:

- under 12 years ______
- High School ______
- College - no degree ______
- Bachelor's degree ______
- Post-graduate degree ______

15. Your age group:

- under 18 ______
- 18-24 ______
- 25-34 ______
- 35-44 ______
- 45-54 ______
- 55 & over ______

16. Sex: _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Would you please indicate which of the following groups your annual before tax household income falls in:

_____ less than $5,000	_____$25,000-29,999	_____$55,000-59,999
_____$ 5,000-7,499	_____$30,000-34,999	_____$60,000-64,999
_____$ 7,500-9,999	_____$35,000-39,999	_____$65,000-69,999
_____$10,000-14,999	_____$40,000-44,999	_____$70,000-74,999
_____$15,000-19,999	_____$45,000-49,999	_____$75,000 and up
_____$20,000-24,999	_____$50,000-54,999	

20. Do you live in a detached house, duplex, apartment or mobile home?

(1) House	(2) Duplex	(3) Apartment	(4) Mobile Home
_______	_______	_______	_______

21. Do you own or rent your home? ____own ____rent

SAN FERNANDO VALLEY SURVEY

Air pollution in the Los Angeles area consists of a variety of gases and particles. Some of these are emitted directly by pollution sources (cars, trucks, industrial facilities) while others are formed in the air from these directly emitted pollutants.

Ozone, the most important gaseous air problem in the South Coast Air Basin, is created when certain other emissions are exposed to sunlight. Ozone is an important air problem because of its effects on human health and well-being.

Please find and open the enclosed sheet of illustrations.

The left-hand side shows the daily maximum ozone concentrations in your area during August and September of this year.

The right-hand side presents a summary of known effects of breathing ozone on humans and experimental animals. The effects are the result of relatively short-term exposure to ozone concentrations that are possible in the South Coast Air Basin.

Ozone concentrations in the air are measured in parts per hundred million. This is a common way of measuring ozone levels.

On this scale a measure of 5 is very clean air for the Los Angeles area. A rating of 40 is very smoggy.

The Federal Standard for ozone requires an hourly average concentration of ozone less than 12 (all references to ozone concentration will be in parts per hundred million).

A Stage One Ozone Episode is called when ozone concentrations exceed 20.

A Stage Two Ozone Episode requires an hourly average of 35. There have been no Stage Three Ozone Episodes, which require a concentration of 50, since 1974.

Some of the effects of ozone levels are:

- Concentrations meeting the Federal Standard (0-12). Ozone levels in this range are identified as Situation A, GOOD air quality, on the illustration.

  - ODOR BRIEFLY NOTICEABLE

  Most people notice the pungent smell of ozone at concentrations around 2. At 5 the "smell" fades in about 5 minutes even if the ozone remains.

o <u>Federal Standard violated (12-20)</u>. Ozone levels in this range are identified as Situation B, FAIR air quality, on the illustration.

- DECREASED ATHLETIC PERFORMANCE

  Athletes performing outdoors show slower speeds in running.

- LOWER RESISTANCE TO LUNG INFECTION

  Some laboratory animals get lung infections more readily.

- SENSITIVE ASTHMATICS HAVE MORE FREQUENT ATTACKS

  The people with asthma who are most sensitive to ozone have more frequent coughing spells.

o <u>Stage One Ozone Episode (20-35)</u>. Ozone levels in this range are identified as Situation C, POOR air quality, on the illustration.

- COUGH, CHEST DISCOMFORT, HEADACHE

  Healthy adults notice discomfort in breathing, get headaches, and cough.

- MORE FREQUENT ASTHMA ATTACKS

  More frequent coughing spells are had by people with asthma.

- RED BLOOD CELL, SPHERING

  Changes in the appearance of red blood cells were noticed in human volunteers.

- DECREASED VISION, CONCENTRATION

  Human volunteers exposed to ozone had decreased sharpness of vision and had more difficulty concentrating. This may contribute to the higher number of automobile accidents when ozone levels rise.

o <u>Stage Two Ozone Episode (35-50)</u>. Ozone levels in this range are identified as Situation D, VERY POOR air quality, on the illustration.

- DECLINE IN LUNG FUNCTION IN HEALTHY INDIVIDUALS

  Human volunteers exposed to ozone at this level had a noticeable decrease in various lung functions. At this level ozone is certainly more than an inconvenience; it presents a health hazard to people.

All effects of ozone at lower concentrations continue at higher concentrations. In the right-hand-side of the illustration these effects are repeated as ozone levels rise. Ozone, however is not usually the cause of eye irritation. Other pollutants in smog are responsible for the stinging eyes.

The left-hand side of the illustrations shows the daily high ozone concentration in your area during last August and September.

Please notice the very high readings just before and during Labor Day Weekend and three weeks later on September 22 and 23. Between these periods of high ozone levels was a period of exceptionally low ozone levels. Earlier in the summer there were rather large day-to-day variations in daily high ozone readings.

Saturday, September 4, was a day with relatively high ozone concentrations in your area. It was the Saturday of Labor Day weekend and is marked on the left-hand-side of the illustration with a solid arrow. This was a day with POOR ozone levels, such as Situation C as shown on the illustration.

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Saturday, September 4?

_____ Yes _____ No (Please Check)

2. If you answered yes, which of these symptoms did you notice?

Symptom	Yourself	Family Member
Decreased Vision	________	________
More frequent asthma attacks	________	________
Cough, Chest discomfort	________	________

Other (please name)________________________________

The principle source of emissions which yield ozone is exhaust from cars and trucks. Factories, refineries, and other industrial facilities, also produce a significant amount of emissions.

A reduction in ozone levels will require the use of more costly procedures in manufacturing and in higher operating costs for automobiles and trucks. All of this would be reflected in higher prices for goods and services.

Over the Labor Day weekend, ozone levels dropped some in your area, to Situation B. There were numerous other days in August and September with B, FAIR air quality.

Try to imagine a summer day with POOR ozone levels, such as Situation C as shown in the illustration.

Ozone levels could be reduced on that day by imposing regulations requiring the use of more expensive procedures as mentioned above. If such regulations were imposed you would be "paying" for an ozone reduction.

4. What is the most your household would be willing to pay to reduce the daily high ozone reading on that day from POOR to FAIR? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

5. What is the most you would be willing to pay to reduce the daily high ozone level on that day from POOR to GOOD? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

6. Answer only if you answered $.00 to questions 4 through 5 above.

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

7. In what outdoor activities do you regularly participate? How often?

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging . . .	_____	_____	_____
Sailing . . .	_____	_____	_____
Tennis	_____	_____	_____
Surfing . . .	_____	_____	_____
Swimming . . .	_____	_____	_____
_________ . . .	_____	_____	_____
_________ . . .	_____	_____	_____
_________ . . .	_____	_____	_____
_________ . . .	_____	_____	_____

8. Do you change your behavior on days with high ozone levels? If so, how?

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
_________________________	____	____	____

9. How long have you lived at your present address? ________ years

10. How long have you lived in the Los Angeles area? ________ years

11. Did you consider air quality when choosing your home? ____Yes ____NO

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
________	________	________	________

13. Home zip code ____________________

14. Your education: under 12 years ______
High School ______
College - no degree ______
Bachelor's degree ______
Post-graduate degree ______

15. Your age group: under 18 ______
18-24 ______
25-34 ______
35-44 ______
45-54 ______
55 & over ______

16. Sex : _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Would you please indicate which of the following groups your annual household income falls in:

_____less than $5,000	_____$25,000-29,999	_____$55,000-59,999
_____$ 5,000-7,499	_____$30,000-34,999	_____$60,000-64,999
_____$ 7,500-9,999	_____$35,000-39,999	_____$65,000-69,999
_____$10,000-14,999	_____$40,000-44,999	_____$70,000-74,999
_____$15,000-19,999	_____$45,000-49,999	_____$75,000 and up
_____$20,000-24,999	_____$50,000-54,999	

20. Do you live in a detached house, duplex, apartment or mobile home?

(1) Detached	(2) Duplex	(3) Apartment	(4) Mobile Home
________	________	________	________

21. Do you own or rent your home? ____own ____rent

Dear Californian:

We are a research team at the University of Wyoming conducting a study related to air quality improvements. Air quality is a familiar topic to people who live in the Los Angeles area. Also, many people are interested in the benefits of having cleaner air.

However, cleaning up the air involves certain costs to society in which all people will share in one way or another. We are interested in finding out whether it is worth it for the people in Los Angeles to pay these costs in light of the benefits they receive from cleaner air.

We would appreciate it if you would take the time to answer some questions which will be helpful in discovering whether pollution control is worthwhile. Before answering these questions, please read through the following information on measuring air quality. Your answers will be held in strict confidence. A postage paid return envelope is enclosed to return the questionnaire form.

Thank you for your cooperation.

ORANGE COUNTY SURVEY

Air pollution in the Los Angeles area consists of a variety of gases and particles. Some of these are emitted directly by pollution sources (cars, trucks, industrial facilities) while others are formed in the air from these directly emitted pollutants.

Ozone, the most important gaseous air problem in the South Coast Air Basin, is created when certain other emissions are exposed to sunlight. Ozone is an important air problem because of its effects on human health and well-being.

Please find and open the enclosed sheet of illustrations.

The left-hand side shows the daily maximum ozone concentrations in your area during August and September of this year.

The right-hand side presents a summary of known effects of breathing ozone on humans and experimental animals. The effects are the result of relatively short-term exposure to ozone concentrations that are possible in the South Coast Air Basin.

Ozone concentration in the air are measured in parts per hundred million. This is a common way of measuring ozone levels.

On this scale a measure of 5 is very clean air for the Los Angeles area. A rating of 40 is very smoggy.

The Federal Standard for ozone requires an hourly average concentration of ozone less than 12 (all references to ozone concentration will be in parts per hundred million).

A Stage One Ozone Episode is called when ozone concentrations exceed 20. A Stage Two Ozone Episode requires an hourly average of 35. There have been no Stage Three Ozone Episodes, which require a concentration of 50, since 1974.

Some of the effects of ozone levels are:

- Concentrations meeting the Federal Standard (0-12). Ozone levels in this range are identified as Situation A, GOOD air quality, on the illustration.

    - ODOR BRIEFLY NOTICEABLE

        Most people notice the pungent smell of ozone at concentrations around 2. At 5 the "smell" fades in about 5 minutes even if the ozone remains.

- Federal Standard violated (12-20). Ozone levels in this range are identified as Situation B, FAIR air quality, on the illustration.

- DECREASED ATHLETIC PERFORMANCE

  Athletes performing outdoors show slower speeds in running.

- LOWER RESISTANCE TO LUNG INFECTION

  Some laboratory animals get lung infections more readily.

- SENSITIVE ASTHMATICS HAVE MORE FREQUENT ATTACKS

  The people with asthma who are most sensitive to ozone have more frequent coughing spells.

o Stage One Ozone Episode (20-35). Ozone levels in this range are identified as Situation C, POOR air quality, on the illustration.

- COUGH, CHEST DISCOMFORT, HEADACHE

  Healthy adults notice discomfort in breathing, get headaches, and cough.

- MORE FREQUENT ASTHMA ATTACKS

  More frequent coughing spells are had by people with asthma.

- RED BLOOD CELL SPHERING

  Changes in the appearance of red blood cells were noticed in human volunteers.

- DECREASED VISION, CONCENTRATION

  Human volunteers exposed to ozone had decreased sharpness of vision and had more difficulty concentrating. This may contribute to the higher number of automobile accidents when ozone levels rise.

o Stage Two Ozone Episode (35-50). Ozone levels in this range are identified as Situation D, VERY POOR air quality, on the illustration.

- DECLINE IN LUNG FUNCTION IN HEALTHY INDIVIDUALS

  Human volunteers exposed to ozone at this level had a noticeable decrease in various lung functions. At this level ozone is certainly more than an inconvenience; it presents a health hazard to people.

All effects of ozone at lower concentrations continue at higher concentrations. In the right-hand-side of the illustration these effects are repeated as ozone levels rise. Ozone, however, is not usually the cause of eye irritation. Other pollutants in smog are responsible for the stinging eyes.

The left-hand side of the illustrations shows the daily high ozone concentration in your area during last August and September.

Please notice the very high readings just before Labor Day Weekend and three weeks later on September 22 and 23. Between these periods of high ozone levels was a period of exceptionally low ozone levels. Earlier in the summer there were rather large day-to-day variations in daily high ozone readings.

Friday, September 3, was a day with relatively high ozone concentrations in your area. It was the Friday before Labor Day weekend and is marked on the left-hand-side of the illustration with a solid arrow. This was a day with FAIR ozone levels such as Situation B as shown on the illustration. B, FAIR day.

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Friday, September 3?

_____ Yes _____ No (Please Check)

2. If you answered yes, which of these symptoms did you notice?

Symptom	Yourself	Family Member
Decreased Vision	________	________
More frequent asthma attacks	________	________
Cough, Chest discomfort	________	________

Other (please name) ______________________________

The principle source of emissions which yield ozone is exhaust from cars and trucks. Factories, refineries, and other industrial facilities, also produce a significant amount of emissions.

A reduction in ozone levels will require the use of more costly procedures in manufacturing and in higher operating costs for automobiles and trucks. All of this would be reflected in higher prices for goods and services.

Over the Labor Day weekend, ozone levels dropped some in your area, to Situation A. There were numerous other days in August and September with A, GOOD air quality.

Try to imagine a summer day with FAIR ozone levels such as Situation B as shown in the illustration.

Ozone levels could be reduced on that day by imposing regulations requiring the use of more expensive procedures as mentioned above. If such regulations were imposed you would be "paying" for an ozone reduction.

5. What is the most your household would be willing to pay to reduce the daily high ozone reading on that day from FAIR to GOOD?
Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

6. Answer only if you answered $.00 to question 3 above.

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

7. In what outdoor activities do you regularly participate? How often?

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging	_____	_____	_____
Sailing	_____	_____	_____
Tennis	_____	_____	_____
Surfing	_____	_____	_____
Swimming	_____	_____	_____
__________	_____	_____	_____
__________	_____	_____	_____
__________	_____	_____	_____
__________	_____	_____	_____

8. Do you change your behavior on days with high ozone levels? If so, how?

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
__________________________	____	____	____
__________________________	____	____	____
__________________________	____	____	____
__________________________	____	____	____

9. How long have you lived at your present address? _________ years

10. How long have you lived in the Los Angeles area? _________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
______	______	______	______

13. Home zip code ____________

14. Your education:
- under 12 years ____
- High School ____
- College - no degree ____
- Bachelor's degree ____
- Post-graduate degree ____

15. Your age group:
- under 18 ____
- 18-24 ____
- 25-34 ____
- 35-44 ____
- 45-54 ____
- 55 & over ____

16. Sex: ____Male ____Female

17. How many members are there in your household? ____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Would you please indicate which of the following groups your annual household income falls in:

____less than $5,000	____$25,000-29,999	____$55,000-59,999
____$ 5,000-7,499	____$30,000-34,999	____$60,000-64,999
____$ 7,500-9,999	____$35,000-39,999	____$65,000-69,999
____$10,000-14,999	____$40,000-44,999	____$70,000-74,999
____$15,000-19,999	____$45,000-49,999	____$75,000 and up
____$20,000-24,999	____$50,000-54,999	

20. Do you live in a detached house, duplex or apartment?

(1) House	(2) Duplex	(3) Apartment	(4) Mobile Home
______	______	______	______

21. Do you own or rent your home? ____owm ____rent

Hello:

I am part of a research team from the University of Wyoming, we are conducting a study related to air quality improvements. Air quality is a familiar topic to people who live in the Los Angeles area.

However, cleaning up the air involves certain costs to society in which all people will share in one way or another. We are interested in finding out whether it is worth it for the people in Los Angeles to pay these costs in light of the benefits they receive from cleaner air.

I would like to take a few minutes of your time to ask some questions. Your answers will be helpful in discovering whether pollution control is worthwhile.

[DO NOT READ ALOUD PASSAGES IN BRACKETS]

Before asking you the questions, I'd like to tell you a few things about ozone.

[SAN GABRIEL VALLEY INTERVIEW]

Air pollution in the Los Angeles area consists of a variety of gases and particles. Some of these are emitted directly by pollution sources (cars, trucks, industrial facilities) while others are formed in the air from these directly emitted pollutants.

Ozone, the most important gaseous air problem in the South Coast Air Basin, is created when certain other emissions are exposed to sunlight. Ozone is an important air problem because of its effects on human health and well-being.

Please look at this illustration.

[HAND ILLUSTRATION TO RESPONDENT]
[POINT TO LEFT SIDE]

The left-hand side shows the daily maximum ozone concentrations in your area during August and September of this year.

[POINT TO RIGHT SIDE]

The right-hand side presents a summary of known effects of breathing ozone on humans and experimental animals. The effects are the result of relatively short-term exposure to ozone concentrations that are possible in the South Coast Air Basin.

[POINT TO SCALE]

Ozone concentrations in the air are measured in parts per hundred million. This is a common way of measuring ozone levels.

[POINT TO "5" AND "40" ON SCALE]

On this scale a measure of 5 is very clean air for the Los Angeles area. A rating of 40 is very smoggy.

[POINT TO 12 ON CENTER SCALE]

The Federal Standard for ozone requires an hourly average concentration of ozone less than 12 (all references to ozone concentration will be in parts per hundred million).

[POINT TO '20' ON CENTER SCALE]

A Stage One Ozone Episode is called when ozone concentrations reach 20.

[POINT TO '35' ON CENTER SCALE]

A Stage Two Ozone Episode requires an hourly average of 35. There have been no Stage Three Ozone Episodes, which require a concentration of 50, since 1974.

Some of the effects of ozone levels are:

[POINT TO 'A' ON CENTER SCALE]

[o Concentrations meeting the Federal Standard (0-12).] Ozone levels in the range of 0 to 12 are identified as Situation A, GOOD [POINT TO 'A', THEN 'GOOD'] air quality, on the illustration.

Here we see

- ODOR BRIEFLY NOTICEABLE [POINT OUT]

This means

Most people notice the pungent smell of ozone at concentrations around 2. At 5 the "smell" fades in about 5 minutes even if the ozone remains.

[o Federal Standard violated (12-20).] Ozone levels of 12 to 20 are identified as Situation B, FAIR air quality,

[POINT TO 'B', THEN 'FAIR']

on the illustration.

Here we see that the effects are

- DECREASED ATHLETIC PERFORMANCE [POINT OUT]

  Athletes performing outdoors show slower speeds in running.

- SENSITIVE ASTHMATICS HAVE MORE FREQUENT ATTACKS [POINT OUT]

  The people with asthma who are most sensitive to ozone have more frequent coughing spells.

- LOWER RESISTANCE TO LUNG INFECTION [POINT OUT]

  Some laboratory animals get lung infections more readily.

[o Stage One Ozone Episode (20-35).] Ozone levels from 20 to 35

[POINT TO 'C', THEN 'POOR']

are identified as Situation C, POOR air quality, on the illustration.

The effects are

- COUGH, CHEST DISCOMFORT, HEADACHE [POINT OUT]

  Healthy adults notice discomfort in breathing, get headaches, and cough.

- MORE FREQUENT ASTHMA ATTACKS [POINT OUT]

  More frequent coughing spells are had by people with asthma.

- RED BLOOD CELL SPHERING [POINT OUT]
  Changes in the appearance of red blood cells were noticed in human volunteers.

- DECREASED VISION, CONCENTRATION

This was left off the illustration.

Human volunteers exposed to ozone had decreased sharpness of vision and had more difficulty concentrating. This may contribute to the higher number of automobile accidents when ozone levels rise.

[o Stage Two Ozone Episode (35-50).] Ozone levels from 35 to 50

[POINT TO 'D', THEN 'VERY POOR']

are identified as Situation D, VERY POOR air quality, on the illustration.

- DECLINE IN LUNG FUNCTION IN HEALTHY INDIVIDUALS [POINT OUT]
  Human volunteers exposed to ozone at this level had a noticeable decrease-in various lung functions. At this level ozone is certainly more than an inconvenience; it presents a health hazard to people.

Please note that effects of ozone at lower concentrations continue at higher concentrations. [POINT TO EACH LIST OF EFFECTS] In the right-hand-side of the illustration these effects are repeated as ozone levels rise. Ozone, however, is not usually the cause of eye irritation. Other pollutants in smog are responsible for the stinging eyes.

[POINT TO LEFT SIDE]

The left-hand side of the illustrations shows the daily high ozone concentration in your area during last August [POINT] and September [POINT].

Please notice the very high readings just before Labor Day Weekend [POINT TO PEAKS] and three weeks later on September 22 and 23. Between these periods [POINT TO VALLEY] of high ozone levels was a period of exceptionally low ozone levels. Earlier in the summer there were rather large day-to-day variations in daily high ozone readings.

Now, I would like to ask you some questions. I will hold the illustration so you can mark your answers. [EXCHANGE ILLUSTRATION FOR CLIPBOARD, DISPLAY ILLUSTRATION FOR RESPONDENT]

Thursday, September 2, was a day with relatively high ozone concentrations in your area. It was the Thursday before Labor Day weekend [POINT TO PEAK] and is marked on the left-hand-side of the illustration with a solid arrow. This was a day with [SLIDE ACROSS TO ' VERY POOR'] VERY POOR ozone levels, such as Situation D as shown on the illustration. The first question is:

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Thursday, September 2?

_____ Yes _____ No [Please Check] Please check your answer

[IF NO, SKIP #2]

2. [If you answered yes,] which of these symptoms did you notice? Please mark your answer sheet. For instance, did you or a member of your family notice decreased vision? How about the other listed symptoms?

symptom	Yourself	Family Member
Decreased Vision	_____	_____
More frequent asthma attacks	_____	_____
Cough, Chest discomfort	_____	_____

Other (please name)______________________________

[PREFACE MATERIAL FOR #3]

The principle source of emissions which yield ozone is exhaust from cars and trucks. Factories, refineries, and other industrial facilities, also produce a significant amount of emissions.

A reduction in ozone levels will require the use of more costly procedures in manufacturing and in higher operating costs for automobiles and trucks. All of this would be reflected in higher prices for goods and services.

Over the Labor Day weekend, ozone levels dropped some in your area, to Situation C. There were numerous other days in August and September with C, POOR air quality.

Most people would agree that they prefer lower ozone levels to higher levels. The next set of questions addresses changes in ozone concentration.

To establish a point of reference for changes, try to imagine a summer day with VERY POOR ozone levels, such as situation D as shown in the illustration.

Ozone levels could be reduced on that day by imposing regulations requiring the use of more expensive procedures as mentioned above. If such regulations were imposed you would be "paying" for an ozone reduction.

On your answer sheet are a series of amounts. Please circle the amount that is your answer to Question 3.

[READ #3]

3. What is the most your household would be willing to pay to reduce the daily high ozone reading on that day from VERY POOR to POOR? [Please circle your answer.]

$ .00	$ 2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

For Question 4, please circle the amount that

4. [What] is the most your household would be willing to pay to reduce the daily high ozone level on that day from VERY POOR to FAIR? [Please circle your answer.]

$ .00	$ 2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

For Question 5, the change is from VERY POOR to GOOD. [BE SURE THAT RESPONDENT UNDERSTANDS THIS IS TOTAL, NOT ADDITIONAL]

5. What is the most your household would be willing to pay to reduce the daily high ozone level on that day from VERY POOR to GOOD? Please circle your answer.

$ .00	$ 2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

If you answered zero for any questions, please answer Question 6.

6. [Answer only if you answered $.00 to questions 3 through 5 above.]

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

Would you answer Question 7 by indicating how often you engage in outdoor activities? For instance, do you hike rarely, occasionally or often? How about other activities whether or not they are listed?

7. [In what outdoor activities do you regularly participate? How often?]

Activity	Barely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging	_____	_____	_____
Sailing	_____	_____	_____
Tennis	_____	_____	_____
Surfing	_____	_____	_____
Swimming	_____	_____	_____
_________	_____	_____	_____
_________	_____	_____	_____
_________	_____	_____	_____
_________	_____	_____	_____

If you change your behavior when ozone levels rise, please answer Question 8. For example, do you drive less if you know that the standard is violated?

8. [Do you change your behavior on days with high ozone levels? If so, how?]

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____

The remaining questions about your and your family will be useful for analyzing peoples' responses to the questions already asked.

Your answers to all these questions are of course strictly confidential. Please mark your answers to the rest of the questions before putting your answer sheet in this pouch. [CLOSE BINDER. DISPLAY OPEN POUCH WITH OTHER ANSWER SHEETS IN IT.]

Thank you.

[BE SURE TO GET ALL QUESTIONS ANSWERED]

9. How long have you lived at your present address? ________ years

10. How long have you lived in the Los Angeles area? ________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
______	______	______	______

13. Home zip code ____________

14. Your education:
- under 12 years ______
- High School ______
- College - no degree ______
- Bachelor's degree ______
- Post-graduate degree ______

15. Your age group:
- under 18 ______
- 18-24 ______
- 25-34 ______
- 35-44 ______
- 45-54 ______
- 55 & over ______

16. Sex: _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Do you live in a detached house, duplex, apartment or mobile home?

(1) House	(2) Duplex	(3) Apartment	(4) Mobile Home
______	______	______	______

20. Do you own or rent your home? ____own ____rent

21. Would you please indicate which of the following groups your annual before tax household income falls in:

_____ less than $5,000	_____ $25,000-29,999	_____ $55,000-59,999
_____ $ 5,000-7,499	_____ $30,000-34,999	_____ $60,000-64,999
_____ $ 7,500-9,999	_____ $35,000-39,999	_____ $65,000-69,999
_____ $10,000-14,999	_____ $40,000-44,999	_____ $70,000-74,999
_____ $15,000-19,999	_____ $45,000-49,999	_____ $75,000 and up
_____ $20,000-24,999	_____ $50,000-54,999	

SAN GABRIEL VALLEY SURVEY

#___________

ANSWER SHEET

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Thursday, September 2?

_____ Yes _____ No (Please Check)

2. If you answered yes, which of these symptoms did you notice?

Symptom	Yourself	Family Member
Decreased Vision	______________	________________
More frequent asthma attacks	______________	________________
Cough, Chest discomfort	______________	________________

Other (please name)____

3. What is the most your household would be willing to pay to reduce the daily high ozone reading <u>on that day</u> from VERY POOR to POOR? Please circle your answer.

$ .00	$ 2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

4. What is the most your household would be willing to pay to reduce the daily high ozone level <u>on that day</u> from VERY POOR to FAIR? Please circle your answer.

$ .00	$ 2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.90
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

5. What is the most your household would be willing to pay to reduce the daily high ozone level <u>on that day</u> from VERY POOR to GOOD? Please circle your answer.

$ .00	$ 2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

6. Answer only if you answered $.00 to questions 3 through 5 above.

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

7. In what outdoor activities do you regularly participate? How often?

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging	_____	_____	_____
Sailing	_____	_____	_____
Tennis	_____	_____	_____
Surfing	_____	_____	_____
Swimming	_____	_____	_____
________	_____	_____	_____
________	_____	_____	_____
________	_____	_____	_____
________	_____	_____	_____

8. Do you change your behavior on days with high ozone levels? If so, how?

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____

9. How long have you lived at your present address? ________ years

10. How long have you lived in the Los Angeles area? ________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
________	________	________	________

13. Home zip code ____________________

14. Your education: under 12 years ______
High School ______
College - no degree ______
Bachelor's degree ______
Post-graduate degree ______

15. Your age group: under 18 ______
18-24 ______
25-34 ______
35-44 ______
45-54 ______
55 & over ______

16. Sex: _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Do you live in a detached house, duplex, apartment or mobile home?

(1) House	(2) Duplex	(3) Apartment	(4) Mobile Home
________	________	________	________

20. Do you own or rent your home? ____own ____rent

21. Would you please indicate which of the following groups your annual before tax household income falls in:

_____less than $5,000	_____$25,000-29,999	_____$55,000-59,999
_____$5,000-7,499	_____$30,000-34,999	_____$60,000-64,999
_____$ 7,500-9,999	_____$35,000-39,999	_____$65,000-69,999
_____$10,000-14,999	_____$40,000-44,999	_____$70,000-74,999
_____$15,000-19,999	_____$45,000-49,999	_____$75,000 and up
_____$20,000-24,999	_____$50,000-54,999	

Hello:

I am part of a research team from the University of Wyoming, we are conducting a study related to air quality improvements. Air quality is a familiar topic to people who live in the Los Angeles area.

However, cleaning up the air involves certain costs to society in which all people will share in one way or another. We are interested in finding out whether it is worth it for the people in Los Angeles to pay these costs in light of the benefits they receive from cleaner air.

I would like to take a few minutes of your time to ask some questions. Your answers will be helpful in discovering whether pollution control is worthwhile.

[DO NOT READ ALOUD PASSAGES IN BRACKETS]

Before asking you the questions, I'd like to tell you a few things about ozone.

[SAN FERNANDO VALLEY INTERVIEW]

Air pollution in the Los Angeles area consists of a variety of gases and particles. Some of these are emitted directly by pollution sources (cars, trucks, industrial facilities) while others are formed in the air from these directly emitted pollutants.

Ozone, the most important gaseous air problem in the South Coast Air Basin, is created when certain other emissions are exposed to sunlight. Ozone is an important air problem because of its effects on human health and well-being.

Please look at this illustration.

[HAND ILLUSTRATION TO RESPONDENT]
[POINT TO LEFT SIDE]

The left-hand side shows the daily maximum ozone concentrations in your area during August and September of this year.

[POINT TO RIGHT SIDE]

The right-hand side presents a summary of known effects of breathing ozone on humans and experimental animals. The effects are the result of relatively short-term exposure to ozone concentrations that are possible in the South Coast Air Basin.

[POINT TO SCALE]

Ozone concentrations in the air are measured in parts per hundred million. This is a common way of measuring ozone levels.

[POINT TO "5" AND "40" ON SCALE]

On this scale a measure of 5 is very clean air for the Los Angeles area. A rating of 40 is very smoggy.

[POINT TO "12" ON CENTER SCALE]

The Federal Standard for ozone requires an hourly average concentration of ozone less than 12 (all references to ozone concentration will be in parts per hundred million).

[POINT TO "20" ON CENTER SCALE]

A Stage One Ozone Episode is called when ozone concentrations exceed 20.

[POINT TO "35" ON CENTER SCALE]

A Stage Two Ozone Episode requires an hourly average of 35. There have been no Stage Three Ozone Episodes, which require a concentration of 50, since 1974.

Some of the effects of ozone levels are:

[o Concentrations meeting the Federal Standard (0-12).] Ozone levels in the range of 0 to 12 are identified as Situation A, GOOD

[POINT TO 'A', THEN 'GOOD']

air quality, on the illustration.

Here we see

- ODOR BRIEFLY NOTICEABLE [POINT OUT]

This means

Most people notice the pungent smell of ozone at concentrations around 2. At 5 the "smell" fades in about 5 minutes even if the ozone remains.

[o Federal Standard violated (12-20).] Ozone levels of 12 to 20 are identified as Situation B, FAIR air quality, on the illustration.

[POINT TO 'B', THEN 'FAIR']

- DECREASED ATHLETIC PERFORMANCE [POINT OUT]

  Athletes performing outdoors show slower speeds in running.

- SENSITIVE ASTHMATICS HAVE MORE FREQUENT ATTACKS [POINT OUT]

  The people with asthma who are most sensitive to ozone have more frequent coughing spells.

- LOWER RESISTANCE TO LUNG INFECTION [POINT OUT]

  Some laboratory animals get lung infections more readily.

[o Stage One Ozone Episode (20-35).] Ozone levels from 20 to 35 are

[POINT TO 'C', THEN TO 'POOR']

identified as Situation C, POOR air quality, on the illustration.

- COUGH, CHEST DISCOMFORT, HEADACHE [POINT OUT]

Healthy adults notice discomfort in breathing, get headaches, and cough.

- MORE FREQUENT ASTHMA ATTACKS [POINT OUT]

  More frequent coughing spells are had by people with asthma.

- RED BLOOD CELL SPHERING [POINT OUT]
  Changes in the appearance of red blood cells were noticed in human volunteers.

- DECREASED VISION, CONCENTRATION

This was left off the illustration

Human volunteers exposed to ozone had decreased sharpness of vision and had more difficulty concentrating. This may contribute to the higher number of automobile accidents when ozone levels rise.

[o Stage Two Ozone Episode (35-50).] Ozone levels from 35 to 50 are

[POINT TO 'D' THEN 'VERY POOR']

identified as Situation D, VERY POOR air quality, on the illustration.

- DECLINE IN LUNG FUNCTION IN HEALTHY INDIVIDUALS [POINT OUT]

  Human volunteers exposed to ozone at this level had a noticeable decrease in various lung functions. At this level ozone is certainly more than an inconvenience; it presents a health hazard to people.

Please note that effects of ozone at lower concentrations continue at higher concentrations. [POINT TO EACH LIST OF EFFECTS] In the right-hand-side of the illustration these effects are repeated as ozone levels rise. Ozone, however is not usually the cause of eye irritation. Other pollutants in smog are responsible for the stinging eyes.

