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INNOVATIVE APPROACHES FOR VALUING
PERCEIVED ENVIRONMENTAL QUALITY

METHODS FOR MEASURING NON-USE VALUES: A CONTINGENT VALUATION STUDY OF GROUNDWATER CLEANUP

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ABSTRACT

This study constitutes the third in a series of studies conducted for the USEPA exploring the use of the contingent valuation method (CVM) for valuing environmental benefits. The CVM is the only methodology now available for measuring non-use benefits which likely comprise a large portion of values for environmental commodities. The measurement of the total benefits (including use, altruistic, bequest and existence values) of cleaning up contaminated groundwater is necessary to evaluate a variety of programs including Superfund (CERCLA) and the Resource Conservation and Recovery Act (RCRA). In particular EPA has proposed a comprehensive regulatory framework for corrective action (55FR:30798-30884. July 27, 1990) based on the Hazardous and Solid Waste Amendments to RCRA of 1984 which broadened EPA's authority to include releases from all solid waste management units. The Office of Solid Waste is in the process of conducting a Regulatory Impact Assessment of this proposed rule which includes the costs and benefits of corrective actions regarding groundwater contamination. Thus, one immediate purpose of this study is to provide information for estimating the benefits of groundwater cleanup.

A theoretical model of the benefits from cleaning up groundwater shows that careful survey design is imperative to the measurement and estimation of values. Interdependent utilities (in the case of non-paternalistic altruism) generate values that may result in double-counting if the method of payment is not specified in the survey instrument (ie., one household need not pay to help another if the recipient household is able to pay to help itself). Intergenerational non-paternalistic altruism may also lead to double counting if benefits are summed for more than one generation (ie., if parents have paid to protect their children's interests, the children's values should not be counted again). Furthermore, an inherent confounding of bequest and existence values exists which suggests that these are best measured jointly. Paternalistic altruism for environmental goods and imperfect water markets leading to overuse today are also shown to be appropriate motivations for bequest values and some respondents were clearly motiviated by these concerns.

We then summarize what our studies have shown about measuring non-use values using the contingent valuation method (CVM). It is our view that there exists a fundamental difference between attempts to measure use and non-use (altruistic. bequest and existence) values, because respondents to surveys evaluating non-use values are in some cases uninformed about the commodity which they are asked to value. Thus, for non-use values, the burden of informing respondents about all aspects of the commodity falls on the survey instrument. In the case of non-use values, many respondents may not have the information necessaryto construct a meaningful value. Thus, since the survey instrument itself must provide the information necessary for respondents to construct values, opportunity for bias exists in the survey design if anything less than perfect Information is provided. Perfect

information includes, for example, not only information on the commodity itself, but also information on substitute commodities, how changes in the level of provision of the commodity will affect the respondent etc. In addition. perfect information implies the necessity of providing the complete psychological context of the economic decision.

Although it may seem that the requirements of perfect information and complete context provide an impossible burden on survey design, the study described here suggests an approach which may both avoid bias and provide a survey of practical length. This process draws much from a new area, cognitive survey design. First, a perfect information, complete context instrument is designed. Ideally, an expert panel would provide the necessary information The Office of Solid Waste at the USEPA served that role for us and provided a range of scenarios for valuation reflecting technical uncertainties. This instrument, while infeasible for field use (potentially, containing as much as 30 to 40 pages of material), can be used in pretesting where subjects are paid to "become experts." Both think-aloud verbal protocols and retrospective reports (wherein subjects speak continuously into a tape recorder while answering the survey or discussing what they were thinking while filling out the survey after the fact) are then utilized to identify problems with scenario rejection, embedding, etc., and to provide insight into critical information problems (ie., areas where mis-information exists). After redesign based on the verbal protocols and retrospective reports, this full information/complete context instrument is applied in a self-administered format to a large enough random sample of individuals so that a statistically meaningful estimate of values can be obtained. These respondents then answer a debriefing survey and are asked what information/context was used in constructing their values. Based on these self-reports, little used or unused information/context is removed in redesigning a more compact survey instrument. The redesigned instrument is then readministered to a new random sample of respondents and the stability of the distribution of values (as compared to the longer original instrument) can be tested. Using this approach we show that informed/full context values have a much smaller variance in values and a substantially lower mean value than uninformed values. Evidence is also presented (1) on the nature of measurement errors resulting from the use of hypothetical questions (these are shown to be right skewed). (2) on embedding (additional information and context are shown to reduce embedding) and (3) on scenario rejection.

A national mailing was undertaken to 5000 households using the shortened survey which resulted in a response rate of about 60%. Econometric analysis of the national mall survey was used to correct for possible measurement error (using a Box-Cox transformation). Three alternative approaches for calculating non-use values are shown to have provided remarkably consistent estimates of such values. All variants of the survey valued complete cleanup. Different variants also asked for the value of alternative programs. These alternative programs included a containment strategy in one case and a public water treatment program in another. A third variant of the survey investigated the change in willingness to pay as the degree of water shortage assodated with groundwater contamination changes. A final version of the survey investigated the willingness to pay for helping to clean up groungwater on a national basis. ‘Ibis last version was also used to oversample areas known to have contaminated groundwater and to further investigate the effects of different levels of information and contact in the survey instrument on value construction.

Additional research is suggested to consider the question of the appropriate market size for the application of the values in estimating national benefits. In addition. econometric methods will have to be developed to deal with situations in which willingness to pay with many true zero bids occurs with right-skewed errors.

By accepting the notion that non-use values must usually be constructed by respondents rather than assuming values preexist. several important philosophical questions arise. The political process often considers motives or values of the type economists consider to be measured in dollar estimates of non-use values. When parklands are set aside for the enjoyment of future generations and the preservation of wilderness, bequest and existence motives clearly reside in the minds of both constituents and their representatives. These motives, however, because of lack of choice experience, real world context and information may share many of the characteristics of what we have termed limited information/limtted context values. In other words, political preferences themselves maybe as incoherent and inconsistent as the contingent values challenged by critics of the CVM.

How might the use of the potentially coherent, consistent values which are created by the process we have outlined be justified? It has long been recognized that rapid changes in measures of attitudes can occur during a political process. However, as more is revealed about the issues (possibly equivalent to the development of full information/Ml context). attitudes crystallize, become stable and relatively constant over time. We would argue that economic values go through a similar process of crystallization. The appropriate goal, we would argue, for the CVM is to attempt to provide crystallized values for public decisionmaking. We hope to have suggested an unbiased process through which such values might be obtained.

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Chapter I

Introduction

This study is the third in a series of USEPA funded studies exploring the use of the contingent valuation method (CVM) for valuing environmental benefits[1]. The larger goals of this research have been to identify both what constitutes an acceptable contingent valuation (CV) study and to determine what the requirements are for reliable measurement of non-use as opposed to use values. The measurement of non-use values has become controversial and this study, building on prior work (which principally examined use values for air quality improvements). focuses on methodological issues in measuring non-use values for groundwater cleanup.

The benefits of groundwater cleanup are of interest to EPA in evaluating a variety of programs including Superfund (CERCLA) as well as the Resource Conservation and Recovery Act (RCRA). In particular EPA has proposed a comprehensive regulatory framework for corrective action (55FR:30798-30884, July 27, 1990) based on the Hazardous and Solid Waste Amendments to RCRA of 19S4 which broadened EPA's authority to include releases from all solid waste management units. The Office of Solid Waste is in the process of conducting aRegulatory Impact Assessment of this proposed rule which includes the costs and benefits of corrective

1 see, Schulze, et. al., 1990, and McClelland, et. al., 1991.

actions regarding groundwater contamination. Thus, one immediate purpose of this study is to provide information for estimating the benefits of groundwater cleanup.

The report is organized as follows: Chapter II defines the sources of benefits which might arise from groundwater cleanup and analyzes a number of theoretical issues relevant to the measurement and estimation of benefits, especially as regards non-use values. Given the controversy surrounding the measurement of non-use values, Chapter III summarizes our methodological research Into the roles of information and context, embedding, hypothetical error, and scenario rejection. Chapter III also seines as a summary of our research tidings on non-use values for groundwater cleanup. Chapter IV = details our initial research and pretesting of a perfect information/full context survey instrument while Chapter V presents the design and pretesting of the mail survey Instrument. Chapters VI and VII present and analyze the results of a national mail survey estimating groundwater values. Chapter VIII discusses limitations of the study as well as suggestions for future research.

Chapter II

A Theoretical Basis for Estimating the Benefits of Groundwater Cleanup

2.1 Introduction

The total value of groundwater cleanup or preservation can be defined as consisting of four components:

- Use Value - the direct value to each household for the clean water they consume themselves (including any adjustment for uncertainty which has been termed option value):

- Altruistic Value - the value that households place on other households having clean groundwater today:

- Bequest Value - the value that the current generation places on the addability of clean groundwater to future generations:

- Existence Value - the value that individuals place on simply knowing that groundwater is clean independent of any use, i.e., the value that would remain for cleanup even if people never used the water.

The latter three categories are generally termed non-use values (see Krutilla, 1967). The application of these value measures in the case of groundwater is not as straightforward as might be supposed. This occurs both because of a possible confounding of use, altruistic, bequest values and existence values and because water markets themselves are highly imperfect.

2.2- A Model of Intergenerational Choice

To explore these issues, we construct a model of intergenerational choice which allows both for groundwater cleanup and assumes that the utility of the present generation (denoted as generation 1) depends on the utility of future generations (collapsed for simplicity into one future generation, generation 2). Thus, we begin the analysis with the assumption of non-paternalism (see Archibald and Donaldson, 1976). That is, generation 1 cares only about generation 2s utility, not about their specific pattern of consumption, Le., generation 1 respects generation 2s tastes. We explore paternalism later since this issue is central to the application of bequest values for groundwater in benefit - cost analysis. In the model let:

X^o = initial stock of clean groundwater.
Z^o = initial stock of contaminated groundwater.
D = amount of groundwater which is decontaminated.
z = $Z^o - D$ = groundwater which remains contaminated.
W_1 = water use now.
W_2 = water use in the future.

C_1 = consumption now,
C_2 = consumption in the future,
Y_1 = income now,
Y_2 = income in the future,
r = interest rate,
$U^1(W_1, C_1, Z, U^2)$ = utility now $(U^1_w, U^1_C, U^1_2 > 0; U^1_Z < 0)$.[1]
$U^2(W_2, C_2, Z)$ = utility in the future $(U^2_w, U^2_C > 0\ U^2_Z < 0)$,
E(D) = cost (expense) of decontamination (E', Et' > 0).[2]

Note that we assume that generation one's utility, U^1, is an increasing function of their own use of groundwater, W_1, their own dollar valued consumption, Cl, and the next generation's utility. U^2. It is also a decreasing function of the amount of contaminated groundwater remaining after decontamination efforts, $Z = Z^0 - D$. The cost of decontamination incurred by generation 1, E(D), is assumed to increase at an increasing rate and approaches infinity as $D \rightarrow Z^0$. The utility of future generation, U^2, is a function of their own water use, W_2, consumption, C_2, and the remaining stock of contaminated groundwater, Z. Any direct disutility to both generations from Z provides a source for existence value in the model. Note that we exclude altruistic value as defined above from this analysis by not explicitly modeling individuals within generation 1 and 2 who may have altruistic preferences for each other. Madariaga and McConnell (1987) and Jones-Lee (1991, 1992) have examined this case in detail and we will summarize their results later.

Two constraints apply to this intergenerational choice problem. First, the availability of groundwater must be defined for the present and future generations. To simplify matters for theoretical purposes, we assume that

1 Subscripts denote partial derivatives.
2 Primes denote derivatives.

no recharge occurs, so groundwater, which is also the only source of water, is "mined." This implies that

(1) $$X^o + D \geq W_1 + W_2.$$

so the initial stock of clean water, X^0, plus the amount of decontaminated water, D, is available for use now and in the future. Second, the intertemporal budget constraint must be specified. This takes the form

(2) $$(1+r)\,[Y_1 - C_1 - E(D)] + Y_2 - C_2 \geq 0,$$

so any savings out of the first generations income, Y_1, after they spend Cl and E(D), accrue Interest at rate r and are available to future generations to increase their consumption, C_2, above their initial income, Y_2. Thus, we assume that perfect intertemporal capital markets exist across generations.

Given our assumption of non-paternalistic intergenerational altruism, no intertemporal planning inconsistency exists (Blackorby, et al., 1973), so an efficient solution can be obtained by maximizing the first generation's utility,

(3) $$U^1(W_1, C_1, Z^o - D\ U^2(W_2, C_2, Z^o - D)).$$

alone (since they must decidehow much cleanup to fund), subject to constraints (1) and (2) specified above. Note that generation 1 chooses both for itself and the future but because of non-paternalism, given the resources left to it generation 2 voluntarily makes the same choices as made for it by generation 1. Two conditions which emerge from the solution, where we rule out comer solutions and assume the contraints are binding, are of special interest. First, the condition for optimal use of groundwater over time,

$$(4) \qquad \frac{U_w^1}{U_c^1}(1+r) = \frac{U_w^2}{U_c^2},$$

can be interpreted as a Hotelling condition such that the price or value placed on water at the margin by generation two (U_w^2/U_c^2) is equal to the marginal value (or price of water) for generation one (U_w^1/U_c^1) increased by the intergenerational interest rate. Thus, the price of water must increase at the rate of interest over time and, for efficiency, a perfect intertemporal market for water (obviously an unrealistic assumption which we consider later) in which the relative values and use now and in the future are balanced by the interest rate must exist. Given (4). wc can write the second condition of interest, that for the optimal level of decontamination, D, as

$$(5) \qquad \left[\frac{U_z^1}{U_c^1} + \left(\frac{1}{1+r}\right)\frac{U_z^2}{U_c^2}\right] + \left[\frac{U_w^1}{U_c^1}\right] = E'.$$

(a) (b) (c)

where the left hand side consists of the marginal benefits of groundwater cleanup and the right hand Side (term (c)) is the marginal cost of cleanup. Term (a) is, unsurprisingly, the discounted present value of marginal existence values over the present and future generation. Term (b), on the other hand, is something of a surprise just reflecting generation ends use value of water with no adjustment whatsoever for bequest value. In other words. With non-paternalistic altruism and perfect water markets bequest values should not be considered in benefit-cost analysis of groundwater cleanup[3]. This occurs because, with perfect water markets, the price of water today, term (b) in equation (5), fully reflects' the opportunity cost of groundwater in future use as determined in the intertemporal water use tradeoff of equation (4). Since many CV studies have estimated large bequest values, this raises the question as to whether or not such values should be incorporated in the benefits of groundwater cleanup. In what follows we relax each of the assumptions required for this result. However, before relaxing these assumptions, we must point out a fundamental confounding of existence and bequest values which results from non-paternalistic altruism. In term (a) of equation 5, which we have defined as existence value, the discounted present value of the second generation's existence value is present solely as a result of the altruism of generation 1 for generation 2. Thus, the expression $(\frac{1}{1+r})(U_z^2/U_c^2)$ could be considered a form of bequest value. Given this confounding, attempts to ask survey respondents to accurately provide separate estimates of bequest and existence values are likely to fail.

Can bequest values result from imperfect water markets? The relevance of this question can be illustrated by water use patterns in

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[3] In stating that "*In the extended model in which some citizens may be concerned about the happiness of others, the part of willingness-to-pay that arises on account of altruistic feelings must be excluded from the benefit-cost calculation in order to identify correctly the projects that are potential Pareto improvements*" Milgrom reaches the same conclusions (Milgrom, 1992, p. S, italics in original) which has been available in the public goods literature for many years (see Hochman and Rodgers (1%9) and Daly and Giertz (1972)) as WC(I as the CVM literature (see Madariaga and McConnell (1987)). However, based on a simple illustrative example, Milgrom shows that non-paternalistic altruism should not be double counted without acknowledging the possibility of either intra- or inter-generational paternalistic altruism and thus incorrectly rejects all altruistic benefits from benefit-cost analysis. Similarly, he fails to consider the impact of imperfect natural resource markets resulting in current overconsumption, an issue which we address below.

California which recently suffered from a prolonged drought. Water users in central valley communities such as Sacramento are unmetered and consequently continued to use more than twice as much water per capita as neighboring communities with meters and priced water. At the same time, water intensive, low profit crops have continued to use vast quantities of subsidized water in spite of the water "shortage" (e.g., rice, a major California crop which requires 1.600 gallons of water per dollar of rice produced). Many communities have been forced to increase their dependence on and use of groundwater under these circumstances. Many of our respondents were concerned about the availability of groundwater in the future because of perceived overuse today.

One way to account for over-consumption of groundwater by generation 1 in the model developed above is to add an additional constraint which “forces” use by generation 1 to exceed the efficient level. This constraint takes the form:

$$(6) \quad W_1 \geq \bar{W}$$

where $\bar{W}$ is an inefficiently high level of use for generation one. In maximizing (3) subject to (1), (2) and (6) the new conditions for water use and decontamination take the form:

$$(7) \qquad \frac{U_w^1}{U_c^1}(1+r) < \frac{U_w^2}{U_c^2} \quad \text{and}$$

$$(8)\quad -\left[\frac{U_z^1}{U_c^1}+\left(\frac{1}{1+r}\right)\frac{U_z^2}{U_c^2}\right] \qquad + \left(\frac{1}{1+r}\right)\left[\frac{U_w^2}{U_c^2}\right] = E'.$$

(a) (b) (c)

In (7) the marginal value of groundwater to future generations (U_W^2/U_C^2) can now be arbitrary high relative to the marginal value to the present generation (U_W^1/U_C^1) depending on how short the future supply of groundwater is as a result of current over-consumption. The failure of equality to hold in (7) implies an important change in (8) as well. Term (b) which was current use value in (5) is now replaced by the present value of future use value. A bequest value can now be derived as follows. The left hand side of (8) represents marginal benefits. The benefits of groundwater cleanup in this model consist of use value to the present generation, bequest value and existence value. These three components can be defined at the margin as

(9) use value = (U_W^1/U_C^1)

(10) bequest value = $\left(\frac{1}{1+r}\right)(U_W^2/U_C^2) - (U_W^1/U_C^1)$

and (11) existence value = $-\left[\frac{U_z^1}{U_c^1}+\left(\frac{1}{1+r}\right)\frac{U_z^2}{U_c^2}\right]$

which sum to the left hand side of (8). Note that if (7) holds with equality, i.e., water markets are perfect and the present generation is not over-exploiting groundwater, bequest value is zero in (10). Bequest values arise from current over-exploitation which raises the discounted present value of future water use above the value of current water use as shown in (7). The differential is the extra Willingness to pay by the current generation, above their own use value, to redress the inefficiency of over-exploitation of the resource. In spite of the awkwardness of defining bequest values in this way, this argument is consistent with the underlying psychology of bequest values in which people today are worried that insufficient resources will be left to future generations. This worry is justified by the introduction of market failures which result in over-exploitation of non-renewable or renewable natural resources.

Another source for bequest values which might be appropriately added to use value arises when the current generation has paternalistic preferences with respect to fixture generations. In this case, the current generation might respect the preferences of future generations over personal consumption but feel some special obligation to provide a clean environment. Water, land, air, and wild species could thus be viewed as somehow different from other "commodities" and merit special concern and stewardship by one generation for the next. As shown in Chapter 3, where we discuss the verbal protocols, many respondents rejected the notion of compensating future generations with money. Rather, many individuals preferred to cleanup groundwater today - direct evidence for non-paternalistic altruism with respect to groundwater. To capture this possible "special" concern beyond non-paternalistic altruism, we modify the utility function of the first generation to include W_2, consumption of groundwater by generation 2, as a direct argument as well as by continuing to include W_2 indirectly as part of the second generations utility function. Thus, (3) is replaced by

(12) $U^1(W_1, W_2, C_1, Z^o - D.\ U^2(W^2, C_2, 2P-D))$

for maximization subject to (1), (2) and (3). We continue to assume water market failure. The condition of interest for D. the amount of decontamination, takes the form:

$$(13)\quad -\left[\frac{U_z^1}{U_c^1} + \left(\frac{1}{1+r}\right)\left(\frac{U_z^2}{U_c^2}\right)\right] + \left(\frac{1}{1+r}\right)\left(\frac{U_{w_2}^2}{U_c^2}\right) + \left(\frac{U_{w_2}^1}{U_c^1}\right) = E'.$$

(a) (b) (c)

Term (a) again provides existence value, term (b) incorporates both use value and any bequest value arising from water market failure, while term (c) provides a paternalistic bequest value for availability of water to future generations. An important point is that this paternalistic bequest value is not discounted at the market rate of interest, r, which does however apply to term (b). Thus, this source of value, if present, could be large for some types of natural resources. It should be noted that the empirical issue of paternalism has provoked considerable debate (e.g., that between Pollack and Becker). However, because of the obvious altruism of parents towards their children, some type of intergenerational altruism is generally assumed to exist. In the design of our surveyinstrument, described in the following chapters, we will carefully define bequest values for respondents, both because of the issue of paternalism and because intergenerational interdependence does present the possibility of the double counting of benefits.

Double counting may arise with non-paternalistic altruism if one evaluates the benefits of cleaning up an unusable aquifer by taking the discounted present value of use values over time beyond the life span of the present generation. If use values are discounted and totaled as the water is extracted (say, over two generations) and one then adds bequest value of generation one which arises from over-exploitation to this figure, the value to the second generation will be counted twice. Assuming non-paternalistic altruism, if the use value analysis over two generations properly accounts for the increase in value to the second generation due to scarcity introduced by over-exploitation, an alternative measure of bequest value is already included. In other words, the bequest and use value of generation one measured by term (b) in (13) already accounts for the use value of the next generation. Paternalistic bequest values are not subject to this double counting problem. To be conservative the future discounted present value of use values should not be added to bequest values. These points are a straightforward extension of those made by Madariaga and McConnell (1987) for the case of altruistic values. They also argue that double counting can result for these values in benefit-cost analysis.

Finally. Madariaga and McConnell demonstrate that the assumptions presented in a CV study about who pays for environmental improvements can affect bids just as their theory and the arguments of Jones-Lee suggest. From a theoretical perspective respondents in the case of altruistic values should be informed that everyoneepays for cleanup. In this situation, with non-paternalistic altruism, no bequest values should be present. However. the results of this study suggest that paternalistic motives are present among some respondents.

2.3 Conclusions

The conclusions which can be drawn from theory that are relevant for survey design and benefit estimations are as follows:

- The method of payment by others for groundwater cleanup must be specified so that, in the case of non-paternalistic altruism, altruistic values will not be overstated by respondents (Madariaga and McConnell). otherwise respondents may assume that the cleanup for others will not occur unless they themselves pay for it. Our surveys are designed so that cleanup scenarios are funded by an. increase in water bills for everyone.

- Bequest values (intergenerational altruism) may suffer from the same type of double counting as proposed by Madariaga and McConnell. Thus, only the values of the present generation should be considered for benefit-cost analysis. The survey design should specify a payment period (say 10 years) over which cleanup will be completely paid for. A conservative approach is to assume that the discounted present value over this period (say 10 years) for those payments constitutes the entire benefit stream.

- Given intergenerational altruism, bequest and existence values are inherently confounded in a way that respondents arc unlikely to understand unless trained in economic theory. Thus, these, sources of non-use values are best estimated jointly.

- Bequest values may arise solely because of a belief that the present generation is overusing groundwater resources today.

Chapter III

Methodological Issues in Using Contingent Valuation to Measure Non-Use Values

3.1 Introduction

The usefulness of the Contingent Valuation Method (CVM) for estimating non-use values has come under attack[1] . This chapter summarizes what has been learned about the CVM in a series of USEPA funded studies which have had as their goal both an assessment of: (1) what constitutes an acceptable CV study and (2) how the nature of the commodity to be valued affects that acceptability. The groundwater study reported herein is the latest in this series. In our view, there exists a fundamental difference between attempts to measure use and non-use (bequest and existence) values because respondents to surveys evaluating non-use values are essentially uninformed about the commodity which they are asked to value. Thus, for non-use values, the burden of Informing respondents about all aspects of the commodity falls on the survey instrument. In the case of

[1]For example, Diamond and Hausman (1992) concluded. based on an assessment funded by EXXON which involved a lengthy list of other collaborators, that "CV does not provide a reliable method to calculate natural resource damages. The inevitable outcome is great uncertainty about the level of damages which maybe assessed since a clearly defined correct method of doing CV evaluations is only a figment of CV proponents imaginations”. (Diamond and Hausman, p. 32-33)

non-use values, many respondents may not have the information necessary to construct a meaningful value.

Use values, by their very nature, suffer less from this problem because respondents are familiar with the sommodity and have a real world decision context to frame their value. In the case of non-use values, the survey instrument itself must provide the information necessary for respondents to construct values. Therefore, the opportunity for bias exists in the survey design if anything less than perfect information is provided. Perfect information includes not only information on the commodity itself, but also information on substitute commodities, how changes in the level of provision of the commodity will affect the respondent etc. In addition, perfect information implies the necessity of provtding the complete psychological context of the economic decision (Fischhoff and Furby, 1988).

Although it may seem that the requirements of perfect information and complete context provide an impossible burden on survey design, the groundwater study described here suggests an approach which may both avoid bias and provide a survey of practical length. This process, summarized here and described in detail in SectIon 3.2 draws much from cognitive survey design. First, a perfect information, complete context instrument is designed. Much of the information in the survey ideally comes from experts who provide a range of scenarios for valuation reflecting technical uncertainties. This instrument, while infeasible for field use (potentially, containing as much as 30 to 40 pages of material), can be used in pretesting where subjects are patd to “become experts.” Both think-aloud verbal protocols and retrospective reports (wherein subjects speak continuously into a tape recorder while answering the surveyor discussing what they were thinking while filling out the survey after the fact) are then utilized to identify problems with scenario rejection and to provide insight into critical infromation problems (i.e., areas where misinformation exists). After redesign based on the verbal protocols and retrospective reports, this full information/complete context instrument is applied in a self administered format to a large enough random sample of individuals that a statistically meaningful estimate of values can be obtained. These respondents then answer a debriefing survey and are asked what information/context was used in constructing their values. Based on these self-reports, little used or unused information/context is removed in redesigning a more compact survey instrument. The redesigned instrument is then re-administered to a new random sample of respondents and the stability of the distribution of values (as compared to the longer original instrument) is examined. Using an approach similar to the idealized description presented above we show that informed/~ context values have a much smaller variance in values (and a substantially lower mean value) than uninformed values.