[POINT TO LEFT SIDE]

The left-hand side of the illustrations shows the daily high ozone concentration in your area during last August [POINT] and September [POINT].

Please notice the very high readings just before and during Labor Day Weekend [POINT TO PEAKS] and three weeks later on September 22 and 23. Between these periods [POINT TO VALLEY] of high ozone levels was a period of exceptionally low ozone levels. Earlier in the summer there were rather large day-to-day variations in daily high ozone readings.

Now, I would like to ask you some questions. I will hold the illustration so that you can mark your answers.

[EXCHANGE ILLUSTRATION FOR CLIPBOARD; DISPLAY ILLUSTRATION FOR RESPONDENT]

Saturday, September 4, was a day with relatively high ozone concentrations in your area. It was the Saturday of Labor Day weekend [POINT TO PEAK] and is marked on the left-hand-side of the illustration with a solid arrow. This was a day with [SLIDE ACROSS TO 'POOR'] POOR ozone levels, such as Situation C as shown on the illustration. The first question is:

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Saturday, September 4?

_____ Yes _____ No [Please Check] Please check your answer

[IF NO, SKIP #2]

2. [If you answered yes,] which of these symptoms did you notice? Please mark your answer sheet. For instance, did you or a member of your family notice decreased vision? How about the other listed symptoms?

Symptom	Yourself	Family Member
Decreased Vision	____________	______________
More frequent asthma attacks	____________	______________
Cough, Chest discomfort	____________	______________

Other (please name) ____

[PREFACE MATERIAL FOR #3]

The principle source of emissions which yield ozone is exhaust from cars and trucks. Factories, refineries, and other industrial facilities, also produce a significant amount of emissions.

A reduction in ozone levels will require the use of more costly procedures in manufacturing and in higher operating costs for automobiles and trucks. All of this would be reflected in higher prices for goods and services.

Over the Labor Day weekend, ozone levels dropped some in your area, to Situation B. There were numerous other days in August and September with B, FAIR air quality.

Most people would agree that they prefer lower ozone levels to higher levels. The next set of questions addresses changes in ozone concentration.

To establish a point of reference for changes, try to imagine a summer day with POOR ozone levels, such as Situation C as shown in the illustration.

Ozone levels could be reduced on that day by imposing regulations requiring the use of more expensive procedures as mentioned above. If such regulations were imposed you would be "paying" for an ozone reduction.

On your answer sheet are a series of amounts. Please circle the amount that is your answer to Question 4.

[READ #4; THERE IS NO #3]
4. What is the most your household would be willing to pay to reduce the daily high ozone reading <u>on that day</u> from POOR to FAIR?
[Please circle your answer.]

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

For Question 5, please circle the amount that

5. [What] is the most you would be willing to pay to reduce the daily high ozone level <u>on that day</u> from POOR to GOOD?
[Please circle your answer.]

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

If you answered zero for either question, please answer Question 6.

6. [Answer only if you answered $.00 to questions 4 through 5 above.]

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

Would you answer Question 7 by indicating how often you engage in outdoor activities? For instance, do you hike rarely, occasionally or often? How about other activities whether or not they are listed?

7. [In what outdoor activities do you regularly participate? How often?]

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging . . .	_____	_____	_____
Sailing . . .	_____	_____	_____

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Tennis	______	______	______
Surfing . . .	______	______	______
Swimming . . .	______	______	______
_________ . . .	______	______	______
_________ . . .	______	______	______
_________ . . .	______	______	______
_________ . . .	______	______	______

If you change your behavior when ozone levels rise please answer Question 8. For example, do you drive less if you know that the standard is being violated?

8. [Do you change your behavior on days with high ozone levels? If so, how?]

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____

The remaining questions about you and your family will be useful for analyzing peoples' responses to the questions already asked.

Your answers to all of these questions are of course strictly confidential. Please mark your answers to the rest of the questions before putting your answer sheet in this pouch.

[CLOSE BINDER. DISPLAY OPEN POUCH WITH OTHER ANSWER SHEETS IN IT.]

Thank you.

[BE SURE TO GET ALL QUESTIONS ANSWERED]

9. How long have you lived at your present address? ________ years

10. How long have you lived in the Los Angeles area? ________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
____________	____________	____________	____________

13. Home zip code ____________________

14. Your education:
- under 12 years ______
- High School ______
- College - no degree ______
- Bachelor's degree ______
- Post-graduate degree ______

15. Your age group:
- under 18 ______
- 18-24 ______
- 25-34 ______
- 35-44 ______
- 45-54 ______
- 55 & over ______

16. Sex: _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Do you live in a detached house, duplex, apartment or mobile home?

(1) Detached ________ (2) Duplex ________ (3) Apartment ________ (4) Mobile Home ________

20. Do you own or rent your home? ____own ____rent

21. Would you please indicate which of the following groups your annual household income falls in:

_____less than $5,000	_____$25,000-29,999	_____$55,000-59,999
_____$ 5,000-7,499	_____$30,000-34,999	_____$60,000-64,999
_____$ 7,500-9,999	_____$35,000-39,999	_____$65,000-69,999
_____$10,000-14,999	_____$40,000-44,999	_____$70,000-74,999
_____$15,000-19,999	_____$45,000-49,999	_____$75,000 and up
_____$20,000-24,999	_____$50,000-54,999	

SAN FERNANDO VALLEY SURVEY

#__________

ANSWER SHEET

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Saturday, September 4?

_____ Yes   _____ No (Please Check)

2. If you answered yes, which of these symptoms did you notice?

Symptom	Yourself	Family Member
Decreased Vision	____________	____________
More frequent asthma attacks	____________	____________
Cough, Chest discomfort	____________	____________

Other (please name)____

4. What is the most your household would be willing to pay to reduce the daily high ozone reading <u>on that day</u> from POOR to FAIR? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

5. What is the most you would be willing to pay to reduce the daily high ozone level <u>on that day</u> from POOR to GOOD? Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	S75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

6. Answer only if you answered $.00 to questions 4 through 5 above.

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.

_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.

_____ Other

7. In what outdoor activities do you regularly participate? How often?

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	______	______	______
Jogging . . .	______	______	______
Sailing . . .	______	______	______
Tennis	______	______	______
Surfing . . .	______	______	______
Swimming . . .	______	______	______
_________ . . .	______	______	______
_________ . . .	______	______	______
_________ . . .	______	______	______
_________ . . .	______	______	______

8. Do you change your behavior on days with high ozone levels? If so, how?

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
________________________	____	____	____
________________________	____	____	____
________________________	____	____	____
________________________	____	____	____

9. How long have you lived at your present address? _________ years

10. How long have you lived in the Los Angeles area? _________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
____________	____________	____________	____________

13. Home zip code ____________________

14. Your education:
- under 12 years ______
- High School ______
- College - no degree ______
- Bachelor's degree ______
- Post-graduate degree ______

15. Your age group: under 18 _____
18-24 _____
25-34 _____
35-44 _____
45-54 _____
55 & over _____

16. Sex: _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Do you live in a detached house, duplex, apartment or mobile home?

(1) Detached (2) Duplex (3) Apartment (4) Mobile Home

_______ _______ _______ _______

20. Do you own or rent your home? ____own ____rent

21. Would you please indicate which of the following groups your annual household income falls in:

_____less than $5,000	_____$25,000-29,999	_____$55,000-59,999
_____$ 5,000-7,499	_____$30,000-34,999	_____$60,000-64,999
_____$ 7,500-9,999	_____$35,000-39,999	_____$65,000-69,999
_____$10,000-14,999	_____$40,000-44,999	_____$70,000-74,999
_____$15,000-19,999	_____$45,000-49,999	_____$75,000 and up
_____$20,000-24,999	_____$50,000-54,999	

Hello:

I am part of a research team from the University of Wyoming, we are conducting a study related to air quality improvements. Air quality is a familiar topic to people who live in the Los Angeles area.

However, cleaning up the air involves certain costs to society in which all people will share in one way or another. We are interested in finding out whether it is worth it for the people in Los Angeles to pay these costs in light of the benefits they receive from cleaner air.

I would like to take a few minutes of your time to ask some questions. Your answers will be helpful in discovering whether pollution control is worthwhile.

[DO NOT READ ALOUD PASSAGES IN BRACKETS]

Before asking you the questions, I'd like to tell you a few things about ozone.

[ORANGE COUNTY INTERVIEW]

Air pollution in the Los Angeles area consists of a variety of gases and particles. Some of these are emitted directly by pollution sources (cars, trucks, industrial facilities) while others are formed in the air from these directly emitted pollutants.

Ozone, the most important gaseous air problem in the South Coast Air Basin, is created when certain other emissions are exposed to sunlight. Ozone is an important air problem because of its effects on human health and well-being.

Please look at this illustration.

[HAND ILLUSTRATION TO RESPONDENT]
[POINT TO LEFT SIDE]

The left-hand side shows the daily maximum ozone concentrations in your area during August and September of this year.

[POINT TO RIGHT SIDE]

The right-hand side presents a summary of known effects of breathing ozone on humans and experimental animals. The effects are the result of relatively short-term exposure to ozone concentrations that are possible in the South Coast Air Basin.

[POINT TO SCALE]

Ozone concentration in the air are measured in parts per hundred million. This is a common way of measuring ozone levels.

[POINT TO "5" AND "40" ON SCALE]

On this scale a measure of 5 is very clean air for the Los Angeles area. A rating of 40 is very smoggy.

[POINT TO "12" ON CENTER SCALE]

The Federal Standard for ozone requires an hourly average concentration of ozone less than 12 (all references to ozone concentration will be in parts per hundred million).

[POINT TO "20" ON CENTER SCALE]

A Stage One Ozone Episode is called when ozone concentrations exceed 20.

[POINT TO "35" on CENTER SCALE]

A Stage Two Ozone Episode requires an hourly average of 35. There have been no Stage Three Ozone Episodes, which require a concentration of 50, since 1974.

Some of the effects of ozone levels are:

[o Concentrations meeting the Federal Standard (0-12).] Ozone levels in the range of 1 to 12 identified as Situation A, GOOD

[POINT TO 'A', THEN 'GOOD']

air quality, on the illustration.

- ODOR BRIEFLY NOTICEABLE [POINT OUT]

This means

Most people notice the pungent smell of ozone at concentrations around 2. At 5 the "smell" fades in about 5 minutes even if the ozone remains.

[o Federal Standard violated (12-20).] Ozone levels of 12 to 20 are identified as Situation B, FAIR air quality, on the illustration.

[POINT TO 'B', THEN 'FAIR']

- DECREASED ATHLETIC PERFORMANCE [POINT OUT]

  Athletes performing outdoors show slower speeds in running.

- SENSITIVE ASTHMATICS HAVE MORE FREQUENT ATTACKS [POINT OUT]

  The people with asthma who are most sensitive to ozone have more frequent coughing spells.

- LOWER RESISTANCE TO LUNG INFECTION [POINT OUT]

  Some laboratory animals get lung infections more readily.

[o Stage One Ozone Episode (20-35).] Ozone levels from 20 to 35 are identified as Situation C, POOR air quality, on the illustration.

[POINT TO 'C', THEN 'POOR']

- COUCH, CHEST DISCOMFORT, HEADACHE [POINT OUT]

  Healthy adults notice discomfort in breathing, get headaches, and cough.

- MORE FREQUENT ASTHMA ATTACKS [POINT OUT]

More frequent coughing spells are had by people with asthma.

• RED BLOOD CELL SPHERING [POINT OUT]

Changes in the appearance of red blood cells were noticed in human volunteers.

• DECREASED VISION, CONCENTRATION

This was left off the illustration.

Human volunteers exposed to ozone had decreased sharpness of vision and had more difficulty concentrating. This may contribute to the higher number of automobile accidents when ozone levels rise.

[o Stage Two Ozone Episode (35-50).] Ozone levels from 35 to 50 are identified as Situation D, VERY POOR air quality, on the illustration.

• DECLINE IN LUNG FUNCTION IN HEALTHY INDIVIDUALS [POINT OUT]

Human volunteers exposed to ozone at this level had a noticeable decrease in various lung functions. At this level ozone is certainly more than an inconvenience; it presents a health hazard to people.

Please note that effects of ozone at lower concentrations continue at higher concentrations. [POINT TO EACH LIST OF EFFECTS] In the right-hand-side of the illustration these effects are repeated as ozone levels rise. Ozone, however, is not usually the cause of eye irritation. Other pollutants in smog are responsible for the stinging eyes.

[POINT TO LEFT SIDE]

The left-hand side of the illustrations shows the daily high ozone concentration in your area during last August [POINT] and September [POINT].

Please notice the very high readings just before Labor Day Weekend [POINT TO PEAKS] and three weeks later on September 22 and 23. Between these periods [POINT TO VALLEY] of high ozone levels was a period of exceptionally low ozone levels. Earlier in the summer there were rather large day-to-day variations in daily high ozone readings.

Now, I would like to ask you some questions. I will hold the illustration so that you can mark your answers.

[EXCHANGE ILLUSTRATION FOR CLIPBOARD; DISPLAY ILLUSTRATION FOR RESPONDENT]

Friday, September 3, was a day with relatively high ozone concentrations in your area. It was the Friday before Labor Day weekend

[POINT TO PEAK] and is marked on the left-hand-side of the illustration with a solid arrow. This was a day with [SLIDE ACROSS TO 'FAIR'] FAIR ozone levels such as Situation B as shown on the illustration. B, FAIR day. The first question is:

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Friday, September 3?

_____ Yes _____ No [Please Check] Please check your answer

[IF NO, SKIP #2]

2. [If you answered yes,] which of these symptoms did you notice? Please mark your answer sheet. For instance, did you or a member of your family notice decreased vision? How about the other listed symptoms?

Symptom	Yourself	Family Member
Decreased Vision	________	________
More frequent asthma attacks	________	________
Cough, Chest discomfort	________	________

Other (please name)______________________________

[PREFACE MATERIAL FOR #5]

The principle source of emissions which yield ozone is exhaust from cars and trucks. Factories, refineries, and other industrial facilities, also produce a significant amount of emissions.

A reduction in ozone levels will require the use of more costly procedures in manufacturing and in higher operating costs for automobiles and trucks. All of this would be reflected in higher prices for goods and services.

Over the Labor Day weekend, ozone levels dropped some in your area, to Situation A. There were numerous other days in August and September with A, GOOD air quality.

Most people would agree that they prefer lower ozone levels to higher levels. The next question addresses changes in ozone concentration.

To establish a point of reference for changes, try to imagine a summer day with FAIR ozone levels such as Situation B as shown in the illustration.

Ozone levels could be reduced on that day by imposing regulations requiring the use of more expensive procedures as mentioned above. If such regulations were imposed you would be "paying" for an ozone reduction.

On your answer sheet are a series of amounts. Please circle the amount that is your answer to Question 5.

[READ #5; THERE IS NO #3 or #4]

5. What is the most your household would be willing to pay to reduce the daily high ozone reading on that day from FAIR to GOOD?
[Please circle your answer.]

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

If you answered zero please answer Question 6.

6. [Answer only if you answered $.00 to question 3 above.]

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

Would you answer Question 7 by indicating how often you engage in outdoor activities? For instance do you hike rearely, occasionally or often? How about other activities whether or not they are listed?

7. [In what outdoor activities do you regularly participate? How often?]

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging	_____	_____	_____
Sailing	_____	_____	_____
Tennis	_____	_____	_____
Surfing	_____	_____	_____
Swimming	_____	_____	_____
_________	_____	_____	_____
_________	_____	_____	_____
_________	_____	_____	_____
_________	_____	_____	_____

If you change your behavior when ozone levels rise, please answer Question 8. For example do you drive less if your know that the standard is being violated?

8. [Do you change your behavior on days with high ozone levels? If so, how?]

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
________________________	____	____	____
________________________	____	____	____
________________________	____	____	____
________________________	____	____	____

The remaining questions about you and your family will be useful in analyzing peoples' responses to the questions already asked.

Your answers to all of these questions are of course strictly confidential. Please mark your answers to the rest of the questions before putting your answer sheet in this pouch.

[CLOSE BINDER. DISPLAY OPEN POUCH WITH OTHER ANSWER SHEETS IN IT.]

Thank you.

[BE SURE TO GET ALL QUESTIONS ANSWERED]

9. How long have you lived at your present address? ________ years

10. How long have you lived in the Los Angeles area? ________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
________	________	________	________

13. Home zip code ________________

14. Your education:

under 12 years	____
High School	____
College - no degree	____
Bachelor's degree	____
Post-graduate degree	____

15. Your age group:

under 18	______
18-24	______
25-34	______
35-44	______
45-54	______
55 & over	______

16. Sex: _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Do you live in a detached house, duplex or apartment?

(1) House ________ (2) Duplex ________ (3) Apartment ________ (4) Mobile Home ________

20. Do you own or rent your home? ____own ____rent

21. Would you please indicate which of the following groups your annual household income falls in:

_____less than $5,000	_____$25,000-29,999	_____$55,000-59,999
_____$ 5,000-7,499	_____$30,000-34,999	_____$60,000-64,999
_____$ 7,500-9,999	_____$35,000-39,999	_____$65,000-69,999
_____$10,000-14,999	_____$40,000-44,999	_____$70,000-74,999
_____$15,000-19,999	_____$45,000-49,999	_____$75,000 and up
_____$20,000-24,999	_____$50,000-54,999	

ORANGE COUNTY SURVEY

#__________

ANSWER SHEET

1. Did you or any of the members of your immediate family experience any of the "ozone-induced" effects described above on Friday, September 3?

_____ Yes _____ No (Please Check)

2. If you answered yes, which of these symptoms did you notice?

Symptom	Yourself	Family Member
Decreased Vision	______________	________________
More frequent asthma attacks	______________	________________
Cough, Chest discomfort	______________	________________

Other (please name)____

5. What is the most your household would be willing to pay to reduce the daily high ozone reading on that day from FAIR to GOOD?
Please circle your answer.

$ .00	$2.00	$4.00	$6.00	$8.00	$11.00	$15.00	$35.00
$ .50	$2.50	$4.50	$6.50	$8.50	$12.00	$20.00	$50.00
$1.00	$3.00	$5.00	$7.00	$9.00	$13.00	$25.00	$75.00
$1.50	$3.50	$5.50	$7.50	$10.00	$14.00	$30.00	$100.00

6. Answer only if you answered $.00 to question 3 above.

Did you bid zero because you believe that:

_____ You do not consider ozone to be a problem for you and your family.
_____ It is unfair or unjust to expect the victim of damages to have to pay the cost of preventing damages.
_____ Other

7. In what outdoor activities do you regularly participate? How often?

Activity	Rarely (1-5 days/year)	Occasionally (5-15 days/year)	Often (More than 15 days/year)
Hiking	_____	_____	_____
Jogging	_____	_____	_____
Sailing	_____	_____	_____
Tennis	_____	_____	_____
Surfing	_____	_____	_____
Swimming	_____	_____	_____
________	_____	_____	_____
________	_____	_____	_____
________	_____	_____	_____
________	_____	_____	_____

8. Do you change your behavior on days with high ozone levels? If so, how?

	At what levels of ozone? B	C	D
Drive less	____	____	____
Exercise at different hours	____	____	____
Stay indoors	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____
______________________	____	____	____

9. How long have you lived at your present address? ________ years

10. How long have you lived in the Los Angeles area? ________ years

11. Did you consider air quality when choosing your home? ____Yes ____No

12. How much new information about air quality in the South Coast Air Basin and the effects of ozone did you find in the background material to this questionnaire?

none	very little	quite a bit	a great deal
__________	__________	__________	__________

13. Home zip code ____________________

14. Your education: under 12 years ______
High School ______
College - no degree ______
Bachelor's degree ______
Post-graduate degree ______

15. Your age group: under 18 ______
18-24 ______
25-34 ______
35-44 ______
45-54 ______
55 & over ______

16. Sex: _____Male _____Female

17. How many members are there in your household? _____persons.

18. Are you the primary income earner in your household? ___yes ___no

19. Do you live in a detached house, duplex or apartment?

(1) House ________ (2) Duplex ________ (3) Apartment ________ (4) Mobile Home ________

20. Do you own or rent your home? ____own ____rent

21. Would you please indicate which of the following groups your annual household income falls in:

______less than $5,000	______$25,000-29,999	______$55,000-59,999
______$ 5,000-7,499	______$30,000-34,999	______$60,000-64,999
______$ 7,500-9,999	______$35,000-39,999	______$65,000-69,999
______$10,000-14,999	______$40,000-44,999	______$70,000-74,999
______$15,000-19,999	______$45,000-49,999	______$75,000 and up
______$20,000-24,999	______$50,000-54,999	

APPENDIX B

I. INTRODUCTION

The makers of the public policy for our environment must be concerned with the effects their efforts have on consumer preferences. For instance, EPA-directed programs in the 1970's have led to research on the health, aesthetic, and property damage consequences of deteriorating air quality. As individuals become aware of these effects, we may expect their preferences for air quality, or the activities which use air quality, to change. Presuming a demand for air quality, we might hypothesize that the demand has increased (shifted to the right) for individuals as a result of this new information. In order to test this hypothesis, some technique must be used for estimating the demand relationship. Here, we examine the possibilities for using the hedonic technique and propose how it can be used to research the changing preferences issue.

The use of the hedonic technique to estimate the implicit (hedonic) prices of the characteristics or qualities of certain goods is becoming widely accepted in the Environmental and Urban economics fields. Its application to residential housing data, whereby, the value of a home is regressed against various site specific, because, these "goods" are not explicitly traded in markets. The resulting estimated implicit prices offer measures to the marginal values consumers reserve for such things as public safety, school quality, and air quality - all with public good qualities. Continuing refinements in estimation techniques make these estimates more and more reliable.[1]

Although the estimation of the hedonic prices has been widely accepted, using them to identify demand functions for the characteristics has not. Rosen (1974) proposed using the estimated hedonic prices, quantities, and consumer tastes and income information to estimate these demand curves. In principle, demand curves for public goods can be identified, because across a large urban area, their qualities are likely to vary. Thus, the hedonic technique reveals the implicit prices associated with the various qualities. The data appear similar to ordinary market data, and, when coupled with the information on consumers, the demand relationships would appear to be identifies.[2] Recently, several researchers have challenged Rosen's proposal (Brown and Rosen, 1982; Palmquist, 1981; and Mendelsohn, 1980). Their basic arguments suggest that the demands can only be identified-with multimarket data, perhaps from several urban areas.

In this appendix we purport to: (a) contribute to a better understanding of the new literature mentioned above; (b) outline the data requirements for implementing the hedonic technique to estimate the demands for public goods; and, (c) present some evidence of changing preferences and outline a complete empirical test of this hypothesis.

The remainder of the appendix has four sections. Section II contains an analysis of the hedonic technique to estimate demand relationships. In section III we present a short discussion of the data available for proceeding with estimation. We believe our data set will enable us to identify a demand for environmental quality. In the fourth section we address the issue of changing preferences. Evidence is presented which is not inconsistent with the hypothesis of preferences changing overtime. The last section contains some concluding remarks.

II. DEMAND ESTIMATION

Our concern is with housing data so we restrict our analyses to this commodity class for the remainder of the paper. Let S, N, and Q represent a vector of site specific characteristics, a vector of neighborhood and locational characteristics, and a scalar measuring the environmental quality, respectively. Then, P(S,N,Q) is the hedonic function faced by consumers and producers in an urban area. It can be visualized by imagining consumers as "bidding" for the characteristics and producers "offering" the various characteristics at different prices. The hedonic function is the locus of tangencies between the consumers' bid functions and the producers' offer functions. Consumers will maximize utility by choosing the bundle of housing characteristics such that their indifference surface is just tangent to P(S,N,Q). With respect to Q, this implies that $\partial P/\partial Q = MRS_{Q,y}$, where y is some numeraire commodity (money). The MRS measures the consumers' marginal willingness to pay for a marginal change in Q. For the ith individual, we denote this by: $W_i = \partial P/\partial Q$. Analogously, the producers will supply characteristic bundles so that their iso-profit loci are just tangent to the hedonic function.

By estimating P(S,N,Q), the $\partial P/\partial Q$ can be measured and, therefore, W_i. The major question concerns using these estimates to identify the demand for Q. The problem is simplied when the supply of available housing units can be assumed fixed at the various locations (Freeman, 1979). For this case, the consumers will bid for the homes with the desired characteristics; the simultaneity between demand and supply can be ignored. The supply of units appears relatively constant in the Los Angeles County area (see Table 1 below) and we make this assumption.[3]

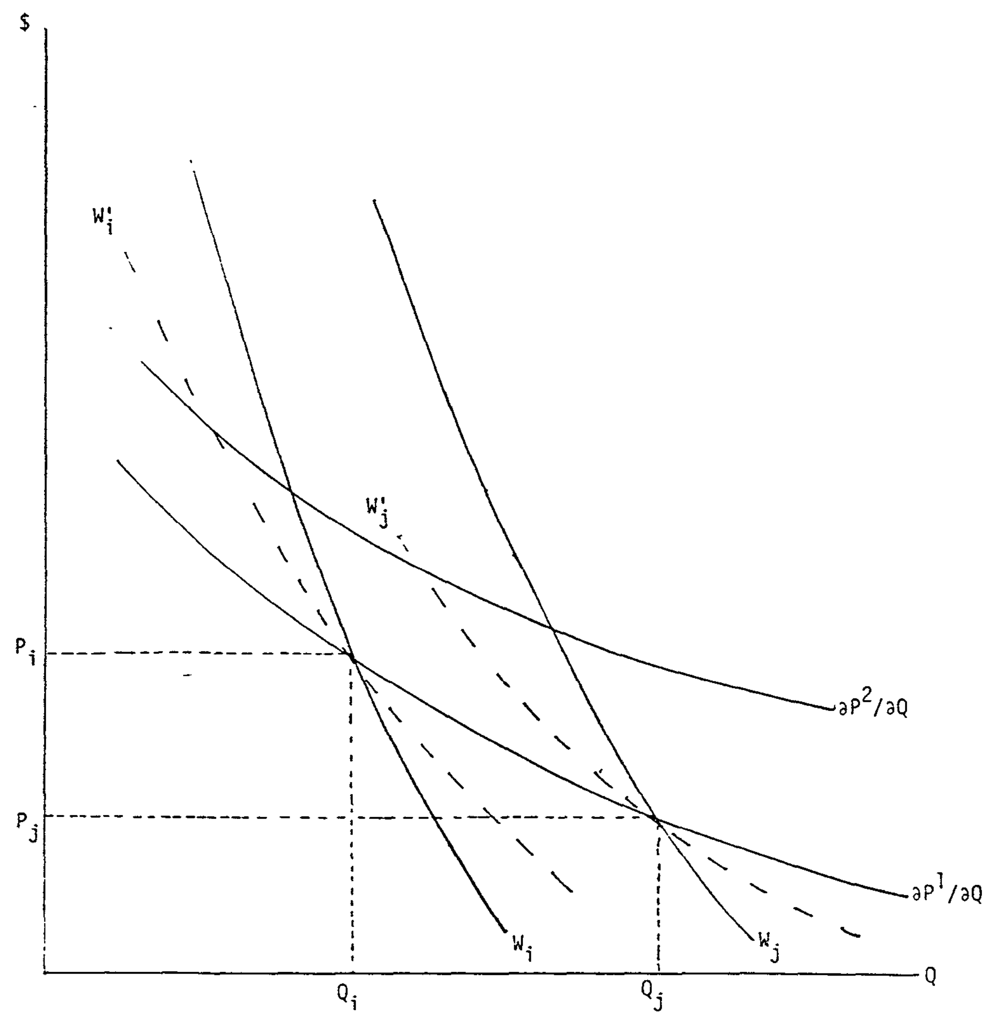
In general, there is no reason to expect that the hednoic function will be linear (Rosen, 1974, p. 38) so different prices will be revealed for different levels of Q. Furthermore, it is unlikely that the demand will be separable from the other characteristics. Using α to denote a vector of individual taste parameters (including income) the demand function can be represented by

$$W_i = W(S, N, Q, \alpha). \qquad (1)$$

Unfortunately, the estimation of (1) will nqt identify the demand curve.[4] To see this, consider Figure 1 where $\alpha P/\alpha Q$ is the estimated implicit price equation for Q. The optimal choice of Q for two individuals (i and j) is represented by Q_i and Q_j, revealing prices P_i and P_j, respectively. It appears as though we have price and quality variation. However, this results from the nonlinear hedonic equation. Different individuals will choose different quantities but, there are <u>no</u> data on how like individuals will react to different prices. The estimates of (1) will not differ between the demands W_i and W_i' or W_j and W_j'. Each demand curve yields precisely the same information.

To overcome these difficulties another hedonic function could be estimated using data from other markets. The implicit price equation from another market is illustrated as $\partial P^2/\partial Q$ in Figure 1. The additional

Figure 1: The Implicit Price Function from Two Different Markets ($\partial P^1/\partial Q$ and $\partial P^2/\partial Q$) and Hypothetical Demand Curves for Two Individuals



information enables us to discern between W_i and W_i', and W_j and W_j'. Obviously, the estimates of the demand function will improve as more and more markets are added to the data.[5]

III. DATA REQUIREMENTS

To estimate demand functions it is necessary to assume a utility function that is common to all individuals with the exception of measurable taste shift parameters. These are usually such variables and education, sex, age, and race. The use of multimarket data may rely on this assumption for diverse geographic regions. For example, data from Dallas, Texas could be merged with data from San Diego, California. The assumption would imply that individuals with the same sex, age, etc., from Texas would have the same preferences for environmental quality as those from California. This assumption may be too restrictive, in that, different preferences may be the <u>cause</u> of different hedonic gradients. Identical preferences for like individuals may be more defensible when different markets can be identified within a geographic region. The problem, then, is to identify the markets.

Mendelsohn (1980) suggests that a sufficient condition for hedonic functions to vary across markets is "that the underlying array of suppliers changes across the markets." Some examples would include different supply arrangements induced by building codes or realtor boards. Another sufficient condition noted by Mendelsohn: "if the number of demanders in a market is independent of the market prices, the supply curves are not perfectly elastic, and the number of demanders vary across markets." This would result when the transportation costs between markets are prohibitive (Palmquist, 1981). Therefore, we have some quide lines on defining different markets within a geographic region. A major task for future efforts is to design and implement statistical tests which may allow markets to be identified.

A data set is being assembled by the authors in conjunction with the Wyoming group which lends itself to these forms of analyses. The data are for several California counties, including two SMSAS, for several years in the 1970s. Ideally, a demand curve for Californians can be identified and compared to others from different geographical regions. Such a procedure may isolate variation in preferences for environmental quality between regions in the U.S.

IV. SHIFTING PREFERENCES

The possibility of the consumers' preferences changing over time can be examined by estimating demand equations from the same geographic region for several different time periods. The hypothesis of an increase in demand for environmental quality could then be tested statistically by comparing the demand for like individuals (with similar quantities of all characteristics) between the time periods. In theory, demand curves will exist for the individual in different time periods. And, under the assumption of constant preferences these demand curves would be identical. Let $\overline{S}$, $\overline{N}$, $\overline{Q}$, and $\overline{\alpha}$ be the vectors of housing characteristics and measurable taste parameters (including income), respectively. Use W_t and W_{t+1} to represent the demand equation estimated in year t and year t+1. Then, the null hypothesis is:

$$H_o: W_t(S, N, Q, \alpha) + W_{t+1}(\overline{S}, \overline{N}, \overline{Q}, \overline{\alpha})$$

and the alternative is:

$$H_A: W_t(\overline{S}, \overline{N}, \overline{Q}, \overline{\alpha}) < W_{t+1}(\overline{S}, \overline{N}, \overline{Q}, \overline{\alpha}).$$

Again, the California data set would facilitate this type of hypothesis testing.

As an initial investigation into this issue, the hedonic function for Los Angeles County has been estimated for 1972 and 1978 data. The means and standard deviations of the data are presented in Table 1 and the estimated coefficients from the regressions in Table 2. For the regressions, a semi-log functional form was used.

In Table 1, the means of the site specific characteristics (bathrooms, living area, fireplaces, etc.) are of particular interest. In comparing 1972 with 1978, we find only small changes in these measures. This is consistent with the assumption of a fixed supply of housing units discussed above. Unfortunately, data are not available from the 1980 census survey to compare the measures for the neighborhood characteristics. Intuitively, we expect these attributes to show some changes. Crime rates and school quality measures were obtained for the different periods. As suspected, a decline in the performance scores on standardized achievement tests is evidenced by the average scores of school quality. On the other hand, crime rates have remained remarkably stable. The 1975 total suspended particulates (TSP) measure is used to proxy air pollution in 1972 and 1978. As more and better air quality data becomes available, the estimation of these hedonic prices in different tine periods will be more precise.