We also show that, when this process is employed, three alternative approaches for obtaining non-use values for groundwater provide consistent estimates. Such values may be of much greater use for policy making than relying on uninformed or partly informed values obtained from CV studies which do not follow the principle of cognitive survey design. However, there is a philosophical issue of the appropriateness of using informed/full context values for public decisionmaking given that the public may hold uninformed values which are quite different from those obtained using this approach. but which are likely to be reflected in the political process

Other than the central issue of information and context in survey design three additional sources of hypothetical bias, which we define as the difference between the distribution of hypothetical bids obtained from a survey and the distribution of bids that would obtain in a real world incentive-compatible market setting, are discussed in this chapter. These are: (1) embedding (2) large positive outlier bids: and (3) refusals to bid. We will summarize what is known about these possible sources of hypothetical bias on the basis of our two prior methodological studies which we conducted to explore the issue of bias as well as from the results of this study. The first of these uses the Denver air quality problem as the commodity to be valued (Schulze, et al., 1990). This study forms the basis for the second study of U.S. east coast visibility values (McClelland, et al. 1991).

The commodity chosen for the first methodological study, air quality in the Denver metropolitan area, has three features which make it appropriate for exploring sources of error. First, a careful psychological study of how residents perceive air pollution in the region is available (Stewart et. al. 1983, 1984). Second. one of the primary features of Denver's air pollution problem, the "Brown Cloud," is that it obscures views of both the center dty skyline and of the Colorado Front Range and is visible throughout the city. Thus, air pollution has relatively little effect on property value markets, so residents have had little or no market experience with the commodity. Third, a high level of awareness of the problem and a community consensus that something must be done has been achieved in the region. For example, the Chamber of Commerce has strongly supported new proposed air pollution controls and innovative measures such as use of oxygenated fuels that have receied wide public support. Although residents have had little or no market experience with the commodity, most have at least thought about the problem. Our choice of commodity can thus be seen as an attempt to examine hypothetical bias by moving away from market experience while still retaining a commodity for which the public has a clear sense of both the nature and importance of the commodity itself. The eastern (U.S.) visibility study then attempts to resolve a number of serious problems which arose in an earlier study (Tolley et al., 1985).

The chapter is organized as follows: SectIon 3.2 summarizes our research tidings on the role of information and context. Sections 3.3, 3.4 and 3.5 describe our evidence on embedding large outlier bids, and scenario rejection.

3.2 The Role of Information and Context In Cognitive Survey Design

3.2.1 Background

Although, in developing the CVM, economists approached survey design as relative neophytes, two principles rapidly became established. These were: (1) that the commodity to be valued must be well defined (e.g., through use of photographs, maps. detailed descriptions of impacts, etc.), and (2) that a realistic payment vehicle (e.g., an entrance fee) must be used so that respondents would consider the hypothetical situation as a transaction rather than as a charitable donation (see Randall, Ives, Eastman, 1974: and Schulze, d'Arge and Brookshire, 1981, for early statements of these principles, which were later reinforced in Cummings, Brookshire and Schulze, 1988, and Mitchell and Carson. 1989).

Tests of the reliability of the CVM in measuring use values such as those conducted by Bishop and Heberlein (1978) who compared contingent values for goose hunting permits to actual transactions in a field experixnen~

BrookShire et. al. (1982) who compared contingent values for Los Angeles air quality to those obtained in a hedonic study of property values and Smith, et al. (1986) who compared contingent values for water quality along the Monongahela River With values obtained using the travel cost method gave researchers considerable confidence in the CVM when the two design principles noted above were carefully employed.

However, early application of the CVM in measuring non-use values gave researchers considerable pause. For example, Schulze et.al. (1983) obtained very large values for preserving visibility at the Grand Canyon. Concerned about the size of the values, they cautioned: 'To our knowledge. this is the first study attempting to estimate existence values per se. Thus, the methodology used in this study should be viewed as experimental." Cummings, Brookshire and Schulze (1986) conclude in their assessment of the CVM that the method might not be reliable for measuring unfamiliar commodities such as non-use values. They argued that the apparent reliability of the CVM shown for use values resulted from the fact that respondents had actual choice experiences with respect to the commodity and its value to them (e.g., whether to live in a polluted area of Los Angeles or to pay a higher price for a home in an area of clean air).

To remedy the familiarity problem for "exotic"[2] or unfamiliar commodities, Mitchell and Carson (1989) and Fischhoff and Furby (1988) as well as other researchers suggested that much more context was needed in survey instruments so that respondents would actually value what the survey researcher intended the respondents to value. Fischhoff and Furby (1988) provided convincing examples of how citizens might interpret survey

[2]The term "exotic" was suggested by Kahneman and Knetsch (1992).

questions in ways never imagined and how respondents might employ prior beliefs in constructing values inconsistent with those assumed by the researcher.

Motivated by these arguments we began a program of research at the University of Colorado funded by USEPA to explore the effect of information and context on survey values. Two of these studies are relevant to this discussion. The first examined eight alternative survey designs which varied both the amount of information and the context presented in the survey instruments for a familiar commodity. Denver's "Brown Cloud." The use values obtained in this study were quite robust to variation in survey design. Even given the careful attention paid to defining precisely the proposed improvement in air quality in the study and the plausibility of the payment vehicle (in fact higher gasoline prices did later result from mandated use of oxygenated fuels). the stability of values was surprising. The Eastern Visibility study reinforced these conclusions. The aim of our current study is to estimate non-use values for groundwater cleanup. This commodity, of great interest to USEPA, also appeared to be ideal for a methodology study since in early development work undertaken for USEPA by Mitchell and Carson (1989) it was apparent that (1) people were generally poorly informed about groundwater contamination and (2) people resisted the non-use scenario used for valuation in which groundwater was to be preserved but never used. In other words the scenario was rejected by respondents. Delighted with our exotic commodity, groundwater cleanup, our strategy was to apply two new tools in designing the survey instrument.

First, in our work on the "Brown Cloud," we collaborated with Paul Slovic, Sarah Lichtenstein and Robin Gregory (see Irwin, Slovic, Lichtenstein and McClelland, in press) who argued persuasively that, when faced with an unfamiliar commodity, respondents must construct a value rather than relying on some pre-existing value to which they could refer (see Gregory, Lichtenstein and Slovic, 1992). Clearly, given the lack of information demonstrated by respondents in earlier work on groundwater values, informed values would have to be constructed by our respondents based on the information and context provided in the survey instrument.

Second, a revolution has been underway in survey design motivated by the discovery made through the use of verbal protocols (See Ericsson and Simon, 1984, for a description of use of verbal protocols) that seemingly clear questions are interpreted in surprising ways by respondents (at least surprising to those who designed the survey). Application of the new methods of cognitive survey design would provide insights hitherto obtained only with difficulty through extensive use of focus groups or individual debriefings (see Jabine et al., 1984, Cannell et al., 1989, and Willis et al., 1991, for discussions of cognitive survey design).

The remainder of this section will summarize the initial survey design developed for groundwater values, testing with verbal protocols and retrospective reports and final design based on self-administered survey samples.

3.2.2 Design of a Perfect Informatin/Complete Context Survey Instrument

Freed from the usual length constraints imposed by designing a survey we pursued the goals of providing perfect information and complete context. The resulting pre-test instrument (described in detail in Chapter IV) was 24 single spaced pages in length and asked respondents to evaluate a completely hypothetical situation of living in a community whose own public landfill had polluted its own groundwater. The objective of the survey was to obtain use and non-use values for decontaminating the groundwater. The instrument was organized as follows: (1) Respondents were educated about groundwater - how fast it moves (very slowly, 100's of feet per year) and how groundwater contamination occurs (a diagram was used). (2) A risk ladder was presented showing relative and absolute risk of drinking the contaminated groundwater. (3) Respondents were asked how they would adjust to a 50% water shortage assuming their groundwater source could not be used as a result of the contamination. (4) A willingness to pay was obtained for buying supplemental temporary piped in water for a one year period using a temporary surcharge on the monthly water bill as the vehicle. (5) In-home water purification was described and costs presented before asking respondents If they would choose this approach. (6) To provide for future generations, an alternative surcharge was proposed to the water bill; money collected would be Invested for 50 years in a trust fund and guaranteed to be made available to future generations to solve their future water availability problems (subjects were informed that $1 invested for 50 years would yield $100 at a 10% interest rate). This was an attempt both to inform respondents about discounting and to obtain a direct measure of bequest values. (7) Public water treatment was described in which a plant would be built to treat water as needed for current use: a value was obtained through a water bill surcharge. (8) Complete groundwater treatment was described in which contaminated groundwater is pumped, cleaned and re-infected so that present and future generations are assured of the availability of clean groundwater. Again, a water bill surcharge was utilized to collect the Willingness to pay. (9) For the final value in (8) respondents were asked to state if their dollar value was just for cleaning up groundwater or if any part of it was for a list of good causes. If they indicated that their stated value was somewhat for other causes they were asked what percent of their bid was just for groundwater cleanup. Respondents were then asked how much of the amount just for groundwater cleanup, as a percent, was for use value and how much for several categories of non-use values. These questions test for any embedding problem and allow a correction to be made (see Section 3.3 for a complete discussion of embedding). (10) Socioeconomic questions completed the survey.

Each of the valuation questions included considerable detail on how programs would be funded and what the money would be used for as well as assurances as to what would be accomplished with the money. Many of the scenarios (3-7 above) represent substitute public or private actions as alternatives for complete groundwater cleanup as presented in (8). Presentation of substitutes is critically important for constructing the value of complete groundwater cleanup. According to utility theory, lack of a substitute will increase the value of a commodity; respondents may be unaware of or fail to think of substitutes for an unfamiliar commodity. Fischhoff and Furby also made the related point that if information or context is not provided, respondents will make default assumptions in constructing values. For groundwater a relevant default scenario might be that people at some future time might have no water to drink unless complete cleanup occurred. Obviously, substitutes such as importing water, surface treatment, etc., demonstrate the unlikely nature of this potential default assumption.

The information used in designing the survey was developed for us by staff members of the Office of Solid Waste of USEPA who served in effect as our "panel of experts." Their technical statements were reworded to be more understandable to the lay person. We now turn to the results of the verbal protocols and retrospective reports.

3.2.3 Verbal Protocols and Retrospective Reports

Many survey design problems can be uncovered rapidly with complete documentation through the use of verbal protocols and retrospective reports. Randomly chosen adult subjects from a nearby (non-university) community spoke continuously into a tape recorder as they completed the survey and responded to additional predetermined prompts from the monitor. These sessions lasted about two hours each. We focus on two design issues: (1) the role of information and (2) rejection of the context provided for a valuation question, a phenomenon which has been labeled scenario rejection which is discussed more fully in Section 3.5 in terms of the impact of scenario rejection on data analysis (a selection problem arises).

The response to the groundwater information. especially the slow rate at which groundwater moves, is summarized in the following statements drawn from the transcripts of the verbal protocols and retrospective reports from six different individuals: (1) "Probably not very fast. Probably depends on where the water comes from 2 feet/second. 2 hours . . ..Maybe 10 miles." (2) "Very surprised [to learn groundwater speed]. I didn't realize that." (3) "Extremely surprised. Think about a potted plant, pour it In and it runs out immediately." (4) "30 miles an hour/ tops. It shoots out of there pretty quick . . . It's got to be quicker than people would guess. Not nearly as quick as a river but I know it flows out of the fields." (5) "It seems like it could go through a mile in a matter of an hour if the water is moving that fast....I would have to guess on something that is fairly shallow like a city water supply it could go at the most maybe 10 or 15 miles.” (6) “Not surprised. I thought it moved slower. I had a geology class recently and that was part of the aquifer and aquafluids so I was aware of how groundwater works and functions.”

The prevailing view that groundwater moves very quickly translated for some respondents into a default assumption that contamination would quickly spread over a very large area, implying larger values than the actual situation would suggest. Interestingly however, although many people had a mental model of how groundwater ‘Works” which differs from that of scientists, they apparently recognized that their model was not factually based and readily adopted the model presented in the groundwater Information section of the survey instrument.

In strong contrast to the willingness of respondents to adopt the groundwater mental model presented in the survey, respondents completely rejected the notion of a fund for future use which would accumulate Interest for 50 years to provide for future generations. Their mental model of such a trust fired differed dramatically from that presented in the survey as shown in the following statements taken from eight ***of the verbal*** protocol and retrospective report transcripts: (1) “No. Just In the sense that I don’t know if...I don’t know in a sense that it would be them. They might spend it on something else. Priorities get mixed up.” (2) “Well, again, when are they going to dip into it to use it.... Local government and unions, people want to dip into this fund that sits there to use it and will make it up later and whether or not that happens is...we sure hope so but to take it in and say it cannot be touched and we are going to let it grow for x amount of years you have to trust that that is going to happen.” (3) “I think it’s a crock...It’s like freezing your body to see if there is something in the future to handle it. I’m not a big believer in that." (4) "I don't lend much credence to guarantees through government systems or whoever Is handling the water. If they could give some feedback on what money they received and what sort of use the money is going towards I would be a lot more satisfied. Until then I would be willing to risk only a bit until we find out what will happen with that." (5) "I'd like to believe it, but when they start talking about the S&L scandal. I don't know." (6) [worth of $1 in bank for 50 years] 'probably 10 cents." (7) "I don't think it would be there the way my bank has service charges. They'd take it. In 50 years, I should know, I'd guess $25." (8) "$1OO for $1 after 50 years? I don't really believe that."

None of the other valuation scenarios provoked this sort of negative . reaction. Respondents found the context of this bequest value question unacceptable and many bid zero dollars even though they indicated elsewhere that they were concerned about preserving groundwater for future generations. Respondents also showed a strong preference for cleaning up groundwater now rather than providing monetary compensation - suggesting paternalistic preferences. Scenario rejection can mislead researchers into concluding that people have no value when instead a design problem has occurred. Unfortunately. changes in "context" which supposedly show the unreliability of the CVM can be unintentionally manufactured by comparing two contexts for the same value, one of which is rejected, and one of which is accepted by respondents. The rejected scenario produces many zero values. drastically lowering the mean, while the accepted scenario provides an actual estimate of the underlying value.

3.2.4 Self-Administered Pretests

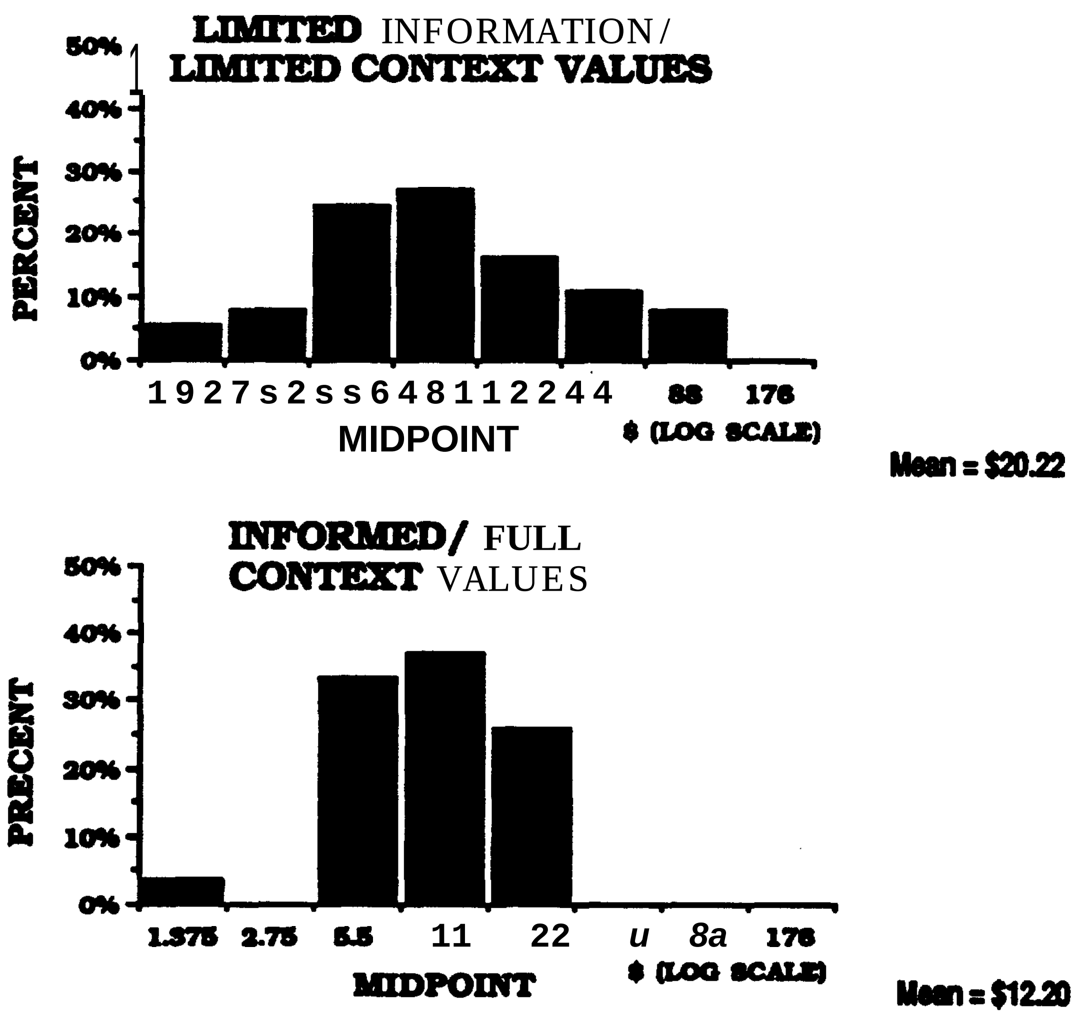
Following the verbal protocols and retrospective reports, two groups of about 40 subjects were randomly chosen from the Denver metropolitan area and brought to a msrket research center (this work is described in detail in Chapter IV). Group 1 was presented only with a description of the physical situation and then directly asked the valuation question on complete groundwater treatment. Thus, the material described in Section 3.2.2 as steps (1) - (7) was deleted from the survey. In other words, both groundwater information and substitute scenarios were deleted. Group 2 was presented with the full information/complete context survey as described in Section 3.2.2. Figure 3.1 presents the frequency distribution of raw values (unadjusted for embedding) obtained from Group 1 (upper panel) and from Group 2 (bottom panel). Scenario rejectors have been deleted from both groups. Two points should be noted. First, a collapse in the variance of values has occurred in the informed/full context values (lower panel) in comparison to the limited information/limited context values (upper panel). Second, to normalize the appearance of the distributions they have been plotted on a log dollar scale. This suggests that errors in bidding which result from lack of information and context are approximately log normally distributed. In fact, although the Group 1 mean is $20.22. and the Group 2 mean is $12.20, the logarithmic means for the two groups are not statistically different.

This result lends additional support to our contention that value errors are log normally distributed, which we have shown both In laboratory, experimental work and through econometric analysis where regressions employ a Box-Cox transformation of the dependent variable (see Section 3.4

for a discussion of hypothetical error). These Box-Cox regressions support a log normal error distribution for contingent values.

Respondents in the self administered perfect information/full context group were given an additional written debriefing survey which they filled out after completing the original instrument. In this debriefing they were

FIGURE 3.1: WTP FOR COMPLETE GROUNDWATER CLEANUP PRETEST V.



asked if each of the information/context components of the original survey raised. lowered, or had no effect on their value for complete groundwater cleanup. These data were then used to shorten the instrument by eliminating or summarizing less Important components of the information/context provided in the original design. The redesigned survey instrument was twelve pages in length and was re-admfnistered to 117 randomly chosen Denver residents in the market research center (see Chapter V for details of this process). Values remained stable as compared to the initial pre-test and removing the abbreviated information and context provided had a similar impact to that shown in Figure 3.1.

3.2.5 Three Methods of Estimating Non-Use Values for Groundwater

Contingent valuation is the only method now able to measure non-use values. It is possible, however, to design CV studies in which the internal consistency of estimated non-use values can be compared. The national survey valuing groundwater cleanup which resulted from the design process described above included variations of the survey instrument in order to provide three alternate approaches for estimating non-use values. (1) Percent Split Approach: all versions of the survey asked for the value of complete groundwater cleanup and for how respondents' values were divided between categories defined as use and non-use values. (2) Scenario Difference Approach: One version of the survey asked respondents for their value for a public treatment option which would only cleanup water as used and thus mostly excluded values for future generations since they would bear the cost of operating and maintaining the treatment plant. The public treatment option mostly captures use value so the difference between the value for total cleanup and public treatment approximates (but likely underestimates) non-use values. (3) Extrapolation Approach: Another version of the survey asked respondents how much they would value the complete groundwater cleanup if the contamination led to a 10%, 40%, or 70% water shortage. We modeled each individual's three values as a quadratic function of the percent of water shortfall.The intercept of this model predicts value for a no shortage situation, thus estimating non-use value for groundwater cleanup.

The mean non-use values (bequest and existence values combined) are $3.49, $2.81 and $3.54 per household/per month for the percent splits, scenario differences and extrapolation approach, respectively (see Chapter VII). These remarkably similar estimates of non-use value demonstrate that internal consistency can be obtained by the contingent valuation method when the survey instrument is developed using the cognitive survey design process described above.

3.2.6 Final Remarks on Infromation and Context

By accepting the notion that non-use values must usually be constructed by respondents rather than assuming values preexist, several important philosophical questions arise. The political process often considers motives or values of the type economists consider to be measured in dollar estimates of non-use values. When parklands are set aside for the enjoyment of future generations and the preservation of wilderness, bequest and existence motives clearly reside in the minds of both constituents and their representatives. These motives, however, because of lack of choice experience, real world context and information may share many of the characteristics of what we have termed limited information/limited context values. In other words, political preferences themselves may be as incoherent and inconsistent as the contingent values challenged by critics of the CVM.

How might the use of the potentially coherent, consistent values which are created by the process we outlined in the introduction be justified? It has long been recognized that rapid changes In measures of attitudes can occur during a political process. However. as more is revealed about the issues (possibly equivalent to the development of full information/full context), attitudes crystallize, become stable and relatively constant over time (Schuman snd Presser, 1981). We would argue that economic values go through a similar process of crystallization. The appropriate goal, we would argue, for the CVM is to attempt to provide crystallized values for public decisionmaking. We hope to have suggested an unbiased process through which such values might be obtained.

3.3 Embedding

3.3.1 Overview

Kahneman and Knetsch (1992) argue that embedding effects are so severe that the usefulness of the contingent valuation method (CVM) for valuing public goods must be questioned. They conjecture that embedding arises because respondents may be valuing something quite different from the commodity for which the investigator hopes to obtain a willingness to pay (W'I'P). Rather, they argue that respondents offer to pay something because the contribution itself provides a source of moral satisfaction. Thus, a change In the commodity to be valued (e.g., cleaning up all lakes versus some lakes) has little impact on respondents' WTP because WTP is based on the moral satisfaction obtained from the contribution rather than from the utility derived from the commodity itself.

Both the results of the Kahneman and Knetsch study Itself and their interpretation contrast sharply with the accumulated evidence obtained in studies testing the reliability of the CVM for use values (as previously mentioned). In these studies WTP obtained from the CVM was compared to WTP obtained from market data using actual transactions, the travel cost method or the property value method. In all of these studies, the CVM gave WTP similar to that obtained from market based methods. For this and other reasons relating to the design snd statistical analysis employed in the Kahneman and Knetsch study, both Glenn Harrison and V.K. Smith in their comments on the Kahneman and Knetsch paper reject the conclusions of the study.

However, it is our view that embedding is a serious problem for the CVM, especially in measuring non-use values. Thus, it is the purpose of the research reported in this section to provide stronger tests of the embedding phenomenon. It should be noted that many researchers have long recognized the embedding issue especially when non-use values are at issue. For example, Cummings, Brookshire and Schulze (1986) raise concerns similar to Kahneman and Knetsch arguing that familiarity with the good is essential to avoid embedding effects. Mitchell and Carson (1989) call embedding "whole-part-whole bias" and discuss methods for avoiding the problem. Fischhoff and Furby (1988) argue that respondents maybe unable to separate component values from larger more broadly conceptualized values.

In this section, we first review alternative explanations for embedding. We then summarize several studies (including our work on groundwater), which demonstrate the embedding problem in different ways. Finally we attempt to resolve the embedding issue (1) through follow up questions which obtain self reports from respondents on the amount of embedding present in their stated values and (2) through the use of increased market context which helps respondents to view their bids as part of a transaction.

3.3.2 Explanations for Embedding

We begin by describing three examples which characterize the embedding problem. Three theories are described which might explain these examples. First. Kahneman and Knetsch and Cummings, Brookshire and Schulze share the notion that embedding is likely to be more of a problem for exotic or unfamiliar commodities. This may explain why embedding has not appeared In the comparison studies mentioned above (which by necessity deal with familiar public goods). Consider a survey asking for the value of preserving an endangered species of butterfly in the Amazon Rainforest. To illustrate the first type of embedding problem consider the following thought experiment:

Step 1) Group A is asked for the value of preserving just one species of "blue winged" butterfly.
Step 2) Group B is asked for the value of preserving all endangered butterfly species in the Amazon Rainforest.
Result Mean bid for preserving one species - mean bid for preserving all species.

To illustrate the second problem consider the following related example:

Step 1) Ask Group A for the value of preserving one species of "blue winged" butterflies.

Step 2) Ask Group A for the value of preserving one species of "green winged" butterflies.
Result: Mean bid for preserving "blue winged" butterflies >> mean bid for preserving "green winged" butterflies.
Step 3) Reverse order with Group B.
Result: Mean bid for preserving "green winged" butterflies >> mean bid for preserving "blue winged" butterflies.

To illustrate the third problem consider a third related thought experiment:

Step 1) Ask Group A for the value of preserving "blue winged" butterflies.
Step 2) Ask Group B for the value of preserving "green winged butterflies.
Step 3) Ask Group C for the value of preserving all butterflies in the Amazon Rainforest.
Result: Mean bid for preserving "blue winged" plus mean bid for preserving "green winged" > mean bid for preserving all butterfly species in the Amazon Rainforest.

Obviously these three problems are interrelated, but how might we explain such patterns of behavior?

Explanation 1: Moral Satisfaction: If as Kahneman and Knetsch argue, bids are based on the moral satisfaction of giving to a good cause and if this moral satisfaction has rapidly diminishing marginal utility in the size of the gift, then Problem 1 results from the same moral satisfaction being obtained from saving one species as saving many. Problem 2 results from the diminished marginal utility of making a second gift to obtain additional moral satisfaction Problem 3 comes about because each separate Group A. B. and C will bid about the same for obtaining moral satisfaction so the sum of the mean bids from Groups A and B will exceed the mean bid of Group C.

Explanation 2: Independent Valuation and Summation: Hoehn and Randall (1989) have correctly pointed out that if the benefits of providing many public goods are each independently estimated in a partial equilibrium framework and then summed across public goods, an overestimation of the value of provision will result. If one assumes strong income and substitution effects one can use the independent valuation and summation argument to explain the pattern of values described above. By these arguments Problem 1can be explained as follows: Imagine that blue winged and all other Amazon butterflies are viewed as nearly perfect substitutes. In this case the preservation of one species is sufficient and the preservation of one or all has the same value. Problem 2 arises both because, once one species is preserved, given near perfect substitutability, the preservation of a second species has little or no value, and because paying for one species reduces the income available to pay for the next. Problem 3 arises because, again assuming near perfect substitution across butterflies, saving any one species or all species in the Amazon Rainforest has the same value. Summing independent values overestimates the total benefits of preserving all species by ignoring substitution and income effects.

Explanation 3: Mental Models of Joint Products: This third explanation, which we focus on in this sectin, arises from many statements made by subjects participating In (1) focus groups, (2) individual debriefings or retrospective verbal reports obtained after filling out CV instruments or (3) verbal protocols obtained while filling out CV instruments. Many (but not all) of these individuals describe their own view of public goods as originating as joint products. This jointness derives from technological reasons such as: "Butterfly species in the Amazon are becoming extinct because of loss of habitat. The only way to save one species is to save all of them by saving the forest as well." When asked for the value of saving one species, such an individual often "corrects" the foolish question asked by the "dumb" researcher and provides a value for saving the entire forest, i.e., not only providing the value for all butterfly species but also for the entire Amazon Rainforest. These views, called "mental models" by psychologists, are often strongly held and will replace whatever mental model the researcher intended to foist on the respondent. Usually these mental models imply jointness as noted above.

Another frequently occurring mental model relates to the way public goods are actually provided in democratic societies. Many respondents view the connection between taxes and public goods as joint Le., more taxes Implies more public goods of all types. Thus, similar to the arguments of Kahneman and Knetsch, some people value much more than the researcher intends. For example, one respondent explained his bid for a particular environmental improvement as incorporating money for education and other unrelated public services: "I know what happened when gasoline taxes were raised to fix roads in Colorado -- the pothole in front of my house is still not fixed -- but those taxes went into the general fund and you (a University of Colorado, Economics Professor debriefing the respondent) got a salary increase!" This respondent was actually happy to have more money go to eduction and incorporated the value of an expansion of all public services in the bid.

The joint product mental model can explain the three embedding problems noted above as follows: In Problem 1 the bid for one butterfly species is the same as the bid for all species because respondents believe (perhaps correctly) that the only way to save one species is to save the habitat for all species. Thus, Group A bids for saving gabitat which provides the benefits of saving all butterfly species in that habitat. In Problem 2. having been asked to bid to save one species, but in actuality having provided a bid to save all species in the habitat, when asked for additional money to save a second species, respondents bid zero because they have already paid to save the second . In effect they reject the scenario presented by the researchers as unrealistic. Finally, in Problem 3 Groups A. B, and C each provide values for preserving butterfly habitat in the Amazon. Thus, the three values are nearly the same so the sum of the mean values from Groups A and B will exceed the mean value of Group C.

One important qualification needs to be made to these arguments. Not all respondents have the same mental models. In fact, debriefings have demonstrated a wide variety of mental models concerning the financing and technology of provision of environmental commodities. Some respondents will accept the implicit mental model used by the researcher in designing the survey, while others will not. Where mental models imply jointness, embedding problems will result, providing a potential problem for the investigator in interpreting the bids obtained from respondents.

Finally, the mental model interpretation of embedding in no way rules out either the arguments of Kahneman and Knetsch (in that one of the joint outputs of a bid could well be a type of moral satisfaction) or the independent valuation and summation argument of Hoehn and Randall (in that some respondents may not hold a joint product mental model but rather view certain environmental commodities as near perfect substitutes). We now turn to a description of a survey specifically testing this inclusive mental model hypothesis.

3.3.3 The Denver Air Quality Study

Our methodological study of air quality values conducted in the Denver metropolitan area was motivated in great part by a controversy over the reliability of values obtained in a CVM study of air quality by Tolley et al., (1985). In that study, respondents were asked to provide a dollar WTP for visibility improvements. Critical reviews of this study motivated both Fischhoff and Furby (1988) and Mitchell and Carson (1989) to question the ability of respondents to provide a separate visibility value, arguing that many Individuals would include values for health as well. In our Denver study (described in detail in Schulze et al., 1989) we mailed eight different versions of a survey instrument which included a color insert presenting photographs of different local air quality conditions. A 71% overall response rate was obtained with no version receiving less than a 69% response rate. Two versions of the survey instrument tested the notion of mental models presented in the previous section. However, before describing these two versions we need to develop a formal economic model of embedding which results from a joint mental model. This theoretical viewpoint then motivates the design of the survey instruments.

Let:

Q = Air Quality,
V = Visibility,
H = Healthiness of the Air,
G = Other Public Goods,
X = Composite Commodity with a price equal to 1.

and X^0 = Income.

We assume that some respondents have a mental model such that

$$H = a_H Q, \quad V = a_V Q, \text{ and } \quad G = a_G Q.$$

where a_H, a_v, and a_G are fixed positive coefficients. In other words, an improvement in Q also results in improvements in V, H, and G and any improvement in V necessarily implies improvements in Q, H, and G. For such respondents, the compensating variation measure of WTP for an improvement in visibility can be obtained by totally differentiating the constant level of utillty of the consumer,

$$U(V,H,G,X^o\text{-}WTP) = U^o$$

subject to the joint product constraints listed above. The marginal willingness to pay for visibility then takes the form:

$$\frac{\partial WTP}{av}\bigg|_{U^o} = \& \quad + \left(\frac{a_H U_H}{a_V U_X}\right) + \left(\frac{a_G U_G}{a_V U_X}\right)$$

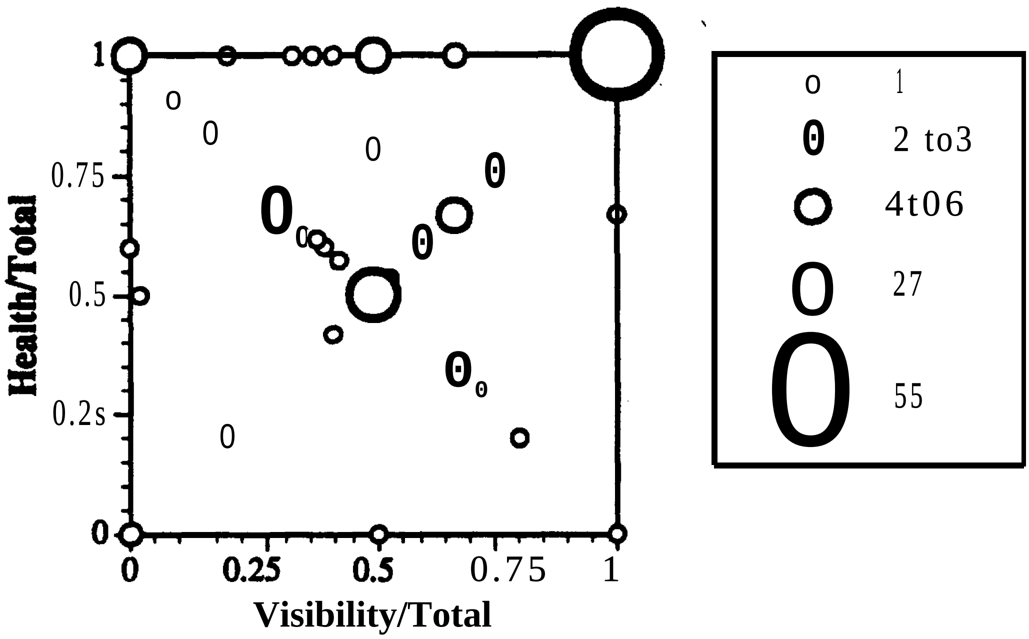
(d) (b) (c)

Thus, if an individual who believes that government services are produced as joint products is asked to provide a bid for a small increase in visibility, the bid will contain not only the marginal Willingness to pay for visibility (term (a) above), but will also contain appropriately proportioned values for related health improvements (term (b) above) and for increases in the provision of other public goods (term (c) above). If an individual does not have such a mental model, i.e., accepts the possibility of only changing health or visibility in response to a particular program. then only term (a) will be present.

We tested this hypothesis in two ways. First, in one survey variant we ask respondents to provide a dollar value for visibility improvement, then a separate dollar value for health improvements, and finally a total bid for the sum of visibility and health improvements for a specific air pollution program. Some people responded with three bids in the following pattern: $50 for visibility, $50 for health, and $100 total indicating that they did not view the proposed program as providing joint products. However. a large number of respondents gave bids in the following pattern, $100 for visibility, $100 for health, $100 total, consistent with the joint product hypothesis. Data from these questions in the Denver study are presented in Figure 3.2. The vertical axis presents the ratio of health improvement bid to total bid for the stated air quality improvement. The horizontal axis shows the ratio of visibility bid to total bid for the stated air quality improvement. The size of the bubbles in the figure (as shown in the key) indicate the number of respondents whose bid pattern corresponds to the point at the center of the bubble.

First, note the clustering of respondents along the diagonal with a slope of -1 (from the upper left to the lower right hand comers of the figure). These individuals follow the first pattern discussed above, e.g.. if .25 of the total bid goes to the visibility bid, .75 goes to the health bid. These Individuals do not show an embedding problem (for the researcher) and represent 36% (49 out of 137) of the sample. Another large group show what Kahneman and Knetsch call “perfect embedding," consistent with the

FIGURE 3.2: ANALYSIS OF EMBEDDING - DENVER AIR QUALITY STUDY



joint product model formalized above. This group consisting of 55 respondents (40% of the total sample) submitted the same bid for visibility, health and total air quality improvement and are located in the upper right hand comer of the figure. Thus, 76% of respondents are consistent With either the hypothesis of no embedding or of perfect embedding. However, the joint product hypothesis can account for other individuals in the sample as well. For example those on the diagonal line with a slope of +1 show a form of partial embedding in which they are unable to disaggregate their values full yinto components. Other points may simply show an ordering effect consistent with the independent valuation and summation argument, i.e., in giving a bid first visibilaty and then for health, when finally coming to the total bid, the respondent may realize that the additive total was more than they wanted to pay.

A second way to examine this issue which encourages consistent answers is to incorporate a follow up question. as we did, in the second version of the Denver Air Quality survey. This version asks respondents only for a total bid, but then asks them to split the bid up into its possible component parts. Thus, a respondent can (as they did on average in the Denver study) plausibly state "my bid was 27% for visibility. 48% for health. and 25% for "other" unspecified values consistent with either preferences constrained or unconstrained by a joint project mental model. Note that those individuals in Version 1 who did not embed (i.e., those in Figure 3.2 who lie along the diagonal with a slope of -1) also favored health over visibility since most responses lie along the diagonal to the upper left in the figure.

In the Denver study no follow up questions asked respondents about the source of values not ascribed to health or visibility. The next section reports on studies exploring this issue.

3.3.4 Studies Seeking Self-Reports of Origins of Embedding

Another early study attempting to analyze and adjust for embedding effects formally was conducted by Chestnut and Rowe (1990), they obtained new estimates of the value of visibility in National Parks using a more sophisticated survey approach (aware of embedding issues) than that of Schulze et. al., (1983). Using follow up questions which followed the valuation question, they estimated that 38% of the stated values were unrelated to the proposed changes in visibility in national parks. What is of specific interest here IS that for the less familiar commodity 'Risibility in national parks," embedding was above the 25% level reported in out study of the very familiar "Brown Cloud" problem in Denver (Schulze, et al. 1989).

A second study to attempt to identify the source of embedding (Rowe et al. 1991) used two different versions of their survey to explore the problem of embedding in WPT values for preventing oil spills off the coast of Washington State. A serious embedding problem was apparent in that many respondents indicated that any program to prevent oil spills was likely to prevent large spills as well as moderate and smaller spills. Thus, a strong tendency to bid to prevent all spills was present. Version 1 asked respondents how much they would pay over the next five years to prevent all spills while Version 2 asked respondents to bid over a five year period to prevent a moderate sized spill. Respondents to both versions were then asked if their value was just for the stated oil spill prevention program or if the bid included values for other environmental and public causes. If they indicated that their bid included values for other environmental or public causes they were asked what percent of their WTP was just for the stated program (either to prevent all oil spills in Version 1 or to prevent moderate sized oil spills in Version 2). In Version 1, only 63.5% of the average bid across respondents was assigned to oil spill prevention. This figure falls to 50.5% for Version 2. Thus, the decreased context and information provided by evaluating only moderate size spills as opposed to evaluating all sizes of spill increased self-reported embedding from 36.5% to 50% of the stated value.

In our groundwater work described in the following chapters we incorporated the "disembedding" question shown in Figure 3.3. In Question 12 respondents are asked if their bid is just for the stated complete groundwater cleanup program or if their stated WTP includes values for a wider range of environmental and/or public causes. This question in effect

FIGURE 3.3: DISEMBEDDING QUESTIONS: GROUNDWATER SURVEY

(Q12 Some people tell us it is difficult to think about paying to reduce just one environmental problem. Would you say that the dollar amount you stated your household would be willing to pay for complete groundwater cleanup (QI 1) is: (Circle number)

1. JUST FOR THE STATED GROUNDWATER PROGRAM (Go to Q 14)

2. SOMEWHAT FOR THE GROUNDWATER PROGRAM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES

3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENTAL OR OTHER WORTHWHILE PUBLIC CAUSES

4. OTHER (Please specify)__________________________

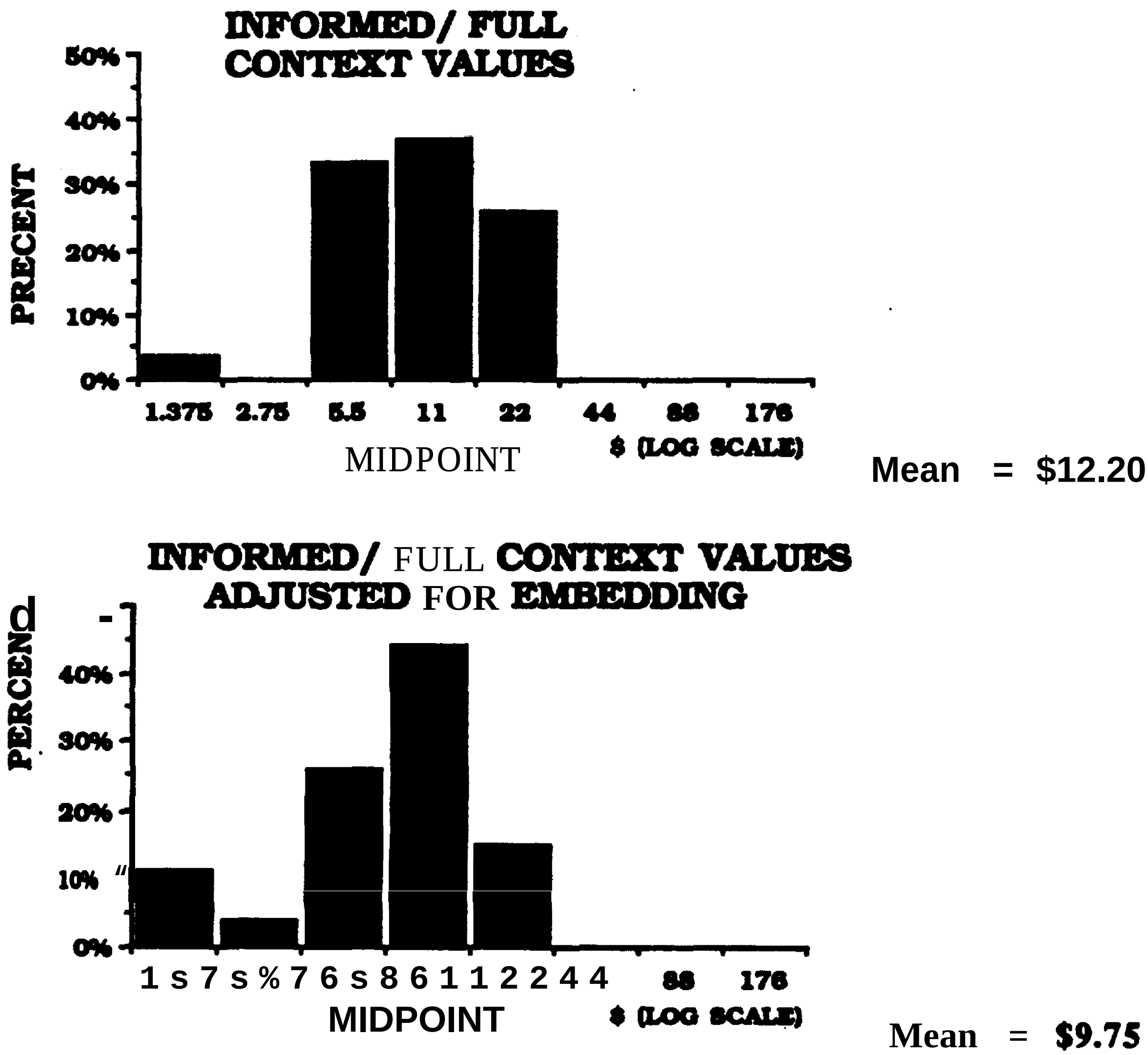
Q1 3 About what percent of your dollar amount is <u>just</u> for the stated complete groundwater cleanup program? (Circle percent)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70?%	80%0	90%	100%

asks "Are you embedding?". If the respondent answers "Yes", Question 13 then asks "How Much?"

For the pretest subjects who were given perfect information and complete context before answering the valuation question, the level of self-reported embedding was 20% of the reported values. Figure 3.4 shows the

FIGURE 3.4: UNADJUSTED WTP AND WTP ADJUSTED FOR SELF-REPORTED EMBEDDING: FULL INFORMATION/FULL CONTEXT SURVEY



frequency distribution of perfect information/complete context bids in the top panel and the frequency distribution of bids which have been individually adjusted for self-reported embedding in the bottom panel. Noting the logarithmic horizontal axis, adjusting for embedding further reduces the right skewness of the bids. The shortened national mail survey for groundwater values retained a nearly identical amount of self-reported embedding of 21.2%, suggesting that retention of appropriate information and context also reduces embedding almost as effectively as the lengthy perfect information / full context pre-test survey.

3.3.5 Conclusions on Embedding

Table 3.1 summarizes the degree of self-reported embedding from the studies discussed above.

Perhaps the most surprising result of these studies is that many respondents unabashedly admit to embedding in a manner consistent with the joint product mental model proposed above. Our evidence is consistent with the psychological notion that people have many different mental models which they use to interpret the world around them. Thus, some respondents do not show an embedding phenomenon at all. It is our view that techniques for resolving the jointness of values must be incorporated into survey design. One successful approach is to ask respondents to partition a total value while another is to increase information and context about the commodity to be valued. We employ both approaches in valuing groundwater cleanup.

TABLE 3.1: SELF-REPORTED EMBEDDING IN CVM STUDIES

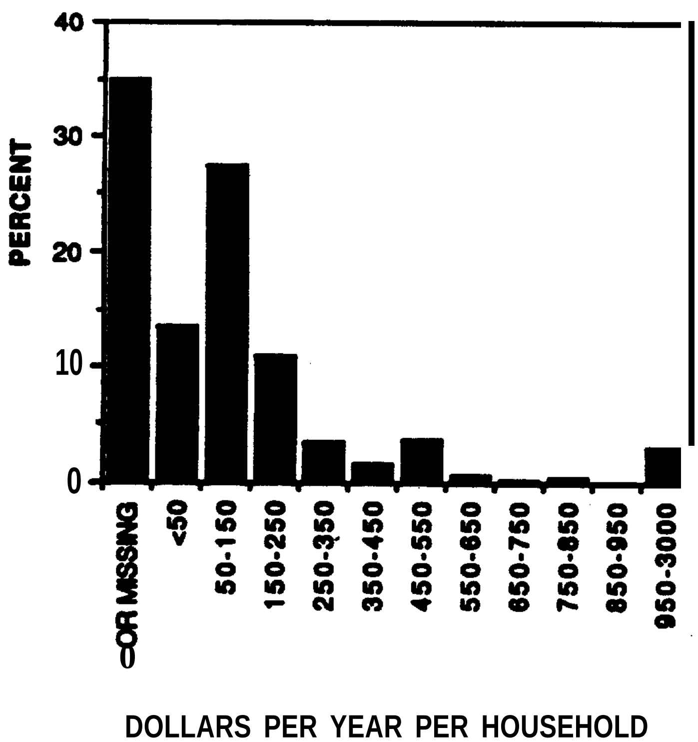
STUDY	COMMODITY	PERCENT EMBEDDING
Chestnut and Rowe (1990)	Visibility in National Parks	38.0%
Rowe et. al. (1991) Medium Size Oil Spill Version	Preventing Death of Seabirds	50.0%
All Oil Spills Version		36.5%
Groundwater Full Information/Full Context	Complete Groundwater cleanup	20.0%
Relevant Information/ Mail Survey		21.2%

3.4 Hypothetical Error

Survey values obtained in the field have tended to be bimodally distributed with a large number of missing or zero bids and an upper mode which is skewed. showing a thick tail of large bids. For example, figure 3.5 shows the distribution of bids from the Denver air quality study. Researchers have viewed both the large number of bid refusals and the very high bids with skepticism. Fortunately, laboratory experiments and more recently our exploration of the role of information and context presented in Section 9.2 above, have shed considerable light on the problem of large bids which suggest a stralghtforward econometric approach. Refusals to bid (mostly in the form of missing bids) can create a selection bias problem in estimating the true value of positive bids, an issue we discuss in the next section.

Researchers first turned to laboratory economics experiments to understand the source of large hypothetical bids obtained in CVM studies. These laboratory experiments typically place subjects in an unfamiliar environment (either with respect to the commodity. the market, or both) and compare an initial hypothetical response to actual laboratory market

FIGURE 3.5: WTP FREQUENCIES (IN DOLLARS) - DENVER AIR QUALITY STUDY



responses where repeated trials are used to provide market experience. We briefly summarize what has been learned from such experiments and, drawing on these experiments, propose both a specific model of hypothetical error (a form of measurement error) and suggest an econometric approach for analysis of contingent values which may reduce such errors.

Results from laboratory experiments show a consistent and striking pattern. Hypothetical bids obtained from subjects for a commodity show an increased variance relative to bids obtained in a laboratory market. Further. increasing market experience (repeated rounds in a particular auction institution) and increasing incentives (increased payoffs for participation in a particular market institution) both tend to reduce variance in bidding.

The first experiment to compare hypothetical bids to auction behavior, undertaken by Coursey, Hovis and Schulze (1987), used a bitter tasting liquid, sucrose octa acetate, which was unfamiliar to subjects as the commodity. Subjects were first given a careful description of the commodity and then were asked how much they would pay to avoid a taste experience. Second, subjects were allowed to taste the liquid prior to being asked again for their willingness to pay (WTP). In this second stage subjects were familiar With the commodity but had no market experience. Third, subjects participated in a competitive auction submitting bids to avoid the commodity. Mean bids (variance) were as follows: Hypothetical with no experience $2.80 ($15.80): hypothetical with experience with the commodity $2.27 ($5.08): and actual auction bids with market experience $1.95 ($5.23). Note, the variance is much greater for the Inexperienced hypothetical bids. However it appears that the decrease in variance was associated with expedience with the commodity rather than With experience with the market institution.

Other recent experiments that allowed more, rounds of actual market experience than the Coursey, Hovis and Schulze experiment show a continued decline in bidding variance both with market experience and reward size (see Irwin, McClelland and Schulze, 1992 and Cox. Smith and Walker, 1989). Figure 3.6, taken from Irwin, McClelland and Schulze, shows how the increased variance in hypothetical bidding can bias estimates of actual behavior. The top panel of Figure 3.6 shows a skewed hypothetical distribution relative to the actual bidding distribution shown in the bottom panel. The extended right hand tail is the source of a large upward bias in the mean hypothetical bid as compared to the mean of actual bids. This source of error dominates the results of this experiment.

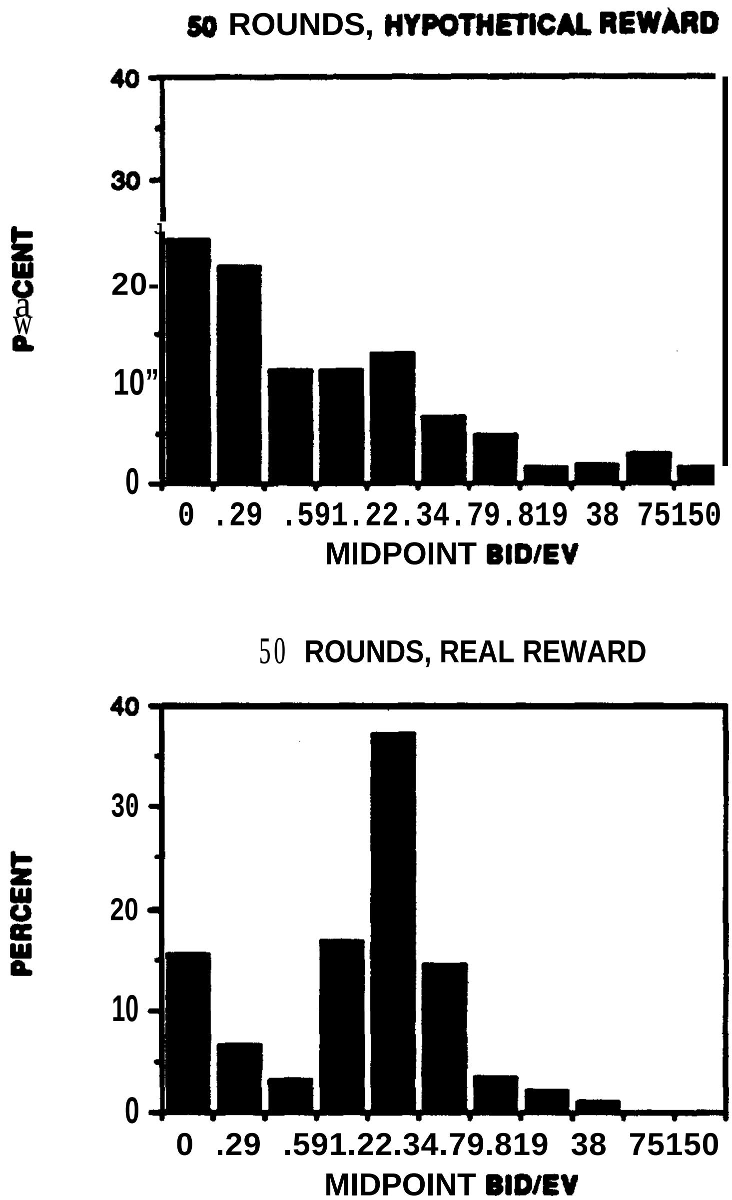
Given the experimental evidence summarized above and our earlier demonstration that provision of information and context appear to reduce the variance in a log normal distribution of hypothetical errors. what model can be used to explain hypothetical bias that might result in field surveys from a lack of information, context and experience? Assume for simplicity that individuals have a true willingness to pay, W. However,the bid they reveal in response to a hypothetical question about willingness to pay is B. The laboratory data in Figure 3.6 suggests that the bids are highly skewed so, for example, a model for the revealed bid could be

$$(1) \qquad \ln B = \ln W + \varepsilon,$$

where ε is measurement error. assumed to be distributed ε - $N(0, \sigma_1^2)$.