The semi-log form is convenient for comparing estimates from different time periods. This is because the estimated coefficient is interpreted as the proportion of the house value devoted to the associated attribute. To see this, consider:

$$\partial(\text{Log } P)/\partial Q. \qquad (2)$$

Let Y = Log P, then:

$$\partial(\text{Log } P)/\partial Q = \partial Y/\partial P \cdot \partial P/\partial Q. \qquad (3)$$

From logarithmic differentiation the first derivative on the right hand side of (3) is 1/P. Thus, (2) is $(\partial P/\partial Q)/P$, which is the percentage change in the price due to a change in Q. Being a percentage, the measure is unit free; we do not need to consider the role of nominal dollars in housing markets. However, to actually compare hedonic prices, measures for price indices must be obtained. Fortunately, these data are available for Los Angeles County (see below).

The estimated coefficients presented in Table 2 allow for a comparison of the percentage of home value attributed to each characteristic in 1972

TABLE 1: MEANS AND STANDARD DEVIATIONS IN PARENTHESES FOR THE VARIABLES USED IN THE HEDONIC EQUATIONS FOR 1972 AND 1978 DATA.[a]

VARIABLE	1972	1978
SELLING PRICE (100s $)	311.69 (172.76)	831.22 (565.50)
SALES DATE	6.62 (3.25)	5.31 (2.82)
AGE OF THE HOME	24.31 (12.94)	27.16 (16.92)
NUMBER OF BATHROOMS	1.61. (.65)	1.69 (.72)
SQUARE FEET OF LIVING AREA	1422.85 (619.18)	1437.94 (625.25)
NUMBER OF FIREPLACES	.61 (.61)	.66 (.61)
POOL [b]	.12 (.32)	.13 (.34)
VIEW [b]	.04 (.21)	.09 (.29)
SCHOOL QUALITY [c]	69.57 (3.62)	60.80 (3.59)
DISTANCE TO BEACH [d]	11.50 (7.50)	12.53 (7.68)
CRIME RATE [c]	.05 (.02)	.05 (.02)
HOME DENSITY [c]	2273.98 (706.14)	2206.83 (728.66)
PERCENTAGE OF POPULATION BLACK [d]	9.29 (24.04)	5.02 (17.50)
PERCENTAGE OF POPULATION OVER 62 [d]	11.24 (7.09)	10.62 (6.90)
EMPLOYMENT LOCATION [e]	.018 (.004)	.018 (.004)
TOTAL SUSPENDED PARTICULATES [e]	106.63 (13.86)	108.23 (14.13)

a. The sample sizis for 1972 and 1978 are 4688 and 4571 respectively.
b. Indicates a dumjy variable
c. Indicates a community specific variable.
d. Indicates a census tract specific varaible.
e. Calculated-Employment Location is calculated for each census tract by weighting the distance to eight employment centers by the employment density. Total suspended particulates are determined for each census tract by finding the closest monitoring stations. The average between the two closest is used unless these fall in the same direction from the census tract.

TABLE 2: ESTIMATED COEFFICIENTS OF HEDONIC EQUAITONS FOR THE 1972 AND 1978 DATA. THE DEPENDENT VARIABLE IS THE SELLING PRICE IN LOGS.

VARIABLE	1972	1978
SALES DATE	.0044	.0226
AGE OF THE HOME	-.0049	-.0025
NUMBER OF BATHROOMS	.1336	.1024
SQUARE FEET OF LIVING AREA	.0003	.0004
NUMBER OF FIREPLACES	.092	.1248
POOL	.1313	-0944
VIEW	.1348	.1489
SCHOOL QUALITY	.0081	.0180
DISTANCE TO BEACH	-.0099	-.0169
CRIME RATE	-.3053*	-.2342*
HOME DENSITY	-.00002	-.00004
PERCENTAGE OF POPULATION BLACK	-.0031	-.0075
PERCENTAGE OF POPULATION OVER 62	.0029	.0039
EMPLOYMENT LOCATION	-7.1023	-2.1254*
TOTAL SUSPENDED PARTICULATES	-.0018	-.0020
CONSTANT	4.9581	5.1958

R-Square	.80	.79
Number of Observations	4688	4571

* Indicates the coefficient is not significant at the .01 level.

and 1978. We find that the age of the home, number of bathrooms, employment distance, existence of a pool, and crime rates (although insignificant) appear to have diminished in the sense that they are all closer to zero. The remainder of the coefficients have increased between 1972 and 1978. Moreover, by using a t-test, statistical inferences can be made concerning these changes.

Focusing on the hypothesis of changing preferences for environmental quality, the t-statistic is calculated to compare the differences (in absolute value) between the coefficients for distance to the beach, view, and TSP (see Table 3). These are of interest because each could be considered a proxy for environmental quality. For example, the simple correlation coefficient between beach and TSP is .70 in both years. Although the simple correlation between view and these measures is slight (-.05 for TSP and -.07 for beach in 1978), it is likely that consumers would be willing to trade a view for more miles to the beach or pollution. Thus, this variable seems important to our analysis.

In Table 3 the t-statistics are presented along with the results from the hypothesis tests. The null hypothesis in each case is that the difference between the coefficients is zero, while the alternative is that the difference is positive. The null hypothesis is rejected for the distance to beach measures but can not be rejected for the other two. It is possible that the beach coefficient is picking up some of the effects of the pollution measure, thus, clouding the hypothesis test. This possibility highlights the importance of a correct econometric methodology for estimating the hedonic equation. In fact, multimarket data may help to break the correlation because the beach variable may not be as important in other areas of California.

The actual hedonic prices for beach, TSP, and view depend on the amounts of the other characteristics in the semi-log form. To examine the prices we examined a home sold in June, which is 25 years old, has one and a half baths, 1425 square feet of living area, a fireplace, and is without a pool or a view. Furthermore, the home is located in an area where the school quality measure is 65, the distance to the beach is 12 miles, the crime rate is .05, the surrounding home density is 2200 per square mile, and the percentages of the local population is 6 (i.e., population that is black), while the percentage greater than 62 years of age is 10 percent. The employment location parameter is .018 and TSP measure is 107. For this hypothetical home, the <u>predicted</u> hedonic prices for distance to the beach, TSP, and view are $273/mile, $49.7/PPM, and $3720, respectively, in 1972. While in 1978 the prices are $1410/mile, $167/PPM, and $12421, respectively. In comparing these figures, assume further that the home is located in the Pasadena area of L.A. County. Then, the housing price indices, with 1967 equal to 100, are 146 for 1972 and 338 for 1978. A comparison of the constant dollar figures is presented in Table 4. The beach price is substantially larger in 1978 while the others are somewhat closer.

These calculations are not conclusive. As stated above, an appropriate test will require the estimation of demand functions. However, they are most interesting since they are not inconsistent with the hypothesis of shifting preferences. In fact, they seem to be supportive.

V. CONCLUSIONS

The discussion above indicates that the hedonic housing value approach remains a technique with considerable research questions unanswered. These include demand curve identifications, changing preferences and others. However, the data sets now being assembled will enable hypothesis testing concerning these issues. The result will be an approach to value environmental goods which possesses considerable theoretical and empirical justification. Further, its use in validating other valuation approaches will also be increased substantially.

TABLE 3: RESULTS OF THE HYPOTHESIS TESTS COMPARING COEFFICIENTS BETWEEN 1972 AND 1978

Coefficient	t-Statistic	Conclusion
DISTANCE TO BEACH	7.254	Reject the null hypothesis
TSP	.42	Fail to reject
VIEW	.758	Fail to reject

The critical value for t is 2.33 at the .01 level.

TABLE 4: ESTIMATED HEDONIC PRICES IN CONSTANT 1967 DOLLARS FOR THE ENVIRONMENTAL QUALITY ATTRIBUTES (DOLLARS PER UNIT)

Good	1972	1978
DISTANCE TO BEACH	187	417
TSP	34	50
VIEW	2548	3675

FOOTNOTES

1. Evidence of the acceptability of estimated hedonic prices was recently published in the <u>AER</u> (Brookshire, et al.). In this paper, the authors used the hedonic prices to test the validity of survey responses.

2. The existing literature contains several examples of this approach. See Freeman (1979) for a review.

3. We are also neglecting the possibilities of market segmentation (Rosen, 1974, p. 40).

4. These comments are drawn mainly from Mendelsohn (1980).

5. In this section, we have only considered the theoretical problems in estimating the demand functions using the hedonic technique. There are econometric problems as well (Brown and Rosen, 1982).

APPENDIX C

SURVEY QUESTIONNAIRES AND ANSWER SHEETS

BUDGET GAME
URBAN SURVEY: Economic Narrative

We are students at the University of Wyoming and are conducting this survey for a research project designed to help in valuing visibility in Grand Canyon National Park in the southwestern United States.

The Clean Air Act, passed by Congress in 1970, declared a national goal of preserving the scenic beauty and pristine air quality of our national parks and wilderness areas.

Air quality, or the "cleanness" of the air, can be affected by either natural occurrences (e.g., dust and humidity) or by man-caused pollution (such as auto emissions or emissions released by industrial facilities). Consequently, visibility, which is the ability to see and appreciate distant objects, activities, scenes or atmospheric phenomena, can be affected by either natural or man-caused pollution sources resulting in changes in the color and clarity of near and far distant vistas.

As you can see in these photographs taken at the Grand Canyon, air pollution can discolor a view to the point where its components cannot be clearly identified and its scenic beauty cannot be fully enjoyed by the viewer [SHOW GRAND CANYON PHOTOGRAPHS: SITUATION A-E]

The photographs represent five levels of visibility during morning and afternoon periods looking both east and west from Hopi Point at the Grand Canyon. Column A represents poor visibility, B, below average; C, average visibility; D, above average; and E, good visibility. Comparing the columns, we can see the variety of air quality conditions and resulting levels of visibility that can be observed in the Grand Canyon. The rows represent the different vistas while standing at Hopi Point. The first row represents the different visibility and air quality conditions looking east, in the morning from Hopi Point. The second row represents morning conditions looking west from Hopi Point. The third row shows the view from Hopi Point in the afternoon looking west.

PAST AND FUTURE USE

In the first part of our survey, we would like to ask a few questions about your household's use of the National Parklands.

1. How many days have you spent visiting the Grand Canyon National Park in the last 10 years? Please put an X by the number of days on your answer sheet for question 1.

2. How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? Please put an X by the number of days on your answer sheet for question 2.

PRESERVATION VALUE ANALYSIS

This part of the survey is designed to determine your concern for preserving visibility levels in Grand Canyon National Park.

Although one does not usually find a dollar value placed on scenery, sunsets or visibility, such things are valuable. Since it does cost money to clean up man-made pollution to improve visibility in our national parks, we are interested in finding out how much good visibility is worth to you.

Unless new and current industrial facilities in the southwest are required to meet current emission standards for particulates and sulfur oxides, air quality in the Grand Canyon will become less than the current average.

3. Would you please indicate the closest estimate of average monthly income for your household after taxes $________________________.

[IF AN INDIVIDUAL CANNOT OR DOES NOT WANT TO REVEAL HIS MONTHLY INCOME, GIVE HIM A HYPOTHETICAL MONTHLY INCOME ON MUTUAL AGREEMENT, AND THEN CONTINUE WITH THE SURVEY]

The basic monthly expenses for most households are listed in the following table. Would you please break down your monthly income in the following categories, trying to be as accurate as possible.

Again, let us look at the photographs representing visual air quality ranging from very poor in Column A to very good in Column E for east and west views in the morning and afternoon from Hopi Point. If current emission standards are maintained, for new and existing power plants, average conditions will be as seen in Column C. If, however, current emission standards for sulfur oxide are not enforced, then the average air quality and visibility in the region will become like Column B. As a result, conditions as represented in Columns C, D, and E will occur less frequently. Conditions in Columns A and B would occur more frequently in the Grand Canyon. <u>Such emission controls will likely make electricity more expensive.</u>

4. We would like to know if you are willing to pay higher electric utility bills if the extra money collected would be used for air pollution controls to <u>preserve</u> current air quality and visibility levels at the Grand Canyon. Note, we want to find out how much preserving visibility at the Grand Canyon is worth to your household. In other words, how much extra would you be willing to pay at most, considering the amount of your expenses in the above-mentioned table, per month, as an increase in your electric utility bill to preserve current average visibility as represented in Column C rather than have the average

deteriorate to that shown in Column B? Please put an X next to the highest amount you would be willing to pay per month for your household on your answer sheet for question 4. [EMPHASIZE THEY ARE ANSWERING QUESTION 4].

[NOTE: IF INDIVIDUAL IS WILLING TO PAY, PLEASE ASK THE RESPONDENT TO REARRANGE HIS EXPENDITURES TO SHOW WHICH CATEGORY THE BID WILL COME FROM: IF BID COMES FROM "OTHER" CATEGORY, PLEASE ASK RESPONDENT TO BE MORE SPECIFIC].

BUDGET GAME

ANSWER SHEET

1. ____Zero Days
____1 day   ____5 days   ____9 days   ____13 days
____2 days   ____6 days   ____10 days   ____l4 days
____3 days   ____7 days   ____11 days   ____15 days
____4 days   ____8 days   ____12 days   ____More than 15 days

2. ____1 day   ____5 days   ____9 days   ____13 days
____2 days   ____6 days   ____10 days   ____14 days
____3 days   ____7 days   ____11 days   ____15 days
____4 days   ____8 days   ____12 days   ____More than 15 days

3. $________________________

Household Expenses	Approx. Amount	Category Bid Will Come From
Electricity		
Shelter		
Entertainment (vacation, bowling recreation, Etc.)		
Savings		
Other (food, clothing, education, phone, water, insurance, transportation, Etc.)		
TOTAL		

Sum should equal monthly income

4. $ .00____/month $ 5.00____/month $30.00____/month $ 60.00____/month
.50____/month $10.00____/month $35.00____/month $ 70.00____/month
1.00____/month $15.00____/month $40.00____/month $ 80.00____/month
2.00____/month $20.00____/month $45.00____/month $ 90.00____/month
3.00____/month $25.00____/month $50.00____/month $100.00____/month
4.00____/month More than $100.00____/month

5. Answer only if you answered $.00 any part of the above question. Did you bid zero because you believe that:

_____ The air quality improvements represented in the columns are not significant.

_____ The source of the air pollution should be required to pay the costs of improving the air quality.

_____ Other (specify) ____

____

6. Home zip code ____________________

7. ____ Rural ____ Suburban ____ Urban

8. Education: under 12 years ____
   High School ____
   College-no degree ____
   Bachelor's degree ____
   Post-graduate degree ____

9. Age group: under 18 ____
   18-24 ____
   25-34 ____
   35-44 ____
   45-54 ____
   55 and over ____

10. Sex: ____ Male ____ Female

11. How many members are there in your household? ________ persons.

12. Are you the primary income earner in your household? ___ yes ___ no

13. Would you please indicate which of the following groups your annual household income falls in:

____ less than $5,000	____ $25,000-29,999	____ $55,000-59,999
____ $ 5,000- 7,499	____ $30,000-34,999	____ $60,000-64,999
____ $ 7,500- 9,999	____ $35,000-39,999	____ $65,000-69,999
____ $10,000-14,999	____ $40,000-44,999	____ $70,000-74,999
____ $15,000-19,999	____ $45,000-49,000	____ $75,000 and up
____ $20,000-24,999	____ $50,000-54,999	

14. Please check the amount below which is closest to your average current monthly electricity bill.

$ .00 ___/month	$ 80.00 ___/month	$160.00 ___/month	$240.00 ___/month
10.00 ___/month	$ 90.00 ___/month	$170.00 ___/month	$250.00 ___. month
20.00 ___/month	$100.00 ___/month	$180.00 ___/month	$260.00 ___/month
30.00 ___/month	$110.00 ___/month	$190.00 ___/month	$270.00 ___/month
40.00 ___/month	$120.00 ___/month	$200.00 ___/month	$280.00 ___/month
50.00 ___/month	$130.00 ___/month	$210.00 ___/month	$290.00 ___/month
60.00 ___/month	$140.00 ___/month	$220.00 ___/month	$300.00 ___/month
70.00 ___/month	$150.00 ___/month	$230.00 /month	

Above $300.00 ___/month

15. Check if additional information was used. ___________

THANK YOU

TEAM____

BASE PLUS MAX WTP PLUS DENVER
URBAN SURVEY: Economic Narrative

We are students at the University of Wyoming and are conducting this survey for a research project designed to help in valuing visibility in Grand Canyon National Park in the southwestern United States.

The Clean Air Act, passed by Congress in 1970, declared a national goal of preserving the scenic beauty and pristine air quality of our national parks and wilderness areas.

Air quality, or the "cleanness" of the air, can be affected by either natural occurrences (e.g., dust and humidity) or by man-caused pollution (such as auto emissions or emissions released by industrial facilities). Consequently, visibility, which is the ability to see and appreciate distant objects, activities, scenes or atmospheric phenomena, can be affected by either natural or man-caused pollution sources resulting in changes in the color and clarity of near and far distant vistas.

As you can see in these photographs taken at the Grand Canyon, air pollution can discolor a view to the point where its components cannot be clearly identified and its scenic beauty cannot be fully enjoyed by the viewer [SHOW GRAND CANYON PHOTOGRAPHS: SITUATION A-E]

The photographs represent five levels of visibility during morning and afternoon periods looking both east and west from Hopi Point at the Grand Canyon. Column A represents poor visibility, B, below average; C, average visibility; D, above average; and E, good visibility. Comparing the columns, we can see the variety of air quality conditions and resulting levels of visibility that can be observed in the Grand Canyon. The rows represent the different vistas while standing at Hopi Point. The first row represents the different visibility and air quality conditions looking east, in the morning from Hopi Point. The second row represents morning conditions looking west from Hopi Point. The third row shows the view from Hopi Point in the afternoon looking west.

PAST AND FUTURE USE

In the first part of our survey, we would like to ask a few questions about your household's use of the National Parklands.

1. How many days have you spent visiting the Grand Canyon National Park in the last 10 years? Please put an X by the number of days on your answer sheet for question 1.

2. How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? Please put an X by the number of days on your answer sheet for question 2.

PRESERVATION VALUE ANALYSIS

This part of the survey is designed to determine your concern for preserving visibility levels in Grand Canyon National Park.

Although one does not usually find a dollar value placed on scenery, sunsets or visibility, such things are valuable. Since it does cost money to clean up man-made pollution to improve visibility in our national parks, we are interested in finding out how much good visibility is worth to you.

Unless new and current industrial facilities in the southwest are required to meet current emission standards for particulates and sulfur oxides, air quality in the Grand Canyon will become less than the current average.

Again, let us look at the photographs representing visual air quality ranging from very poor in Column A to very good in Column E for east and west views in the morning and afternoon from Hopi Point. If current emission standards are maintained, for new and existing power plants, average conditions will be as seen in Column C. If, however, current emission standards for sulfur oxide are not enforced, then the average air quality and visibility in the region will become like Column B. As a result, conditions as represented in Columns C, D, and E will occur less frequently. Conditions in Columns A and B would occur more frequently in the Grand Canyon. Such emission controls will likely make electricity more expensive.

3. We would like to know if you are willing to pay higher electric utility bills if the extra money collected would be used for air pollution controls to preserve current air quality and visibility levels at the Grand Canyon. Note, we want to find out how much preserving visibility at the Grand Canyon is worth to your household. In other words, how much extra would you be willing to pay, at most, per month as an increase in your electric utility bill to preserve current average visibility as represented in Column C rather than have the average deteriorate to that shown in Column B? Please put an X next to the highest amount you would be willing to pay per month for your household on your answer sheet for question 3. [EMPHASIZE THEY ARE ANSWERING QUESTION 3].

4. Now suppose that with all households paying $____________ per month, this amount of money would be insufficient to allow for the preservation of visibility level C at the Grand Canyon. Would you be willing to pay ($____________ plus $1.00)? [CONTINUE BIDDING PROCESS TO MAXIMUM WILLINGNESS TO PAY].

5. Why did you bid zero?

6. Preserving air quality is also of concern in Denver and other urban areas. Suppose that someone just like me could ask you tomorrow how much you would be willing to pay to see air quality preserved in Denver. Would you still be willing to pay the $__________ you indicated for the Grand Canyon?

7. If no please indicate maximum willingness to pay for the Grand Canyon.

BASE + MWTP + DENVER

ANSWER SHEET

1. ____1 day ____5 days ____9 days ____13 days
____2 days ____6 days ____10 days ____14 days
____3 days ____7 days ____11 days ____15 days
____4 days ____8 days ____12 days ____More than 15 days

2. ____1 day ____5 days ____9 days ____13 days
____2 days ____6 days ____10 days ____14 days
____3 days ____7 days ____11 days ____15 days
____4 days ____8 days ____12 days ____More than 15 days

3. $____________________
Grand Canyon

4. $____________________
Maximum Bid

5. Answer only if you answered $.00 to question 3 above. Did you bid zero because you believe that:

____The air quality improvements represented in the columns are not significant.

____The source of the air pollution should be required to pay the costs of improving the air quality.

____Other (specify)____

____

____

6. ____ yes ____ no; if no please answer question 7.

7. $______________
Grand Canyon

8. Home zip code ____________________

9. ____ Rural ____ Suburban ____ Urban

10. Education:

under 12 years	____
High School	____
College-no degree	____
Bachelor's degree	____
Post-graduate degree	____

11. Age group: under 18 ____
18-24 ____
25-34 ____
35-44 ____
45-54 ____
55 and over ____

12. Sex: ____Male ____Female

13. How many members are there in your household? ________persons.

14. Are you the primary income earner in your household? ___ yes ___no

15. Would you please indicate which of the following groups your annual household income falls in:

____less than $5,000	____$25,000-29,999	____$55,000-59,999
____$ 5,000- 7,499	____$30,000-34,999	____$60,000-64,999
____$ 7,500- 9,999	____$35,000-39,999	____$65,000-69,999
____$10,000-14,999	____$40,000-44,999	____$70,000-74,999
____$15,000-19,999	____$45,000-49,000	____$75,000 and up
____$20,000-24,999	____$50,000-54,999	

16. Please check the amount below which is closest to your average current monthly electricity bill.

$ .00___/month	$ 80.00___/month	$160.00___/month	$240.00___/month
10.00___/month	$ 90.00___/month	$170.00___/month	$250.00___.month
20.00___/month	$100.00___/month	$180.00___/month	$260.00___/month
30.00___/month	$110.00___/month	$190.00___/month	$270.00___/month
40.00___/month	$120.00___/month	$200.00___/month	$280.00___/month
50.00___/month	$130.00___/month	$210.00___/month	$290.00___/month
60.00___/month	$140.00___/month	$220.00___/month	$300.00___/month
70.00___/month	$150.00___/month	$230.00___/month	

Above $300.00___/month

17. Check if additional information was used. ___________

THANK YOU

TEAM____

BUDGET CONSTRAINT PLUS MAXIMUM WTP
URBAN SURVEY: Economic Narrative

We are students at the University of Wyoming and are conducting this survey for a research project designed to help in valuing visibility in Grand Canyon National Park in the southwestern United States.

The Clean Air Act, passed by Congress in 1970, declared a national goal of preserving the scenic beauty and pristine air quality of our national parks and wilderness areas.

Air quality, or the "cleanness" of the air, can be affected by either natural occurrences (e.g., dust and humidity) or by man-caused pollution (such as auto emissions or emissions released by industrial facilities). Consequently, visibility, which is the ability to see and appreciate distant objects, activities, scenes or atmospheric phenomena, can be affected by either natural or man-caused pollution sources resulting in changes in the color and clarity of near and far distant vistas.

As you can see in these photographs taken at the Grand Canyon, air pollution can discolor a view to the point where its components cannot be clearly identified and its scenic beauty cannot be fully enjoyed by the viewer [SHOW GRAND CANYON PHOTOGRAPHS: SITUATION A-E]

The photographs represent five levels of visibility during morning and afternoon periods looking both east and west from Hopi Point at the Grand Canyon. Column A represents poor visibility, B, below average; C, average visibility; D, above average; and E, good visibility. Comparing the columns, we can see the variety of air quality conditions and resulting levels of visibility that can be observed in the Grand Canyon. The rows represent the different vistas while standing at Hopi Point. The first row represents the different visibility and air quality conditions looking east, in the morning from Hopi Point. The second row represents morning conditions looking west from Hopi Point. The third row shows the view from Hopi Point in the afternoon looking west.

PAST AND FUTURE USE

In the first part of our survey, we would like to ask a few questions about your household's use of the National Parklands.

1. How many days have you spent visiting the Grand Canyon National Park in the last 10 years? Please put an X by the number of days on your answer sheet for question 1.

2. How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? Please put an X by the number of days on your answer sheet for question 2.

PRESERVATION VALUE ANALYSIS

This part of the survey is designed to determine your concern for preserving visibility levels in Grand Canyon National Park.

Although one does not usually find a dollar value placed on scenery, sunsets or visibility, such things are valuable. Since it does cost money to clean up man-made pollution to improve visibility in our national parks, we are interested in finding out how much good visibility is worth to you.

Unless new and current industrial facilities in the southwest are required to meet current emission standards for particulates and sulfur oxides, air quality in the Grand Canyon will become less than the current average.

3. Would you please indicate the closest estimate of average monthly income for your household after taxes $______________________.

The-basic monthly expenses for most households are listed in the following table. Would you please break down your monthly income in the following categories, trying to be as accurate as possible.

Again, let us look at the photographs representing visual air quality ranging from very poor in Column A to very good in Column E for east and west views in the morning and afternoon from Hopi Point. If current emission standards are maintained, for new and existing power plants, average conditions will be as seen in Column C. If, however, current emission standards for sulfur oxide are not enforced, then the average air quality and visibility in the region will become like Column B. As a result, conditions as represented in Columns C, D, and E will occur less frequently. Conditions in Columns A and B would occur more frequently in the Grand Canyon. <u>Such emission controls will likely make electricity more expensive.</u>

4. We would like to know if you are willing to pay higher electric utility bills if the extra money collected would be used for air pollution controls to <u>preserve</u> current air quality and visibility levels at the Grand Canyon. Note, we want to find out how much preserving visibility at the Grand Canyon is worth to your household. In other words, how much extra would you be willing to pay at most, considering the amount of your expenses in the above-mentioned table, per month, as an increase in your electric utility bill to preserve current average visibility as represented in Column C rather than have the average deteriorate to that shown in Column B? Please put an X next to the highest amount you would be willing to pay per month for your household on your answer sheet for question 4. [EMPHASIZE THEY ARE ANSWERING QUESTION 4].

[NOTE: IF INDIVIDUAL IS WILLING TO PAY, PLEASE ASK THE RESPONDENT TO REARRANGE HIS EXPENDITURES TO SHOW WHICH CATEGORY THE BID WILL COME FROM: IF BID COMES FROM "OTHER" CATEGORY, PLEASE ASK RESPONDENT TO BE MORE SPECIFIC].

5. Now suppose that all households are paying $______per month. This amount would be insufficient to allow for preservation of visibility level "C" at the Grand Canyon. Would you be willing to pay $_________ plus $1.00? [CONTINUE BIDDING PROCESS UNTIL MAXIMUM WTP]

BUDGET CONSTRAINT PLUS MAXIMUM WTP

ANSWER SHEET

1. _____zero days

_____1 day	_____5 days	_____9 days	_____13 days
_____2 days	_____6 days	_____10 days	_____14 days
_____3 days	_____7 days	_____11 days	_____15 days
_____4 days	_____8 days	_____12 days	_____More than 15 days

2.

_____1 day	_____5 days	_____9 days	_____13 days
_____2 days	_____6 days	_____10 days	_____14 days
_____3 days	_____7 days	_____11 days	_____15 days
_____4 days	_____8 days	_____12 days	_____More than 15 days

3. $____________________
Monthly income

MONTHLY
HOUSEHOLD EXPENSES

Housing	
Food	
Recreation/ Entertainment	
Transportation	
Savings	
Other	

4. $____________________
Initial Bid

5. $____________________
Maximum Bid

6. Answer only if you answered $.00 to question 3 above. Did you bid zero because you believe that:

_____The air quality improvements represented in the columns are not significant.

_____The source of the air pollution should be required to pay the costs of improving the air quality.

_____Other (specify)____

____

____

7. Home zip code ______________________

8. _____ Rural _____ Suburban _____Urban

9. Education: under 12 years _____
High School _____
College-no degree _____
Bachelor's degree _____
Post-graduate degree _____

10. Age group: under 18 _____
18-24 _____
25-34 _____
35-44 _____
45-54 _____
55 and over _____

11. Sex: _____Wale _____Female

12. How many members are there in your household? ________persons.

13. Are you the primary income earner in your household? ___yes ___no

14. Please check the amount below which is closest to your average current monthly electricity bill.

$ .00 ___/month	$ 80.00 ___/month	$160.00 ___/month	$240.00 ___/month
10.00 ___/month	$ 90.00 ___/month	$170.00 ___/month	$250.00 ___.month
20.00 ___/month	$100.00 ___/month	$180.00 ___/month	$260.00 ___/month
30.00 ___/month	$110.00 ___/month	$190.00 ___/month	$270.00 ___/month
40.00 ___/month	$120.00 ___/month	$200.00 ___/month	$280.00 ___/month
50.00 ___/month	$130.00 ___/month	$210.00 ___/month	$290.00 ___/month
60.00 ___/month	$140.00 ___/month	$220.00 ___/month	$300.00 ___/month
70.00 ___/month	$150.00 ___/month	$230.00 ___/month	

Above $300.00 ___/month

15. Check if additional information was used. ____________

THANK YOU

TEAM ____

SOPG PLUS MAX WTP PLUS OTHER NATIONAL PARKS
URBAN SURVEY: Economic Narrative

We are students at the University of Wyoming and are conducting this survey for a research project designed to help in valuing visibility in Grand Canyon National Park in the southwestern United States.

The Clean Air Act, passed by Congress in 1970, declared a national goal of preserving the scenic beauty and pristine air quality of our national parks and wilderness areas.

Air quality, or the "cleanness" of the air, can be affected by either natural occurrences (e.g., dust and humidity) or by man-caused pollution (such as auto emissions or emissions released by industrial facilities). Consequently, visibility, which is the ability to see and appreciate distant objects, activities, scenes or atmospheric phenomena, can be affected by either natural or man-caused pollution sources resulting in changes in the color and clarity of near and far distant vistas.

As you can see in these photographs taken at the Grand Canyon, air pollution can discolor a view to the point where its components cannot be clearly identified and its scenic beauty cannot be fully enjoyed by the viewer [SHOW GRAND CANYON PHOTOGRAPHS: SITUATION A-E]

The photographs represent five levels of air quality conditions from very poor (A) to very good (E). The rows represent morning conditions for the Grand Canyon, Mesa Verde and Zion National Parks. Row 1 looks out from Hopi Point towards the east in the morning at the Grand Canyon. Row 2 represents the vista from Mesa Verde at Far View overlook towards the south in the morning. Finally, Row 3 is at Lava Point in Zion National Park looking southeast in the morning.

PAST AND FUTURE USE

In the first part of our survey, we would like to ask a few questions about your household's use of the National Parklands.

1. How many days have you spent visiting the Grand Canyon National Park in the last 10 years? Please put an X by the number of days on your answer sheet for question 1.

2. How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? Please put an X by the number of days on your answer sheet for question 2.

3. How many days have you spent visiting National Parks in the southwest (Arizona, Utah, New Mexico, and Colorado) in the last 10 years? Please circle the number of days by each National Park on your answer sheet for question 3.

4. How many days for each National Park do you expect to visit in the next 10 years? Please circle the number of days by each National Park on your answer sheet for question 4.

PRESERVATION VALUE ANALYSIS

This part of the survey is designed to determine your concern for preserving visibility levels in Grand Canyon National Park.

Although one does not usually find a dollar value placed on scenery, sunsets or visibility, such things are valuable. Since it does cost money to clean up man-made pollution to improve visibility in our national parks, we are interested in finding out how much good visibility is worth to you.

Unless new and current industrial facilities in the southwest are required to meet current emission standards for particulates and sulfur oxides, air quality in the Grand Canyon will become less than the current average.

Again, let us look at the photographs representing visual air quality ranging from very poor in Column A to very good in Column E for east and west views in the morning and afternoon from Hopi Point. If current emission standards are maintained, for new and existing power plants, average conditions will be as seen in Column C. If, however, current emission standards for sulfur oxide are not enforced, then the average air quality and visibility in the region will become like Column B. As a result, conditions as represented in Columns C, D, and E will occur less frequently. Conditions in Columns A and B would occur more frequently in the Grand Canyon. Such emission controls will likely make electricity more expensive.

5. We would like to know if you are willing to pay higher electric utility bills if the extra money collected would be used for air pollution controls to preserve current air quality and visibility levels at the Grand Canyon. Note, we want to find out how much preserving visibility at the Grand Canyon is worth to your household. In other words, how much extra would you be willing to pay, at most, per month as an increase in your electric utility bill to preserve current average visibility as represented in Column C rather than have the average deteriorate to that shown in Column B? Please put an X next to the highest amount you would be willing to pay per month for your household on your answer sheet for question 3. [EMPHASIZE THEY ARE ANSWERING QUESTION 5].