If we replace 1nW with an econometric model

FIGURE 3.6: EXPERIMENTAL VALUES (Source: Irwin, McClelland Schulze (1992)



(2) $\ln M = \Sigma\beta_i X_i, + V$

where Xi are explanatory variables, there is now an additional source of error, v due to the econometric model. Substituting equation 2 into equation 1 gives:

(3) $\ln B = \Sigma\beta_i X_i, + (\varepsilon + \nu).$

Assume v - N(O, σ_v^2). If there were no measurement error, the predicted mean bid using the formula

(4) $\hat{B} = e^{\Sigma\hat{\beta}_i X} + 1/20V2$

would be a consistent estimate of the true mean WTP. With both errors present,

(5) $\hat{B} = e^{\Sigma\hat{\beta}_i X_i + 1/2\,\hat{\sigma}^2}$

where $\sigma^2 = V(\varepsilon + v)$. This is an upper bound estimate which will give a predicted mean approximately equal to the raw mean of the contingent value bids used in the analysis. It is Impossible to know a *priori* how much of the errors is model error, and how much is measurement error. But from laboratory experiments and our examinatino of the Impact of information and context we know that skewed measurement error is likely to be present, which implies that the raw mean of the CVM bids will overestimate true values. If there is no model or measurement error, the predicted mean bid given by

$$(6) \qquad \hat{B} = e^{\hat{\beta}_i X_i}$$

is a consistent estimate of the true mean WTP. If we assume ε and v are uncorrelated. then

$$(7) \qquad e^{\Sigma\hat{\beta}_i X_i} \leq e^{\Sigma\hat{\beta}_i X_i + 1/2\, \sigma_v^2} \leq e^{\Sigma\hat{\beta}_i X_i + 1/2\, \sigma 2}$$

and we can bracket the appropriate bid with a lower and upper bound.

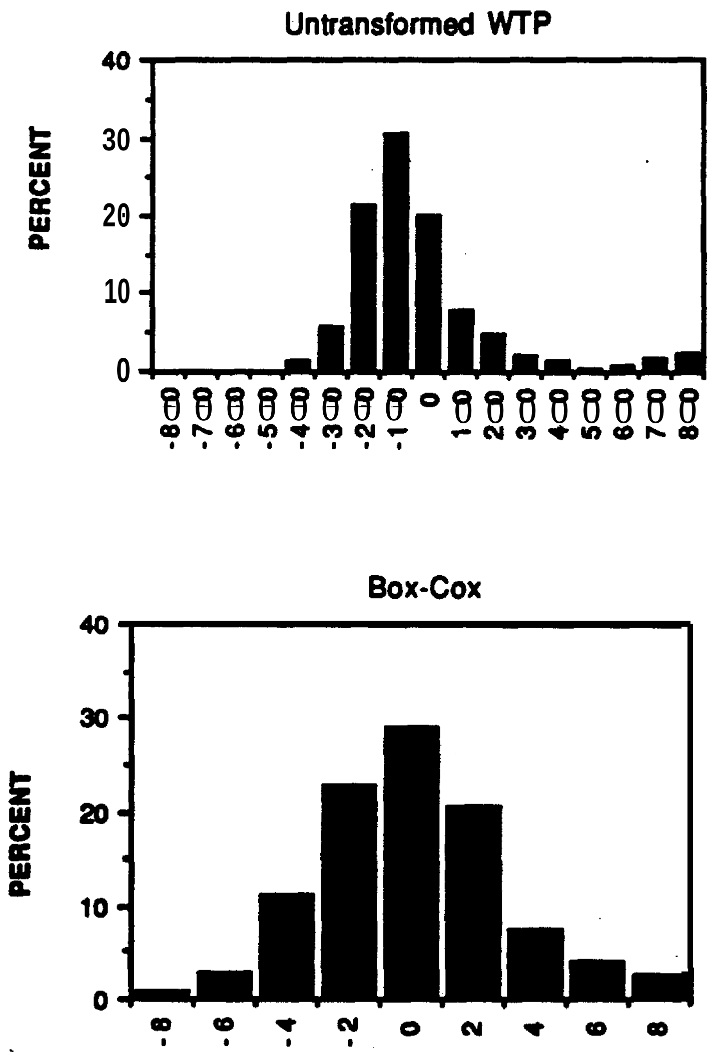
We propose use of a more general transformation than the log transformation to account for skewed measurement error. This transformation is the Box-Cox, $(B^a - 1)/a$, where a is determined to normalize the error distribution in regression analysis (Box and Cox, 1964). Predicted bids from the regression analysis should then be used as a lower bound for policy analysis. Note that this transformation incorporates both the linear (a = 1) and natural logarithm (a = 0) transformations as possibilities.

Use of this procedure has several advantages. In the past large suspect bids obtained in the CVM have been removed through timming e.g., Desvousges, Smith and Fisher, 1987). Trrimming procedures remove large outliers which deviate from an estimated linear regression model by exceeding some predetermined statistical threshold. However, in the situation where the bid distribution shows a thick upper tail, the mean of predicted bids falls as that threshold is lowered, making final estimated values dependent on the threshold chosen. If skewed measurement error is present, the procedure we propose will also lower mean values if bids generated by the estimated regression equation are used in calculating the mean. However, the reduction In predicted mean bid will be determined by the estimated value of α, the Box-Cox parameter, so as to make the distribution of residuals as normal as possible. If measurement error dominates the residual then it is obviously desirable to use an estimating procedure which does not bias the estimated coefficients through a skewed error distribution. Predicted values from this estimated equation can then be used to calculate mean or total willingness to pay.

In the Denver air quality study, the Box-Cox procedure was employed and gave an estimated coefficient of a = 0.12. The mean of predicted bids was a little over half of the raw mean of the bids (about $118/per per household vs. $202/year per household), varying somewhat depending on specification of the regression equations and the treatment of the selection bias issue. The frequency distribution of residuals from a linear regression for comparison to those from the Box-Cox regression explaining bids is shown in Figure 3.7. (Nearly identical estimates of a were obtained in the Eastern U.S. Visibility Study and in our work on groundwater). Obviously substantial skew is present in the linear regression and the Box-Cox procedure produces an essentially normal distribution of residuals. Thus, the procedure developed above can be defended on purely econometric grounds as an appropriate method for dealing with large outliers which would otherwise bias CVM studies.

However. it should be noted that the econometric model used to predict bids in the Box-Cox regression in the case of the Denver study'had a fairly low explanatory power since the R^2 was about .13. Thus, the predicted bids might underestimate actual values since a substantial amount of model error may be present. Additional variables were added to the groundwater survey to help explain values. Although the Box-Cox coefficient was similar to our earlier results, the R^2 in this case rose to .30.

FIGURE 3.7: RESIDUALS FOR WTP REGRESSIONS - DENVER AIR QUALITY STUDY



3.5 Scenario Rejection

A second problem in the interpretation and analysis of contingent values is the presence of missing bids or protest zero bids when respondents are asked for willingness to pay (WTP). When pretesting survey instruments, researchers have often found that failures to bid or zero bids are not associated with a zero value to the respondent. Four reasons have been identified for such behavior through verbal protocols and debriefing questions. First, the respondent may not feel responsible for the problem and as a result conceals their value. The mental process leading a respondent to conceal WTP as revealed by debriefing in the Denver air pollution study was as follows: “Cleaner air is very valuable to me so I would have to pay a lot to reflect that value: but, fortunately, air pollution is not my fault so I should not have to pay. So, I just will not answer the question since it does not apply to me.”

A second reason for scenario rejection is that the respondent prefers another technical solution for cleaning up the environment than that presented in the scenario to be valued. Thus, for example, in our groundwater work described herein some individuals bid zero for complete groundwater cleanup because they preferred just treating contaminated water as it was pumped up for use. In effect, although they had a use value which was provided by complete cleanup, they refused to reveal that value with a bid for complete cleanup because they did not wish to endorse that technical approach. This type of scenario rejection is especially common when using the referendum format (see Chapter IV).

A third reason for scenario rejection is that the respondent may not believe that the objectives of the scenario presented for valuation will be achieved by the scenario. Our previous example of "a fund for future use" to allow future generations to cleanup contaminated groundwater was, as noted in Section 3.2, rejected by respondents because, in great part, they did not trust the government to maintain such a fund for 50 years or wanted cleanup to occur immediately.

Finally, the fourth reason for scenario rejection (actually a false zero bid) is the tendency of respondents to either round off their value estimates to zero or refuse to bid if their values are small or if the effort of bidding is high. The cognitive effort of estimating a 50¢ bid is unlikely to be worthwhile to the respondent to a CV survey. Similarly, respondents who are asked to state a value may imagine that a very precise number is required such as $28.32 and feel unable to come up with the anticipated level of precision and so refuse to bid. One solution to this problem is to provide approximate values such as $0, $1, $5, $10 and so on so as to indicate the desired level of precision.

As argued by Smith and Desvousges (1987), the absence of bids from such respondents who reject the scenario results in a potential selection bias problem since as many as 35% of respondents may refuse to provide credible values as they did in our Denver study. In estimating a regression model for those respondents who do provide a WTP value, selection bias must be accounted for to obtain unbiased coefficients (Heckman. 1979). However, in the Denver air pollution study we found that correcting for selection bias requires that the first stage probit equation must include an appropriate identifiers. Since we did not such variables available, we could not obtain reasonable predictions for missing bids. In other words, appropriate variables explaining whether a respondent gave a bid must be included in the probit equation, but excluded from or be insignificant in the equation explaining WTP. We had no such variables in the Denver study but, based on debriefing questions included in the survey, determined that acceptance of responsibility (as opposed to the presence of benefits) for paying for air pollution cleanup was one missing factor. Thus, In the Eastern visibility survey instruments we included a number of variables attempting to measure this factor. Responsibility variables were highly significant in the probit equation explaining "missing" WTP responses and these same variables were non-significant in the estimated willing to pay equation. With a properly identified model, selection bias was not present and predicted bids for missing respondents were $49 per household per year as opposed to predicted bids for those who gave values of $132. Note that excluding missing values would lead to an overestimate of willingness to pay for the population as a whole. Based on this study it would be more accurate to assign a zero value to those with missing values rather than assign the mean value of those who did respond with a positive bid.

Another approach for avoiding a selection bias problem is to design the survey instrument itself to avoid scenario rejection. This approach was pursued in the groundwater work reported here with considerable success in that the number of bid refusals fell to 5% of the sample. We reduced scenario rejection both by dropping the referendum format (although our initial pretesting used this approach) and by presenting subjects with approximate values to choose from. These values were drawn from an approximately logarithmic scale so as to avoid truncating the distribution of values. Obviously, a selection model was unnecessary in this case for scenario rejection. However. the question of the appropriate value to be used for survey non-respondents remains. Based on our earlier work on Eastern visibility values where item non-respondents had low values, we suggest a zero value be ascribed to survey non-respondents as a conservative approach.

3.6 Implications for Applications of the CVM to Non-Use Values

The objective of the research described above was to refine our understanding of the CVM by examining potential sources of error by first using a relatively well understood commodity, air pollution and then proceeding to attempt to estimate non-use values of a less familiar commodity. What are the implications of this research for the valuation of non-use values?

First, the more exotic the commodity. the larger the measurement error is likely to be. In other words in valuing very unfamiliar commodities, people are likely to make larger errors in predicting what they would actually pay. If these errors are positively skewed, a procedure such as the Box-Cox method proposed here will be essential to avoid overestimating values.

Second, the more unfamiliar and difficult the commodity is for people to value, the more likely it is that people will be unable to come up with a value. These missing responses may create a selection bias problem since, as we have shown, such respondents may have lower' values than respondents who do provide values. However, changes in survey design can greatly reduce scenario rejection. especially using the cognitive survey design approach.

Third, embedding problems are likely to be very severe for issues such as species preservation. Many people will find it impossible to value saving one species of butterfly without saving all species in the forest, as well as saving the particular forest, if not all forests! We have shown that many people do view environmental preservation as a joint product phenomenon which requires careful attention by researchers. A problem occurs when researchers ask Group A for the value of one species of butterfly, Group B for the value of another species and sum the values. If both Groups A and B were in fact valuing both species plus the value of preserving the whole forest not only are butterfly values double counted but the value of preserving the entire forest is included as well. Careful pretesting can reveal such problems and appropriate debriefing questions can be incorporated into surveys to find out what values respondents have included in their answers.

Finally, as the commodity becomes more exotic, the role of survey information and context increases dramatically. If respondents have no a ***priori*** idea as to the nature and characteristics of the commodity, the survey context itself must totally define the parameters used by the respondent to construct a value. Cognitive survey design allows an understanding of what information is necessary for respondents to construct meaningful values. Furthermore, additional information and context appear to reduce the amount of self-reported embedding, as well as increasing the likelihood of respondents providing a bid.

Chapter IV

Perfect Information/Full Context Survey Instrument Design and Testing

4.1 Description of Pre-Test Surveys

4.1.1 Survey Design

The main goal in designing the pretest surveys was to provide perfect information and full context for valuation of a plausible groundwater cleanup scenario. Both a perfect information/full context version and a shorter and simpler limited information/Mmited context version were tested using (1) verbal protocols and retrospective reports and (2) two samples of self-administered surveys with a written self-administered debriefing survey. We also report statistical tests which assess the effect of information context. The two surveys which were administered during preliminary pretesting are presented in Appendixes A and B.

There are five different conceptual sections to the pretest surveys, each of which is described In some detail below.

Section 1 provides a short introduction designed to present the issue of groundwater contamination and ask a few easy preliminary questions which assess subjects' general awareness of groundwater issues.

Section 2 presents the detailed information about groundwater issues, hazards, and remediation. It begins with a set of questions asking about subjects' knowledge of and experience with groundwater contamination in their own area, interspersed with short sections of text which give various facts and information about groundwater, A diagram showing schematically how leachate from a landfill might enter the water table and contaminate the public water supply is also presented. A set of questions asking for detailed information about subjects' current water usage. including their average monthly water bill, follows.

Next information IS presented about four alternate response options to a particular groundwater contamination scenario. Subjects are asked to think about and place values on each option. This seines as a framework within which to place further detailed context and information. Subjects are asked to read about and think about a hypothetical situation in which their groundwater supply has been contaminated by leachate from a municipal landfill. The risk level associated with drinking the water is stated as "about 10 additional deaths per million among people who drink the water per year" and a risk ladder comparing this risk to other risks is displayed. Subjects are told that, due to the groundwater contamination, there is a 50-50 chance of a 50% shortfall in the community's future water supply. The uncertainty resulting from variations in surface water availability was introduced to attempt to measure use value. They are then asked whether or not they would consider voting for a proposed referendum which would increase water bills to deal with the groundwater problem in a specified manner. If they state they would vote "NO." they are asked to write down an explanation. If they state they would vote "YES" they are asked What is the most your household would be willing to pay EACH MONTH on top of your current water bill before you would vote NO on OPTION X?" and are asked to circle a dollar value from a listing of 23 value choices ranging from $.50 to $500.

Each of these scenarios presents the identical groundwater contamination scenario, and they differ only in the response option being evaluated. The particular response options were chosen because they imply different combinations of use and non-use values and provide information on substitutes for complete cleanup. The specific options and their hypothesized value components are as follows:

OPTION 1: BUYING WATER FROM ANOTHER CITY: In this option the city proposes to deal with its groundwater problem in a temporary fashion by buying surplus water from another city for one year to make up the shortfall caused by the groundwater contamination. Responses to this option should include only use value since there Is no benefit to future generations and nothing is done about the contamination.

OPTION 2: IN-HOME WATER PURIFICATION This option presents the possibility of dealing with the groundwater problem privately versus publicly by having each homeowner install their own water purification system. Again, responses to this option should include only use value.

OPTION 3: CREATING A FUND FOR FUTUREUSE: In this option it is proposed to setup a fund which would earn interest and could be used in the future to deal with groundwater contamination in whatever manner people at some future point see fit. Responses to this option should include only bequest value and possibly some future existence value since there is no immediate use benefit.

OPTION 4: WATER SUPPLY TREATMENT: In this option the city proposes to deal with the groundwater contamination problem by building and maintaining a water supply treatment facility to clean up the water only as it is needed. It is not clear a ***priori*** precisely which value components people see as important for this response option: it should be mostly use and altruistic value, since the benefit is for immediate use and only what is needed is cleaned up, but some people likely view this option as providing, at least to some extent, continuous benefits to future generations since a treatment plant is constructed now.

Section 3 asks subjects to think about and evaluate one final response option which is described as a 'complete groundwater treatment program." In this option the city proposes to remove all of the contamination immediately by pumping up and cleaning the groundwater and removing the contaminated soil and placing it in a new, safe landfill. Responses to the COMPLETE GROUNDWATER TREATMENT option should include use, alturistic, bequest and existence values since all of the contamination is removed as soon as possible, providing both immediate and long-term benefits, and all of the groundwater is cleaned up immediately. It was expected that this option would prove to be the most popular (it was) and would seine as our best and most complete measure of overall value for groundwater protection. Subjects were then asked several follow-up questions in the survey immediately after their evaluation of this option. First, subjects were asked to estimate what percentage of their value was Included because of concern for "you and your family." "future generations," and "not allowing contaminants to remain in the groundwater independent of any present or future use."- 'Ibis question gives us a method for separating out the use and non-use value components from subjects' overall values. At this point in the research we were unaware of Madariaga and McConnell (1987) research on altruistic values so did not include this category. The final survey design described in Chapter V adds this category.

Second. subjects were asked to reevaluate the COMPLETE GROUNDWATER TREATMENT option for a one-time instead of a monthly water bill increase, so that any effect of "temporal embedding" (as described by Kahneman and Knetsch, 1992) could be examined. Third, in order to investigate and adjust for embedding, subjects were asked to reconsider their evaluation and state "about what percentage of their dollar amount was just for the stated groundwater program" rather than "a general contribution to all environmental causes." Finally, subjects were also asked to rank order all six response option possibilities contained in the survey from most to least preferred.

Section 4 is a "debriefing" section designed to collect information on the strategies used by subjects to arrive at their contingent values and on the effects of specific categories of context and information on their judgments. Subjects first were asked to take a few minutes to write an open-ended description describing the "reasoning and strategies" behind their evaluation of the COMPLETE GROUNDWATER TREATMENT option. Subjects were then presented with eleven specific questions in which they were asked to go back to previous sections of the survey and assess what, if any, effect specific categories of context and information they had read about had on their evaluations.

Section 5 asks for the standard demographic information, including gender, age, education, ethnic background, and income.

The survey shown in Appendix A differs from that shown In Appendix B in that Section 3. the evaluation of the COMPLETE GROUNDWATER TREATMENT option, is presented twice: once just after the short . introductory section and before the long context sectin, and again after the detailed context has been presented. Instructions in this version make it clear to subjects that they will be making the same judgment of the identical scenario twice and that they should (a) treat the first judgment as a preliminary evaluation. while knowing they maybe presented information in later sections that might influence their judgment, and (b) treat the second judgment as their final evaluation, which they could choose to be the same or different from their preliminary evaluation, as they see fit.

Of course. the most critical sections of the survey for the research questions we wish to answer are those which present the detailed information and context about groundwater hazards and their remediation. In these sections we have made an effort to present as clearly and in as much detail as practicable (a) all of the information our subjects might want to have available in order to make an informed valuation based on USEPA's technical guidance and (b) all of the context which we are aware has been hypothesized to significantly impact contingent values. The following list describes five general categories of information/context included in the survey as well as their subcategories and potential effects:

1. Personal and community experience with groundwater. There are severat questions at the beginning of the survey which ask subjects in detail about the groundwater and landfill situation in their community and any local groundwater problems they have heard about. These questions likely induce people to think about their community's groundwater experience (and any potential implications for the valuation tasks in the survey) in much more detail than they otherwise would. The effect of these questions would likely depend on the individual's experience and what part of that experience -is most likely to be recalled. Since contamination incidents and problems are especially newsworthy and memorable, people may be more

likely to recall information that acts to increase their level of concern and increase their contingent value for that reason.

2. Groundwater information. There are several expository paragraphs in the survey which present information and facts about groundwater such as where it comes from, how it is extracted for human use, and how fast It moves. There is also a diagram which helps to explain how a community's groundwater supply could become contaminated by a leaky landfill. For many subjects, this information will be new to them or may contradict some assumptions they had made about groundwater. For example, most people overestimate the speed at which groundwater moves underground (often by orders of magnitude), and some clearly hold a mental model of groundwater as moving like an underground river. When told that groundwater in fact moves very slowly, they may decide that the problem is not so serious as they had thought and lower their value for groundwater protection. Alternatively, some people may decide the situation is worse than they thought because now they know the contaminantts will remain where they are and not be diluted, which may cause them to raise their value.

3. Economic information. At several places in the survey subjects are focused on certain types of monetary information. For example, at one point they are asked detailed questions about their water bill: later in the survey. they are presented cost information for an in-home water purification system. This monetary Information may serve as a cue or anchor for subjects when deciding how much they are willing to pay. Someone who was thinking of a very low value might, for instance, adjust their value upward after considering that what they were thinking of was just a small portion of what they pay for water; or, someone thinking of a very high value might

adjust their value downward after learning that the problem could be taken care of by private means for much less than they were thinking of paying.

Subjects are also presented in the survey a short section which explains the concept of discounting and points out to them that money paid now to solve environmental problems in the future will become more valuable as it earns interest over time. Some subjects might lower their value after considering this information since they realize they don't have to pay as much as they thought immediately to have a lot of money accrued in the future: alternatively, some subjects might raise their value after considering this information simply because they like the idea and feel that the discounting information means that whatever they can contribute is that much more valuable.

4. Alternative response options. A-e section of the survey is devoted to presenting in detail and focusing subjects upon the relative benefits provided by several different potential ways a community could respond to a groundwater contamination problem other than by implementing the COMPLETE GROUNDWATER TREATMENT program. These other options constitute substitute private or public goods for complete groundwater treatment. These options include buying water from a nearby city, simply employing water conservation techniques to decrease the amount of water the community needs, private options such as installing in-home water purification systems, creating a fund for people in the future to use to solve groundwater problems, and building a water supply treatment facility. Although some subjects may have thought of some of these possibilities on their own. it is unlikely given the unfamiliarity of groundwater problems that most subjects would considerall of these alternatives and their implications without the information provided in the

survey. This information might have varied effects. For example, some people may have been thinking of a high value simply because they were unaware there were alternatives which might cost less, and accordingly lower their values. Alternatively. other subjects may find fault with the alternative options and reading about them may point out benefits provided by the complete program which they had not realized before. These people might subsequently raise their value to account for this increased perceived benefit.

5. Risk communiction. In the survey subjects are presented with a "risk ladder" which compares the level of risk posed by groundwater contamination in the scenario they are judging with the magnitudes of several other well-known risks. This risk comparison information should act to give subjects a better understanding of the magnitude of the risk associated with the scenario they are valuing, but this understanding mayor may not increase concern for the risk. Some subjects may, after seeing the comparisons, realize that the risk posed by contaminated groundwater is truly quite low and not worth worrying about. If, however, subjects are simply unwilling to accept any level of risk whatsoever from groundwater contamination, these risk comparisons could have very little effect upon subsequent values.

It should be noted that the information and context manipulation in this study is limited to the categories of information and context described above and does not involve the. details of the hypothetical evaluation scenario (e.g., the level of risk or who was responsible for the contamination) or the details of the contingent valuation question (e.g., the payment vehicle or the referendum format). These variables were identical for all of the contingent values collected for the COMPLETE GROUNDWATER TREATMENT option.

4.1.2 **Experimental Design**

The experimental design is based on the differences in the surveys shown in Appendixes A and B. The survey shown in Appendix A was administered to one pretest group in October of 1990. These subjects were asked to make two evaluations of the COMPLETE GROUNDWATER TREATMENT option, once before being presented the detailed context and information, and once after. The survey shown in Appendix B was administered to a new set of pretest subjects in December of 1990. These subjects made only a single evaluation of the COMPLETE GROUNDWATER TREATMENT option after being presented the detailed context information. This design was chosen to allow the following comparisons to be tested.

(1) Comparing the preliminary and final values for the October pretest group allows a within-subjects test of the effect of perfect information/ complete context. The question here is, did providing context and information about groundwater cleanup cause subjects to revise their preliminary values in a predictable direction?

(2) Comparing the values for the December pretest group with the preliminary values for the October pretest group allows a between-subjects test of the effect of detailed context. The question here is, do values elicited from one group of subjects before perfect information/full context reliably differ in any way from values elicited from a separate group after they have been presented With perfect information/full context.

It should be noted that all three values obtained by this design (the preliminary and final evaluations of the COMPLETE GROUNDWATER TREATMENT OPTION for the October group and the corresponding final-only evaluations for the December group) were obtained with the exact same scenario and contingent valuation questions: the only difference was in the timing of presentation. The results of statistical tests based upon this design should allow clear predictions as to the direction and magnitude of any information/context effects as well as the implications of any such effects for national benefit estimation.

4.2 Survey Implementation

4.2.1 Pretesting Using Verbal Protocol Methodology

Prior to administration of the pretest surveys in October and December of 1990, preliminary versions of both were administered to 5 subjects each. These subjects were run individually and they were asked to "think aloud" as they read through the survey and answered the survey questions. After the think-aloud session they were asked several sets of debriefing questtons as well. Their "think-aloud protocols" were recorded and transcribed to provide a record of what subjects were thinking as they filled out the survey. The method and procedure for eliciting verbal protocols was adapted from Ericsson and Simon (1984). Verbal protocol techniques have the advantage of allowing the collection of individual data without contamination from other subjects (as would occur, for example, when pretesting a survey using a focus group) while minimizing experimenter demand effects (as might occur in a question-and-answer session with an experimenter) and self-presentation and memory bias effects (as might occur when asking subjects to provide self-reports of what they were thinking after the fact).

Our main purpose in collecting the verbal protocols was to aid in redesigning the surveys before proceeding with larger-scale pretesting.

Indeed, the verbal reports identified several places in the survey which were unclear or were not being interpreted by subjects in the desired fashion, allowing us a chance to correct such problems before the October and December pretests. For example, several subjects stated in their verbal reports that they were rejecting the COMPLETE GROUNDWATER TREATMENT scenario because they were worried that the groundwater might be contaminated again when the program was over: in later versions of the survey we were able to change the description of the program to assure that recontamination would not occur, and thereby help reduce the incidence of scenario rejection. Another problem was conti.mien over the water shortage scenario in which the 50% risk of a 50% shortage was to be evaluated. Several individuals interpreted the expected shortage as 50% rather than twenty five percent. Since EPA was interested in use value estimates of value, we temporarily left a clarified version of this scenario in the survey instruments for the next stage of pretesting.

A second purpose for collecting the verbal protocols was to help gain some insight into the processes people use to interpret survey information and to arrive at contingent values. For example, it is clear from the verbal protocols of several subjects that their zero bids are not true zero values but instead represent scenario rejecting, Le., dissatisfaction with some particular aspect of the scenario being valued. Samples from the verbal protocols and debriefing responses obtained from these subjects, arranged by conceptual categories, are presented In Appendix C.

4.2.2 Self-Administered Survey Pretests

The survey shown in Appendix A was administered to a group of 41 subjects in October of 1990, while the survey shown In Appendix B was administered to a separate group of 39 subjects in December of 1990. The two groups were recruited in an identical manner and did not differ reliably on age, gender, or income. The surveys were administered in person by an experimenter, not by mail or phone, so that any questions or problems with the purposefully long and complicated pretest instruments could be identified and answered.

Subject recruitment for the pretest studies was done by a marketing research firm experienced in recruiting people for studies of public issues. All subjects participating in the pretest sessions were from the greater Denver metropolitan area. No demographic restrictions were placed on subject eligibility, although telephone recruiters were instructed to obtain a good mix on such factors as gender, age, and income. Both afternoon and evening sessions were provided to help ensure recruitment of a diverse sample. Care was taken to ensure that subjects or my household members were not currently employed by a marketing research firm or any environmental, governmental, or legislative group. In addition, any subjects who had ever participated in a public issues session on a related topic or had participated in a public issues session on any topic within the past three months was disqualified. At the time of remitment, subjects were simply told that they were being recruited to participate in “a very special type of study in which we are inviting selected individuals like yourself to participate in a group session that will focus on public issues for a research group at the University of Colorado.” Subjects therefore did not know that the issue at hand was "groundwater protection” until the time of survey administration. On average, ten phone calls were necessary to recruit one subject; 45 subjects were recruited for each administration to obtain the final samples of 41 and 39 subjects.

Subjects were run in groups of 10 to 15 per session, and there were three sessions each in October and December. Subjects worked individually on the survey, and there was no discussion of the survey until after everyone had finished. Each of the conceptual sections of the s-was explained by the experimenter and administered separately. Subjects were allowed to keep all of the survey sections with them until the session was over so that they could refer back to them, if desired, during the debriefing sections. A typical session lasted one-and-one-half hours. After each session, subjects were thanked for their participation and the purpose of the survey was explained. Subjects were them paid $25 in cash for their participation.

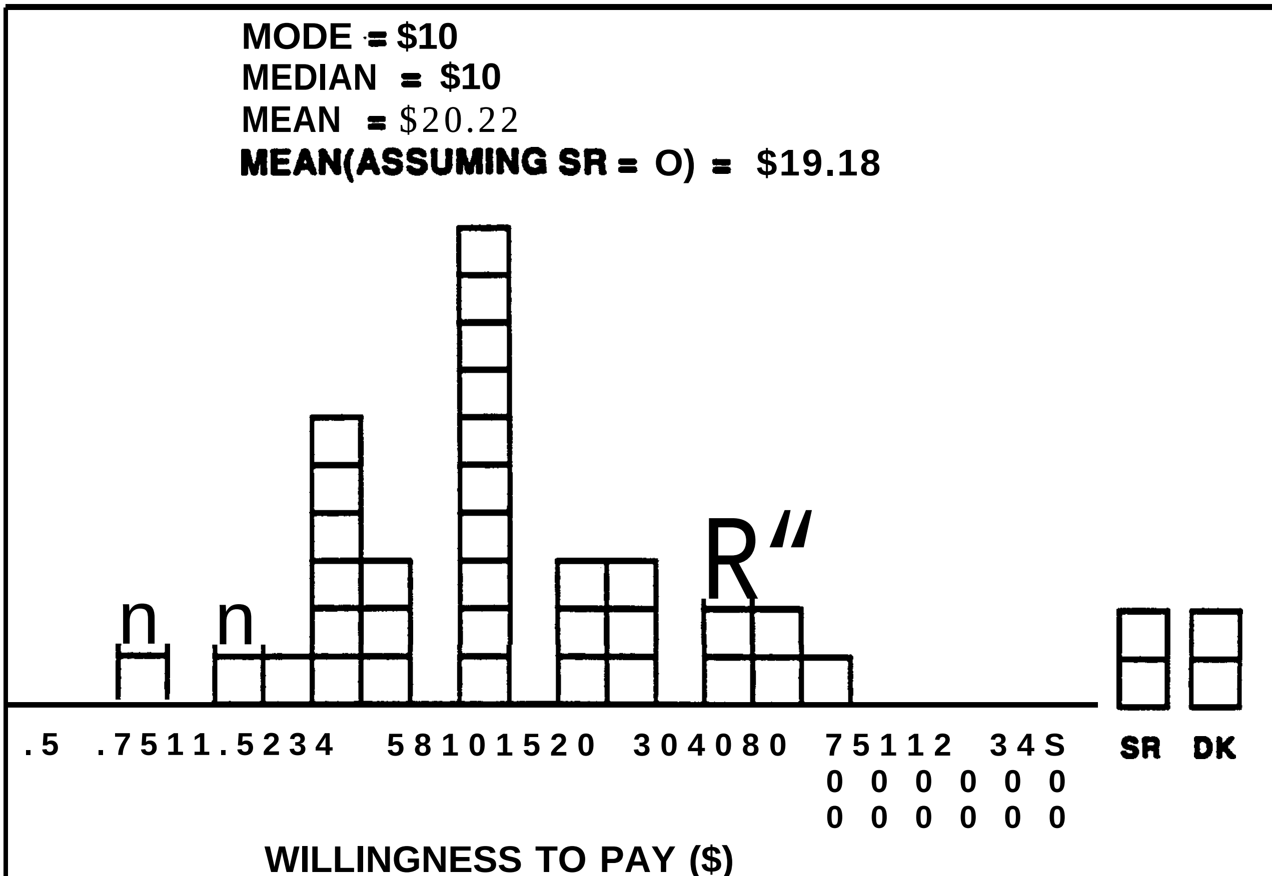
4.3 Survey Pre-Test Results

4.3.1 Frequency Distributions of Values

In designing the pretest surveys it was assumed that the COMPLETE GROUNDWATER TREATMENT option would be the most preferred and it was therefore presented to subjects as their main task in order to be utilized as their final, best value for protecting groundwater. This option was indeed the most preferred by the pretest subjects. Figures 4.1, 4.2, and 4.3 present frequency distributions of values for the October preliminary, December final and October final 1990 pretests respectively.

Figure 4.1 shows the preliminary monthly values for the COMPLETE GROUNDWATER TREATMENT option for the October 1990 pretest. These are values which were elicited at the beginning of the session before subjects were presented any information about groundwater or any detailed context; the complexity, detail, and wording of the scenario, however, was

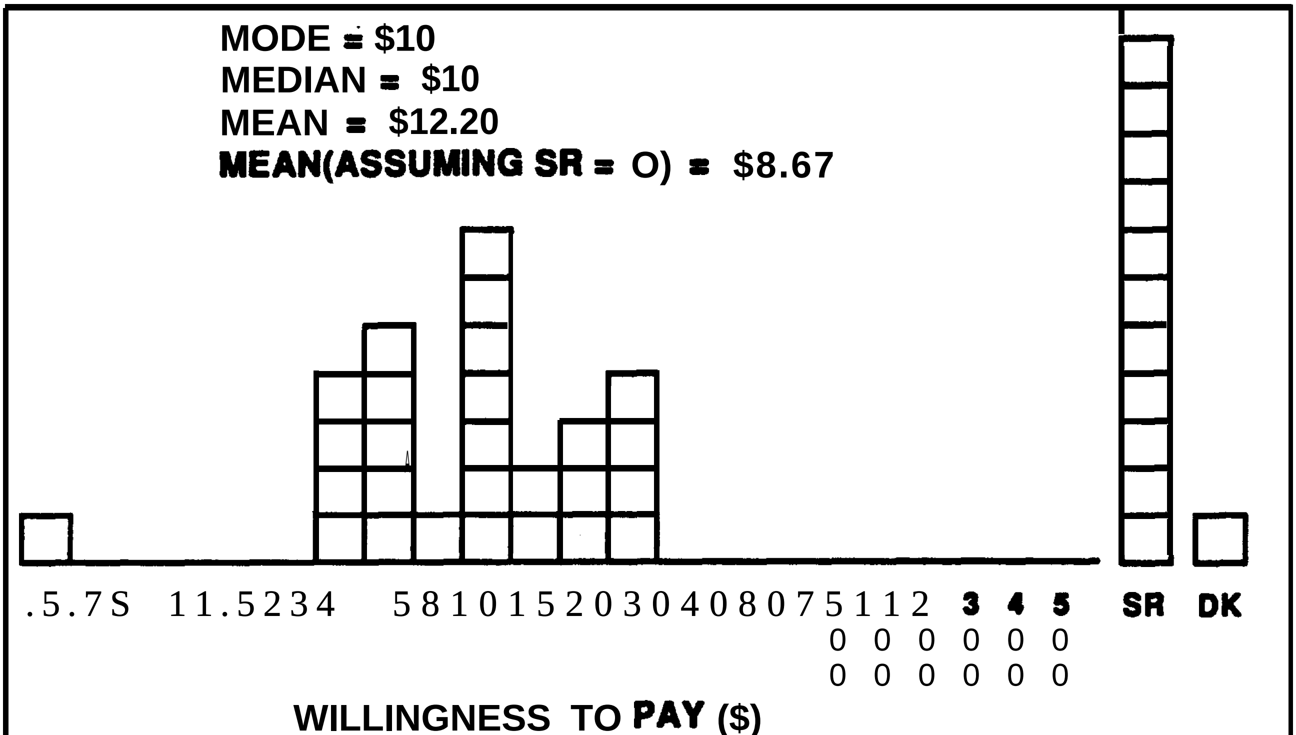
FIGURE 401: WTP FOR COMPLETE GROUNDWATER CLEANUP - OCTOBER 1990 - PRELIMINARY



Distribution of preliminary monthly values (before context) for the **COMPLETE** GROUNDWATER **TREATMENT** option (October 1990 pretest). **SR** = **scenario** rejection: DK = don't know. These are the answers to Q-7 of **Appendix A.** In this and the following figures, each box represents one pretest subject. Also, the dollar bins **along** the horizontal scales here and **elsewhere** correspond to the options from which subjects chose their willingness to **pay;** note that the scales are not linear but are Instead quite **compressed.**

identical to that used in the final valuations. There is a lot of variance in the distribution the bids range from $1 up to $100 and the median ($10) and mean ($20.22) are highly discrepant. Even with this high variance, the mean Willingness to pay of $20.22 Is not unreasonable: it is likely that the

FIGURE 4.2: WTP FOR COMPLETE GROUNDWATER CLEANUP - DECEMBER 1990

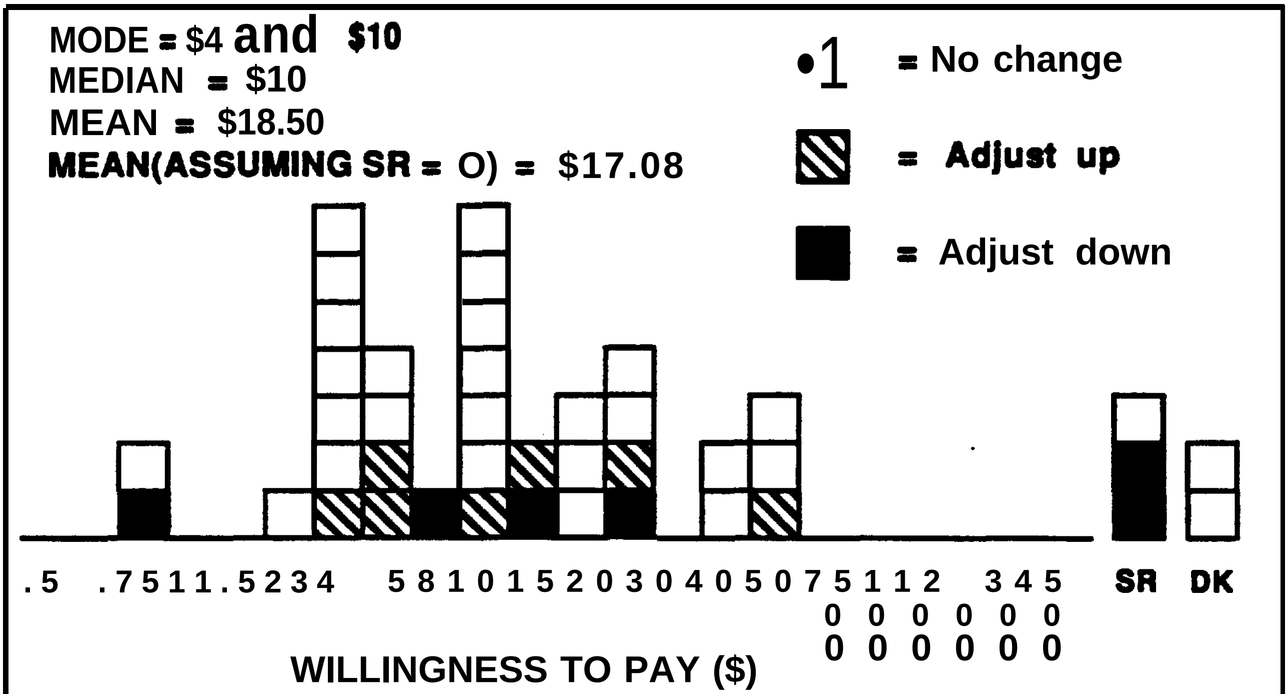


Distribution of monthly values (after context) for the COMPLETE GROUNDWATER TREATMENT option (December 1990 pretest). SR = **scenario rejection;** DK = don't know.

reasonableness and detail of the valuation scenario and willingness to pay question are doing some work in keeping values low over and above any effect of additional information and context. For example, the use of the water bill as a vehicle seemed to reduce embedding effects since it is more difficult to imagine money from a water bill increase to be used for other good causes such as education or cleaning up air pollution.

Figure 4.2 shows the monthly values for the COMPLETE GROUNDWATER TREATMENT option for the December 1990 pretest. These are values which were elicited only after subjects had worked through

FIGURE 4.3: WTP FOR COMPLETE GROUNWATERCLEANUP - OCTOBER 1990 PRETEST - FINAL (SHOWING ADJUSTMENTS FROM PRELIMINARY)



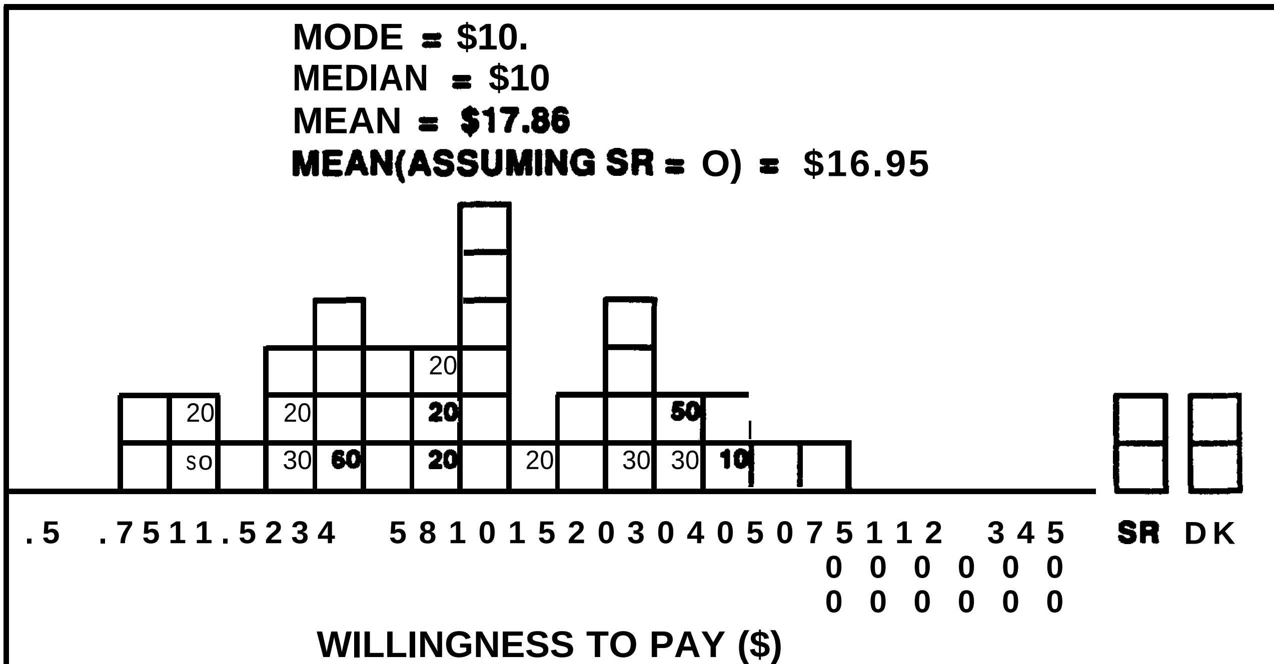
Distribution of final monthly values (after preliminary evaluation and after context) for the COMPLETE GROUNDWATER TREATMENT option (October 1990 pretest). SR = scenario rejection: DK = don't know.

all of the detailed context and alternate scenarios in the survey, and they had not made any preliminary evaluation of the scenario. There are two major difference between this figure and Fig. 4.1. First, the varl.ante Is much lower, and there are no extreme values. The mean willingness to pay is much lower ($12.20), although the median value is identical to that in Fig. 4.1. This suggests that detailed context may be working in some way to lower values that might otherwise be extreme, but that it has little affect upon values that are already relatively moderate or low. Second, there is much more scenario rejection than in the October 1990 pretest. Very few people. in fact, rejected all options. Most of the scenario rejection in the pretests was due to subjects preferring alternatives other than the final one, complete cleanup. This difference in scenario rejection raises another interesting point: although detailed context may have some beneficial effect in reducing the number of extreme values given by individuals, at the same time it apparently increases scenario rejection. In fact, the referendum format itself seemed to encourage scenario rejection when other substitute scenarios had been presented. For example, why would an individual who preferred water treatment vote for the complete cleanup option when the individual had already voted for the preferred option, water treatment. Since presentation of substitutes may account for much of the elimination of extreme values, we dedded to drop the referendum format in the next stage of the research.

Figure 4.3 shows the distribution of final monthly values for COMPLETE GROUNDWATER TREATMENT for the October 1990 pretest. These are values given by the same subjects shown in Fig. 4.1 after they had been presented the detailed context in the survey and been asked to reconsider their preliminary evaluation. Although the mean of the distribution ($18.50) is slightly lower than the mean of the preliminary values ($20.22), few people (13 of 41) in this within-subjects design were willing to revise their initial value. This suggests that if information and context is to have any effect, it must be presented before values are elicited.

Figures 4.4,4.5, and 4.6 show the same distributions as Figures 4.1, 4.2. and 4.3, respectively, after they have been revised to take into account subjects' self-reported reductions due to embedding. When asked whether or not their willingness-to-pay values were just for the stated groundwater program or to some extent a general contribution to other public goods or all environmental causes, roughly one-third of subjects, upon reflection,

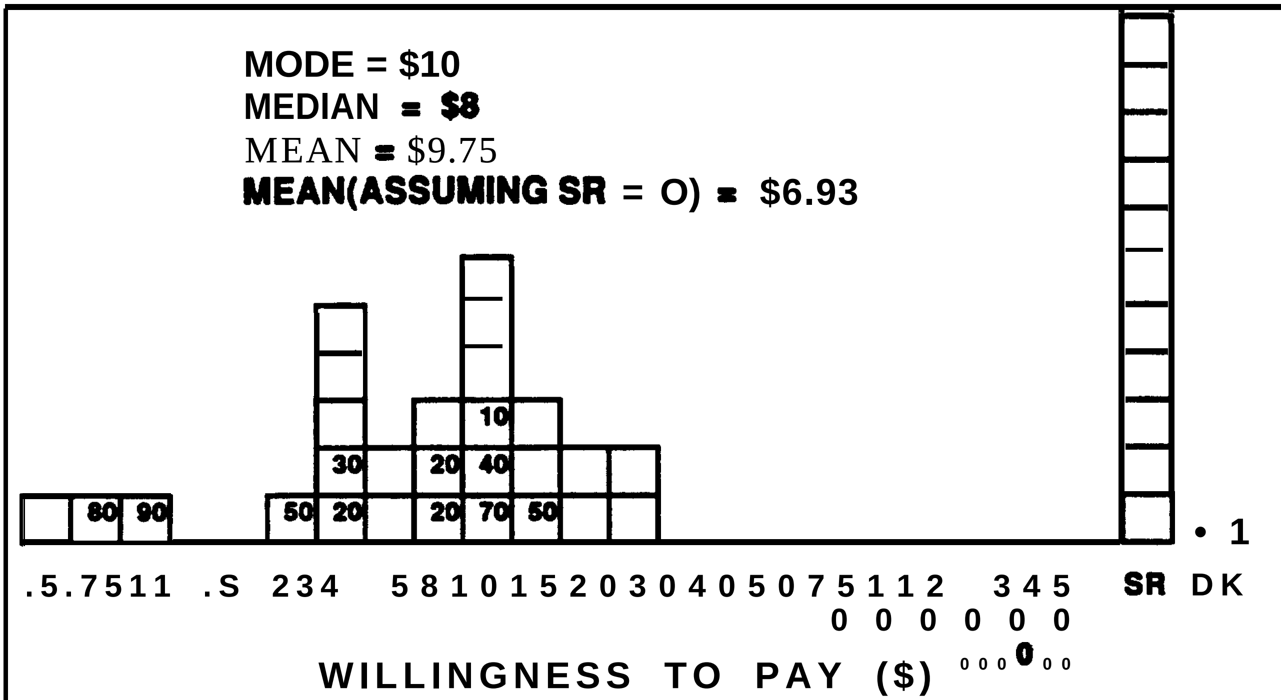
FIGURE 4.4: REDUCED WTP FOR COMPLETE CLEANUP - OCTOBER 1900 PRETEST - PRELIMINARY



Distribution of reduced preliminary monthly values (multiplied by the **percentage** reduction due to **embedding, Q-47,** Appendix **A)** for the **COMPLETE** GROUNDWATER **TREATMENT** option (October 1990 pretest). **SR** = scenario rejection: DK = don't know. Thirteen of the 41 subjects 'educed their value **in** response to **Q-47;** the exact percentage reduction for these **subjects is** shown in the boxes in the diagram.

stated a percentage reduction. Applying these percentage reductions to subjects' values reduces the means of the distributions, on average, by about 15 or 20% (for example, the mean of the distribution for the December 1990 pretest reduces from $12.20 (Fig. 4.2) to $9.75 (Fig. 4.5). However, the majority of subjects do not state a reduction, but instead claim that their entire value applies only to the specific program stated. These results suggest that embedding does occur to a substantial degree among at least part of the population and should be taken into account in survey design and in estimating use and non-use values. However, as noted in

FIGURE 4.5: REDUCED WTP FOR COMPLETE CLEANUP - DECEMBER 1990 PRETEST



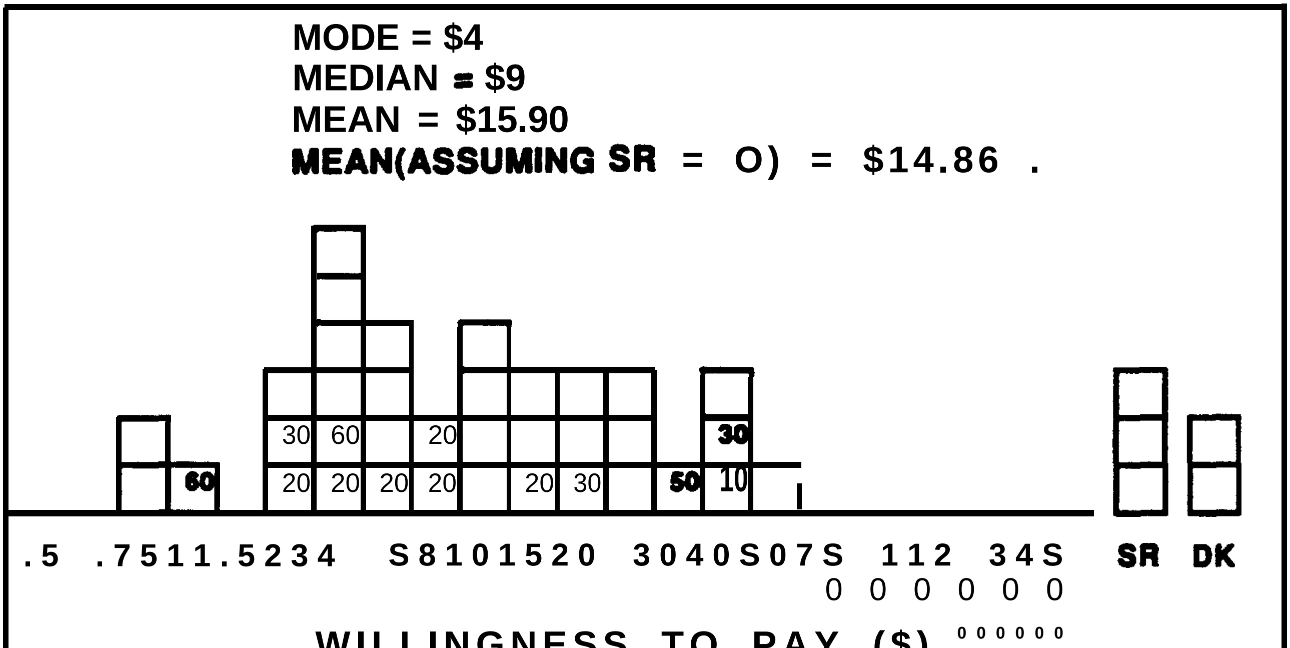
Distribution of reduced monthly values (multiplied by the percentage reduction due to embedding, Q-45, Appendix B) for the COMPLETE GROUNDWATER TREATMENT option (December 1990 pretest). SR = scenario rejection: DK = don't know. Eleven of the 39 subjects reduced their value in response to Q-45: the exact percentage reduction for these subjects is shown in the boxes in the diagram.