6. Now suppose that with all households paying $__________ (Grand Canyon) and $__________(Regional) per month, this amount of money would be insufficient to allow for the preservation of visibility level C at the Grand Canyon. Would you be willing to pay $__________ plus $1.00 (Grand Canyon) and $__________ plus $1.00 (Regional)?

[CONTINUE BIDDING PROCESS TO MAXIMUM WILLINGNESS TO PAY].

[IF THE BID FOR QUESTION 6 IS ZERO THEN SKIP THE FOLLOWING TWO QUESTIONS

8. Preserving air quality is also of concern in other National Parks such as Yosemite, Yellowstone, the Petrified Forest, Mt. McKinley and others (NOTE: There are 77 other National Parks with 36 threatened by visibility deterioration). Suppose that someone just like me could ask you tomorrow how much you would be willing to pay to see air quality preserved in all these areas, would you still be willing to pay the $____________ (Grand Canyon) and $____________________(Regional) you indicated for the Grand Canyon and other Parklands?

9. If no please indicate maximum willingness to pay for both the Grand Canyon and the other Parklands.

SOPG + MWTP + OTHER NATIONAL PARKS

ANSWER SHEET

1.

____1 day	____5 days	____ 9 days	____13 days
____2 days	____6 days	____10 days	____14 days
____3 days	____7 days	____11 days	____15 days
____4 days	____8 days	____12 days	____More than, 15 days

2.

____1 day	____5 days	____ 9 days	____13 days
____2 days	____6 days	____10 days	____14 days
____3 days	____7 days	____11 days	____15 days
____4 days	____8 days	____12 days	____More than 15 days

3.

Zion Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15
Mesa Verde Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15
Bryce Canyon Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15
Canyonlands Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15

4.

Zion Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15
Mesa Verde Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15
Bryce Canyon Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15
Canyonlands Nat. Park	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 +15

5. $________________________ $________________________

Grand Canyon Regional

6. $________________________ $________________________

Grand Canyon (Max Bit) Regional (Max Bid)

7. Answer only if you answered $.00 to question 3 above. Did you bid zero because you believe that:

_____The air quality improvements represented in the columns are not significant.

_____The source of the air pollution should be required to pay the costs of improving the air quality.

_____Other (specify)____

____

____

8. ____ ____; if no please answer question 9.

yes no

9. $____________________ $____________________ (new bids)

Grand Canyon Regional

10. Home zip code ______________________

11. ____ Rural ____ Suburban ____Urban

12. Education:

under 12 years	____
High School	____
College-no degree	____
Bachelor's degree	____
Post-graduate degree	____

13. Age group:

under 18	____
18-24	____
25-34	____
35-44	____
45-54	____
55 and over	____

14. Sex: ____Male ____Female

15. How many members are there in your household? _______persons.

16. Are you the primary income earner in your household? ___yes ___no

17. Would you please indicate which of the following groups your annual household income falls in:

____less than $5,000	____$25,000-29,999	____$55,000-59,999
____$ 5,000- 7,499	____$30,000-34,999	____$60,000-64,999
____$ 7,500- 9,999	____$35,000-39,999	____$65,000-69,999
____$10,000-14,999	____$40,000-44,999	____$70,000-74,999
____$15,000-19,999	____$45,000-49,000	____$75,000 and up
____$20,000-24,999	____$50,000-54,999	

18. Please check the amount below which is closest to your average current monthly electricity bill.

$ .00___/month	$ 80.00___/month	S160.00___/month	$240.00___/month
10.00___/month	$ 90.00___/month	$170.00___/month	$250.00___.month
20.00___/month	$100.00___/month	$180.00___/month	$260.00___/month
30.00___/month	$110.00___/month	$190.00___/month	$270.00___/month
40.00___/month	$120.00___/month	$200.00___/month	$280.00___/month
50.00___/month	$130.00___/month	$210.00___/month	$290.00___/month
60.00___/month	$140.00___/month	$220.00___/month	$300.00___/month
70.00___/month	$150.00___/month	$230.00___/month	

Above $300.00___/month

19. Check if additional information was used. ____________

THANK YOU

TEAM____

BUDGET CONSTRAINT PLUS SOPC PLUS MAX WTP
PLUS OTHER NATIONAL PARKS
URBAN SURVEY: Economic Narrative

We are students at the University of Wyoming and are conducting this survey for a research project designed to help in valuing visibility in Grand Canyon National Park in the southwestern United States.

The Clean Air Act, passed by Congress in 1970, declared a national goal of preserving the scenic beauty and pristine air quality of our national parks and wilderness areas.

Air quality, or the "cleanness" of the air, can be affected by either natural occurrences (e.g., dust and humidity) or by man-caused pollution (such as auto emissions or emissions released by industrial facilities). Consequently, visibility, which is the ability to see and appreciate distant objects, activities, scenes or atmospheric phenomena, can be affected by either natural or man-caused pollution sources resulting in changes in the color and clarity of near and far distant vistas.

As you can see in these photographs taken at Zion, Mesa Verde, and, the Grand Canyon, air pollution can discolor a view to the point where its components cannot be clearly identified and its scenic beauty cannot be fully enjoyed by the viewer [SHOW GRAND CANYON PHOTOGRAPHS: SITUATION A-E]

The photographs represent five levels of air quality conditions from very poor (A) to very good (E). The rows represent morning conditions for the Grand Canyon, Mesa Verde and Zion National Parks. Row 1 looks out from Hopi Point towards the east in the morning at the Grand Canyon. Row 2 represents the vista from Mesa Verde at Far View overlook towards the south in the morning. Finally, Row 3 is at Lava Point in Zion National Park looking southeast in the morning.

PAST AND FUTURE USE

In the first part of our survey, we would like to ask a few questions about your household's use of the National Parklands.

1. How many days have you spent visiting the Grand Canyon National Park in the last 10 years? Please put an X by the number of days on your answer sheet for question 1.

2. How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? Please put an X by the number of days on your answer sheet for question 2.

3. How many days have you spent visiting National Parks in the southwest (Arizona, Utah, New Mexico, and Colorado) in the last 10 years? Please circle the number of days by each National Park on your answer sheet for question 3.

4. How many days for each National Park do you expect to visit in the next 10 years? Please circle the number of days by each National Park on your answer sheet for question 4.

PRESERVATION VALUE ANALYSIS

This part of the survey is designed to determine your concern for preserving visibility levels in Grand Canyon National Park.

Although one does not usually find a dollar value placed on scenery, sunsets or visibility, such things are valuable. Since it does cost money to clean up man-made pollution to improve visibility in our national parks, we are interested in finding out how much good visibility is worth to you.

Unless new and current industrial facilities in the southwest are required to meet current emission standards for particulates and sulfur oxides, air quality in the Grand Canyon will become less than the current average.

5. Would you please indicate the closest estimate of average monthly income for your household after taxes $____________________.

The basic monthly expenses for most households are listed in the following table. Would you please break down your monthly income into the following categories, trying to be as accurate as possible.

Again, let us look at the photographs representing visual air quality ranging from very poor in Column A to very good in Column E for Grand Canyon, Mesa Verde and Zion national Parks.

If current emission standards are maintained, for new and existing power plants, average conditions will be as seen in Column C. If, however, current emission standards for sulfur oxide are not enforced,

Monthly
HOUSEHOLD EXPENSES

HOUSING/UTILITIES	
FOOD	
RECREATION/ ENTERTAINMENT	
TRANSPORTATION	
SAVINGS	
OTHER	
TOTAL INCOME: After Taxes	

then the average air quality and visibility in the region will be

represented as in Column B. As a result, conditions as represented in Colums C, D, and E will occur less frequently, and conditions in Columns A and B will occur more frequently. We would like to know how much the maintenance of average regional visibility is worth to you.

6. We would like to know if you are willing to pay higher electric utility bills if the extra money collected would be used for air pollution controls to preserve current air quality and visibility levels at the Grand Canyon and other Parklands. Note, we want to find out how much preserving visibility at the Grand Canyon and other Parklands is worth to your household. In other words, how much extra would you be willing to pay, at most, considering the amount of your expenses in the above-mentioned table, per month as an increase in your electric utility bill to preserve current average visibility as represented in Column C rather than have the average deteriorate to that shown in Column B? Please put an X next to the highest amount you would be willing to pay per month for your household on your answer sheet for question 6. [EMPHASIZE THEY ARE ANSWERING QUESTION 6].

7. Now suppose that with all households paying $______________ (Grand Canyon) and $_______________(Regional) per month, this amount of money would be insufficient to allow for the preservation of visibility level C at the Grand Canyon. Would you be willing to pay $_______________ plus $1.00 (Grand Canyon) and $__________________ plus $1.00 (Regional)?

[CONTINUE BIDDING PROCESS TO MAXIMUM WILLINGNESS TO PAY].

[IF THE BID FOR QUESTION 7 IS ZERO THEN SKIP THE FOLLOWING TWO QUESTIONS]

9. Preserving air quality is also of concern in other National Parks such as Yosemite, Yellowstone, the Petrified Forest, Mt. McKinley and others (NOTE: There are 77 other National Parks with 36 threatened by visibility deterioration). Suppose that someone just like me could ask you tomorrow how much you would be willing to pay to see air quality preserved in all these areas, would you still be willing to pay the $___________ (Grand Canyon) and $___________________(Regional) you indicated for the Grand Canyon and other Parklands?

10. If no please indicate maximum willingness to pay for both the Grand Canyon and the other Parklands.

BUDGET CONSTRAINT + SOPG + MAXIMUM WTP + ONP

ANSWER SHEET

1.

____1 day	____5 days	____9 days	____13 days
____2 days	____6 days	____10 days	____14 days
____3 days	____7 days	____11 days	____15 days
____4 days	____8 days	____12 days	____More than 15 days

2.

____1 day	____5 days	____9 days	____13 days
____2 days	____6 days	____10 days	____14 days
____3 days	____7 days	____11 days	____15 days
____4 days	____8 days	____12 days	____More than 15 days

3.

Zion Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15
Mesa Verde Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15
Bryce Canyon Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15
Canyonlands Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15

4.

Zion Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15
Mesa Verde Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15
Bryce Canyon Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15
Canyonlands Nat. Park	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	+15

5. $____________________

Monthly Income

MONTHLY
HOUSEHOLD EXPENSES

HOUSING/UTILITIES	
FOOD	
RECREATION/ ENTERTAINMENT	
TRANSPORTATION	
SAVINGS	
OTHER	
TOTAL INCOME After Taxes	

6\. $____________________ Grand Canyon $____________________ Regional

7\. $____________________ Grand Canyon (Max Bid) $____________________ Regional (Max Bid)

8\. Answer only if you answered $.00 to question 3 above. Did you bid zero because you believe that:

_____ The air quality improvements represented in the columns are not significant.

_____ The source of the air pollution should be required to pay the costs of improving the air quality.

_____ Other (specify) ____

____

____

9\. _____ yes   _____ no; if no please answer question 9.

10\. $____________________ Grand Canyon $____________________ Regional   (new bids)

11\. Home zip code ____________________

12\. _____ Rural   _____ Suburban   _____ Urban

13\. Education:
- under 12 years _____
- High School _____
- College-no degree _____
- Bachelor's degree _____
- Post-graduate degree _____

14\. Age group:
- under 18 _____
- 18-24 _____
- 25-34 _____
- 35-44 _____
- 45-54 _____
- 55 and over _____

15\. Sex: _____ Male   _____ Female

16\. How many members are there in your household? ________ persons.

17\. Are you the primary income earner in your household? ___ yes ___ no

18. Please check the amount below which is closest to your average current monthly electricity bill.

$ .00___/month	$ 80.00___/month	$160.00 ___/month	$240.00 ___/month
10.00___/month	$ 90.00___/month	$170.00___/month	$250.00 ___.month
20.00___/month	$100.00___/month	$180.00___/month	$260.00___/month
30.00___/month	$110.00___/month	$190.00 ___/month	$270.00___/month
40.00___/month	$120.00 ___/month	$200.00 ___/month	$280.00 ___/month
50.00___/month	$130.00___/month	$210.00___/month	$290.00 ___/month
60.00___/month	$140.00 ___/month	$220.00___/month	$300.00 ___/month
70.00___/month	$150.00___/month	$230.00 ___/month	

Above $300.00 /month

19. Check if additional information was used. ___________

THANK YOU

TEAM______________________________

COMPONENT VALUES STUDY
URBAN SURVEY: Economic Narrative

We are students at the University of Wyoming and are conducting this survey for a research project designed to help in valuing visibility in Grand Canyon National Park in the southwestern United States.

The Clean Air Act, passed by Congress in 1970, declared a national goal of preserving the scenic beauty and pristine air quality of our national parks and wilderness areas.

Air quality, or the "cleanness" of the air, can be affected by either natural occurrences (e.g., dust and humidity) or by man-caused pollution (such as auto emissions or emissions released by industrial facilities). Consequently, visibility, which is the ability to see and appreciate distant objects, activities, scenes or atmospheric phenomena, can be affected by either natural or man-caused pollution sources resulting in changes in the color and clarity of near and far distant vistas.

As you can see in these photographs taken at the Grand Canyon, air pollution can discolor a view to the point where its components cannot be clearly identified and its scenic beauty cannot be fully enjoyed by the viewer [SHOW GRAND CANYON PHOTOGRAPHS: SITUATION A-E]

The photographs represent five levels of visibility during morning and afternoon periods looking both east and west from Hopi Point at the Grand Canyon. Column A represents poor visibility, B, below average; C, average visibility; D, above average; and E, good visibility. Comparing the columns, we can see the variety of air quality conditions and resulting levels of visibility that can be observed in the Grand Canyon. The rows represent the different vistas while standing at Hopi Point. The first row represents the different visibility and air quality conditions looking east, in the morning from Hopi Point. The second row represents morning conditions looking west from Hopi Point. The third row shows the view from Hopi Point in the afternoon looking west.

PAST AND FUTURE USE

In the first part of our survey, we would like to ask a few questions about your household's use of the National Parklands.

1. How many days have you spent visiting the Grand Canyon National Park in the last 10 years? Please put an X by the number of days on your answer sheet for question 1.

2. How many days do you expect to spend visiting the Grand Canyon National Park in the next 10 years? Please put an X by the number of days on your answer sheet for question 2.

PRESERVATION VALUE ANALYSIS
-Grand Canyon-

This part of the survey is designed to determine your concern for preserving visibility levels in Grand Canyon National Park.

Although one does not usually find a dollar value placed on scenery, sunsets or visibility, such things are valuable. Since it does cost money to clean up man-made pollution to improve visibility in our national parks, we are interested in finding out how much good visibility is worth to you.

Unless new and current industrial facilities in the southwest are required to meet current emission standards for particulates and sulfur oxides, air quality in the Grand Canyon will become less than the current average.

Again, let us look at the photographs representing visual air quality ranging from very poor in Column A to very good in Column E for east and west views in the morning and afternoon from Hopi Point. If current emission standards are maintained, for new and existing power plants, average conditions will be as seen in Column C. If, however, current emission standards for sulfur oxide are not enforced, then the average air quality and visibility in the region will become like Column B. As a result, conditions as represented in Columns C, D, and E will occur less frequently. Conditions in Columns A and B would occur more frequently in the Grand Canyon. As new power plants are built, such emission-controls to preserve condition "C" will make electricity more expensive.

3. We would like to know if you are willing to pay higher electric utility bills if the extra money collected would be used for air pollution controls to preserve current air quality and visibility levels at the Grand Canyon. Note, we want to find out how much preserving visibility at the Grand Canyon is worth to your household. In other words, how much extra would you be willing to pay, at most, per month as an increase in your electric utility bill to preserve current average visibility as represented in Column C rather than have the average deteriorate to that shown in Column B? Please put an X next to the highest amount you would be willing to pay per month for your household on your answer sheet for question 3. [EMPHASIZE THEY ARE ANSWERING QUESTION 3].

[IF ZERO BID, SKIP TO QUESTION 6, AND THEN TO THE SOCIOECONOMICS QUESTIONS]

COMPONENT VALUES ANALYSIS

You have indicated that you would be willing to pay $____________/month to preserve the "C" level of air quality at the Grand Canyon. This section of the survey is designed to "break down" this dollar amount (or preservation value) into the several reasons why you might be willing to preserve "C" level air quality.

[IF INDIVIDUAL HAS INDICATED NON-USE, PROCEED TO PART II]

4. User Analysis.

a. The first reason you might be willing to pay for preservation is Actual User Value. That is, when you actually visit the Grand Canyon, you would rather have air quality at "C" rather than at "B". Category a, then, deals with actual use and is called Actual Use Value.

b. The second reason is Option of Use Value. Although you might be uncertain as to whether or not you will ever visit the Grand Canyon, you might be willing to pay to preserve your "Option of Use" to visit the Grand Canyon under conditions represented by "C" rather than those represented by "B". Option of Use Value can also be explained using automobfle insurance as an example. That is, an individual obtains automobile insurance because he believes there is a possibility that he might have an accident sometime in the future. So he is willing to pay his insurance premiums to maintain his "option of using" his insurance should he need it. Note that, on average you pay more in insurance premiums than you ever can expect to get back in damage collections.

In a similar manner, you may be uncertain about ever visiting the Grand Canyon, but you may be willing to pay to maintain the "option of using" the Grand Canyon under conditions represented by "C" rather than "B". Thus you may be willing to pay an extra amount above user value to insure good visibility at the Grand Canyon if you do decide to visit. Category b, then is called Option of Use Value.

c. The third reason is called Existence Value. Whether or not you ever visit the Grand Canyon, you are willing to pay soleiy to ensure the existence of air quality conditions at the Grand Canyon for the benefit of your generation as represented by "C" rather than those represented by "B". Therefore, just the knowledge that air quality conditions are being maintained has value. Thus, category c is called Existence Value.

d. The last part is closely related to existence value as defined above. However, in this case, you are willing to pay to preserve air quality conditions at the Grand Canyon for the benefit of future generations. Thus, part four represents a willingness to endow future generations with a preserved Grand Canyon and is called Bequest Value.

5. Non-User Analysis

a. The first reason you might be willing to pay for preservation is Option of Use Value. Although you might be uncertain as to whether or not you will ever visit the Grand Canyon, you might be willing to pay to preserve your "Option of Use" to visit the Grand Canyon under conditions represented by "C" rather than those represented by "B". Option of Use Value can also be explained using automobile insurance as an example. That is, an individual obtains automobile insurance because he believes there is a possibility that he might have an accident sometime in the future. So he is willing to pay his insurance premiums to maintain his "option of using" his insurance should he need it. Note that, on average, you pay more in insurance premiums than you ever can expect to get back in damage collection.

In similar manner, you may be uncertain about ever visiting the Grand Canyon under conditions represented by "C" rather than "B". Category b, then is called Option of Use Value.

The next two parts are independent or separate from one's actual use of option to use. Rather, these categories deal with the simple existence of particular air quality conditions at the Grand Canyon.

b. Whether or not an individual visits the Grand Canyon, the individual may be willing to pay to ensure the existence of air quality conditions at the Grand Canyon for the benefit of his generation as represented by "C" rather than "B". Therefore, just the knowledge that air quality conditions are being maintained has value and this value is called Existence Value.

c. The last part is closely related to existence value as defined above. However, in this case, you are willing to pay to preserve air quality conditions at the Grand Canyon for the benefit of future generations. Thus, part four represents a willingness to endow future generations with a preserved Grand Canyon and is called Bequest Value.

SUPPLEMENT FOR OPTION OF USE VALUE

Assume you pay an insurance premium of $400.00 per year. Over your lifetime you may only get back $300/year in car repairs, etc. Therefore, you have paid $100 more than "necessary".

Of the total $400 you paid;

1. $300 is a user charge, that is, $300 of the premium was actually used for the accidents.

2. The remaining $100 is therefore the option premium paid in case of an unexpected drastic accident which may cost hundreds of thousands of dollars or even death.

In a similar manner, there may be some chance of an unplanned visit to the Grand Canyon, that is, an unexpected vacation, a sudden request made-by friends or relatives, etc. Since this uncertainty does exist, you may be willing to pay to keep open the "option of using" the Grand Canyon under air quality condition "C" as opposed to air quality condition "B".

COMPONENT VALUE STUDY

ANSWER SHEET

1. ____Zero Days

____1 day	____5 days	____ 9 days	____13 days
____2 days	____6 days	____10 days	____14 days
____3 days	____7 days	____11 days	____15 days
____4 days	____8 days	____12 days	____More than 15 days

2.

____1 day	____5 days	____ 9 days	____13 days
____2 days	____6 days	____10 days	____14 days
____3 days	____7 days	____11 days	____15 days
____4 days	____8 days	____12 days	____More than 15 days

3.

$ .00____/month	$ 5.00____/month	$30.00____/month	$ 60.00____/month
.50____/month	$10.00____/month	$35.00____/month	s 70.00____/month
1.00____/month	$15.00____/month	$40.00____/month	$ 80.00____/month
2.00____/month	$20.00____/month	$45.00____/month	$ 90.00____/month
3.00____/month	$25.00____/month	$50.00____/month	$100.00____/month
4.00____/month			More than $100.00____/month

4. User Value $____________
Option Value $____________
Existence Valve $____________
Bequest Value $____________

5. Option Value $____________
Existence Value $____________
Bequest Value $____________

6. Answer only if you answered $.00 any part of the above question.
Did you bid zero because you believe that:

_____The air quality improvements represented in the columns are not significant.

_____The source of the air pollution should be required to pay the costs of improving the air quality.

_____Other (specify)____

____

7. Home zip code ____________________

8. ____ Rural ____ Suburban ____Urban

9. Education: under 12 years ____
High School ____
College-no degree ____
Bachelor's degree ____
Post-graduate degree ____

10. Age group: under 18 ____
18-24 ____
25-34 ____
35-44 ____
45-54 ____
55 and over ____

11. Sex: ____Male ____Female

12. How many members are there in your household? ________persons.

13. Are you the primary income earner in your household? ___yes ___no

14. Would you please indicate which of the following groups your annual household income falls in:

____less than $5,000	____$25,000-29,999	____$55,000-59,999
____$ 5,000- 7,449	____$30,000-34,999	____$60,000-64,999
____$ 7,500- 9,999	____$35,000-39,999	____$65,000-69,999
____$10,000-14,999	____$40,000-44,999	____$70,000-74,999
____$15,000-19,999	____$45,000-49,000	____$75,000 and up
____$20,000-24,999	____$50,000-54,999	

15. Please check the amount below which is closest to your average current monthly electricity bill.

$ .00___/month	$ 80.00___/month	$160.00___/month	$240.00___/month
10.00___/month	$ 90.00___/month	$170.00___/month	$250.00___.month
20.00___/month	$100.00___/month	$180.00___/month	$260.00___/month
30.00___/month	$110.00___/month	$190.00___/month	$270.00___/month
40.00___/month	$120.00___/month	$200.00___/month	$280.00___/month
50.00___/month	$130.00___/month	$210.00___/month	$290.00___/month
60.00___/month	$140.00___/month	$220.00___/month	$300.00___/month
70.00___/month	$150.00___/month	$230.00___/month	
Above $300.00	/month		

16. Check If additional information was used. ___________

THANK YOU

TEAM____

APPENDIX E

RTI SURVEY AREAS FOR THE HOUSTON EXPERIMENT

RTI STUDY AREAS

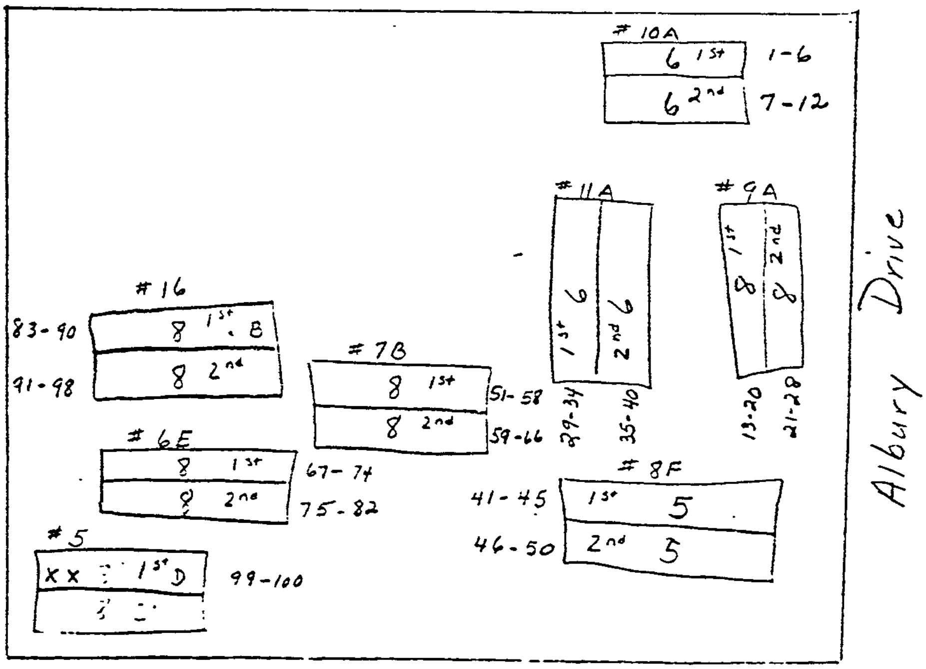
In the balance of this Appendix, study areas (denoted segment ID) for the Houston study are given as they were established by the Research Triangle Institute. Samples drawn from each segment are described in the text, Table 3.1. Methodology for defining segments (study areas) is described in "Field Interviewers Manual, A Prototype Study for Estimating Recreational and Related Benefits of Water Quality." RTI Project 2222-2, Research Triangle Park, NC, November 1981.

Indicate North

SEGMENT SKETCH

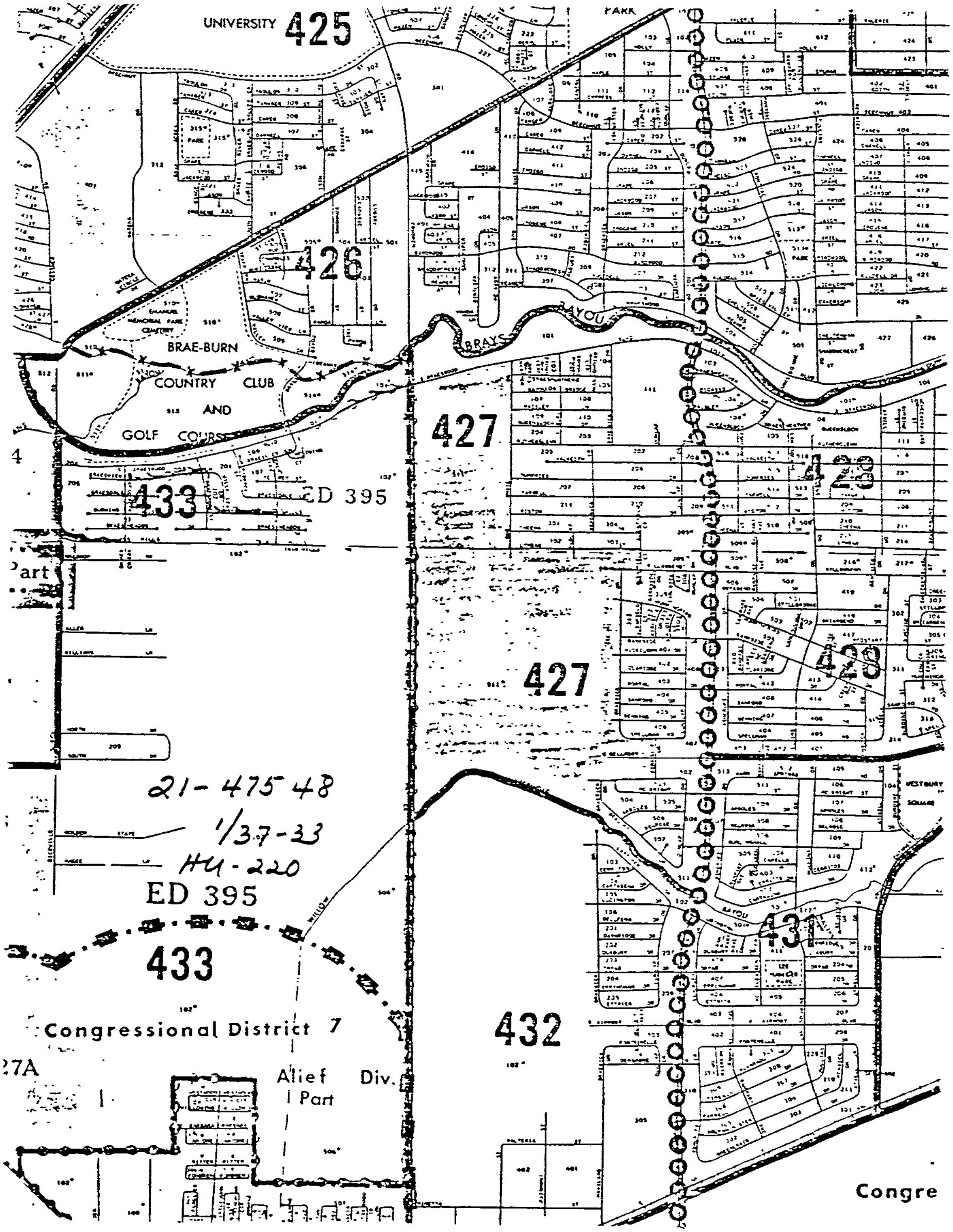
SEGMENT ID 21-47548 RATE 1/1 START # 1 EST. HU's 100

INTERVIEWER ______ PLACE HOUSTON



BELLFORT SOUTHCREST
PHASE I

200 Apts.


UNIVERSITY 425
PARK
426
BRAE-BURN
COUNTRY CLUB
AND
GOLF COURSE
BRAYS
BAYOU
427
433
ED 395
428
427
21-47548
1/37-33
HU-220
ED 395
433
Congressional District 7
Alief Div.
Part
432
431
WESTBURY SQUARE
Congre

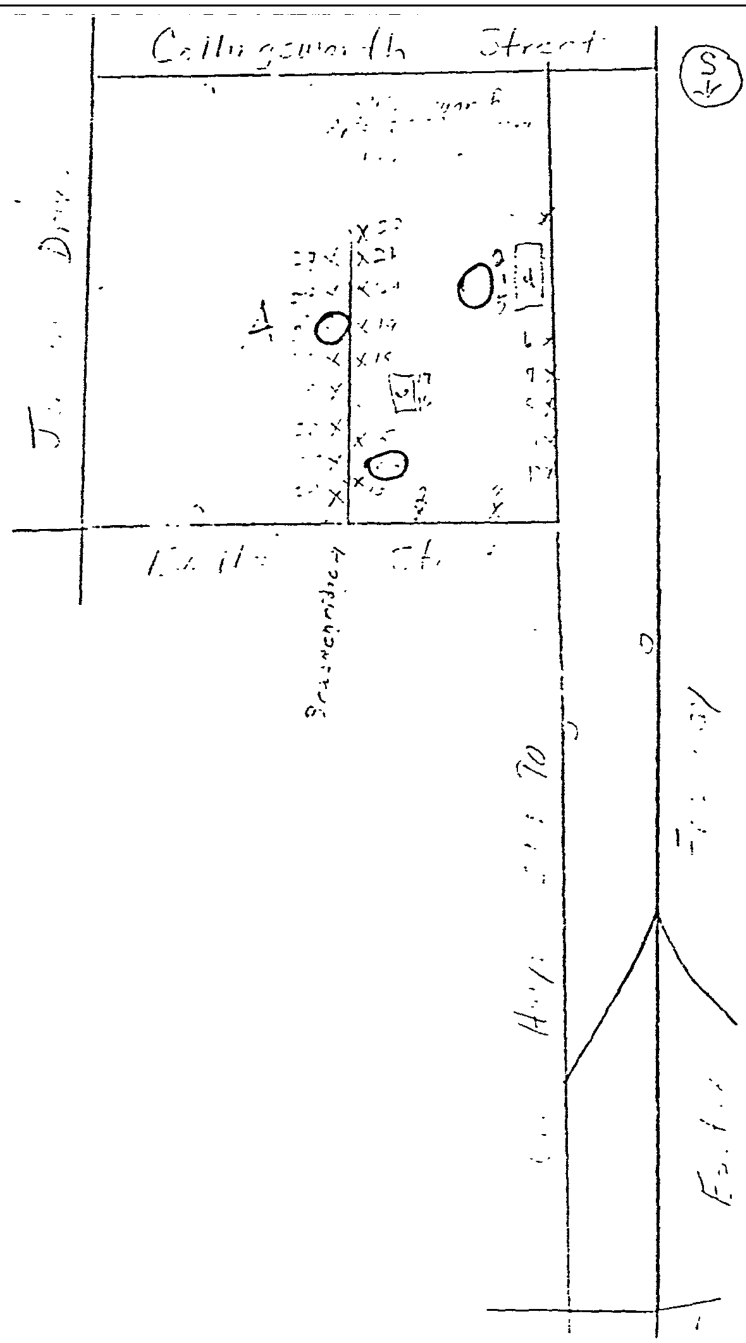
Indicate North ↑

SEGMENT SKETCH

SEGMENT ID 21-04064 RATE 1/22 START # 3 EST. HU's 147

INTERVIEWER ____________ PLACE Houston Tx

Harris Co



LIST UNIT SKETCH

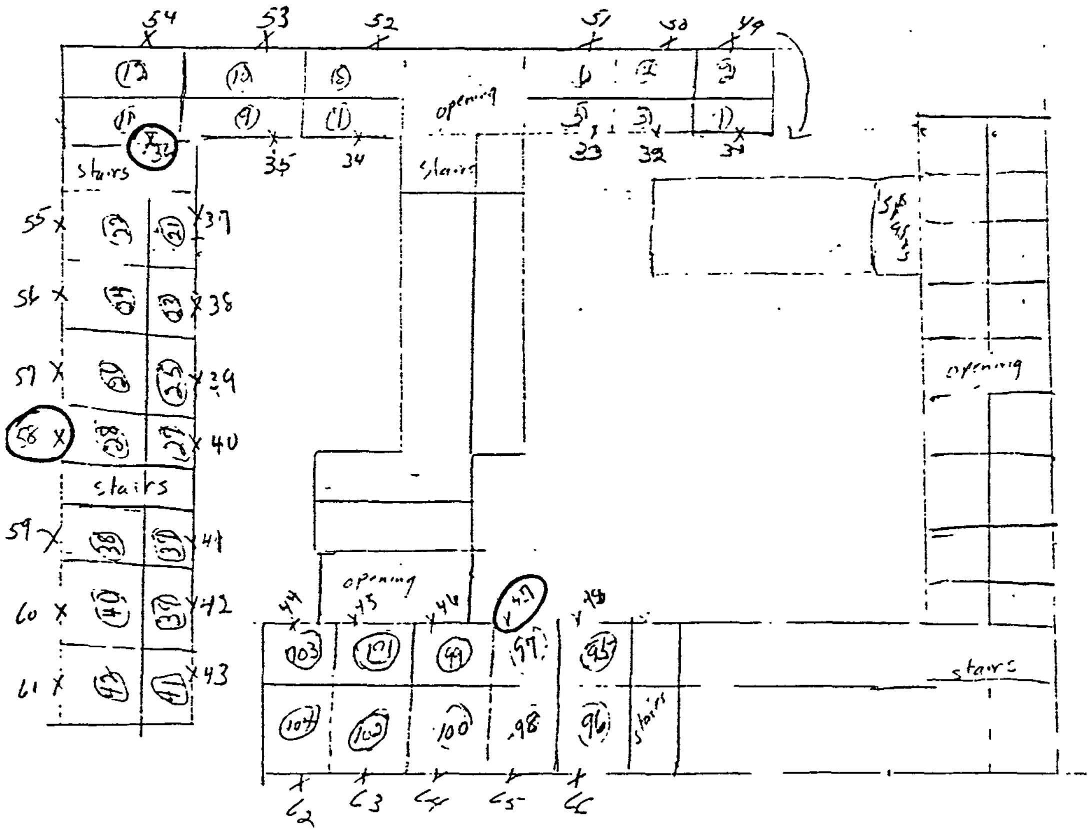
SEGMENT ID 21-04064 PLACE Houston TX Harris Co.

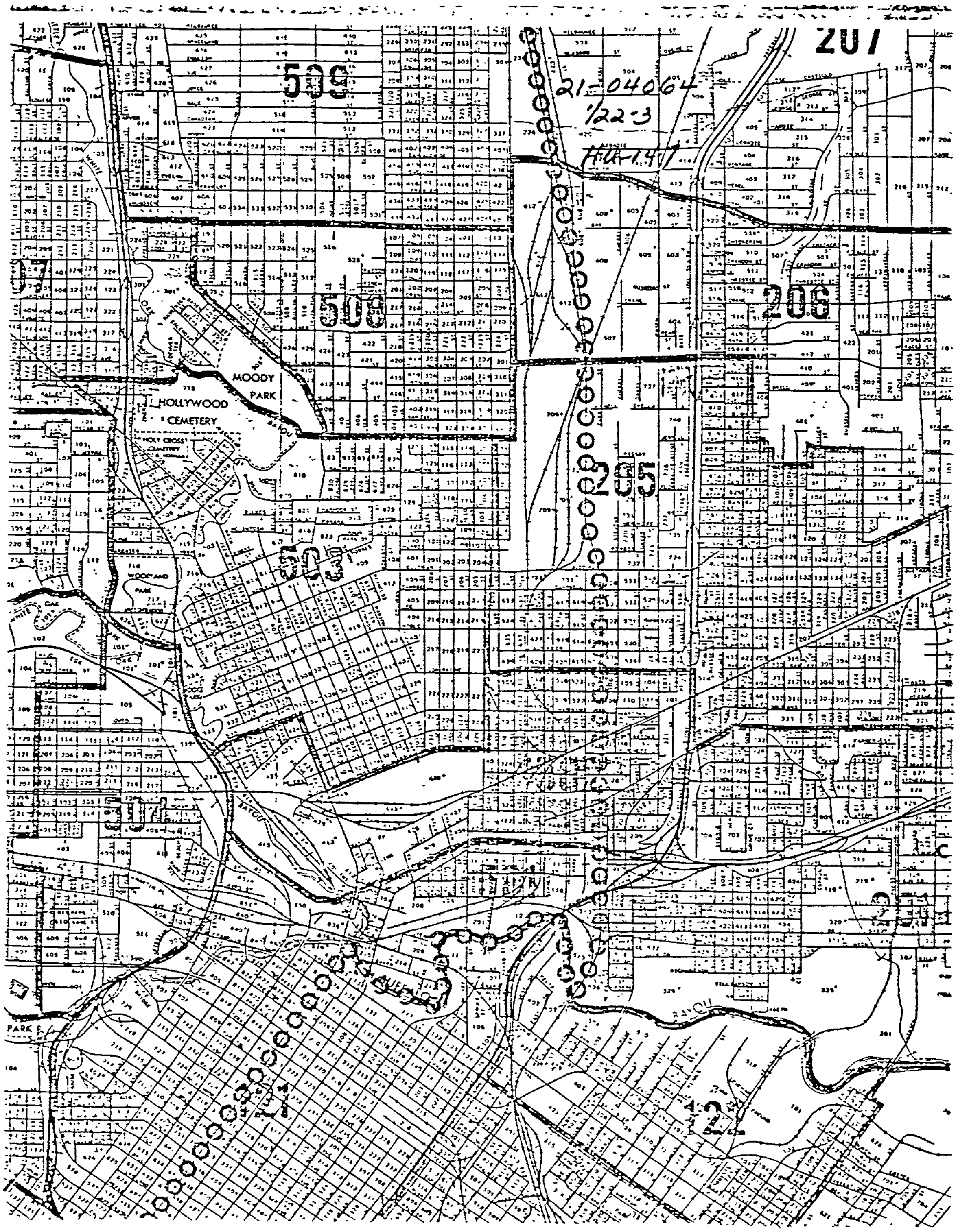
PREPARED BY Chris Butler DATE 05/25/8?

REVIEWED BY ______ DATE ______

Indicate North
↑ North

The Collingsworth Apts 2828 Collingsworth
Hand drawn - not to scale





509
506
206
207
205
503
MOODY PARK
HOLLYWOOD CEMETERY
HOLY CROSS CEMETERY
WOODLAND PARK
BAYOU
21-04064
1/22-3

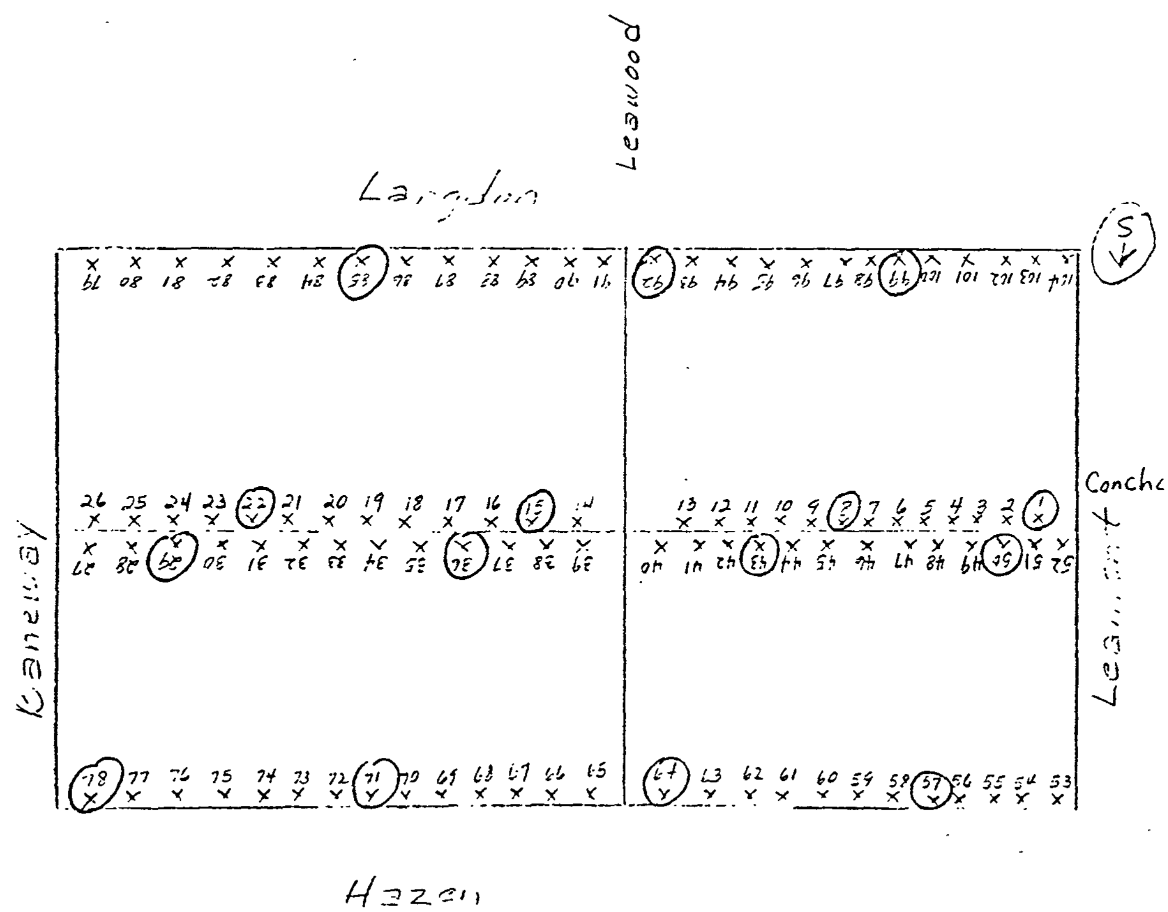
LU

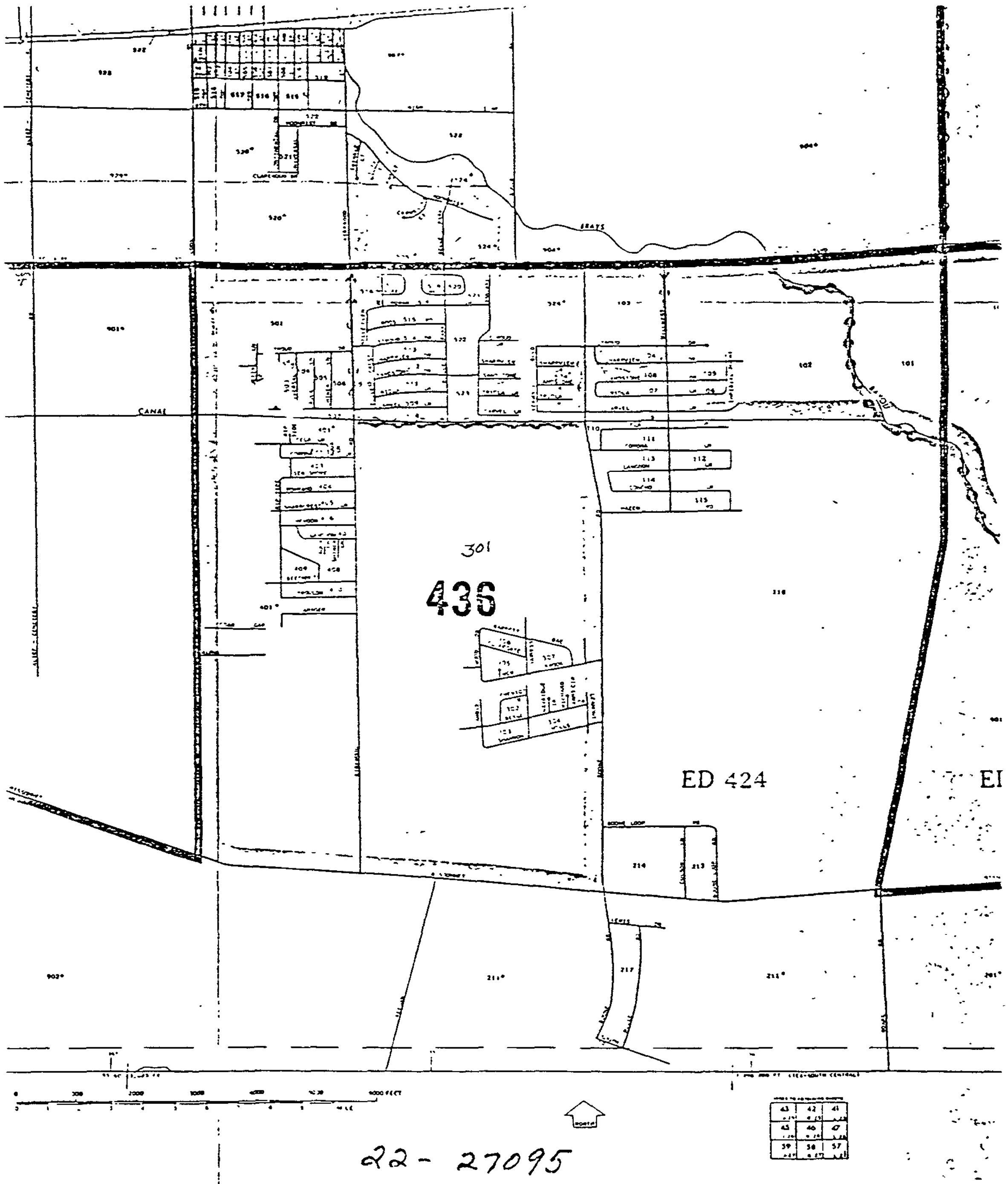
SEGMENT SKETCH

Indicate North ↑

SEGMENT ID 22-27095 RATE 1/7 START # 1 EST. HU's 104

INTERVIEWER ____________ PLACE Harris County





22- 27095
1/116- 9
#11-755

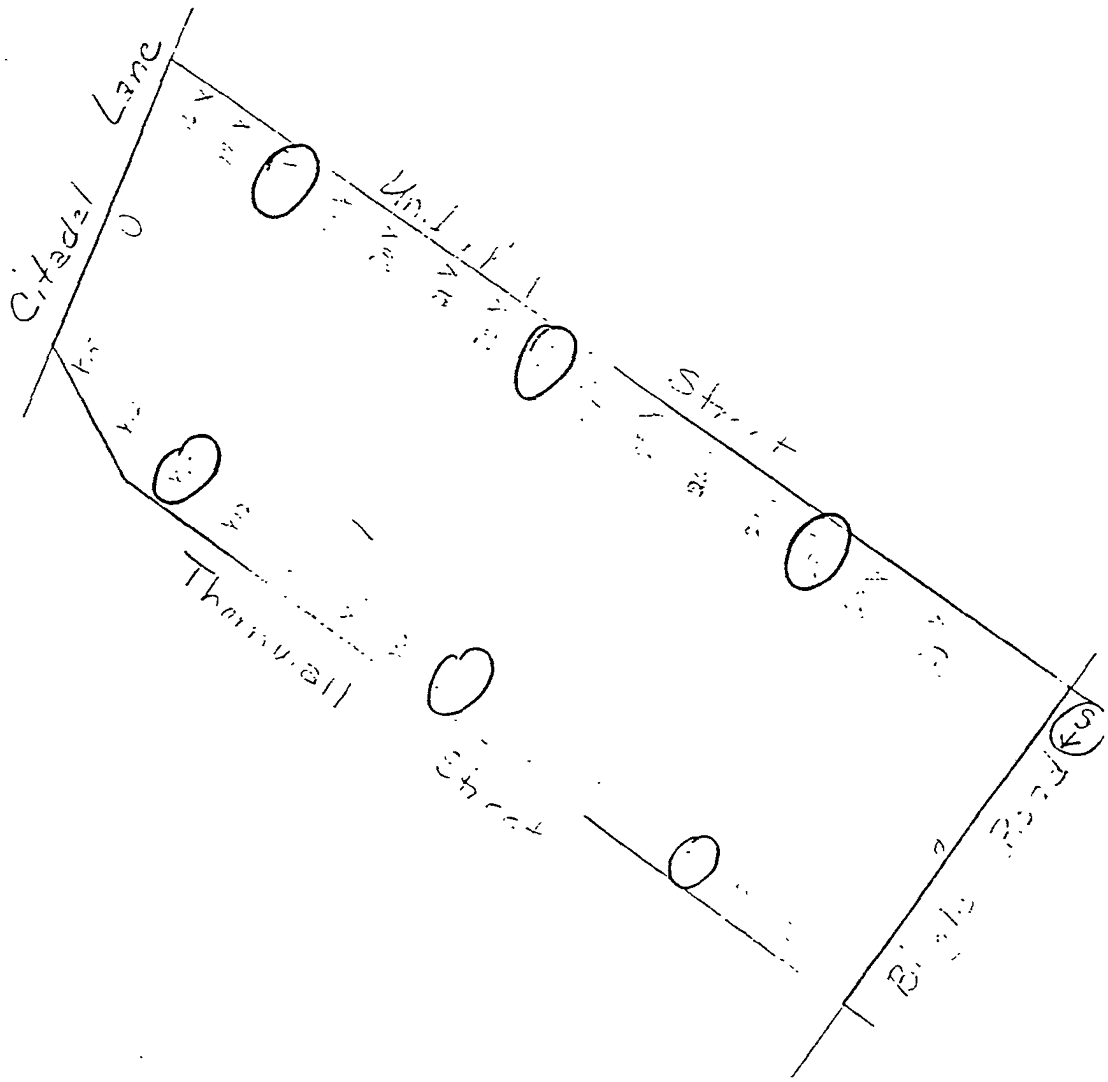
Indicate North ↑

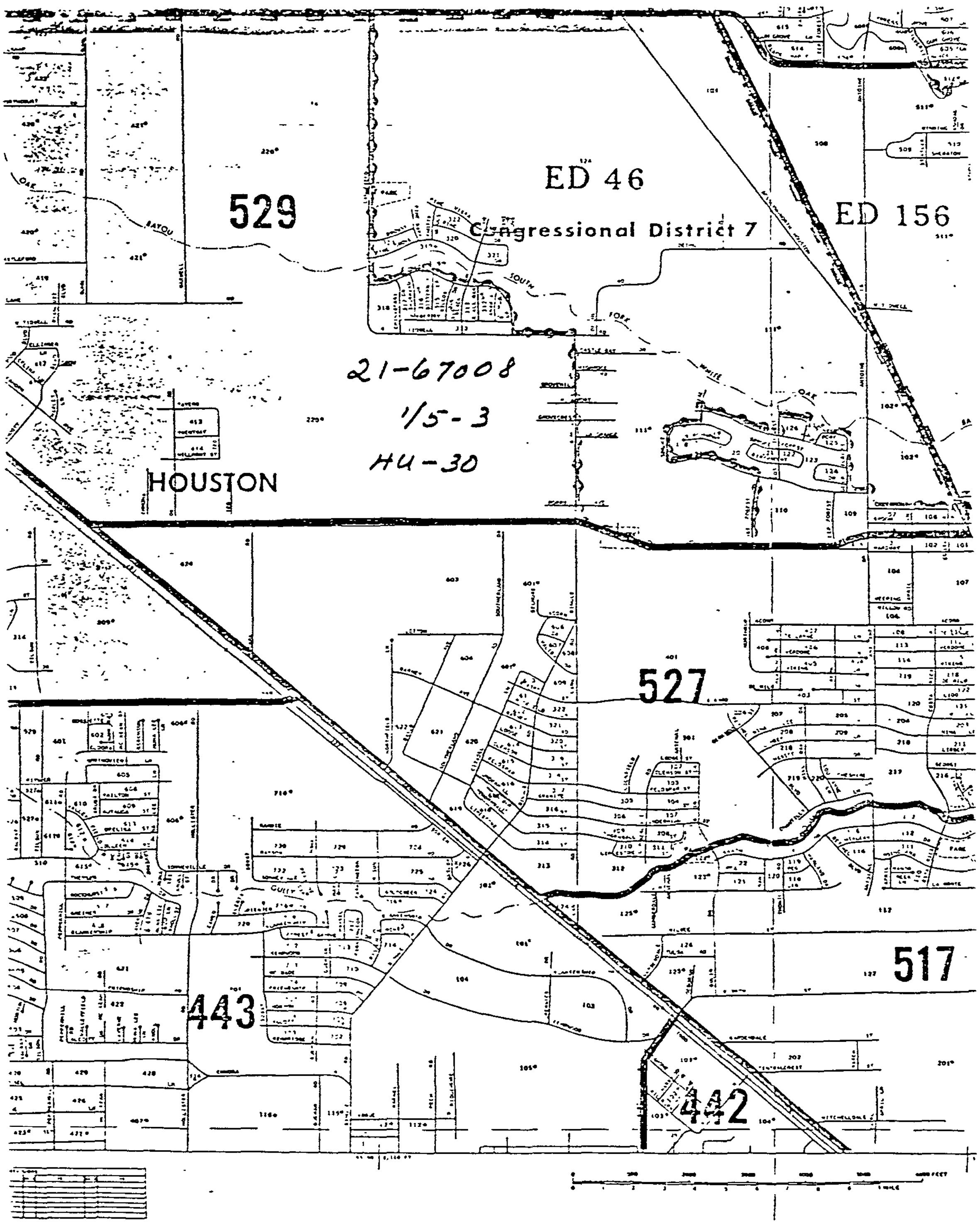
SEGMENT SKETCH

SEGMENT ID 21-67008 RATE 1/5 START # 3 EST. HU's 30

INTERVIEWER ________ PLACE Houston Tx

Harris Co



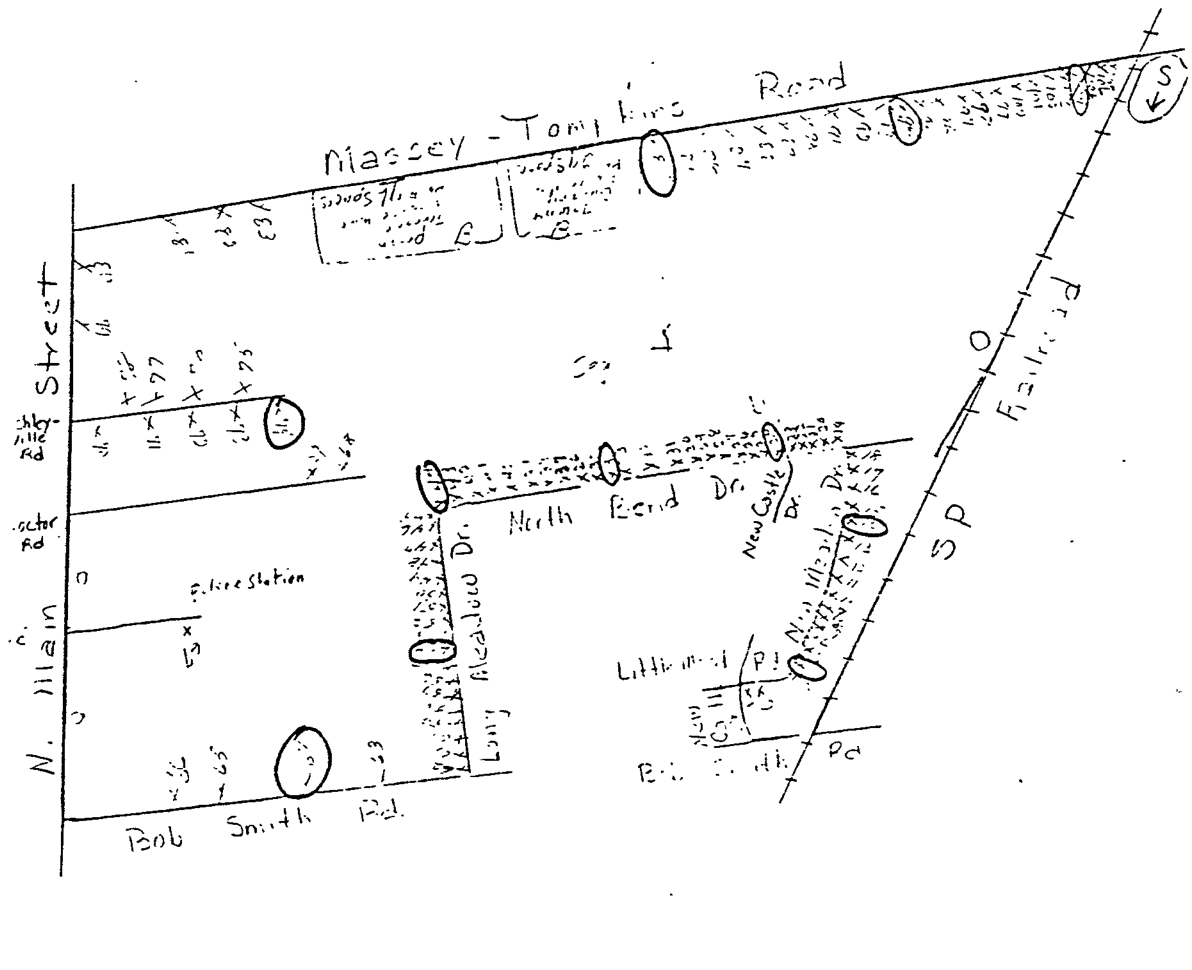

ED 46
ED 156
Congressional District 7
529
21-67008
1/5-3
HU-30
HOUSTON
527
517
443
442

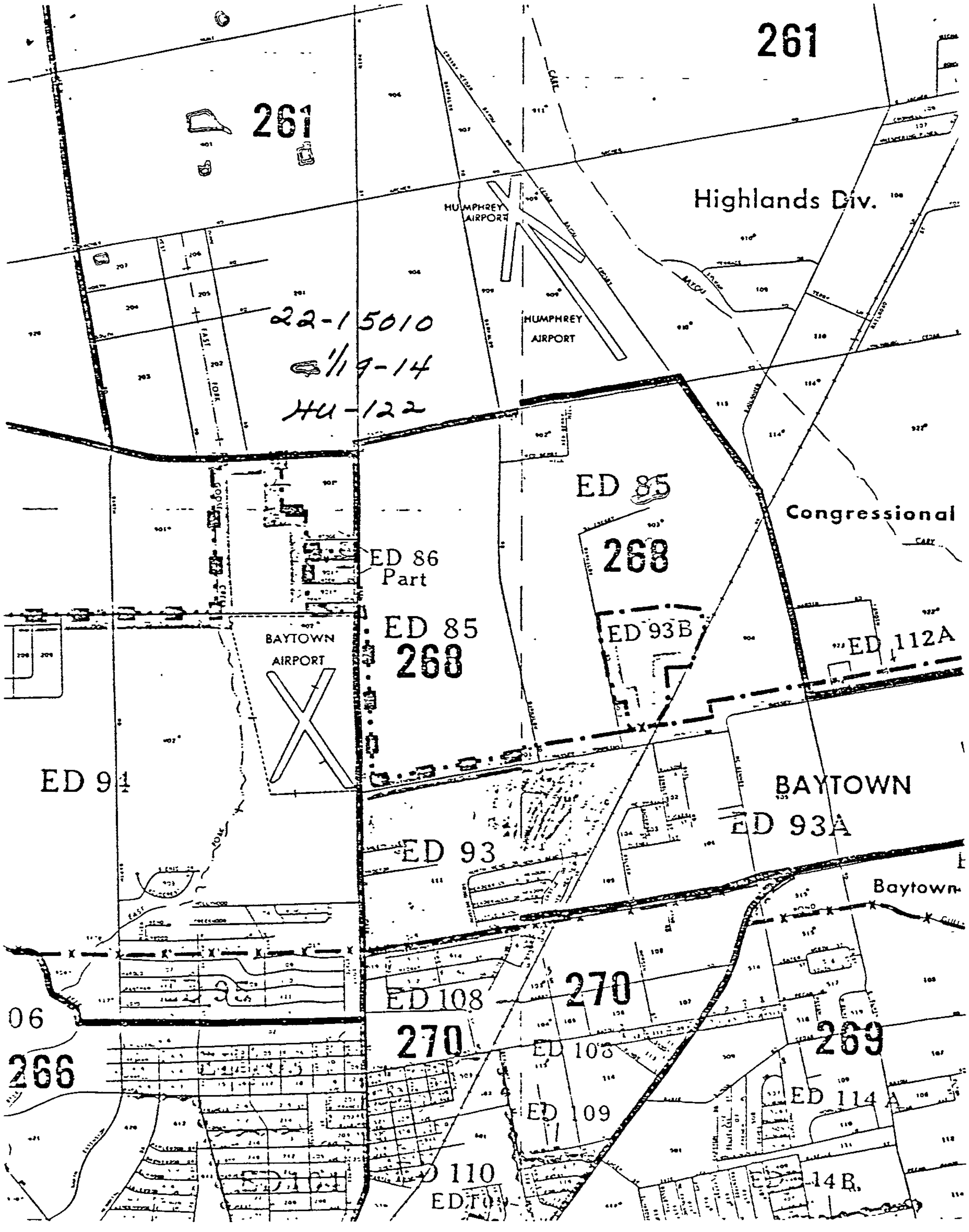
Indicate North

SEGMENT SKETCH

SEGMENT ID 22-15010 RATE 1/19 START # 14 EST. HU's 122

INTERVIEWER PLACE Baytown Tx Harris Co.