Chapter III this percent level of embedding is the lowest we are aware of having been reported for any study employing debriefing questions of this type.

4.4 Estimates of Use Value

The pretest surveys were designed to yield several potential measures of use and non-use values. Each measure relies on one or more of the dollar responses to the groundwater protection options described in the survey.

FIGURE 4.6: REDUCED WTP FOR COMPLETE CLEANUP - OCTOBER 1990 PRETEST-FINAL

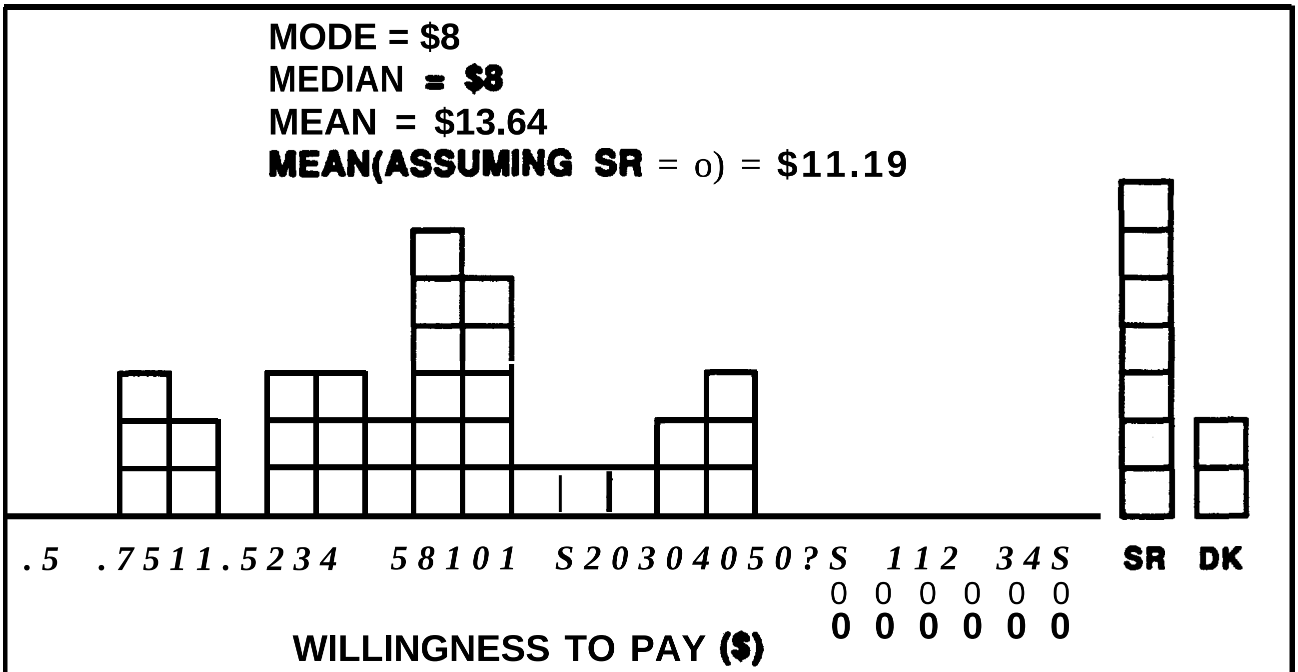


Distribution of reduced final monthly values (multiplied by the percentage reduction due to embedding, Q-47, Appendix B) for the **COMPLETE GROUNDWATER** TREATMENT option (October 1990 pretest). SR = scenario rejection: DK = don't know. Thirteen of the 41 subjects reduced their value in response to Q-47: the exact percentage reduction for these **subiects** is shown **in** the boxes in the **diagram.**

Each measure has its own advantages and disadvantages, which will be discussed below. It should be noted that the measures vary widely with respect to the degree to which they are affected by scenario rejection. all of the estimates employ values which have been reduced to account for self-reported embedding as described above.

It should also be noted that these pretest estimates maybe somewhat over- or underinflated due to order effects. For example, there was a trend in the data such that willingness to pay for groundwater protection tended to decrease over time. Since the BUY WATER option was always first or

FIGURE 4.7: VALUE FOR BUY WATER OPTION - USE VALUE METHOD 1-OCTOBER 1990 PRETEST

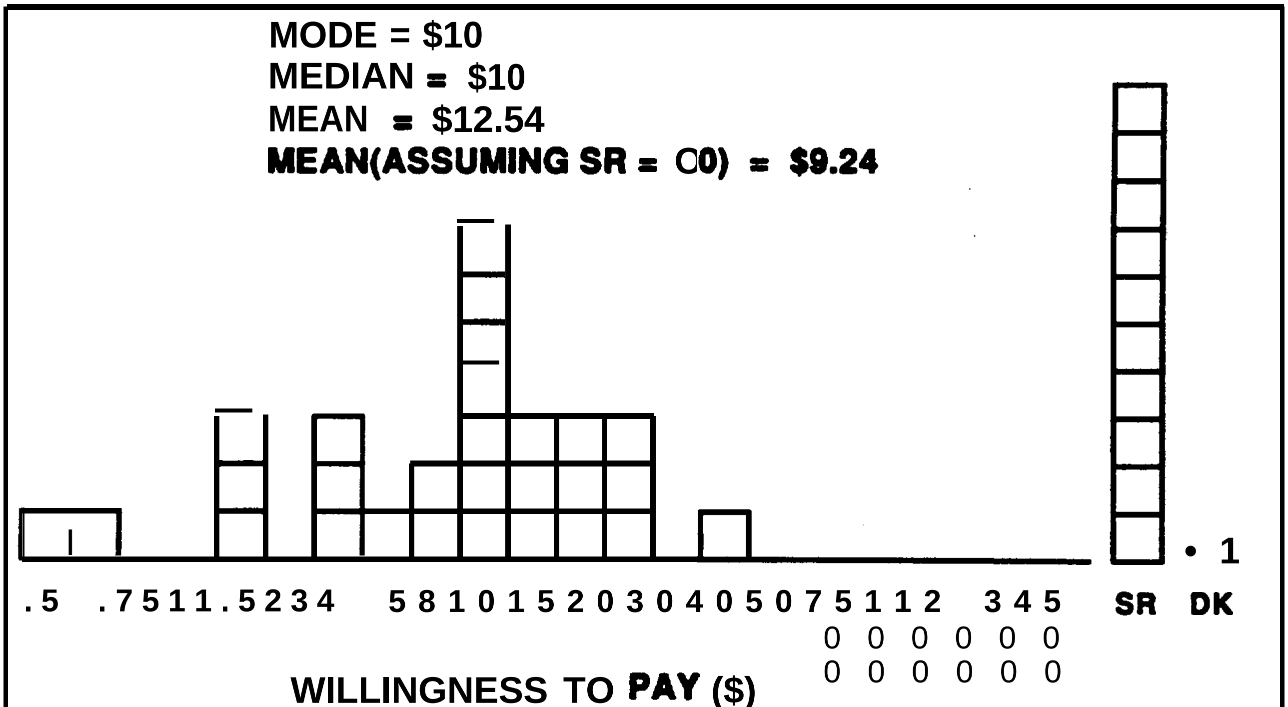


Jse value estimate, Method 1: reduced (from Q-47, Appendix A) monthly values for the BUY WATER FROM ANOTHER CITY option (October 1990 pretest). SR = scenario rejection: DK = don't know. Due to taking the percentage reductions due to embedding, some values here and in the following figures no longer correspond to the exact dollar bins shown. The reported means are based on the exact percentage-reduced responses.

second for the pretest subjects, use value estimates based on BUY WATER responses are likely to be overestimates. Or, it is possible that, since the CREATE A FUND FOR FUTURE USE option was the most highly rejected option and the WATER SUPPLY TREATMENT option was always next, WATER SUPPLY TREATMENT may have seemed especially valuable in comparison.

Figures 4.7 and 4.8 show the distribution of monthly values for the BUY WATER option for the October 1990 and December 1990 pretests, respectively (use value Method 1). These values should represent only use

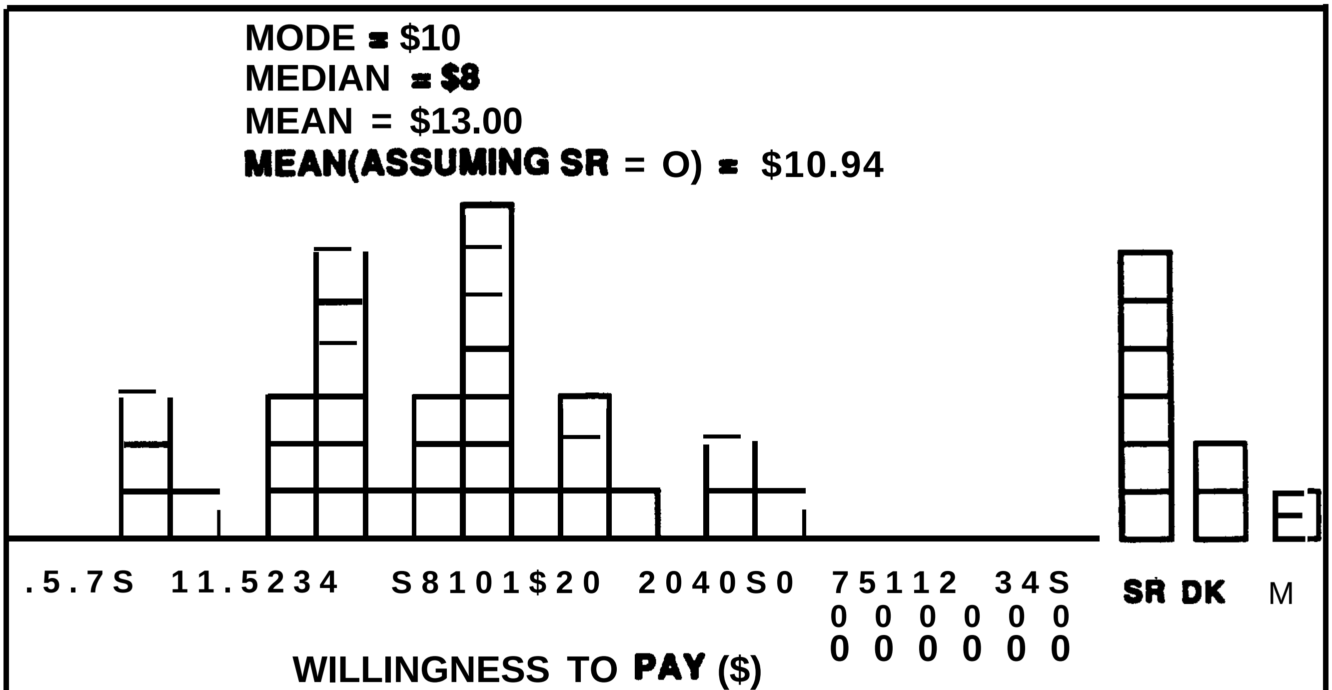
FIGURE 4.8: VALUE FOR BUY WATER OPTION - USE VALUE METHOD 1- DECEMBER 1990 PRETEST



Use **value** estimate, Method 1: reduced (from Q-45, Appendix B) monthly **values** for the BUY WATER FROM ANOTHER CITY option (December 1990 **pretest).** SR = scenario rejection: DK = don't know.

value since the program being valued is restricted to purchasing water to replace the contaminated groundwater that could no longer be used, it provides no benefit for future generations, snd it does nothing to improve the groundwater situation. The means of the distribution are very similar ($13.64 vs. $12.54) for the two pretest groups, although it should be noted that these estimates of use value are likely somewhat inflated because they are early estimates for both groups. The similarity of these distributions also provides evidence that the two pretest subject populations did not differ in their views at the beginning of the survey: the values for the COMPLETE GROUNDWATER TREATMENT option are lower for the December 1990

FIGURE 4.9 VALUE FOR WATER SUPPLY TREATMENT OPTION - USE VALUE METHOD 2 - -- 1990 PRETEST

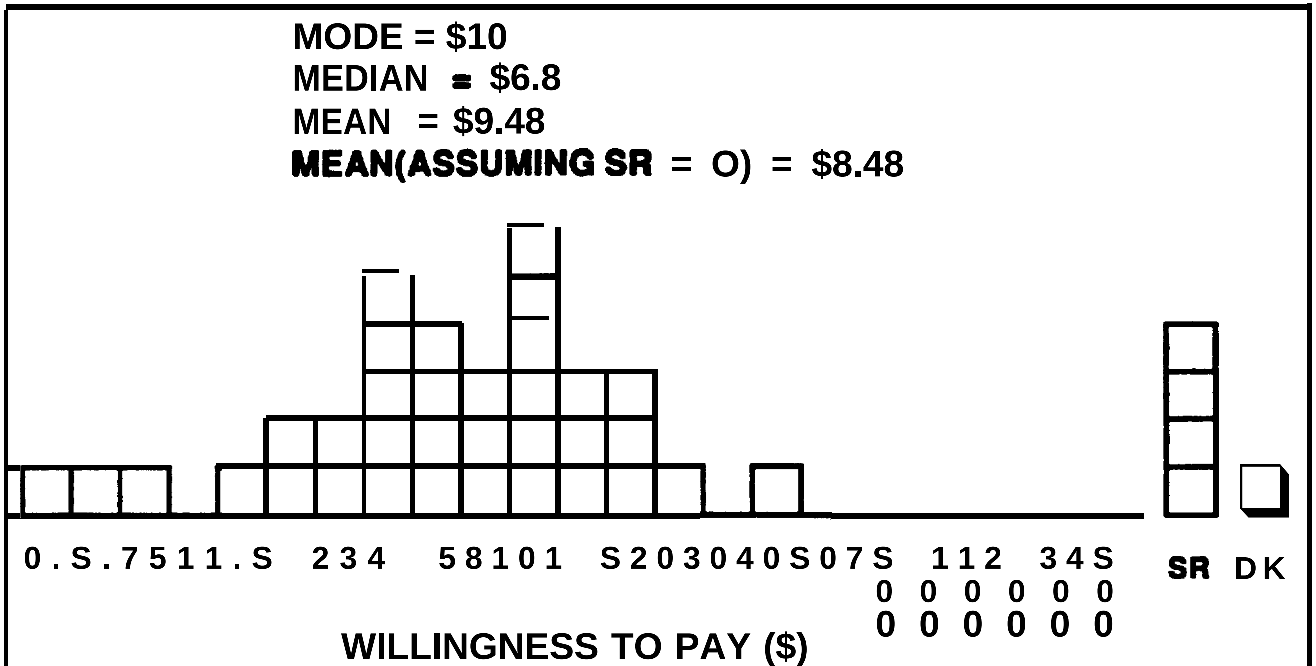


Use value estimate, Method 2: reduced (from Q-47, Appendix A) monthly values for the WATER SUPPLY TREATMENT option (October 1990 pretest). SR = scenario rejection; DK = don't know; M = missing data

group in spite of the fact that the values for BUY WATER are not substantially different between pretest groups. This suggests that any difference between the groups is not simply due to differences in the sample populations but is instead due to the information/context manipulation.

Figures 4.9 and 4.10 show the distribution of monthly values for the WATER SUPPLY TREATMENT option for the October 1990 and December 1990 pretests, respectively (use value Method 2). The mean of the distribution for the October 1990 group is $13.00, while that for the December' 1990 group is substantially lower ($9.48). This difference likely represents the differntial effect of context between pretest groups

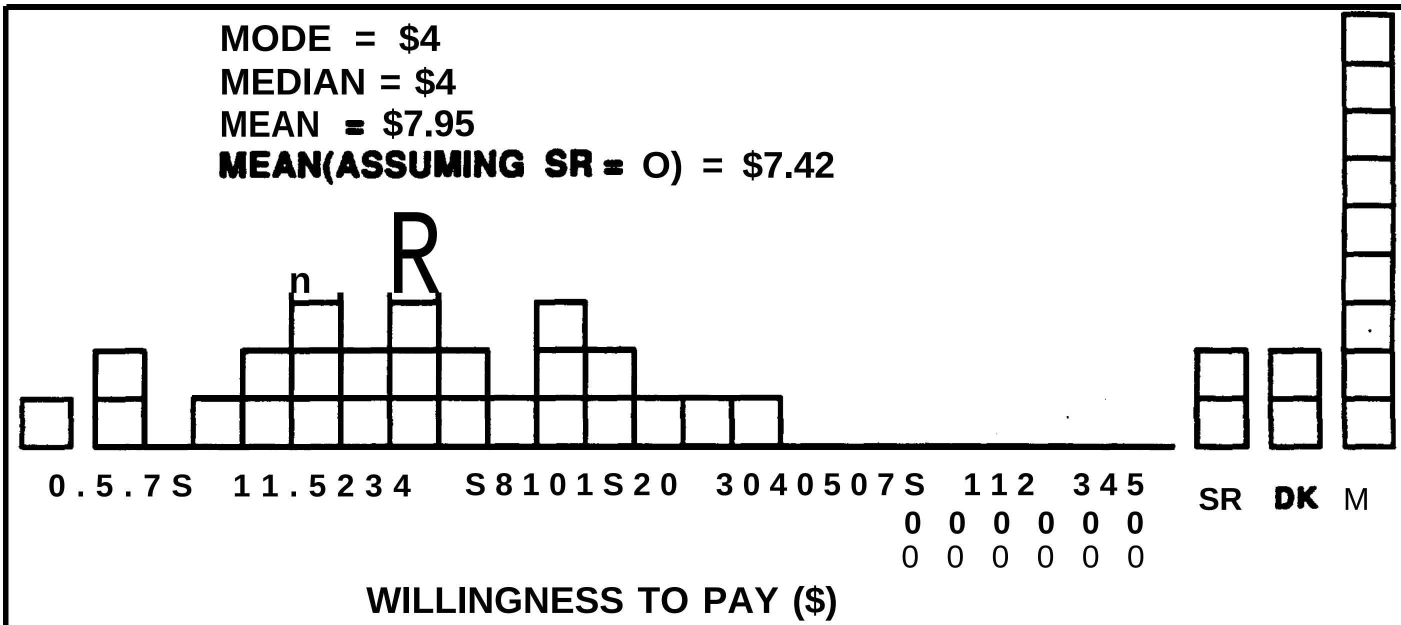
FIGURE 4.10 VALUE FOR WATER SUPPLY TREATMENT OPTION - USE VALUE METHOD 2 - DECEMBER 1990 PRETEST



Use value estimate, Method 2: reduced (from Q-45, Appendix B) monthly values for the WATER SUPPLY TREATMENT option (December 1990 pretest), SR = scenario rejection: DK = don't know.

described earlier in the values for COMPLETE GROUNDWATER TREATMENT. Unlike the BUY WATER option, however, it is unclear that subjects arc interpreting the WATER SUPPLY TREATMENT option as strictly a use value question some subjects instead see this option as preferable to COMPLETE GROUNDWATER TREATMENT because they prefer an option that takes care of the contamination as the water is needed, rather than cleaning up all the contamination at once and facing potential recontamination in the future. In this sense subjects may be interpreting the WATER SUPPLY TREATMENT option to have altruistic as well as some bequest and existence value components as well as a use value component.

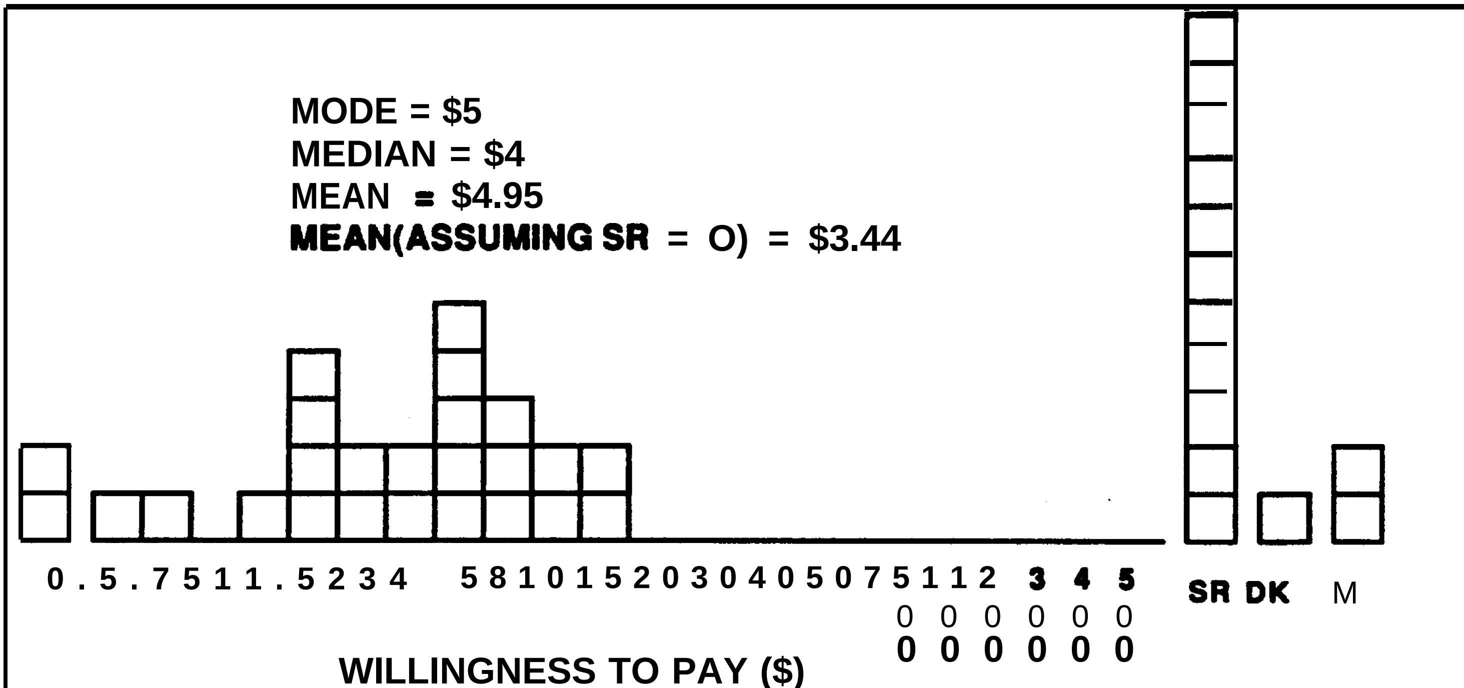
FIGURE 4.11: USE VALUE FOR COMPLETE GROUNDWATER TREATMENT - USE VALUE METHOD 3- OCTOBER 1990 PRETEST



Use value estimate, Method **3:** reduced **(from** Q-47, **Appendix A) final monthly** values for the COMPLETE GROUNDWATER **TREATMENT** option (October 1990 pretest), multiplied by the percentage stated as use **value** (from **Q-42, Appendix** A). SR = scenario **rejection;** DK = don't **know;** M = missing **percentage split.**

Figures 4.11 and 4.12 show the distribution of monthly values for the COMPLETE GROUNDWATER TREATMENT option multiplied by subjects* self-reported percentage attributable to use value for the October and December 1990 pretests, respectively (use value Method 3). This method attempts to extract the use value component of a value which naturally includes use value, bequest value (the water is cleaned up immediately for future generations), and existence value (all of the contaminants are removed from the groundwater as soon as possible) components. The mean of the distribution for the October 1990 group is $7.95, while that for the December 1990 group is substantially lower ($4.95). Both of these estimates are substantially lower than the estimates of use value derived by

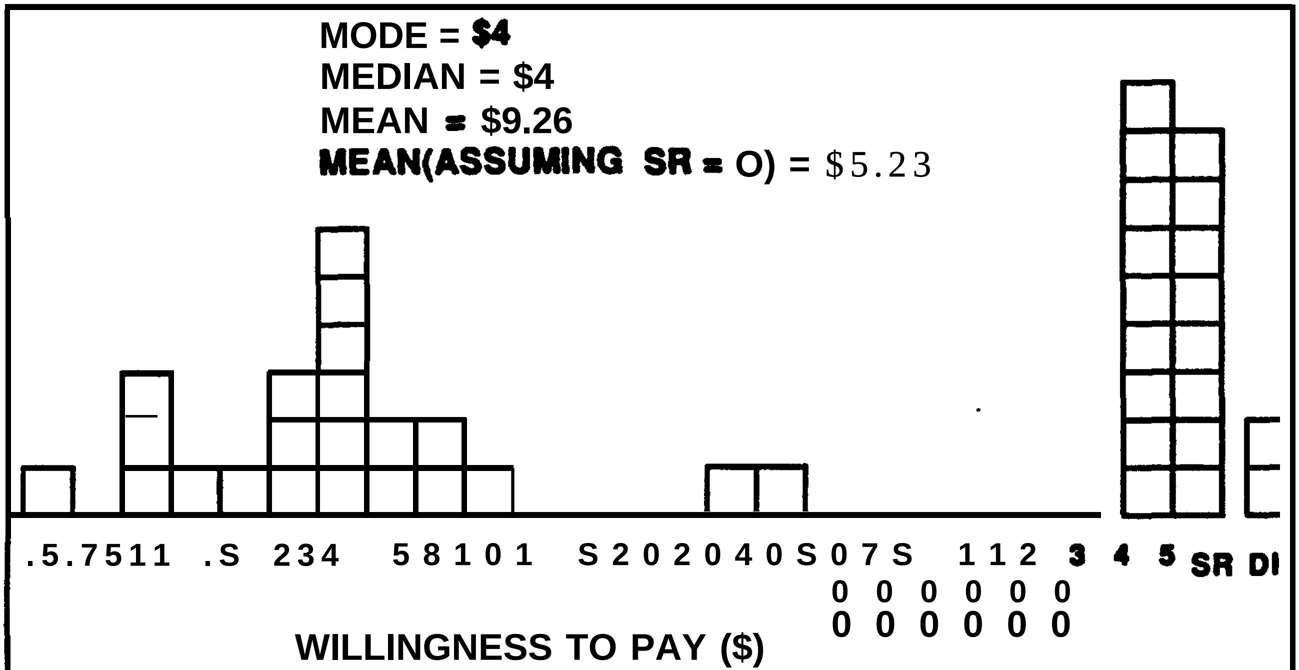
FIGURE 4.12: USE V“ FOR COMPLETE GROUNDWATER TREATMENT - USE VALUE METHOD 3- DECEMBER 1990 PRETEST



Jse value estimate. Method **3:** reduced (from Q-45, Appendix B) monthly values for the **COMPLETE GROUNDWATER** TREATMENT option (December 1990 pretest), multiplied **by** the percentage stated as use value (from **Q-40,** Appendix B). SR = scenario rejection: **DK** = don’t **know;** M = missing **percentag**e split.