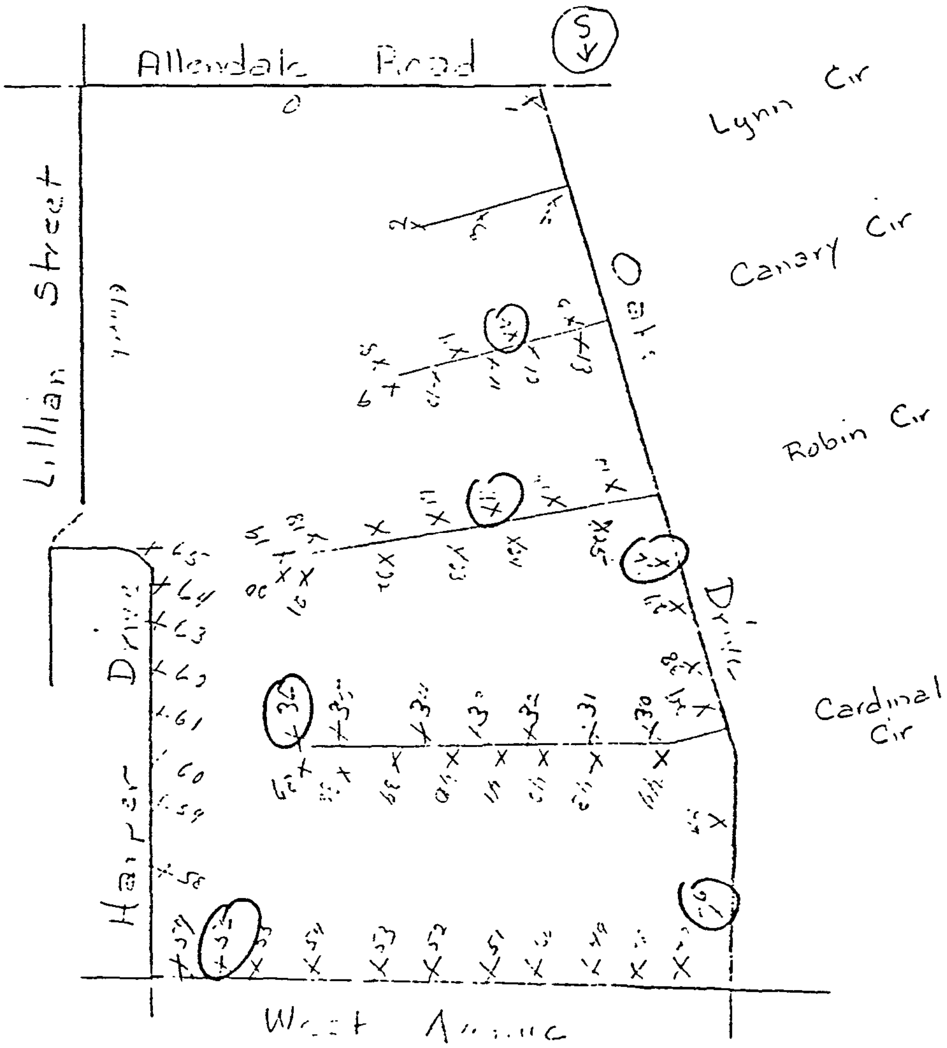

261
261
Highlands Div.
HUMPHREY AIRPORT
HUMPHREY AIRPORT
22-15010
1/19-14
HU-122
ED 85
268
Congressional
ED 86 Part
BAYTOWN AIRPORT
ED 85
268
ED 93B
ED 112A
ED 91
BAYTOWN
ED 93A
ED 93
Baytown
270
ED 108
06
270
ED 108
269
266
ED 114 A
ED 109
ED 110
14 B

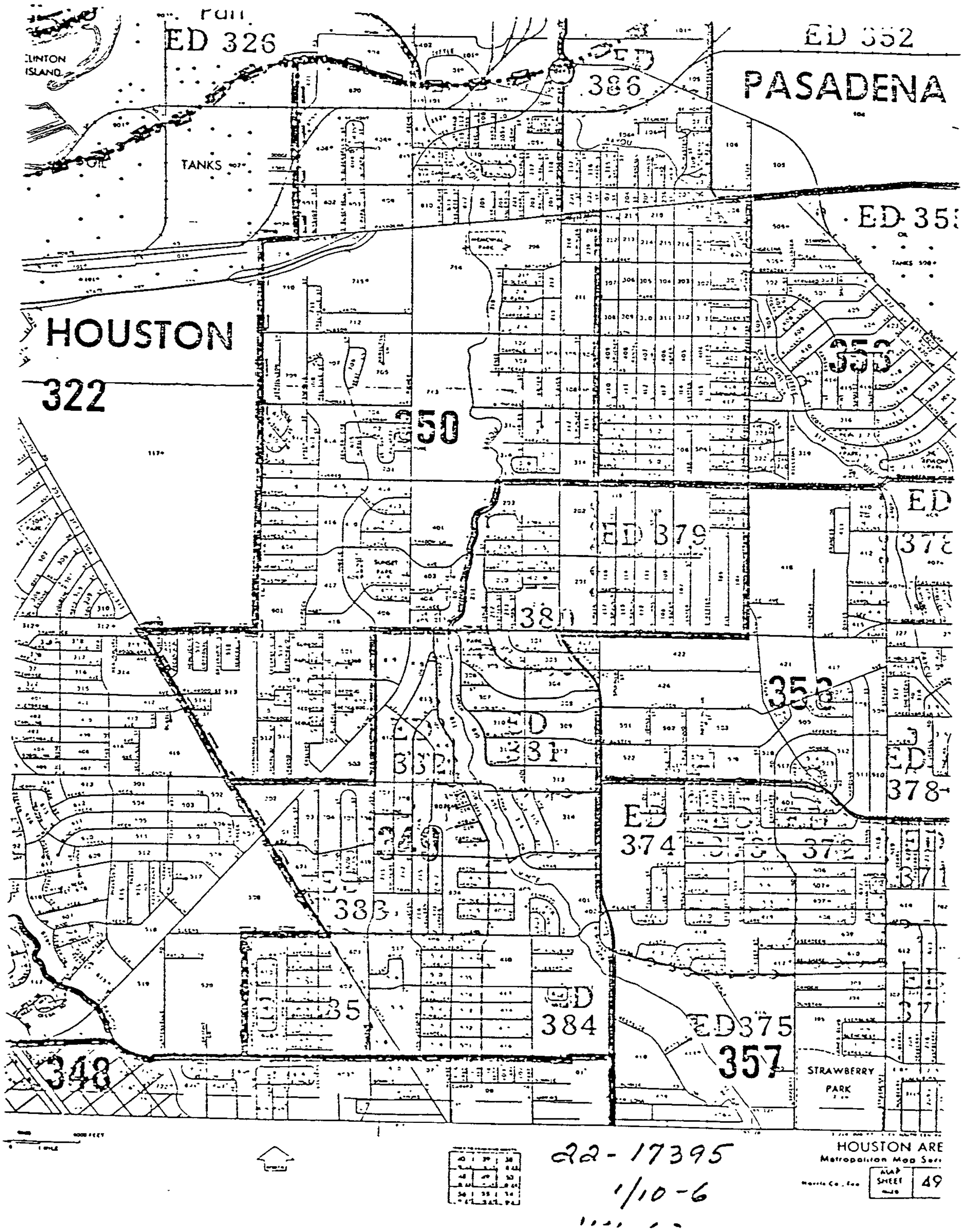
Indicate North
↑

SEGMENT SKETCH

SEGMENT ID 22-17395 RATE 1/10 START # 6 EST. HU's 62

INTERVIEWER ______________ PLACE Pasadena Tx. Harris Co.




ED 326
CLINTON ISLAND
TANKS
ED 352
PASADENA
ED 386
ED 353
HOUSTON
322
350
353
ED 379
ED 378
380
358
ED 381
382
ED 378
ED 374
349
383
384
ED 375
357
348
STRAWBERRY PARK
HOUSTON ARE
Metropolitan Map Seri
MAP SHEET 49
22-17395
1/10-6

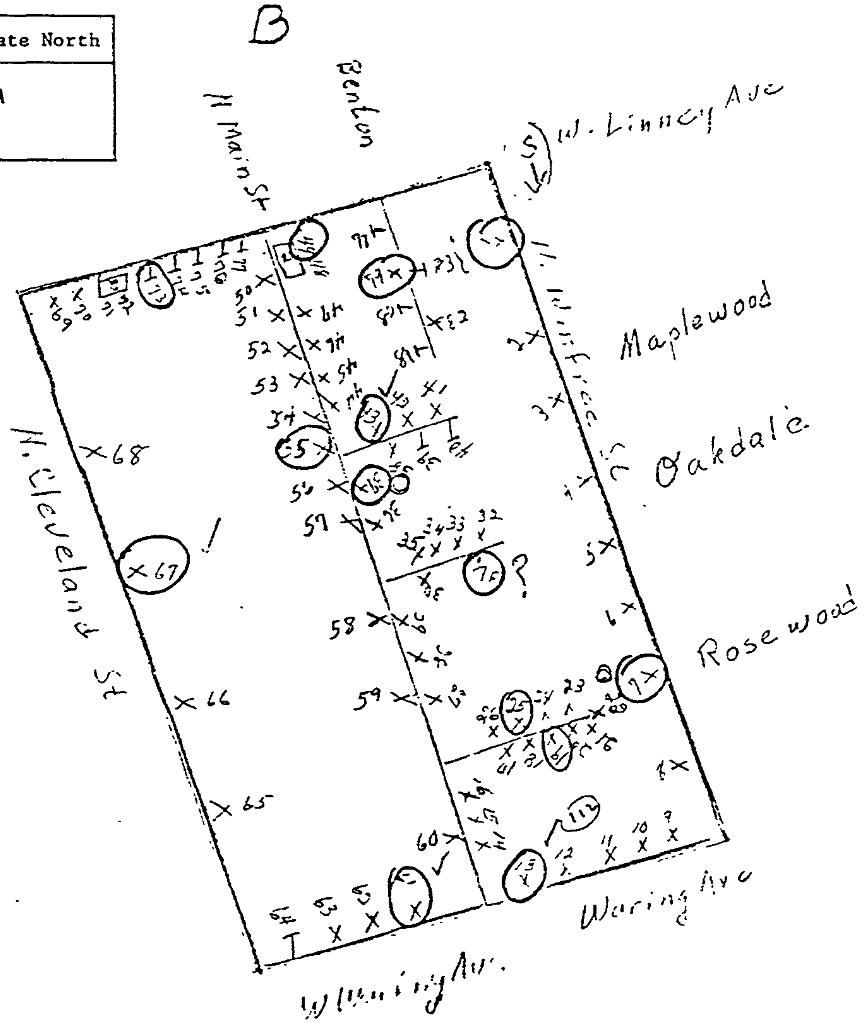
LIST UNIT SKETCH

SEGMENT ID 22-34579 PLACE Dayton Tx 77535

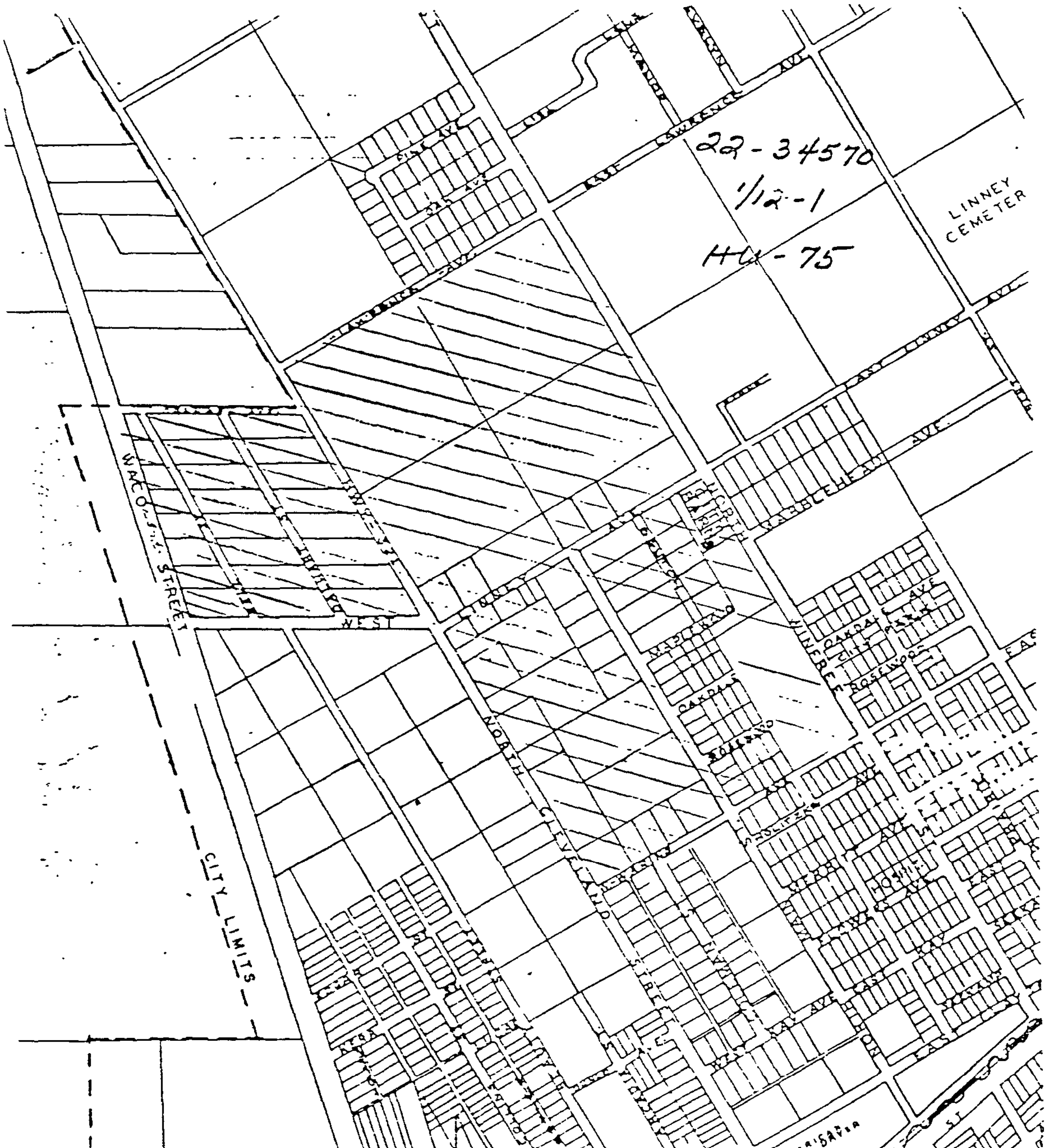
PREPARED BY E. Swig DATE 05/03/82

REVIEWED BY ______ DATE 05/03/82

Indicate North ↑



TAKE S.W. FREEWAY EAST
TO HUMBLE, TAKE Rd 1960 EAST to Dayton


22-34570
1/12-1
HU-75
LINNEY CEMETERY
CITY LIMITS
WEST ST
SHOPPING CENTER

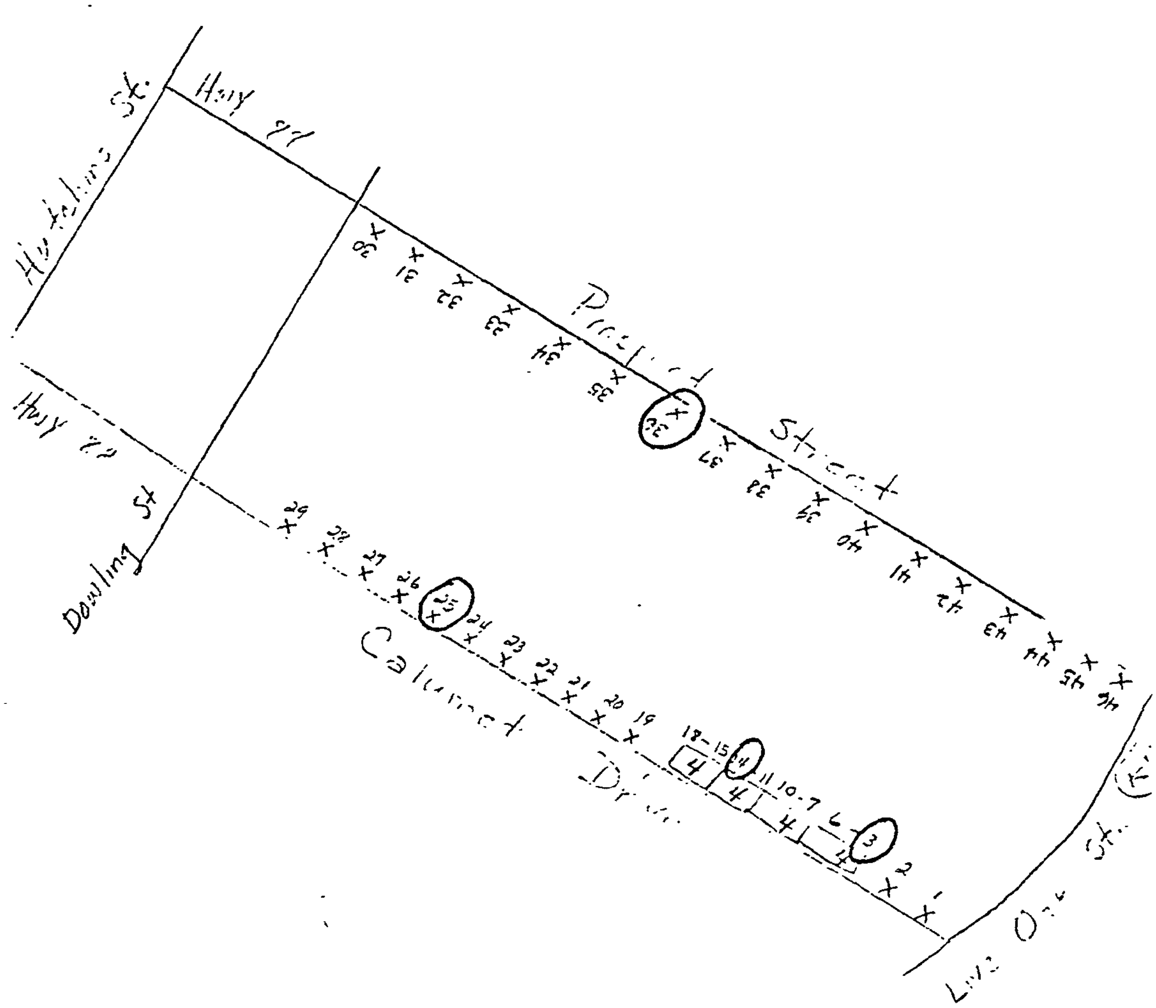
Indicate North ↑

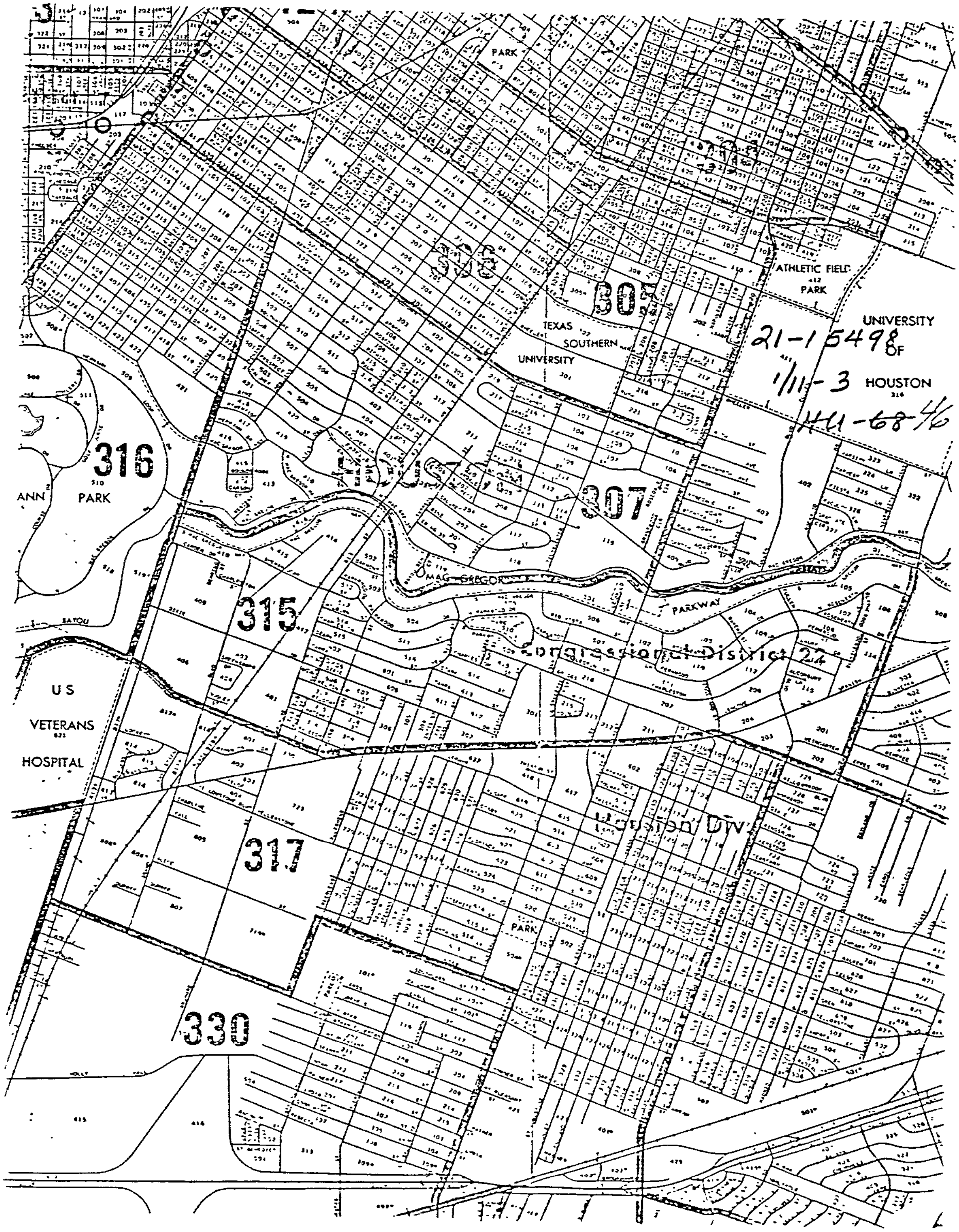
SEGMENT SKETCH

(46)

SEGMENT ID 21-15498 RATE 1/11 START # 3 EST. HU's 68

INTERVIEWER PLACE Houston Tx.



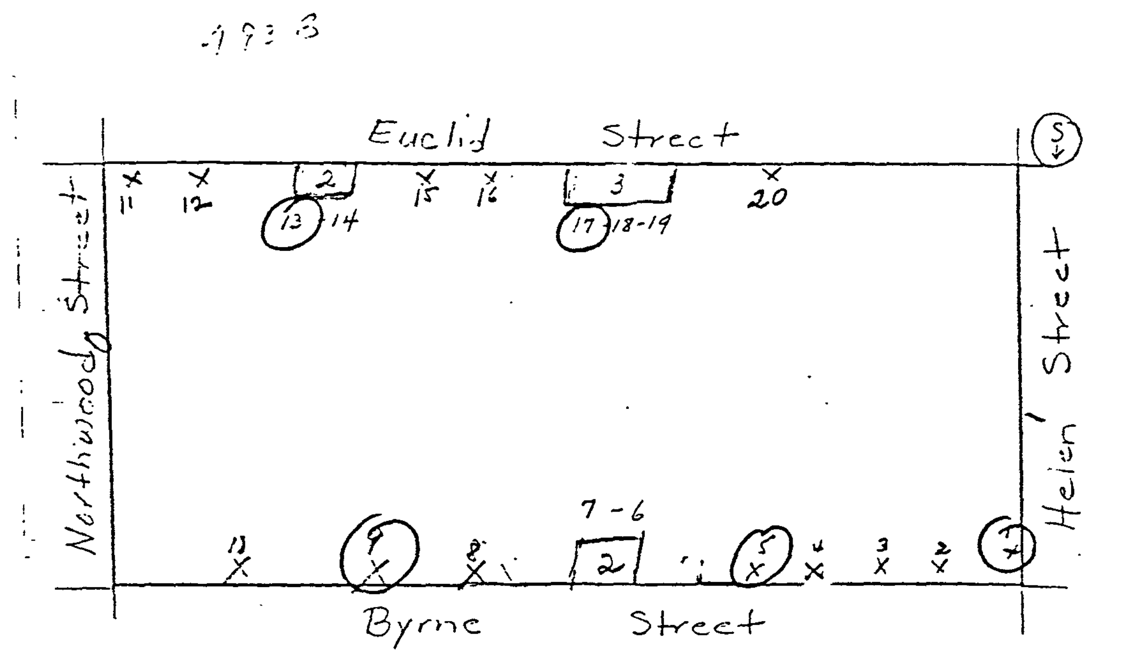

316
307
315
317
330
ATHLETIC FIELD
PARK
UNIVERSITY OF HOUSTON
TEXAS SOUTHERN UNIVERSITY
PARK
ANN
US
VETERANS
HOSPITAL
MAC GREGOR
PARKWAY
BAYOU
PARK
21-15498
1/11-3
HU-6846

Indicate North
↑

SEGMENT SKETCH

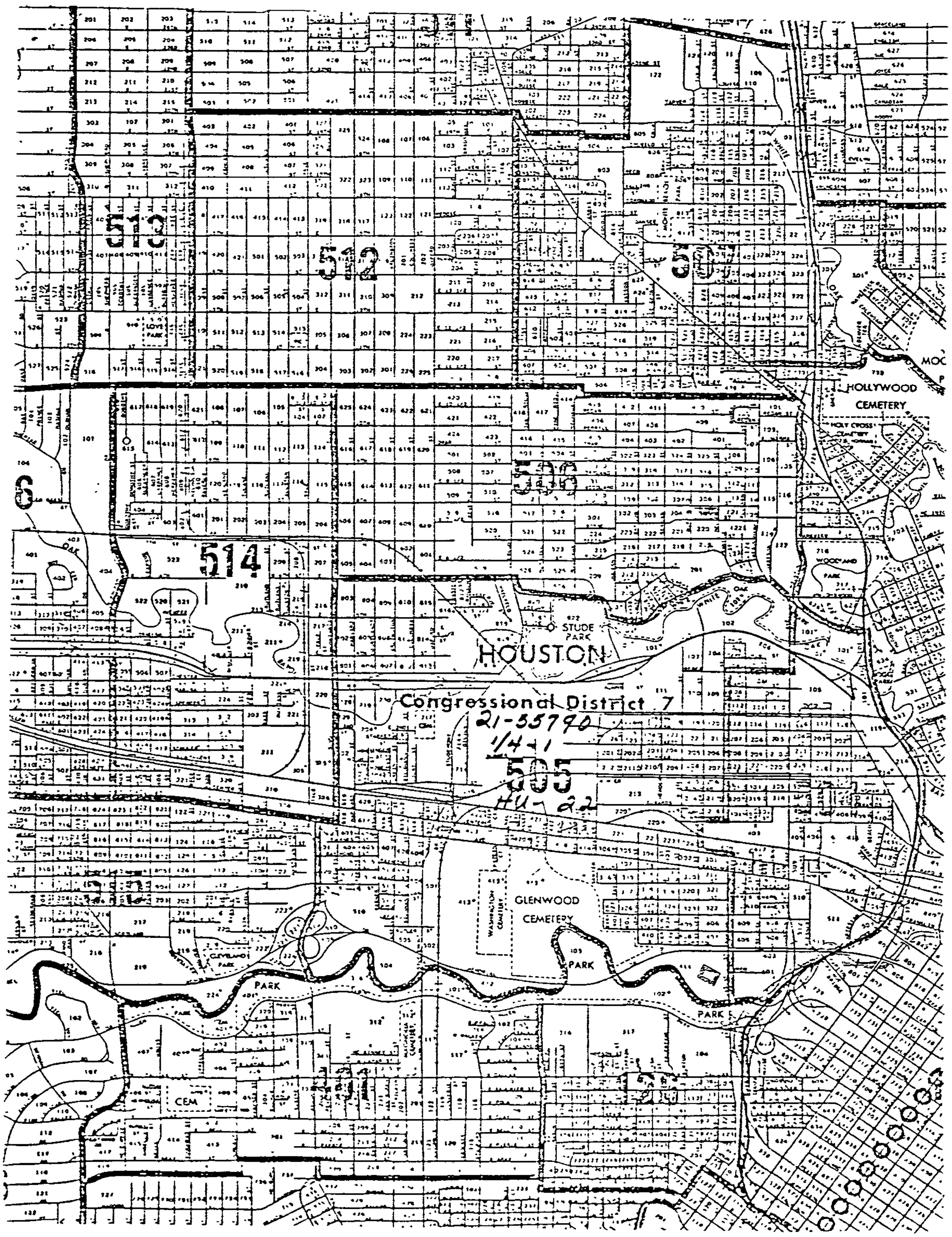
SEGMENT ID 21-55790 RATE 1/4 START # 1 EST. HU's ~~22~~ 20

INTERVIEWER ______ PLACE Houston Tx Harris Co.



All Block Area

Take 10 to Studemont

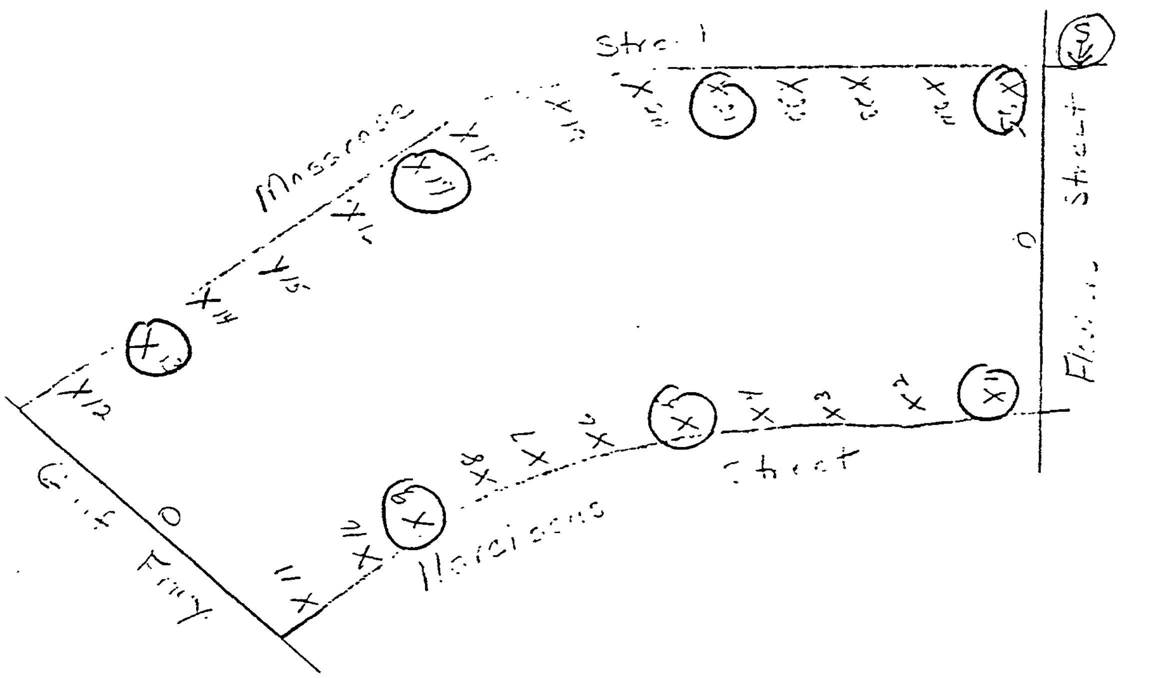

513
512
514
506
505
HOLLYWOOD
CEMETERY
STUDE
PARK
HOUSTON
Congressional District 7
21-55790
1/4-1
HU-22
GLENWOOD
CEMETERY
PARK
CEM

Indicate North ↑

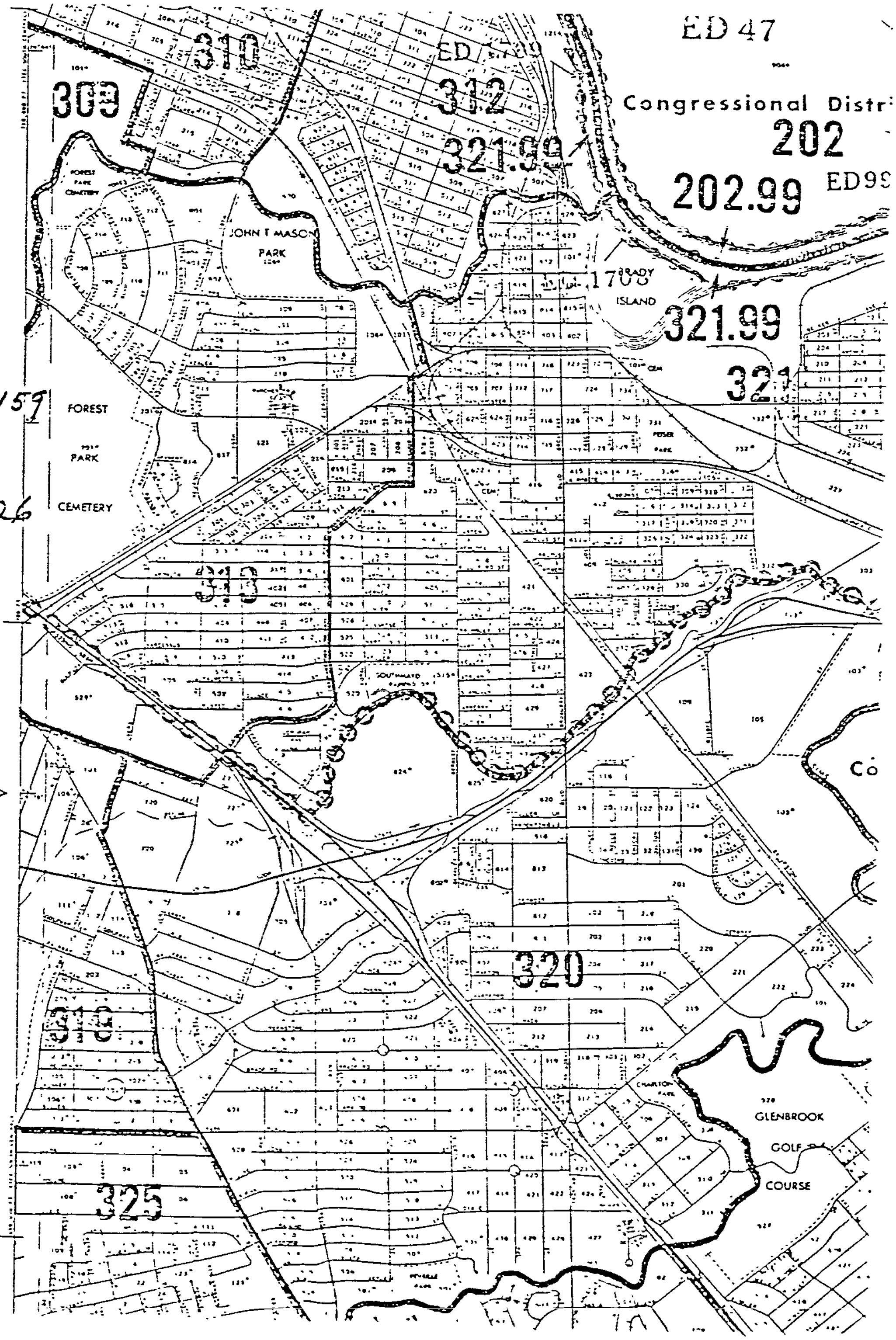
SEGMENT SKETCH

SEGMENT ID 21-18159 RATE 1/4 START # 1 EST. HU's 26

INTERVIEWER ______ PLACE Houston Tx Harris Co.