Methods 1 and 2. Also, as was the case with Method 2, the December 1990 pretest group yields a significantly lower estimate than the October 1990 pretest group. One potential drawback with this method is that it is unclear how reliably subjects are at separating out after the fact components of values which were elicited globally. Also, some subjects are eliminated from the distribution by this procedure because they have difficulty assigning percentages to the different value components (Le.. the total percentage assigned did not add to 100%).

FIGURE 4.13: NON-USE VALUE FOR CREATE A FUND FOR FUTURE USE - NON-USE VALUE METHOD 1- OCTOBER 1990 PRETEST



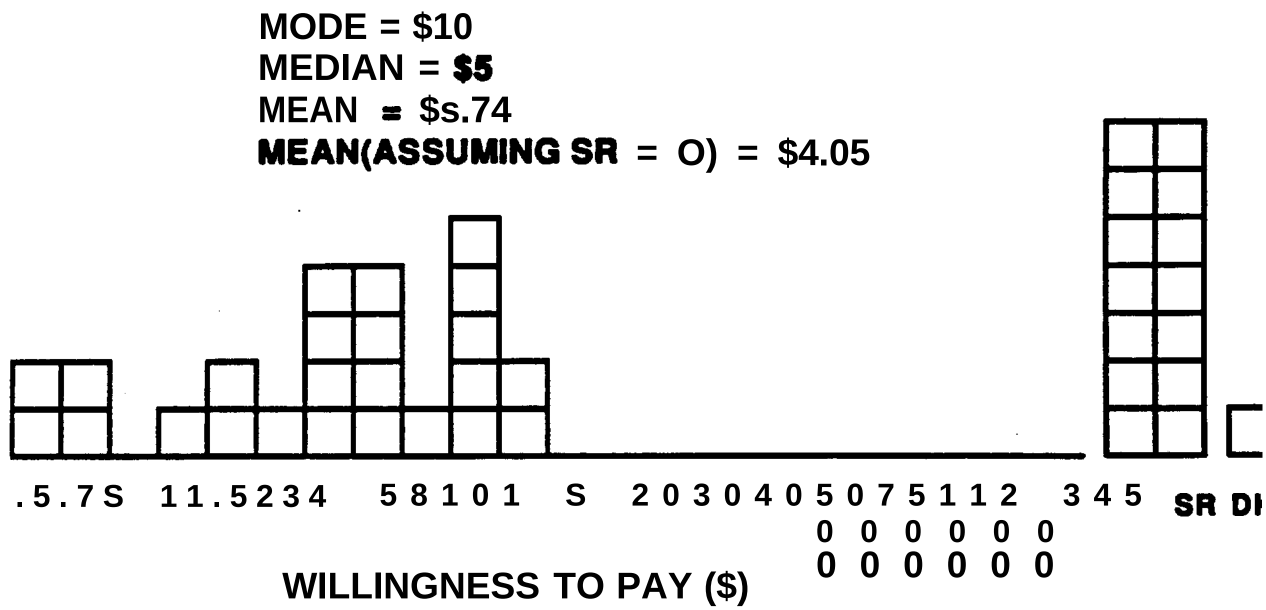
Non-use value estimate, Method 1: reduced from(Q-47, Appendix A) monthly values for the CREATE A FUND FOR FUTURE USE option (October 1990 pretest). SR = scenario rejection; DK = don't know.

4.5 Estimates of Non-Use Value

As we reported for use value in section 4.4, we report here three alternate methods for estimating non-use value for groundwater protection. For our purposes non-use value is defined as all value over and above use value and includes bequest value and existence value.

Figures 4.13 and 4.14 show the distribution of monthly values for the CREATE A FUND FOR FUTURE USE option for the October 1990 and December 1990 pretests, respectively (non-use value Method 1). These values should represent only bequest and future existence value since the

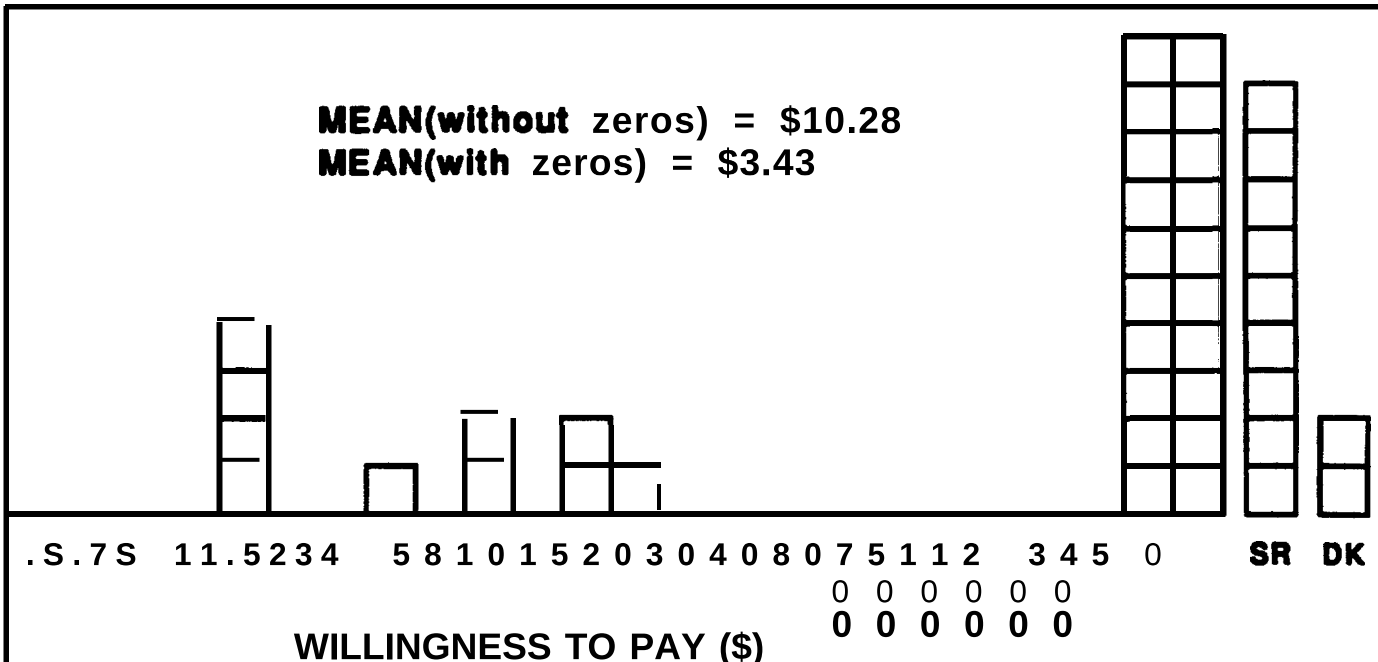
FIGURE 4.14: NON-USE VALUE FOR CREATE A FUND FOR FUTURE USE - NON-USE VALUE METHOD 1- DECEMBER 1990 PRETEST



Non-use value estimate, **Method** 1: reduced (from Q-45, Appendix B) **monthly** values for the CREATE A FUND FOR FUTURE USE option (**December 1990 pretest). SR = scenario** rejection: DK = don't know.

program is for future only and not present use. The most striking aspect of these distributions is the high degree of scenario rejection: over one-third of the pretest subjects rejected this option in both groups. Many people either do not believe that their money will truly be used for its stated purpose or believe that the program will be mismanaged. Others reject the program simply because they feel the groundwater problem should be dealt with more immediately by one of the other options. The mean of the distribution for the October 1990 group is $9.26, while that for the December 1990 group Is substantially lower ($5.74). This is further evidence, now in the domain of non-use values, that the average values of the

FIGURE 4.15 NON-USE VALUE METHOD 2 - COMPLETE GROUNDWATER TREATMENT MINUS WATER SUPPLY TREATMENT - OCTOBER 1990 PRETEST

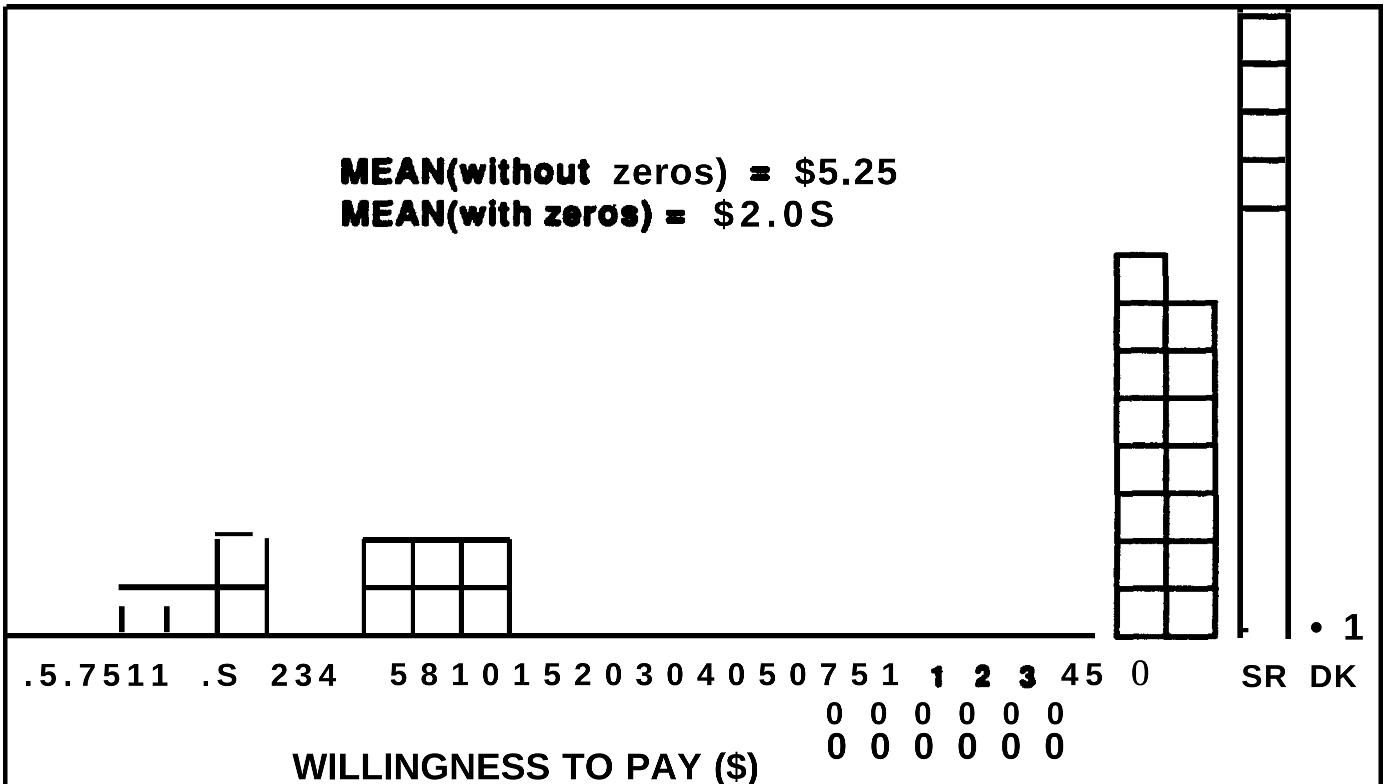


Non-use value estimate, Method 2: reduced (from Q-47, Appendix **A)** monthly **values** for the COMPLETE GROUNDWATER TREATMENT option - reduced **monthly** values for the WATER SUPPLY TREATMENT option (October 1990 **pretest).** SR = scenario rejection (one or both); DK = don't **know;** O = no difference.

December 1990 pretest group seem to rapidly become lower due to the relative absence of extreme values.

Figures 4.15 and 4.16 show the distribution of monthly values for the COMPLEtE GROUNDWATER TREATMENT option minus the monthly values for the WATER SUPPLY TREATMENT option for the October 1990 and December 1990 pretests (non-use value Method 2). This method Is based on the premise that the WATER SUPPLY TREATMENT option measures only use value, which, as discussed above, is problematic. Although the means of the two distributions ($10.28 and $5.25) are quite close to the respective

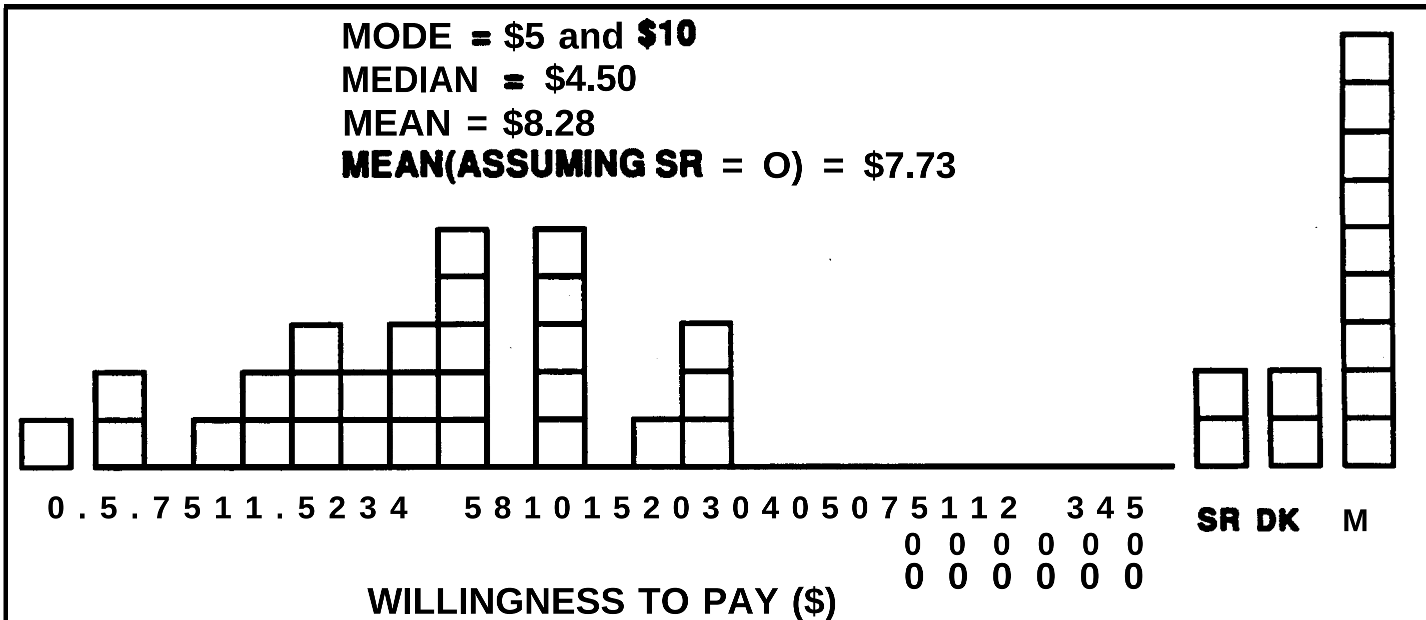
FIGURE 4.16: NON-USE VALUE METHOD 2- COMPLETE GROUNDWATER TREATMENT MINUS WATER SUPPLY TREATMENT - DECEMBER 1990 PRETEST



Non-use value estimate, Method 2: reduced (from Q-45, Appendix B) monthly values for the COMPLETE GROUNDWATER TREATMENT option - reduced monthly values for the WATER SUPPLY TREATMENT option (December 1990 pretest). SR = scenario rejection (one or both): DK = don't know; O = no difference.

means of the non-use value Method 1 distributions, these means are based on extremely few subjects due to the large number of subjects who rejected one or both of the relevant scenarios and to the large number of zero values (subjects who gave identical responses to the two scenarios). As noted above this method is likely to underestimate non-use values (especially if zeros are included) since some non-use values are included In the value for water

FIGURE 4.17: NON-USE VALUE METHOD 3 - COMPLETE GROUNDWATER TREATMENT TIMES PERCENTAGE FOR NON-USE - OCTOBER 1900 PRETEST

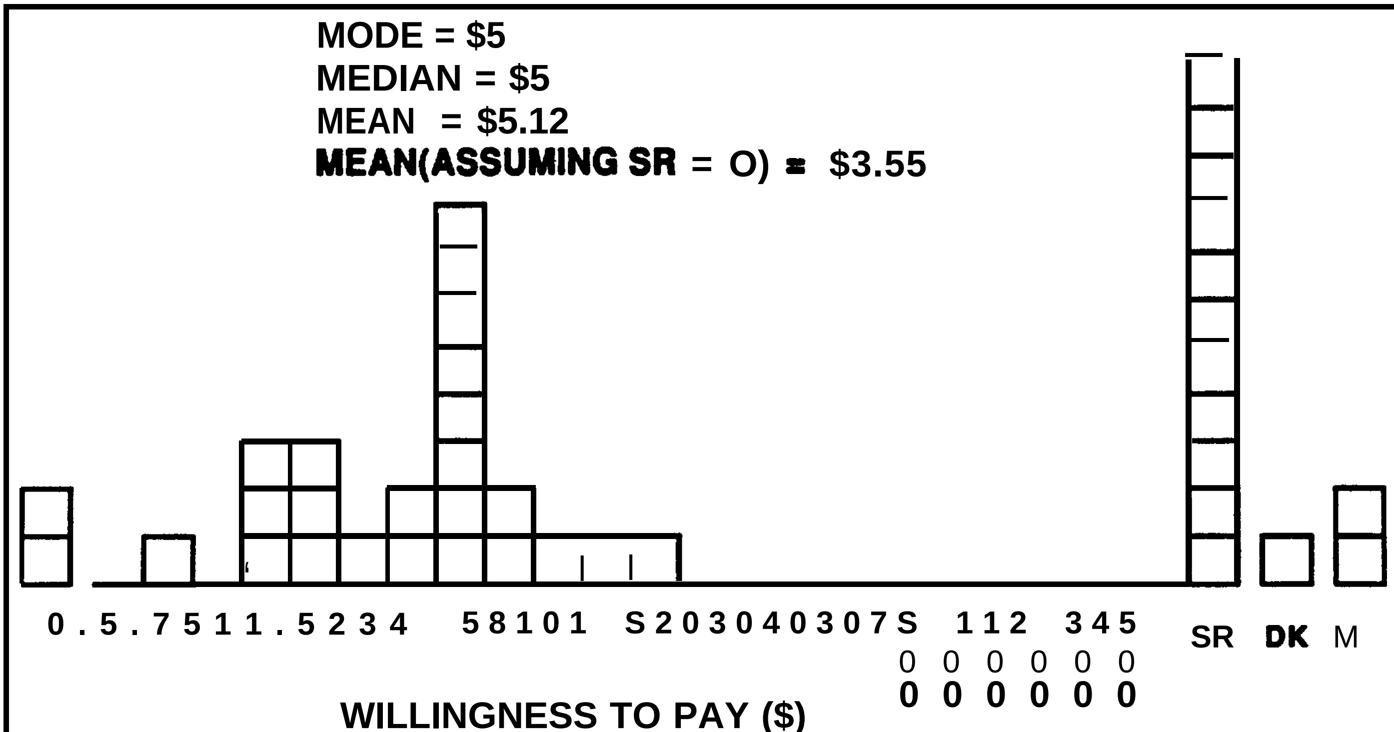


Non-use value estimate, Method 3: reduced (from Q-47, Appendix A) final monthly values for the COMPLETE GROUNDWATER TREATMENT option (October 1990 pretest), multiplied by the percentage stated as non-use value (from Q-42, Appendix A). SR = scenario rejection: DK = don't know; M = missing percentage split.

supply treatment and since some subjects may not recognize the difference in implications of the two scenarios.

Figures 4.17 and 4.18 show the distribution of monthlyvalues for the COMPLETE GROUNDWATER TREATMENT option multiplied by subjects" self-reported percentage attributable to non-use value for the October and December 1990 pretests, respectively (non-use value Method 3). This method is identical to use value Method 3, with the exception of multiplying by self-reported non-use value rather than self-reported use value, and it has the same strengths and limitations. The mean of the distribution for the October 1990 group Is $8.28, while that for the December 1990 group is

FIGURE 4.18: NON-USE VALUE METHOD 3 - COMPLETE GROUNDWATER TREATMENT TIMES PERCENTAGE FOR NON-USE - DECEMBER 1900 PRETEST



Non-use value estimate, **Method 3:** reduced from(Q-45, Appendix B) final monthly values for the COMPLETE GROUNDWATER TREATMENT option (December 1990 **pretest),** multiplied by the percentage stated as non-use value (from **Q-40, Appendix A).** SR = **scenario** rejection: DK = don't **know;** M = **missing** percentage **split.**

once again substantially lower ($5. 12). As was also true for use value, both of these estimates are lower than the estimates of non-use value derived by Methods 1 and 2.

Methods 1 and 3 for estimating non-use value make an interesting comparison. The values within a pretest group are quite similar, In spite of the fact that many subjects were removed from the Method 1 distribution due to scenario rejection. This is a strong indication that scenario rejection should not generally be interpreted as a zero value. Subjects who were not

willing to pay anything when evaluating non-use value in one way were willing to pay substantial amounts when evaluating non-use value in a different way.

4.6 Summary of Value Estimates

Table 4.1 summarizes the results of all three estimation methods for both use and non-use value and for both pretest groups. It is clear from this table that non-use value components such as bequest value and existence value are important for groundwater protection, perhaps as important as use values. By adding different use and non-use value estimates. it would be possible to obtain total monthly value estimates ranging from $10.07 to $23.92. The most obvious pattern evident in the table is that the estimates for the December 1990 pretest group are the lowest for all six methods.

A simple way to choose the best estimates for use and non-use value from this table would be to, first, assume that the results from the December 1990 pretest are more representative of people's true values since they were obtained after all information/context was presented and without implicitly encouraging subjects to "defend" a preliminary pre-context evaluation. Second, there are good reasons for choosing Method 3 for both intrinsic and use value: all of the other methods depend on values for options which may not be reliable. The BUY WATER option values are almost surely overestimates because they were always elicited before much of the detailed context. The WATER SUPPLY TREATMENT values are not unambiguously interpretable as representing strictly use values and the CREATE A FUND FOR FUTURE USE option was so often rejected that estimates based upon it cannot be regarded as representative.

TABLE 4.1: SUMMARY OF USE AND NON-USE VALUE ESTIMATES

Method	October 1990 Pretest	December 1990 Pretest
Use Value Estimates		
1) Monthly value for BUY WATER option	$13.64	$12.54
2) Monthly value for WATER SUPPLY TREATMENT option	$13.00	$9.48
3) Monthly value for COMPLETE GROUNDWATER TREATMENT X % use value	$7.95	$4.95
Non-Use Estimates		
1) Monthly value for CREATE A FUND FOR FUTURE USE option	$9.26	$5.74
2) Monthly value for COMPLETE GROUNDWATER TREATMENT - Monthly value for WATER SUPPLY TREATMENT	$10.28	$5.25
3) Monthly value for COMPLETE GROUNDWATER TREATMENT x % intrinsic value	$8.28	$5.12

By this logic, the lower estimate of $10.07 per month for total value for groundwater protection maybe preferable. It should be noted that this conclusion corresponds quite well to the medians and modes (but not the means) of all three distributions of values for COMPLETE GROUNDWATER TREATMENT presented in Figs. 4.1.4.2, and 4.3.

4.7 Debriefing Comments

After the main survey sections, subjects were asked an open-ended debriefing question and a series of more specific debriefing questions (Q-49 through Q-59 in Appendix A, Q-47 through Q-57 in Appendix B) about what parts of the surveyor items of information had any effect upon them when deciding on their values for the COMPLETE GROUNDWATER TREATMENT option. Since there was little revision of preliminary values for the October 1990 pretest group, we present here the debriefing results only for the December 1990 pretest group, who were not asked to make a preliminary evaluation and were therefore more likely to respond to context and information. Although these results are based on post-valuation self-reports. they provide several useful insights into what specific types of information and context may prove to have reliable effects on values as well as the direction of such effects.

Table 4.2 summarizes the self-reports of context effects from the December 1990 pretest, showing the percentage of subjects who indicated that information or questions in the survey had no affect upon their valuation of COMPLETE GROUNDWATER TREATMENT. caused them to lower their value, or caused them to raise their value for each of ten specific categories of information and context. The most striking element of this table is that the “no effect" category dominates for all ten types of information context in spite of the fact that information/context lowered the mean bid almost by half: even the categories which had the most self-reported effect on values were stated as having no effect at all by over 60% of the subjects. This suggests that information/context mostly effects subjects with extreme values. There are many reasons to expect context to make no difference in

TABLE 4.2 SELF-REPORTED EFFECTS OF CONTEXT - DECEMBER 1000 PRETEST

Self-reported Effects of Context from December 1990 Retest (Summary of responses to Q-47 through Q-56, Appendix B)					
	Percentage				
Self-reported effect	Q-47 Pers. exp.	Q-48 Def. of gwater.	Q-49 Speed of gwater.	Q-SO Water bill	Q-51 Buy water option
No effect	75%	82%	90%	77%	67%
Lowered value	o%	3%	8%	8%	20%
Raised value	25%	15%	2%	15%	13%
	Percentage				
Self-reported effect	Q-52 Water cons.	Q-53 Private options	Q-54 Dis-counting	Q-55 W. S. T. option	Q-56 Risk commun.
No effect	72%	66%	79%	61%	76%
Lowered value	13%	24%	10.5%	34%	9%
Raised value	15%	11%	10.5%	5%	15%

the evaluations of many people especially in light of the fact that the modal value remains the same in both the perfectly informed/full context and limited information/limited context groups. First, some people's values may be already well-formed or "crystallized" and therefore resistant to new information. Second, some subjects are likely using very simplified heuristics to arrive at a willingness-to-pay value which are independent of or allow them to ignore much of the context information (e.g., spending as much as they feel they can afford, or spending their current water bull X 50%). Third, the context information may be something many people already knew about or thought about on their own. Fourth. some subjects may not attend to some context information because they do not believe it or they dislike its implications (e.g., people may overlook or ignore the price information given about private options in the survey because they feel the issue should be dealt with publicly). Finally, some of the context categories which experts and survey designers feel should be important in valuing groundwater protection maybe seen by lay people as unimportant or irrelevant.