21-18159
1/4-1
HU-26



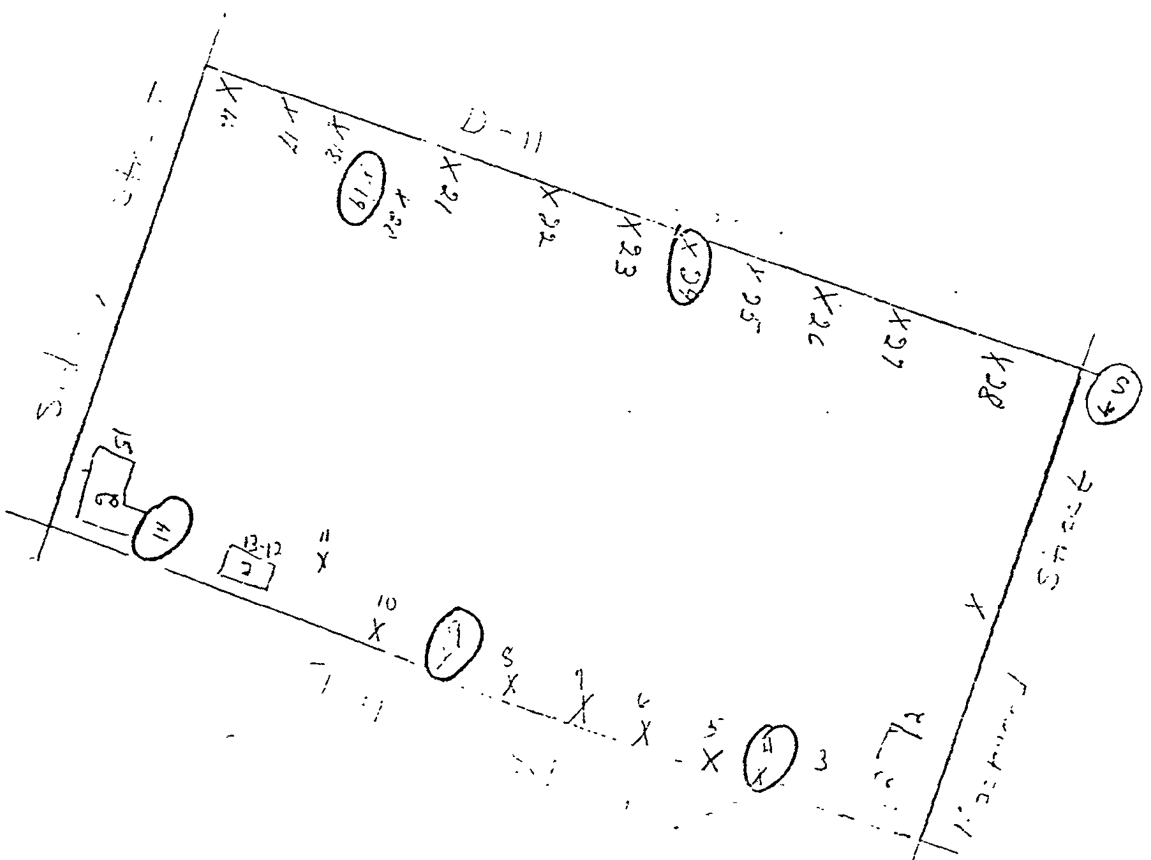
Indicate North
↑

SEGMENT SKETCH

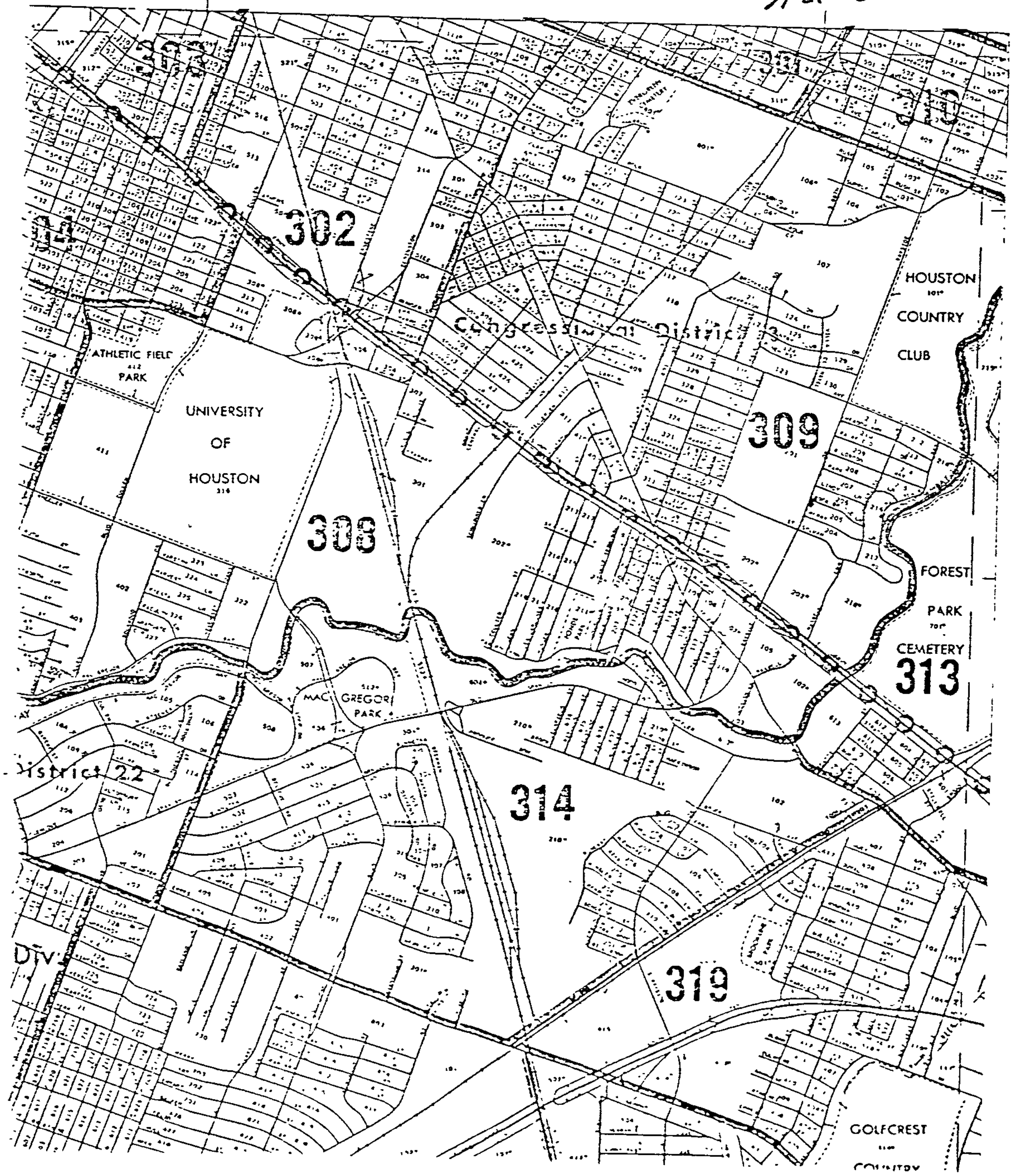
SEGMENT ID 21-12782 RATE 1/5 START # 4 EST. HU's 33

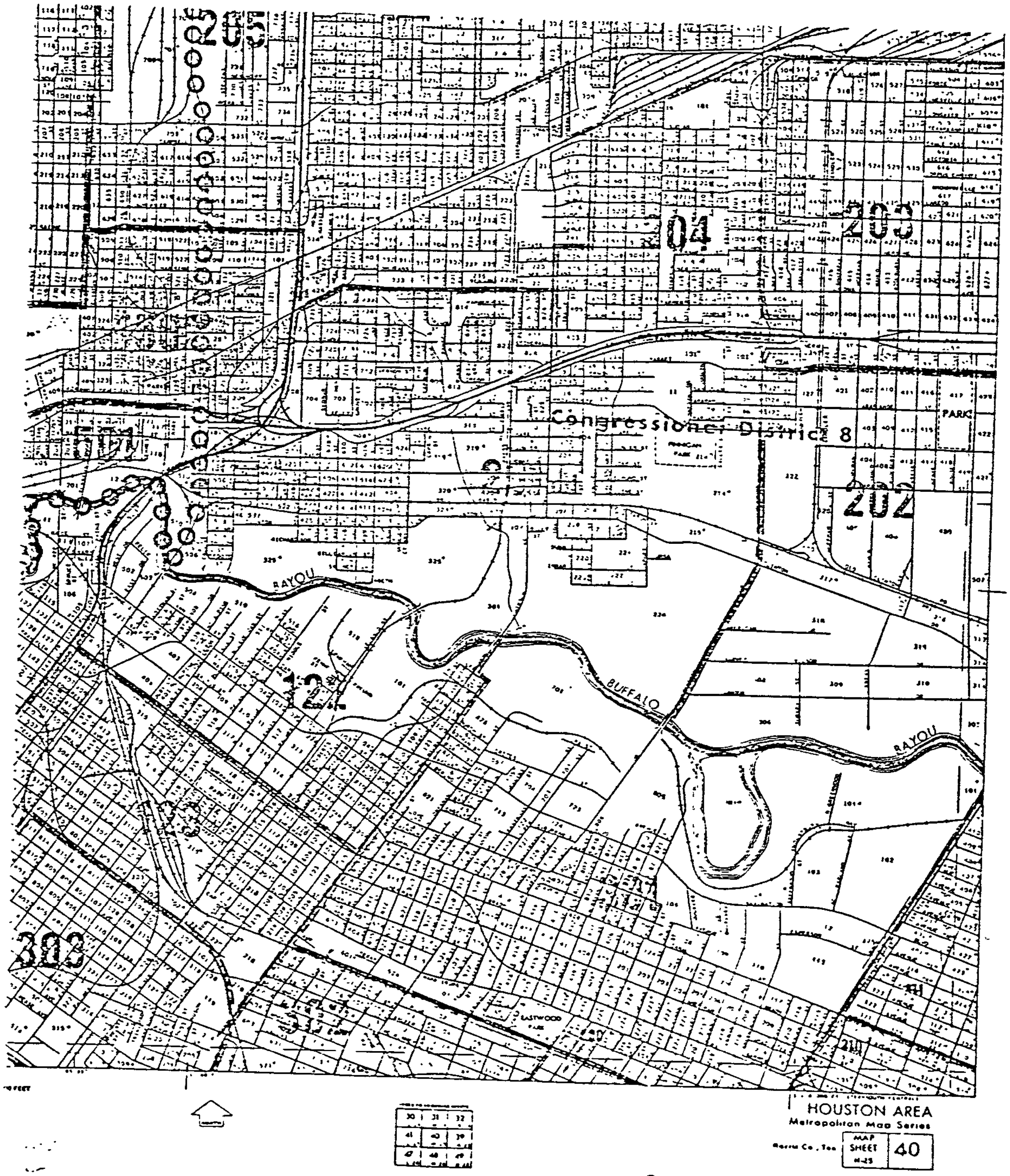
INTERVIEWER ________ PLACE Houston Tx

Harris Co



21- 12782
1/5-4
HU-33





205
204
203
Congressional District 8
202
501
12
303
BAYOU
BUFFALO
BAYOU
PARK
EASTWOOD PARK
HOUSTON AREA
Metropolitan Map Series
MAP SHEET H-25
40

21-12782

Indicate North

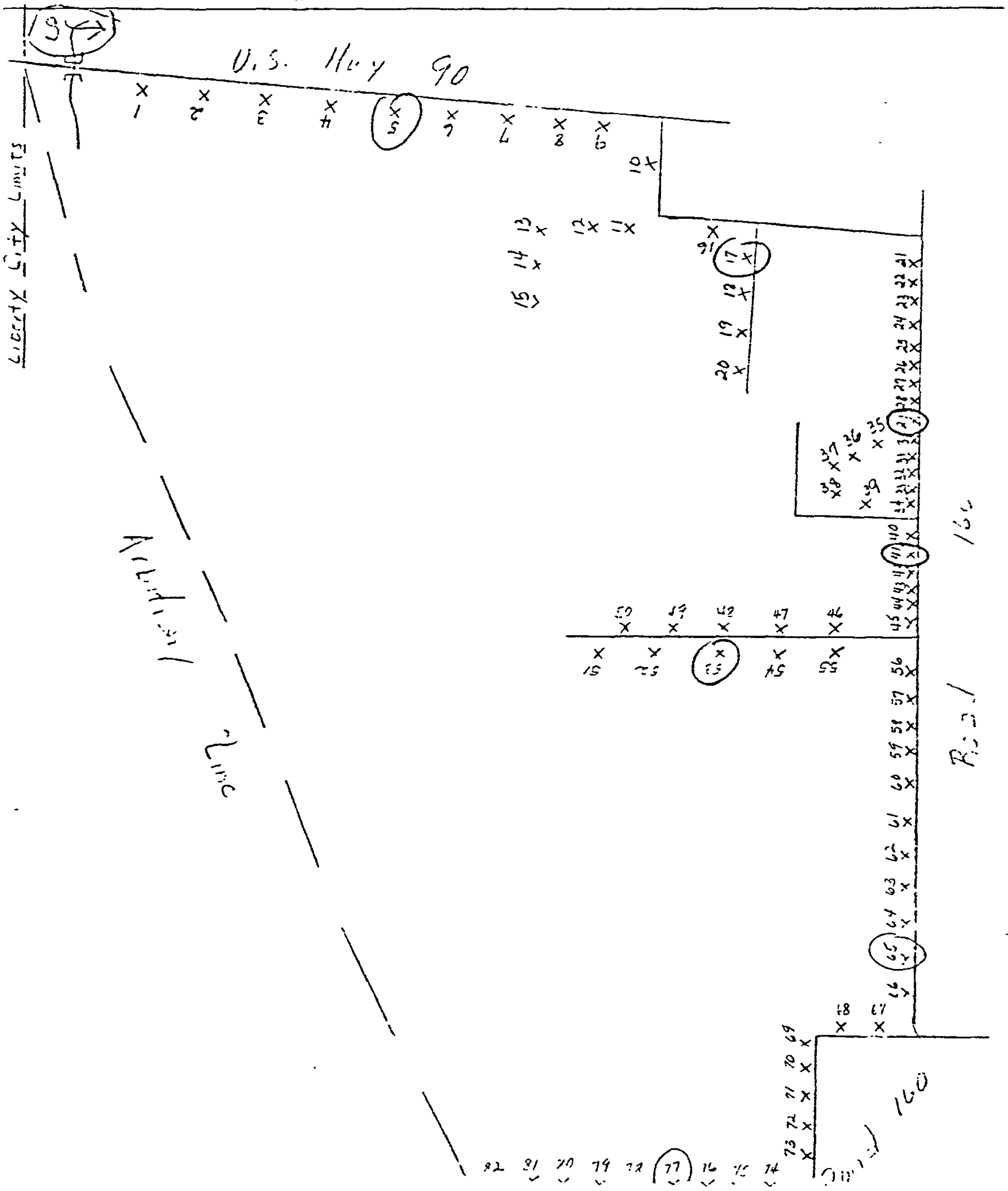
↑

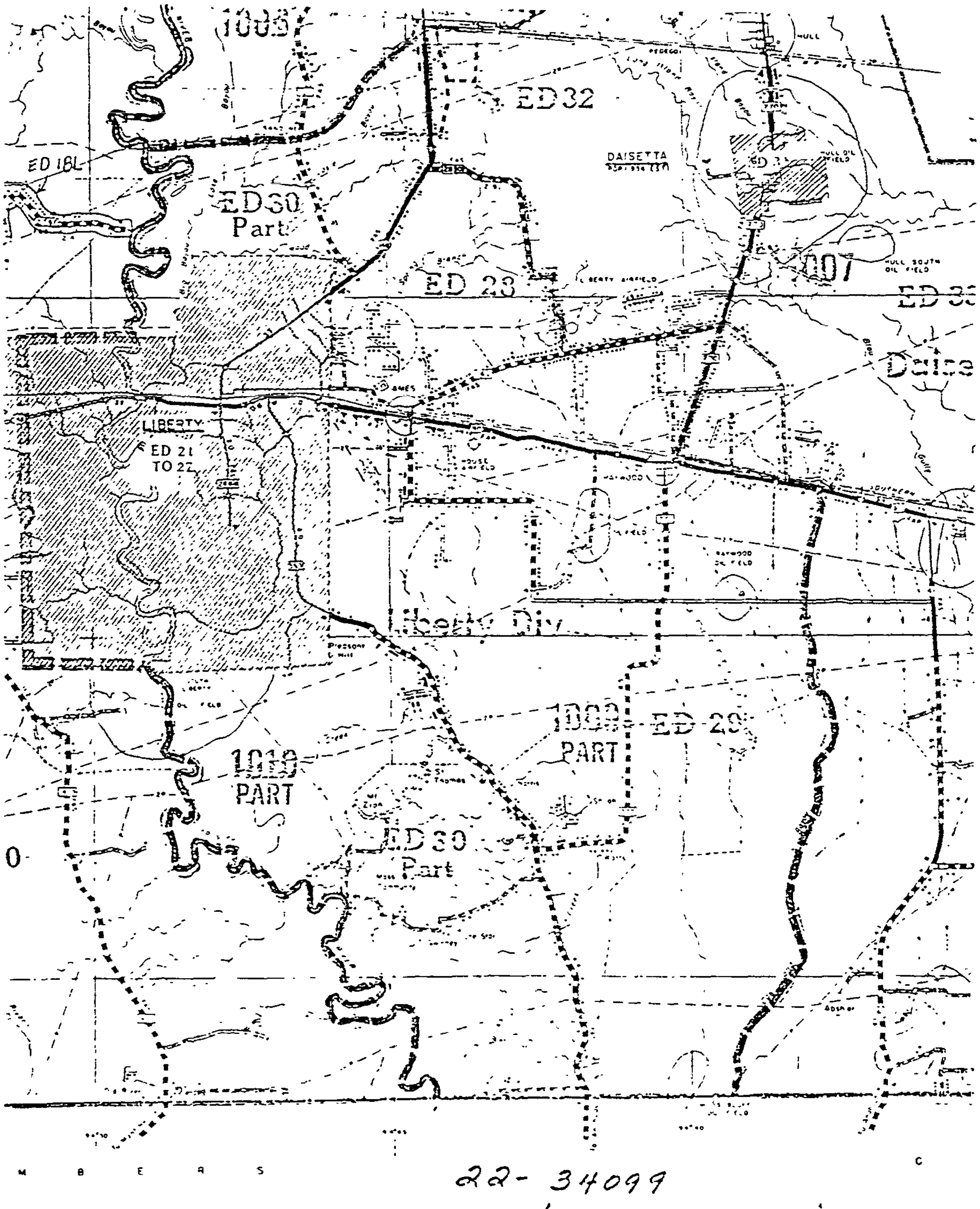
SEGMENT SKETCH

(82)

SEGMENT ID 22-34099 RATE 1/12 START # 5 EST. HU's 55

INTERVIEWER PLACE Liberty County





22- 34099
1/12-5

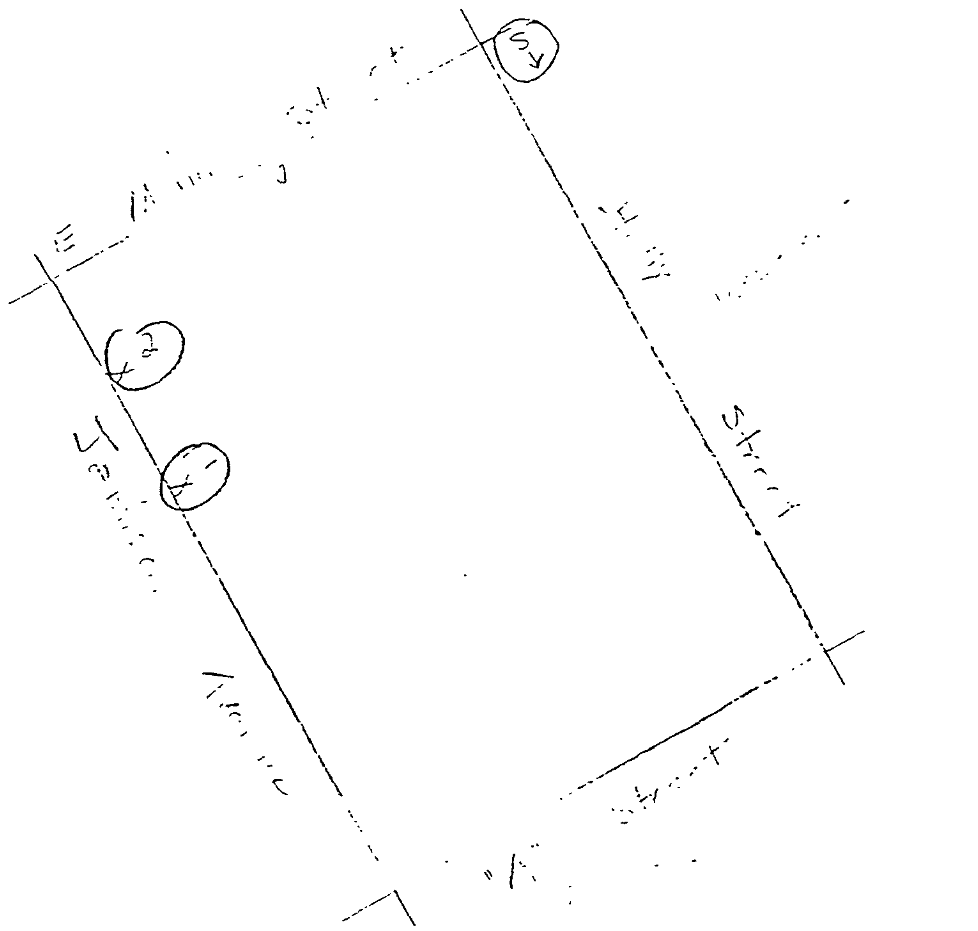
Indicate North

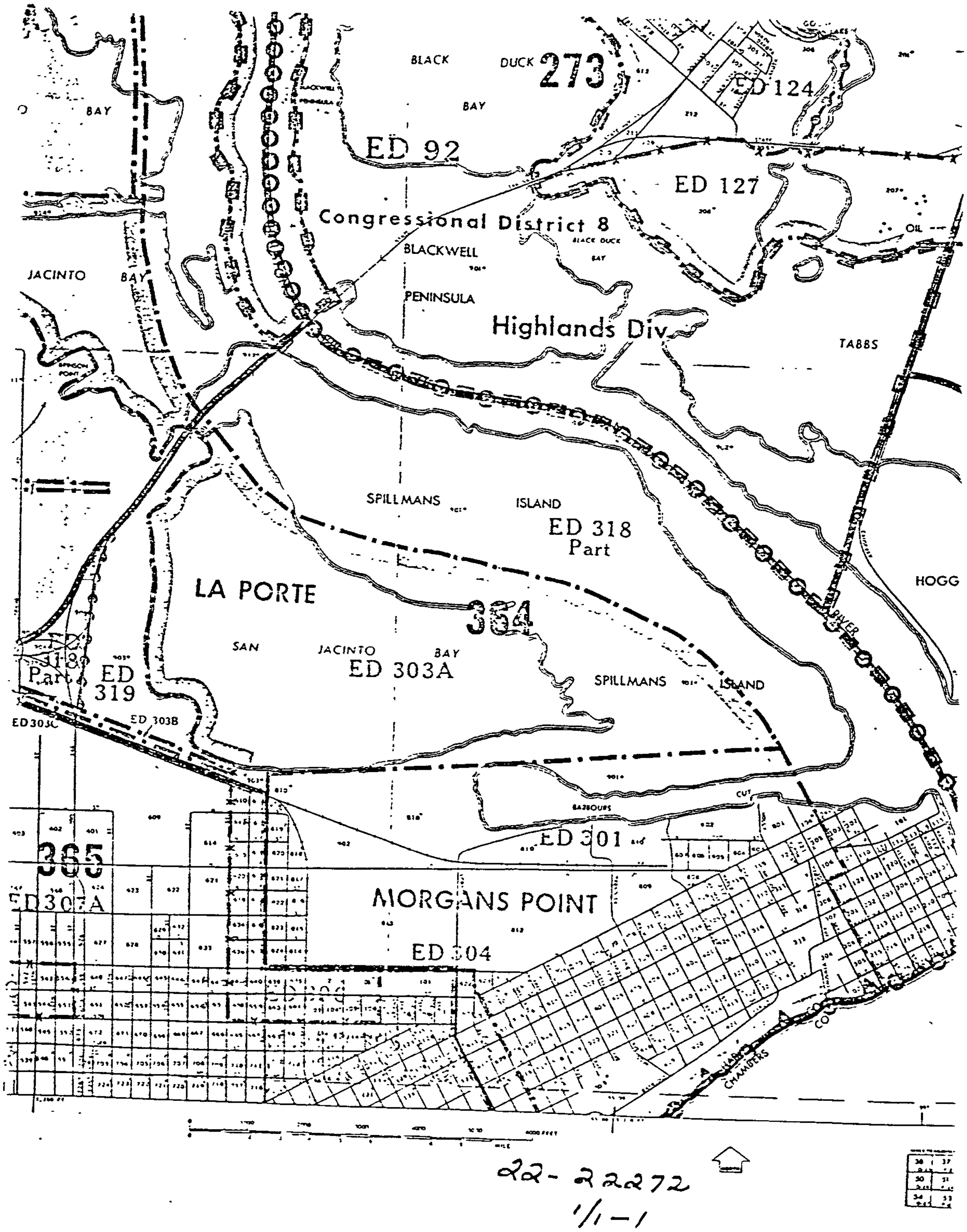
↑

SEGMENT SKETCH

SEGMENT ID 22-2227 RATE 1/1 START # 1 EST. HU's 5

INTERVIEWER ______ PLACE Morgans Point Harris Co.




BLACK DUCK BAY
273
ED 124
ED 92
ED 127
BAY
JACINTO BAY
Congressional District 8
BLACKWELL PENINSULA
Highlands Div.
TABBS
SPILLMANS ISLAND
ED 318 Part
HOGG
LA PORTE
364
SAN JACINTO BAY
ED 303A
SPILLMANS ISLAND
ED 319
ED 303B
ED 303C
ED 301
365
ED 307A
MORGANS POINT
ED 304
CHAMBERS
22- 22272
1/1-1

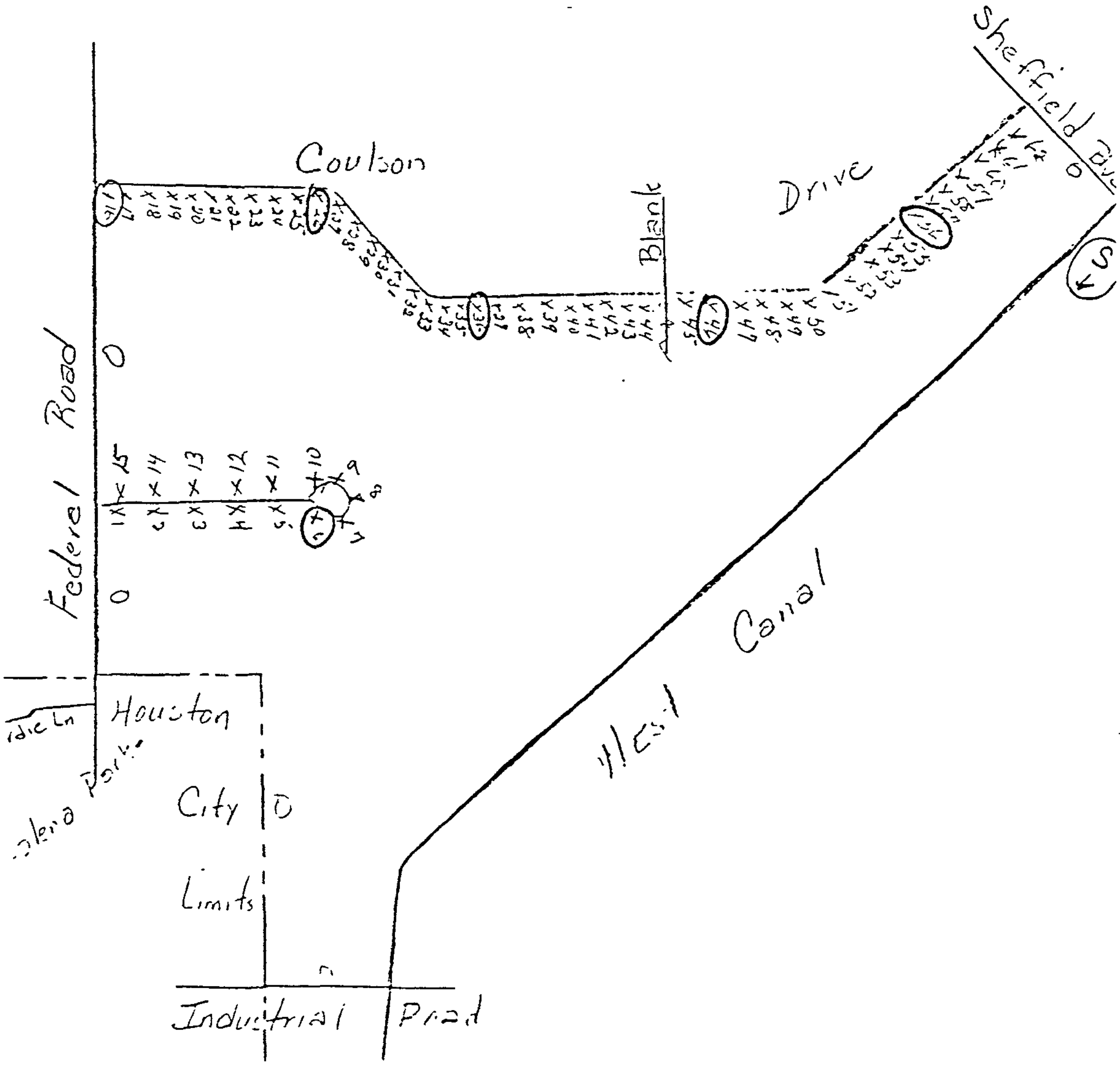
Indicate North

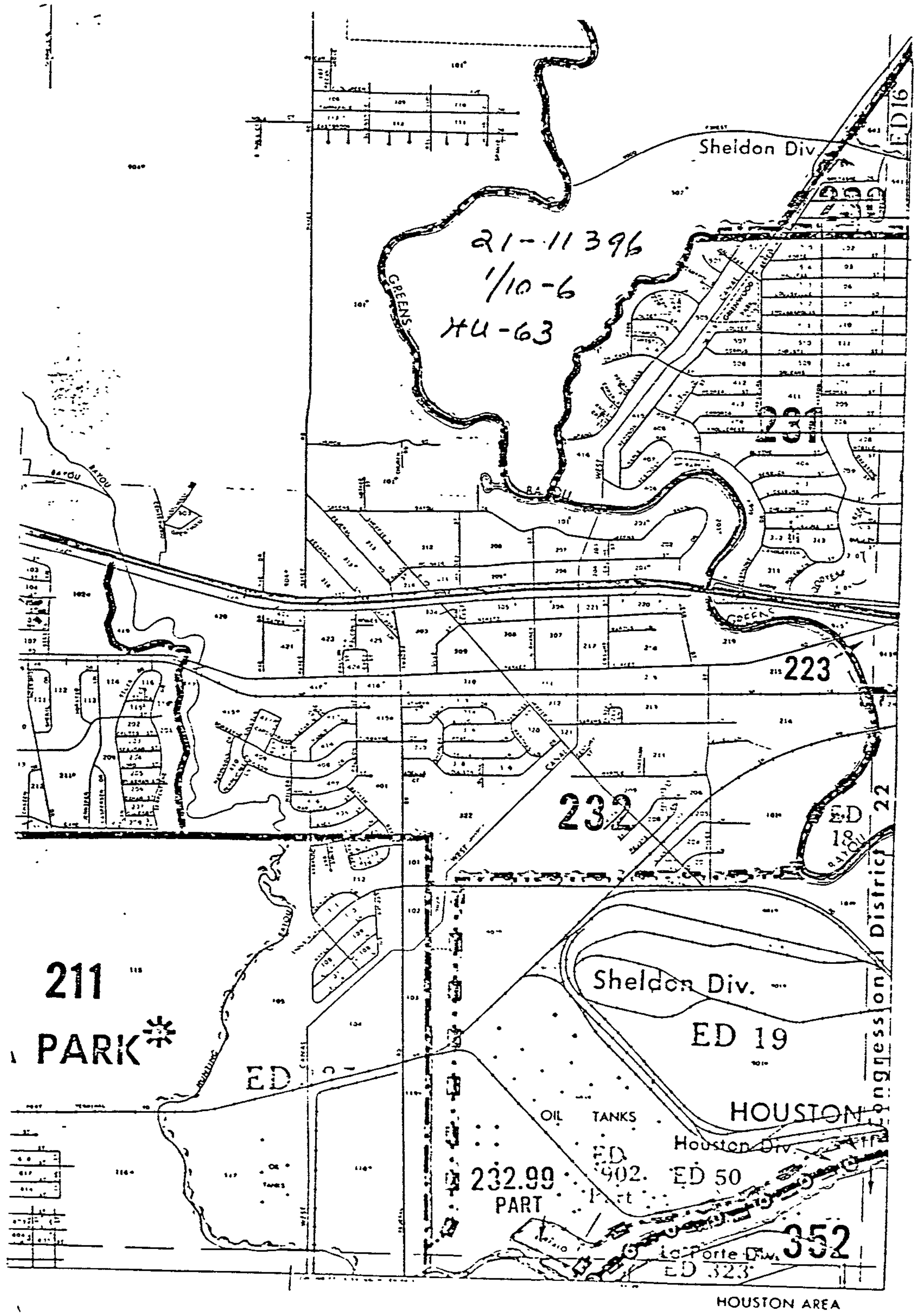
SEGMENT SKETCH

SEGMENT ID 21 -11396 RATE 1/10 START # 6 EST. HU's 63

INTERVIEWER ______ PLACE Houston Tx

Harris Co



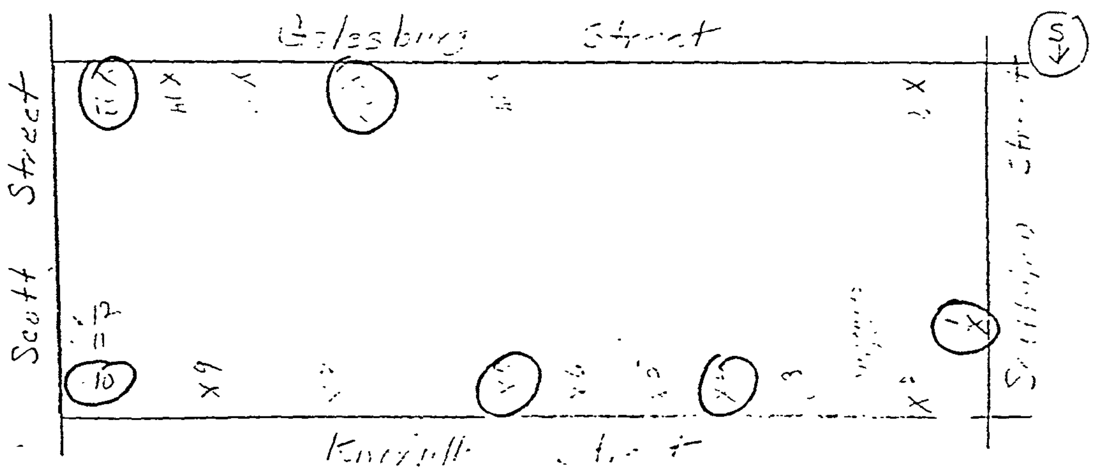

21-11396
1/10-6
HU-63
Sheldon Div.
ED16
231
223
232
ED 18
Congressional District 22
211
PARK
Sheldon Div.
ED 19
OIL TANKS
HOUSTON
Houston Div.
ED 902.
ED 50
232.99
PART
352
La Porte Div.
ED 323
HOUSTON AREA

SEGMENT SKETCH

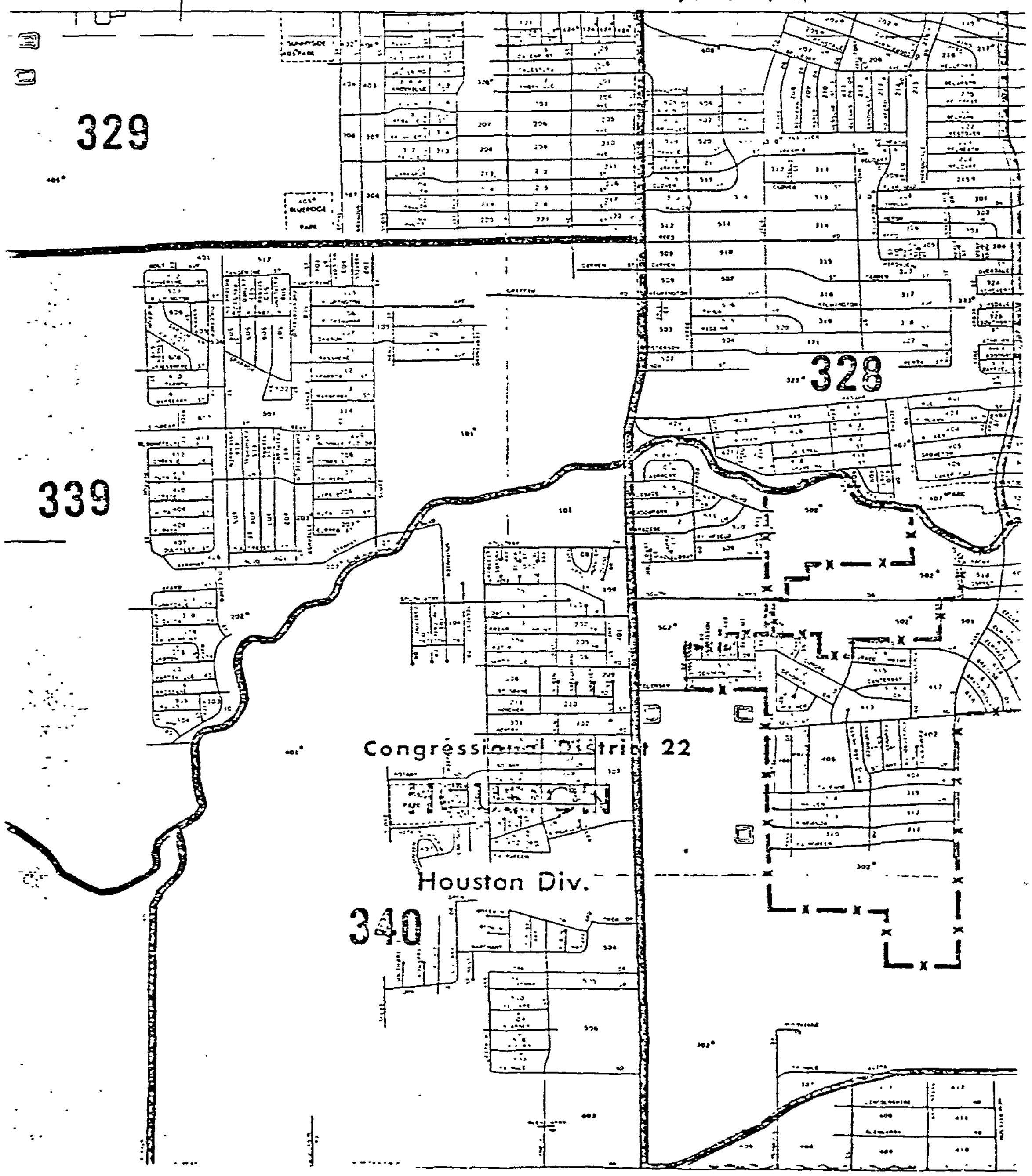
Indicate North ↑

SEGMENT ID 21-27619 DATE 1/3 START # 1 EST. HU's 18

INTERVIEWER ______ PLACE Houston Tx Harris Co



21-27619
1/3-1
HU-18



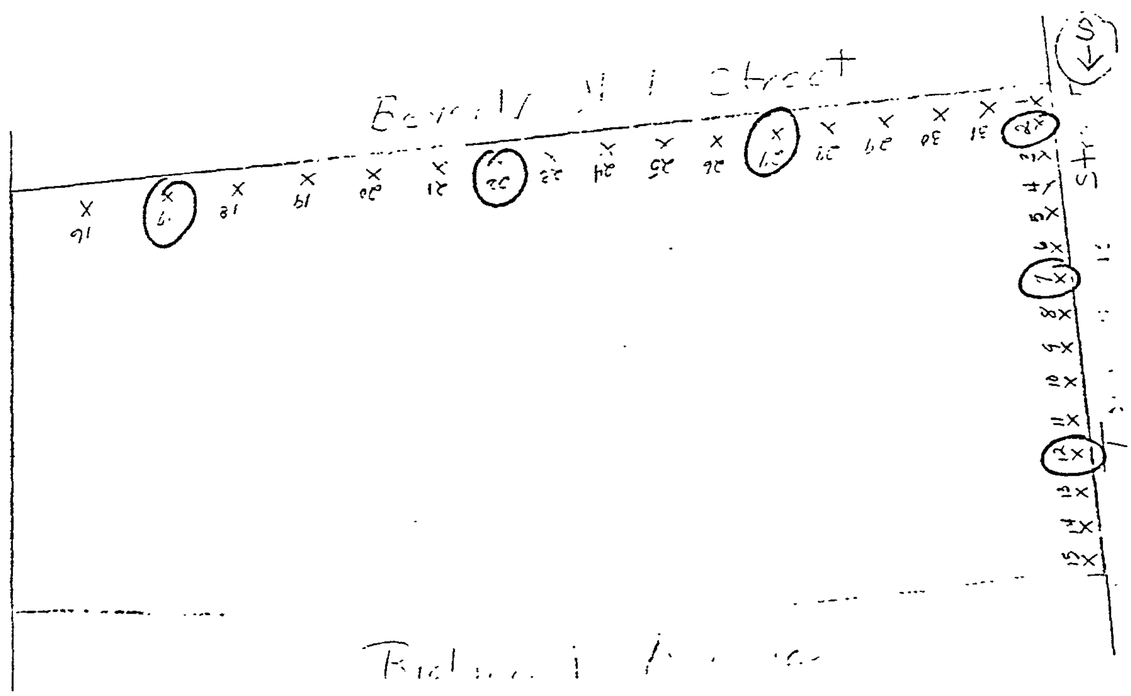
(31)

Indicate North
↑

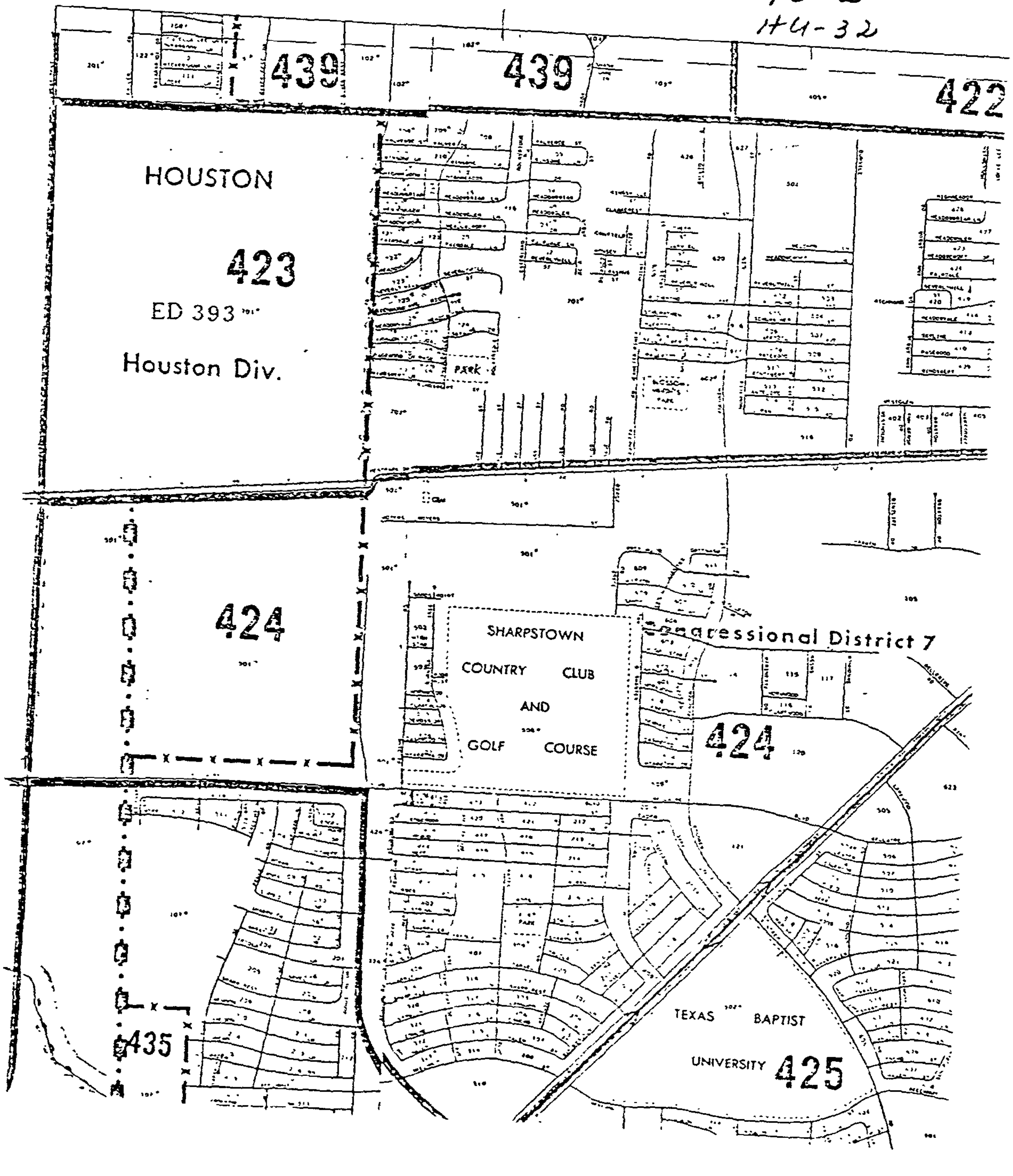
SEGMENT SKETCH

SEGMENT ID 21-45424 RATE 1/5 START # 2 EST. HU's 32

INTERVIEWER ______ PLACE Houston Tx



21-45424
1/5-2
HU-32



APPENDIX F

DATA FROM THE THREE-CITY POLICY BID EXPERIMENT

NOTATION

OBS: Observation Number

SE: Starting Bid (dollars/month)

BD: Maximum Bid (MB in text) - dollars/month

FB: "Fifty percent" Bid -- dollars/month

DB: "Other goods" Bid (OG in text); dollars/month

AI: Average Annual Income (thousands)

AG: Respondent's Age (number years)

RC: Race: 1 = white; 2 = non-white

SX: Respondent's Sex: 0 = female; 2 = male

CN: Children (under 18) in Household: 1 = yes; 2 = no

EN: Respondent's Education (years)

SET A (B): Albuquerque and Houston: Participants not given (given) budget information.

SET 1 (2): New Haven: Participants not given (given) cost data.

ALBUQUERQUE DATA (SET A)

OBS	SB	BD	FR	DI	AI	AG	RC	SX	CN	EN
1	0	0	0.0	0	31	40	1	1	0	17
2	50	75	75.0	45	40	28	1	1	0	19
3	5	10	10.0	10	50	49	1	1	1	19
4	1	2	2.0	2	26	54	1	3	0	17
5	5	20	20.0	5	24	49	0	1	1	14
6	0	0	0.0	0	6	83	0	1	0	10
7	25	50	50.0	15	12	25	1	1	0	16
8	15	20	10.0	5	25	53	0	0	0	17
9	80	100	50.0	18	30	28	0	1	1	14
10	30	30	50.0	10	20	30	0	0	1	12
11	10	18	9.0	9	48	31	1	0	1	16
12	45	45	0.0	10	65	31	1	0	1	16
13	15	25	25.0	25	14	66	1	0	0	19
14	15	15	7.5	8	9	23	1	1	0	15
15	50	110	110.0	110	36	44	1	0	0	14
16	25	25	25.0	5	18	22	0	1	0	12
17	30	50	50.0	30	25	31	1	1	0	19
18	5	15	0.0	5	40	36	0	1	0	12

ALBUQUERQUE DATA (SET B)

OBS	SB	BD	FB	DB	AI	AG	RC	SX	CN	EN
1	50.00	75.0	75.0	60.00	28.0	33	1	1	1	19
2	50.00	100.0	100.0	100.00	45.0	55	1	1	1	19
3	20.00	30.0	30.0	30.00	38.0	48	1	1	1	16
4	70.00	100.0	100.0	100.00	27.0	29	0	1	0	19
5	15.00	20.0	20.0	2.00	22.0	28	0	1	0	15
6	1.00	1.0	1.0	1.00	8.0	59	0	1	1	12
7	5.00	15.0	15.0	5.00	20.0	32	1	1	1	16
8	5.00	5.0	5.0	5.00	17.0	57	1	0	0	17
9	5.00	5.0	5.0	5.00	50.0	52	1	1	1	16
10	0.20	1.8	1.0	1.00	11.0	25	1	1	1	12
11	0.25	1.0	1.0	1.00	9.0	21	0	1	0	13
12	50.00	75.0	5.0	75.00	25.0	35	1	1	0	15
13	0.50	0.5	0.5	0.25	30.0	44	1	1	1	17
14	3.00	5.0	1.0	5.00	12.0	72	1	1	0	16
15	5.00	10.0	10.0	10.00	36.0	61	1	1	0	13
16	5.00	5.5	5.0	5.00	17.0	33	1	1	0	13
17	5.00	10.0	10.0	10.00	15.0	61	1	1	0	16
18	5.00	10.0	10.0	10.00	24.0	42	1	1	1	17
19	10.00	20.0	10.0	20.03	13.0	66	1	0	0	13
20	0.50	1.0	0.0	1.00	20.0	61	1	0	0	14
21	0.00	0.0	0.0	0.00	12.0	42	0	1	1	12
22	4.00	5.0	5.0	5.00	10.5	74	0	0	0	17
23	1.00	1.0	1.0	1.00	42.0	46	1	1	1	12
24	5.00	5.0	5.0	1.00	30.0	28	1	1	0	16
25	15.00	20.0	20.0	14.00	17.5	29	0	1	0	17
26	25.00	30.0	30.0	15.00	2.0	23	0	0	0	16
27	15.00	20.0	20.0	1.00	16.0	36	1	0	1	15
28	35.00	40.0	40.0	30.00	47.0	31	1	0	0	17
29	0.00	0.0	0.0	0.00	36.0	38	1	1	1	14
30	10.00	10.0	10.0	2.00	7.0	27	0	1	0	18
31	10.00	50.0	50.0	50.00	36.0	62	0	1	0	14
32	3.00	9.0	9.0	9.00	30.0	26	0	1	1	17

HOUSTON (INTENSIVE) DATA (SET A)

DBS	SB	BD	FB	DB	AI	AG	RC	SX	CN	LN
1	5.0	12.0	0.0	8.0	25	35	1	0	1	16
2	20.0	100.0	100.0	30.0	[illegible]	[illegible]	1	1	0	16
3	25.0	30.0	30.0	15.0	75	[illegible]	1	1	0	14
4	3.0	5.0	0.0	0.8	20	[illegible]	1	1	0	17
5	20.0	20.0	5.0	4.0	33	36	0	1	1	9
6	0.0	0.0	0.0	0.0	70	35	0	1	1	16
7	1.0	15.0	0.0	7.0	30	51	1	1	0	16
8	0.1	0.5	0.5	0.5	60	42	1	1	1	17
9	15.0	15.0	15.0	15.0	30	[illegible]	1	1	0	17
10	0.1	0.1	0.0	0.0	55	[illegible]	1	1	1	16
11	10.0	100.0	0.0	20.0	60	32	3	0	1	17
12	0.1	0.5	0.5	0.5	80	60	1	0	0	16
13	0.0	0.0	0.0	0.0	28	42	0	1	1	12
14	0.0	0.0	0.0	0.0	21	25	0	1	1	9
15	0.1	1.0	1.0	0.1	25	49	1	1	0	16
16	10.0	10.0	1.0	1.0	30	[illegible]	1	0	0	11
17	20.0	50.0	15.0	10.0	75	34	1	1	3	17
18	1.0	2.0	2.0	0.4	100	44	1	1	1	16
19	20.0	30.0	15.0	30.0	30	44	1	1	0	10
20	75.0	100.0	0.0	20.0	125	63	1	1	0	12
21	80.0	80.0	80.0	80.0	128	39	1	0	1	16
22	0.1	0.1	0.1	0.1	19	20	0	1	0	16
23	5.0	15.0	15.0	15.0	30	59	1	0	1	14
24	1.0	7.0	7.0	0.0	20	29	1	1	0	16
25	30.0	40.0	20.0	40.0	22	63	1	0	0	14
26	25.0	25.0	25.0	25.0	15	45	1	1	0	12
27	50.0	100.0	100.0	50.0	90	53	1	1	1	17
28	20.0	35.0	35.0	15.0	15	19	1	1	0	14
29	0.0	0.0	0.0	0.0	18	32	1	0	1	12
30	1.0	2.0	0.0	0.5	24	28	1	1	1	12
31	80.0	80.0	0.0	80.0	40	55	1	1	1	14
32	1.0	2.0	2.0	2.0	45	49	1	0	0	16
33	0.0	0.0	0.0	0.0	7	65	1	1	0	16
34	2.0	2.0	0.0	2.0	7	49	1	0	1	9
35	80.0	300.0	300.0	60.0	125	52	1	0	1	12
36	50.0	50.0	50.0	50.0	100	59	1	1	1	12
37	1.0	2.0	2.0	2.0	30	28	1	1	1	14
38	1.0	2.0	1.0	2.0	50	68	1	1	0	18
39	2.0	10.0	0.0	10.0	30	26	1	1	1	12
40	5.0	20.0	0.0	23.0	30	25	1	0	1	11
41	10.0	20.0	0.0	20.0	45	30	1	1	0	12
42	5.0	6.0	0.0	6.0	14	51	1	1	1	13
43	3.0	3.0	3.3	3.0	110	48	1	1	0	12
44	1.0	5.0	1.3	1.0	110	46	1	0	0	12
45	5.0	15.0	15.0	15.0	[illegible]	23	1	0	0	16

HOUSTON (EXTENSIVE, door-to-door) DATA (SET A)

OBS	SB	BD	FB	DB	AI	HG	RC	SX	CN	LN
1	0.1	0.1	0.10	0.1	20	23	1	1	0	14
2	0.0	0.0	0.00	0.0	20	45	1	0	1	12
3	15.0	20.0	20.00	5.0	15	22	1	1	0	16
4	0.0	0.0	0.00	0.0	12	46	1	0	0	12
5	5.0	8.0	5.00	5.0	18	25	1	0	0	16
6	30.0	50.0	50.00	50.0	19	26	1	0	0	16
7	5.0	10.0	2.00	5.0	25	27	1	0	0	16
8	2.0	3.0	3.00	2.0	50	31	1	1	0	16
9	20.0	35.0	25.00	25.0	25	25	1	1	0	16
10	0.5	0.5	0.25	0.1	10	34	0	0	0	17
11	0.5	1.5	1.50	1.5	24	22	1	1	0	12
12	0.0	0.0	0.00	0.0	12	51	1	0	0	16
13	20.0	20.0	20.00	20.0	25	42	1	1	1	14
14	5.0	5.0	5.00	5.0	30	27	1	1	0	8

HOUSTON (INTENSIVE) DATA (SET B)

BS	SB	BD	FB	DB	HI	AG	RC	SX	CN	EN
1	50.0	50	50.0	50.0	80	51	1	1	1	16
2	50.0	75	75.0	75.0	42	32	1	1	1	13
3	50.0	75	75.0	75.0	30	48	1	0	1	15
4	25.0	39	39.0	39.0	15	34	1	1	0	14
5	40.0	50	20.0	15.0	35	26	1	0	0	16
6	50.0	75	0.0	75.0	50	50	1	1	0	17
7	1.0	1	1.0	0.3	47	38	1	1	1	16
8	80.0	100	10.0	20.0	125	45	1	1	1	18
9	25.0	75	75.0	15.0	19	25	1	0	0	16
10	1.0	5	5.0	5.0	16	32	1	0	0	12
11	5.0	12	12.0	12.0	85	38	1	1	1	12
12	10.0	25	25.0	5.0	13	27	1	0	0	12
13	10.0	20	0.0	5.0	32	39	1	1	1	14
14	25.0	40	0.0	40.0	60	67	1	1	0	15
15	5.0	10	5.0	10.0	36	46	1	1	1	16
16	15.0	20	20.0	8.0	60	49	1	1	0	16
17	1.0	10	10.0	10.0	55	38	1	1	1	15
18	0.1	1	1.0	0.5	8	62	0	1	0	11
19	80.0	130	130.0	130.0	125	40	1	1	1	17
20	10.0	20	20.0	20.0	20	37	1	0	0	14
21	1.0	1	1.0	0.5	45	49	1	1	1	16
22	33.0	33	0.0	10.0	100	52	1	0	0	13
23	0.0	0	0.0	0.0	100	45	1	1	1	16
24	2.0	7	1.0	3.0	40	36	1	1	1	16
25	25.0	95	95.0	25.0	20	41	1	0	0	17
26	3.0	7	7.0	5.0	22	23	1	1	0	13
27	30.0	40	20.0	10.0	45	32	1	0	1	17
28	5.0	12	0.0	6.0	33	36	1	0	1	12
29	10.0	25	10.0	15.0	45	50	1	1	1	12
30	5.0	10	10.0	10.0	11	25	1	1	0	12
31	10.0	10	10.0	2.0	41	31	1	1	0	12
32	10.0	15	15.0	15.0	30	55	1	1	0	17
33	50.0	80	80.0	16.0	32	27	1	1	0	10
34	5.0	5	5.0	1.0	22	33	0	0	0	14
35	50.0	60	60.0	60.0	60	52	1	1	1	6
36	10.0	15	15.0	15.0	20	65	1	0	0	10
37	3.0	3	0.0	3.0	20	58	1	0	0	16
38	5.0	8	8.0	1.0	23	47	1	1	1	12
39	5.0	10	10.0	10.0	25	29	1	1	1	15
40	10.0	13	13.0	10.0	14	19	1	1	0	12
41	10.0	12	6.0	12.0	15	27	1	0	1	12
42	10.0	15	7.5	10.0	22	43	1	0	1	14
43	0.0	0	0.0	0.0	10	30	1	1	1	12
44	10.0	10	10.0	10.0	[illegible]	32	1	1	1	14

HOUSTON (EXTENSIVE, door-to-door) DATA (SET B)

OBS	SL	BD	FB	DB	AI	AG	RC	SX	CM	EN
1	5	8	8	8.0	60.0	40	1	1	1	19
2	5	5	5	5.0	25.0	25	1	0	0	16
3	5	8	0	2.0	20.0	33	1	1	0	16
4	5	5	5	1.0	12.0	28	1	0	0	14
5	1	1	1	1.0	11.0	27	1	1	0	18
6	5	12	12	6.0	17.5	28	1	0	0	15
7	25	50	50	50.0	40.0	35	1	1	0	12
8	5	5	5	5.0	6.5	30	1	0	1	17
9	5	5	5	0.5	40.0	43	1	0	1	13
10	5	10	10	10.0	28.0	30	1	0	1	12

NEW HAVEN DATA (SET 1)

OBS	SB	BD	FB	AI	AG	KC	SX	CN	EN
1	10.00	10	10	23	31	1	0	0	18
2	0.25	10	10	43	35	i	0	0	19
3	2.00	10	5	24	34	i	0	0	12
4	2.00	10	0	10	42	1	0	0	12
5	20.00	25	25	26	52	1	0	1	15
6	2.00	2	2	5	25	1	1	1	12
7	0.00	0	0	5	66	0	0	0	7
8	15.00	25	25	18	29	1	0	0	17
9	5.00	10	10	18	24	1	1	0	14
10	80.00	100	100	50	31	1	0	1	17
11	20.00	50	25	70	40	1	1	1	16
12	2.00	10	0	15	31	1	1	1	14
13	1.00	2	2	14	20	1	1	0	14
14	15.00	20	20	10	30	1	1	0	16
15	20.00	50	50	30	32	1	1	1	16
16	5.00	20	10	50	34	1	0	1	17
17	2.00	20	10	28	28	1	0	1	12
18	10.00	30	30	42	37	1	1	1	17
19	10.00	10	10	22	64	1	1	1	16
20	10.00	20	20	28	52	1	0	1	17
21	0.00	0	0	15	61	1	0	0	12
22	10.00	20	10	58	43	1	1	0	19
23	10.00	25	25	30	71	1	0	0	17
24	2.00	4	4	30	45	1	1	1	19
25	50.00	150	150	41	34	1	i	1	18
26	30.00	50	50	55	48	1	2	0	14
27	10.00	15	15	26	30	1	1	0	17
28	10.00	50	50	65	47	1	1	1	17
29	1.50	4	4	27	47	1	1	0	12
30	5.00	5	5	50	36	1	1	1	16
31	10.00	25	25	50	54	1	0	1	14
32	5.00	10	0	40	41	1	0	1	13
33	50.00	50	50	22	34	0	1	0	12
34	10.00	10	10	44	62	1	1	0	15
35	5.00	10	5	30	54	1	0	1	14
36	10.00	25	25	38	51	1	1	1	16
37	50.00	125	125	32	40	1	1	1	15
38	50.00	50	0	22	51	1	1	0	8
39	5.00	10	10	9	7.	1	1	0	19
40	1.00	5	5	13	38	1	0	0	12
41	5.00	20	10	28	27	1	0	1	12
42	1.00	5	5	30	31	1	1	1	16
43	15.00	20	20	20	39	1	1	0	17
44	-10.00	15	5	21	75	1	1	0	16

NEW HAVEN DATA (SET 2)

OBS	DB	DG	FB	AI	AG	[illegible]	[illegible]	CN	EN
1	20.0	25.0	25.0	21.0	34	1	0	1	17
2	10.0	25.0	25.0	36.0	30	1	1	1	16
3	5.0	10.0	10.0	8.0	25	1	0	0	18
4	75.0	125.0	125.0	30.0	34	1	0	1	18
5	55.0	100.0	50.0	22.0	39	1	0	1	15
6	25.0	50.0	25.0	30.0	34	1	0	1	12
7	10.0	15.0	10.0	7.2	59	1	0	0	14
8	10.0	10.0	10.0	22.0	52	1	1	1	17
9	10.0	30.0	30.0	40.0	36	1	1	1	17
10	10.0	22.0	22.0	6.0	22	1	0	0	16
11	15.0	30.0	30.0	50.0	52	1	0	1	17
12	50.0	50.0	0.0	50.0	35	1	0	1	15
13	15.0	15.0	10.0	15.0	29	1	0	0	16
14	0.0	0.0	0.0	45.0	47	1	1	1	16
15	3.0	5.0	5.0	37.0	56	1	1	1	12
16	20.0	35.0	35.0	42.0	[illegible]	1	0	1	19
17	3.0	7.0	0.0	36.0	32	1	1	0	19
18	1.0	2.0	0.0	18.0	28	0	0	0	12
19	15.0	25.0	25.0	28.0	41	1	0	1	14
20	20.0	30.0	0.0	23.0	32	1	0	1	19
21	5.0	7.5	7.5	35.0	46	1	1	0	17
22	2.0	2.0	2.0	40.0	33	1	1	0	17
23	3.0	6.0	6.0	28.0	69	1	1	0	18
24	80.0	160.0	160.0	50.0	62	1	0	1	16
25	20.0	85.0	95.0	27.0	43	1	0	1	17
26	1.0	10.0	5.0	16.0	30	1	0	1	14
27	30.0	40.0	20.0	55.0	41	1	1	1	16
28	10.0	20.0	10.0	60.0	32	1	1	1	16
29	3.0	11.0	5.5	15.0	22	1	0	0	16
30	0.5	5.0	5.0	15.0	23	1	0	0	13
31	1.5	7.0	7.0	22.0	33	1	0	0	17
32	20.0	40.0	40.0	42.0	31	1	1	1	16
33	70.0	100.0	100.0	40.0	39	1	1	1	12
34	15.0	40.0	0.0	7.[illegible]	23	1	1	0	16
35	5.0	10.0	10.0	30.0	31	1	1	0	12
36	25.0	40.0	25.0	35.0	34	1	1	1	19
37	1.0	2.0	2.0	17.0	33	1	1	0	12
38	10.0	15.0	15.0	32.0	48	0	1	1	17
39	20.0	30.0	13.0	22.0	42	1	1	1	16
40	0.0	0.0	0.0	35.0	[illegible]	0	1	0	13
41	5.0	10.0	0.0	27.0	[illegible]	1	1	1	12
42	20.0	50.0	50.0	8.0	34	1	3	0	17
43	50.0	100.0	100.0	30.0	31	1	1	1	17
44	0.0	0.0	0.0	100.0	[illegible]	1	0	1	12