The difficulty in predicting the effect of context and the difference between the perceptions of experts and lay people is well illustrated by three of the context categories in the table: information about the speed of groundwater, information about "discounting." or the manner in which money Increases in value over time, and Information about the objective level of risk and how it compares to other risks people face (the risk communication information given in the form of a 'risk ladder" in the survey). Experts on groundwater, economics, and risk would certainly take this information into account in their judgments and there would likely be general agreement among such experts as to the direction of the effect such information should have: the slower the speed of the groundwater, the less dangerous and costly the problem: one should discount one's present payments to take into account the fact that they will earn interest in the future; or, the lower the level of risk in comparison to other risks, the less one should be willing to pay to avoid the risk. Although only 10% of subjects reported that finding out about the speed of groundwater changed their value, 8% of these lowered their potentially extreme values. Twenty-one percent reported information on discounting to have an effect. However, precisely half raised their values and half lowered them. Twenty-three percent reported risk information to have an effect but in spite of the fact that the rtsk level stated in the scenario was chosen deliberately to be extremely low, about three fourths of these raised their value.

Certain categories of information and context do appear to have very reliable directional effects. Asking people to think about the groundwater situation in their own community, for example, caused 25% of subjects to raise their values and none to lower their values. Also, the information about other response options to groundwater contamination (for example, the possibility of buying water elsewhere, of using private options, or of treating the water only as it is needed) caused many people to lower their values, although a substantial, but smaller, number raised their values instead. The effect of these alternate response options may be generally to make people lower their values because they realize less expensive alternatives are available, although a few may raise their values after reading about these options because they make more salient certain benefits they were getting with the COMPLETE GROUNDWATER TREATMENT program which they had not previously thought of.

Another hypothesis concerning the implicit decline in groundwater values which occurs throughout the lengthy perfect information/full context treatment is that, just as is seen in laboratory experiments, repeated bidding encourages people to think about their values with a consequent reduction in bidding means and variances. Note that having people bid successively over different scenarios provides the “excuse” for obtaining repeated bids.

Finally, subjects were also asked whether going through the information and response options in the surveys “made them any more or less optimistic about our ability to deal with groundwater contamination problems now and in the future.” Fifty percent of subjects indicated that the information had indeed made them more optimistic, 37% indicated the information made no difference, and only 13% indicated the information made them feel less optimistic. These results suggest that there may, in addition to the effects of specific categories of information and context. also be some general context effect which is working to lower values simply because there is a lot of detailed information presented in the survey in a calm and reasonable manner.

4.8 Statistical Analysis of Pre-Test Results

Differences between the questionnaire as administered in October and December provide an experimental design that allows us to answer several important questions. This section reports the analysis of those questions.

In the October administration respondents initially gave their contingent values for complete groundwater treatment for a particular scenario. Then, after reading many pages of material designed to provide additional information and context and after providing contingent values for many other groundwater treatment options, they again gave contingent values for the same complete groundwater treatment option. Thus, the first question to be addressed here is. did providing the detailed contextual information about groundwater hazards and their remediation change contingent values in the aggregate? For the 36 respondents who gave both initial and final values the descriptive data[1] are:

Time	Mean	S.D.
Initial	17.22	19.70
Final	17.83	19.92

This very small difference between initial and final contingent values is not statistically significant ($t(35) = 0.62$, $p = 0.54$)[2]. Note also that there is negligible change in the variability of the individual responses. Thus, there is no indication that the additional information and context had any impact on values in the aggregate in this treatment.

We further tested the idea that providing initial values may have biased final values by removing the initial question from the December administration of the survey. Otherwise, those respondents in the December administration received the same context and information as the October group before providing their final value for complete groundwater treatment. It is therefore interesting to compare the values from the

[1]The data analyzed in this section arc the reduced values--the contingent values reduced by the proportion of that value the respondent said was clue solely to complete groundwater treatment rather than to other public goods and values. The results arc essentially the same whether the original or reduced values arc in the analysis.

[2]Note that in the paired ~-test each respondent serves as his or her own control. It is therefore neither necessary nor appropriate to control for personal characteristics such as income.

December group to each of the two values from the October administration. The comparison data for 27 respondents from the December group are:

Time	Mean	S.D.
Final.Dec	9.75	7.94

Both the mean and the standard deviation appear to be noticeably lower than for the October administration. In fact, the variances for the earlier groups are reliably different from the variance for the December group ($F(35,26)=6.16$, $p < .0001$ for the comparison to the initial October value and X(35,26) = 6.29, $p < .0001$ for the comparison to the final October value). The difference in the variances invalidates use of the common t-test for independent groups so we must use an adjusted t-test instead to compare the means. The means for either of the October values are statistically higher than the means for the December group ($t(48.7) = 2.06$, $p = .045$ for the comparison to the initial October value and $t(50.3) = 2.15$, $p = .037$ for the comparison to the final October value)[3]. It therefore appears that indeed giving the initial value biased the final value. Without the initial value, the context appears to have reduced both the mean and the variance for the December group.

However, a closer examination of the data reveals that the differences in both the mean and the variance appear to be due to individuals in the October group with extreme values. Further, the relationship between the mean and modal values in the above analyses is a clear indicator of skew as

[3]Note that the adjustment to the t-test for unequal variances involves adjusting the degrees of freedom, often to non-integer values as in this case. It is customary to control for income in analyses of contingent values. However, in this case income was not ● significant predictor of values and its inclusion considerably complicates the analysis when heteroscedasticty exists, as it does in this case. Hence, income is omitted here. The corresponding analyses including income show the same result.

well as of heteroscendasticity. These are exactly the problems our analysis of errors in hypothetical values and empirical experience (see Chapter III) would lead us to expect. Both theory and expedence suggest that transformations would be appropriate both for removing the heteroscedasticity and the skewness induced by a few extreme values. It would be best to use the Box-Cox method for finding the best transformation as we did for the contingent values for improved air quality as described in Chapter 111. However, the present sample size is not adequate for the maximum likelihood estimation procedure. Instead, here we will use a log transform because it is both consistent with theory and close to the empirical transformations estimated in our other contingent value studies. The log transformed values from all the administrations are

Time	Mean	S.D.	Exp(Mean)
Initial, Oct.	2.20	1.21	9.02
Final, Oct.	2.26	1.16	9.58
Final, Dec.	1.89	1.03	6.62

Exp(Mean) is the geometric mean of the value. There is no longer any difference In the variances between the initial October and final December or between the final October and final December values ($F(35,26) = 1.40$, $p=.38$, and 1.27, $p=.53$, respectively). More Importantly, there is no longer any statistically significant difference between the means ($t(61) = 1.07$, $p=.29$, and 1.32, $p=.19$, respectively). Thus, once correcting for skewness and heteroscedasticty. there are no significant differences. This suggests, contrary to the earlier analysis of untransformed values. that information and context had little effect once the skewed distribution of hypothetical error was accounted for. Thus, a more parsimonious description of these results is that any differences between the two administrations can be attributed to the fact that information and context eliminated extreme values from the December group.

Using the untransformed values and assuming that the difference in raw values between those two administration represents a true effect of information and context the following argument can be made: the mean value from a survey with limited information and limited context would be about $17-$18 and the mean value from a survey providing perfect information and full context would be about $9-$10. However, simply taking the geometric mean of the limited Information/limited context survey would yield Exp(2.20) = 9.02. In other words, taking the geometric mean of the short limited information/limited context survey produces about the same estimate as the arithmetic mean of the values after perfect information and full context are provided. Thus, if the context effect in this analysis is real, then simply taking the geometric mean of the admittedly sloppy initial values has the same effect as providing full information and context. Taking the geometric mean of a short and inexpensive mail survey would obviously be more cost effective than administering a 20-30 page in-person interview required for perfect information and complete context. This interesting possibility needs verification in other studies of non-use values before it can be assumed to be a reliable approach. Furthermore, it should be noted that our limited information/limited context treatment still provides more information and context than many CV studies have employed in the past.

4.9 Conclusions

A number of the results of pretesting have major implications for the design of the national survey instrument.

- The 50-50 chance of a 50% water shortage caused by groundwater contamination remained a source of considerable confusion among subjects. many of whom interpreted this as an expected shortage of 50% rather than 25%. Thus, we concluded that a certain water shortage should be evaluated by respondents in the final surveydesign.

- The fund for future use scenario was overwhelmingly rejected by respondents and is unsuitable for use in the final survey design.

- The lengthy and complex risk ladder was used little by respondents and might well be deleted and replaced by one simple comparison to a well known risk.

- The inclusion of substitute options for complete cleanup seemed of considerable importance in subjects' construction of value for complete cleanup.

- However, the Inclusion of substitute options increased scenario rejection for complete cleanup since some subjects did not want to vote for a less preferred option. The no vote for complete cleanup did not correspond to a zero value, however. since these individuals in almost every case had voted for another option and provided a positive WI"P. Thus, the complete cleanup option implicitly did have some benefit for these individuals. In our previous work on the Brown Cloud air pollution study (see Chapter III), we found no difference between the referendum format and a dirtec WTP question so we conclude that a direct WTP question should replace the referendum approach for this particular commodity.

Self-reported embedding (about 20%) was as low as we have ever seen reported. Information and context appear to reduce self-reported embedding. In this case, the use of the monthly water bill seemed especially helpful.

- Depending on the results of further pretests, a shortened mail survey might be acceptable for two reasons: (1) Based on retrospective reports parts of the perfect information/complete context survey might well be shortened or deleted, and (2) The information and context provided appeared mostly to reduce extreme values, leaving the modal value unchanged. The Box-Cox transformation of values which we recommend in Chapter III eliminates or reduces the impact of extreme values, leaving the modal value unchanged. Thus, even if a shortened mail survey increases hypothetical error, it is plausible to suppose that a Box-Cox transformation may assist in allowing estimation of the underlying demand equation consistent with perfect information and complete context. This procedure, however. in our view, is no substitute for careful cognitive survey design.

In the next chapter we describe the design and testing of a mail survey based upon the perfect information/complete context instrument presented in this chapter.

Chapter V

Design and Testing of Mail Survey Instrument

5.1 Changes From Full information/Full Context Survey

In this chapter we discuss the changes made in survey design to develop a shortened instrument of mailable length. These changes were based on the results of verbal protocols, retrospective reports and debriefing information from the survey pre-testtng described in Chapter IV. In addition, changes were made based on additional technical information which became available following the initial design of the complete information/ full context survey. Finally, changes were adopted to reformat the survey into a mailable length and to develop additional variations of the base scenario to test for alternate aspects of valuation for both local and national groundwater cleanup.

The primary objective in redesigning the survey instrument was to maintain all information and context relevant for individuals to construct values for the scenarios described while trying to shorten the instrument to a mailable length. If an instrument containing all necessary information can not be made short enough for a mail survey. alternatives would include in-person interviews and administration in market research centers around the nation. The tradeoff between higher per respondent cost and the resulting representativeness of such a sample would be at issue relative to a mailable or in-person survey.

The instrument was shortened to twelve pages which is of mailable length. To insure that the shorter survey instrument had not deleted necessary information we re-tested the shortened instrument, again using a market research center. Statistical results from this re-test were compared to those from the initial pre-test described in Chapter IV. The comparison of values between the full information/full context surveys showed that the shortened survey instrument still seemed to provide adequate information for individuals to construct values corresponding to those in the longer instrument, especially as demonstrated by a comparable variance in the bids.

Several changes were implemented following the verbal protocols, retrospective reports and survey pretesting based on the conclusions presented in Chapter IV. These include the following alterations.

The 50-50 chance of a 50% water shortage was misinterpreted by many individuals. The 50-50 chance was replaced with a certain water shortage if no action for cleanup was to be taken. New text described the impending water shortage as a certain event resulting from groundwater contamination.

The scenario of a fund for future use was rejected by respondents in the verbal protocols and was dropped from the survey design as a method of estimating bequest values. As discussed in Chapter VII, alternative approaches to estimating non-use values proved quite successful in the final survey design although it may prove conceptually difficult for respondents to distinguish between bequest and existence values.

The risk ladder which had been used in the full information survey was removed, because individuals did not appear to make particular use of much of the information in the risk ladder. The statement regarding the comparability of the risks from x-ray exposure to the risks from groundwater contamination was retained in the early survey sections which develop information and context.

From the pretesting and verbal protocols it was obvious that the inclusion of substitute options was important to individuals for constructing their values. It was also found that using the referendum approach on each alternative led to scenario rejection of less favored alternatives. We therefore retained the information regarding alternative approaches for dealing with the groundwater contamination and the water shortage but did not have the individuals value each of these prior to valuing complete groundwater cleanup. Instead of using the referendum valuation approach on each alternative, the respondents were asked to indicate their level of satisfaction with each alternative on a scale of one to seven (1= not at all satisfied and 7 = extremely satisfied). Using this approach the respondents were able to consider substitute options prior to valuing complete groundwater cleanup. In addition, the valuation question for complete groundwater cleanup was changed from a referendum type question to a direct WTP question since previous work has suggested that there is little difference in the two approaches other than a reduction in scenario rejection.

To make the survey a mailable length the valuation questions for different scenarios were partitioned into different versions of the survey. These versions included two new scenarios described below. In four of the five versions of the survey (Versions A-D), individuals worked trough the exact same information and context sections before valuing the complete groundwater cleanup. Version E of the survey limited the information and context to test for the impact of the "quantity" of information and context on valuations. Following this valuation section the five different versions of the survey incorporated different sections to value different programs including public treatment, containment, national groundwater cleanup and different degrees of water shortfall.

Finally, the format for valuing alternative scenarios was changed. It was apparent from the analysis of the pretest results that the complete cleanup option was the most highly valued option for deling with groundwater cleanup. Based on this observatin, the valuation questions for the alternative scenarios were framed as a value relative to the value for the complete groundwater cleanup. Thus, using scales in which the value for the alternative scenario was stated as a percent of the value for complete groundwater cleanup would not cause the distribution of values to be truncated.

Two changes were made to the basic groundwater contamination scenario based on new technical information. First, the percentage of water shortage faced in the hypothetical scenario was changed from 50% to 40%. Second, the description of the physical size of groundwater contamination was lowered from two square miles to approximately five acres. This change was made based on information from the Office of Solid Waste of E.P.A. regarding the typical physical dimensions of actual groundwater contamination sites.

Other changes in the survey design were made to make the survey a mailable length and to attempt to estimate values for alternative scenarios not originally included in the full information/full context survey instrument. Following the research of Madariaga and McConnell (1987) a category for altruistic values was added to the question asking respondents for their component breakdown of their value for complete groundwater cleanup. This “altruistic” value asked what percent of their value did the respondent attribute to ensuring that “other households in your community have enough clean water to use.”

The section of the full information/ full context survey described in Chapter IV as the debriefing section was removed. This section had been used primarily for analyzing respondents use of information and context for survey development. For purposes of re-testing the shortened survey design, a separate debriefing survey was administered which served the same purpose as this section but no longer needed to be included in the survey instrument.

The diagram illustrating the mechanism of groundwater contamination proved highly useful to respondents in understanding the information and context of the groundwater problem and therefore was placed on the cover of survey and referred to as needed in the survey text. Having the diagram on the survey cover helped to convey valuable information to respondents and increase interest in completing the survey. (This diagram is shown on the first page of Appendix D).

Three variants were added to the original survey design to gather information for policy purposes. First, information received from the Office of Solid Waste at EPA suggested that, in some situations, complete groundwater cleanup as proposed in the base scenario would not be technically feasible. As a “next-best” approach to solving groundwater contamination problems, a containment option was included among the alternative options to complete cleanup. Containment involves drilling wells around the contaminated area to prevent the flow of contaminated groundwater and the drilling of new wells in an uncontaminated protion of the aquifer to provide clean water for use.

A “National” variant question was added asking individuals how much they would be willing to pay to help clean up groundwater in other communities. Two versions of the nattonal groundwater question were developed, one a full context/full information question and the other a limited information/limited context question. In the full information variant used in one version of the survey, respondents were provided with information regarding the number of landfills nationwide and how many of these were expected to cause groundwater contamination. They were asked to help fund cleanup in communities other than their own that did not completely fund complete clean up locally. In the limited information variant individuals were not given information regarding the number of landfills nationwide or the likelihood of these contaminating groundwater. In addition they were not told that their payments would be supplemental to those already provided by the other communities. Note that for the local cleanup options presented, everyone would pay for cleanup through an increase in water bills.

Another version of the survey asked for willingness to pay depending on the degree of water shortage they faced. As described earlier the base scenario evaluated a situation where the individual’s community faced a 40% water shortage due to groundwater contamination. This variant of the survey asked how much the respondent’s WTP would change if faced with only a 10% water shortage or if faced with a 70% water shortage. Changing the magnitude of the current water shortage should change WTP for use and altruistic values but presumably not for bequest and existence values.

Including a Variant examining changes in WTP when faced with different levels of water shortage provides an additional method for estimating rim-use values. Two approaches were already available in the percent splits and scenario difference approaches already considered in the pre-test survey. The "percent splits" approach uses the component valuations individuals assign to their stated Willingness to pay treating bequest and existence values as non-use components. The "scenario difference" approach takes the difference between the WTP for complete groundwater cleanup and the public treatment option. The difference between these valuations will be bequest and existence values minus whatever bequest value the respondent places on the "bequest" of capital equipment to future generations in the form of a water treatment plant.

The variation of water supply shortage presents a third approach for estimating non-use values by extrapolating the valuation to a condition of zero water shortage. Using within-subject data on WTP when faced with 10%, 40% or 70% water shortages a quadratic equation can be fitted with WTP as a function of water shortage. Setting the water shortage due to contamination equal to zero, the vertical intercept of the quadratic equation, the predicted value will be entirely bequest and existence values since there will be no loss of use under zero percent water shortage. As the WTP values used in the extrapolation approach are the reduced WTP values, the vertical intercept derived using this approach are values just for clean groundwater and not for other environmental or public goods. Chapter VII describes and compares the results of these three approaches for measuring non-use values for the national groundwater survey.

5.2 Survey Design

The shortenedsurvey instruments (shown in final form in Appendix D) contained six sections, one of which was varied In each of the five versions of the survey to answer a variety of questions.

The survey cover provides an introduction to the survey by presenting the title of the survey in question form and showing the respondents the diagram of the scenario to be valued. The cover asks for the head of the household to complete the survey and return the instrument to the Center for Economic Analysis at the University of Colorado.

The “Issues” section presents the respondent with information regarding the extent of use of groundwater and has the individual consider his or her own use of groundwater and possible contamination. This section retains much of the context and information from the full information/full context survey to let the individual understand the problem of groundwater contamination, how such contamination affects him or her and how this problem compares to other public policy issues.

The “How Communities Can Respond to Contaminated Groundwater” presents the individual with the hypothetical scenario to be valued and presents several alternatives to complete groundwater cleanup. This section includes Information regarding the physical scenario to be valued. the risks involved and the need to do something about the problem. It is emphasized that standard landfill practices caused the problem so that individuals will not reject the payment scenario if they feel that those who cause the problem should pay for it. In addition to the complete cleanup option, containment public treatment, home treatment and water rationing are described and the individuals are asked to indicate their level of satisfaction with each of these options.

The next section, “How Much Is It Worth to You to Completely Clean Up Contaminated Groundwater?." asks the individual how much he or she is willing to pay to completely clean up groundwater if faced with the hypothetical situation outlined in the previous seciton. It is emphasized that costs are not known at this time and that the program would only take place if it costs less than people were willing to pay. It is emphasized that scientists are satisfied that the program can be completed as described and that recontamination would not occur. The willingness to pay question is followed by disembedding, component splits and responsibility questions.

Following the complete cleanup valuation section each version of the survey incorporated a different section designed to examine specific valuations. The five versions of the survey are characterized in Table 5.1.

The final section of all versions requested socio-demographic information from the individuals including income. age, ethnicity, gender, education, and household composition. Further questions related to environmental “awareness” in terms of how much the individual recycles materials and of how many environmental organizations the individual has joined.

5.3 Survey Implementation

The shortened survey instrument was pretested on October 12, 1991 in Denver at a marketing research firm. The firm recruited a total of 117 individuals to participate In a survey dealing with public policy issues. Individuals were randomly assigned to five different groups each of which

TABLE 5.1: DIFFERENT VERSIONS OF MAIL SURVEY

VERSION	TITLE	DESCRIPTION
A	HOW MUCH IS IT WORTH TO YOU TO PREVENT FURTHER SPREADING OF CONTAMINATED GROUNDWATER?	Value for groundwater containment program
B	ABOUT THE NATIONAL GROUNDWATER PROBLEM	How much individual is willing to help to pay for other communities to clean up their groundwater contamination problems - full context and information
C	HOW MUCH IS IT WORTH TO YOU TO HAVE A CLEAN SUPPLY OF WATER?	Willingness to pay for a public water treatment program
D	WHAT IF YOU FACED A DIFFERENT LEVEL OF GROUNDWATER CONTAMINATION	How the degree of water shortage affects the willingness to pay - if faced with a 10% or a 70% water shortfall instead of the 40% shortfall
E	ABOUT THE NATIONAL GROUNDWATER PROBLEM	Same as Version B except with limited context and information

completed one of the versions of the survey. Following completion of the survey the participants were given a separate debriefing questionnaire to complete. They kept the valuation survey to refer to while completing the debriefing questionnaire. The complete process took about an hour for which individuals received $25.00 cash.

Table 5.2 presents socio-demographic information regarding the Denver pm-test subjects.

TABLE 5.2: SOCIO-DEMOGRAPHIC INFORMATION - DENVER PRE-TEST - OCTOBER1991

TOTAL NUMBER OF SUBJECTS	117
GENDER	43 FEMALE 73 MALE 1 NO ANSWER
AVERAGE AGE	44 YEARS
AVERAGE EDUCATION LEVEL	SOME COLLEGE
AVERAGE INCOME	$41,853
INCOME DISTRIBUTION	UNDER $9,999 3 $10,000 to 19,999 12 $20,000 to 29,999 27 $30,000 to 39,999 23 $40,000 to 49,999 14 $50,000 to 59,999 17 $60,000 to 69,999 8 $70,000 to 79,999 2 $80,000 to 89,999 7 over $90,000 3 no answer 1
ETHNIC GROUP	CAUCASIAN 106 AFRICAN AMERICAN 5 HISPANIC 1 ASIAN 3 OTHER 1 NO ANSWER 1

5.4 Results

5.4.1 Frequency Distributions of Values

The obtained willingness to pay values for the various programs are presented in the Figures 5.1-5.8. The distributions are plotted on log-dollar scales which essentially normalize the distributions. The vertical scale indicates the percentage of responses falling into each "bucket."

Reduced willingness to pay for complete groundwater cleanup (from Versions A, B, C and D) is presented in Figure 5.1. Figure 5.2 presents the distribution of WTP for complete cleanup for the no-context version. The geometric mean (anti-log of the mean of log WI'P) of reduced WTP for complete groundwater cleanup is $5.86 for the full context surveys and $7.30 for the no-context survey Version E. tHE reduced willingness to pay for complete groundwater cleanup is the willingness to pay for the program adjusted to account for self-reported embedding. This value was derived in all five versions of the survey, but Version E is a low-context variant so it is treated separately. The modal value in the no-context Version E is the same as in the full-context survey versions but the distribution has a higher variance with more of a right skew.

Figures 5.3 and 5.4 present the distribution of willingness to pay for the public treatment and containment options respectively. The geometric mean for these distributions are $1.62 for the public treatment program and $1.46 for the containment program. The apparent discontinuities in these distributions are attributable to the relatively small sample sizes of 22 respondents for each version. As for the distribution of WTP for complete cleanup, these distributions are close to log-normal distributions.

Figure 5.5 and 5.6 presents the distribution for willingness to pay for the national groundwater cleanup program for Version B (full context) and Version E (low context) respectively. The geometric mean for the full-context national WTP is $0.46 and for the low-context national WTP is $0.76. Both distributions are essentially log-normal truncated at zero. The no-context distribution has significantly higher variance than the full-context distribution as discussed in Section 5.5.

Figures 5.7 and 5.8 present the distributions of WTP for complete cleanup of contaminated groundwater under conditions of 10% water shortage and 70% water shortage respectively. The geometric means for WTP are $2.97 with a 10% water shortage and $10.38 with a 70% water shortage. As in the other distributions of WTP in the Denver pre-test, the small number of observations may cause apparent discontinuities in the graphs of the distributions which are very close to log-normal distributions.

FIGURE 5.1: REDUCED WILLINGNESS TO PAY FOR COOMPLETE CLEANUP
FULL CONTEXT VERSIONS
OCTOBER 1091- DENVER PRETEST

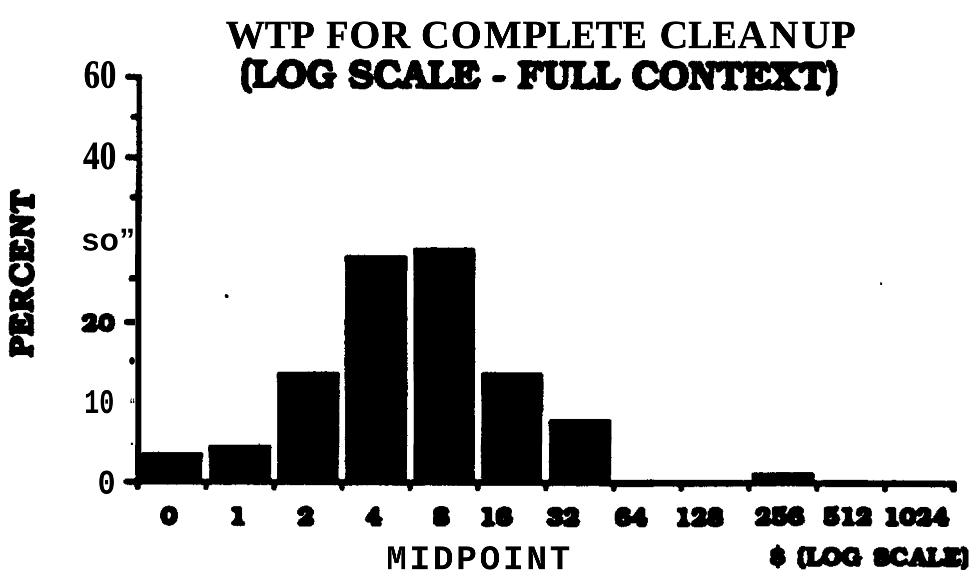


FIGURE 5.2: REDUCED WILLINGNESS TO PAY FOR COMPLETE CLEANUP - NO CONTEXT VERSION
OCTOBER 1991- DENVER PRETEST

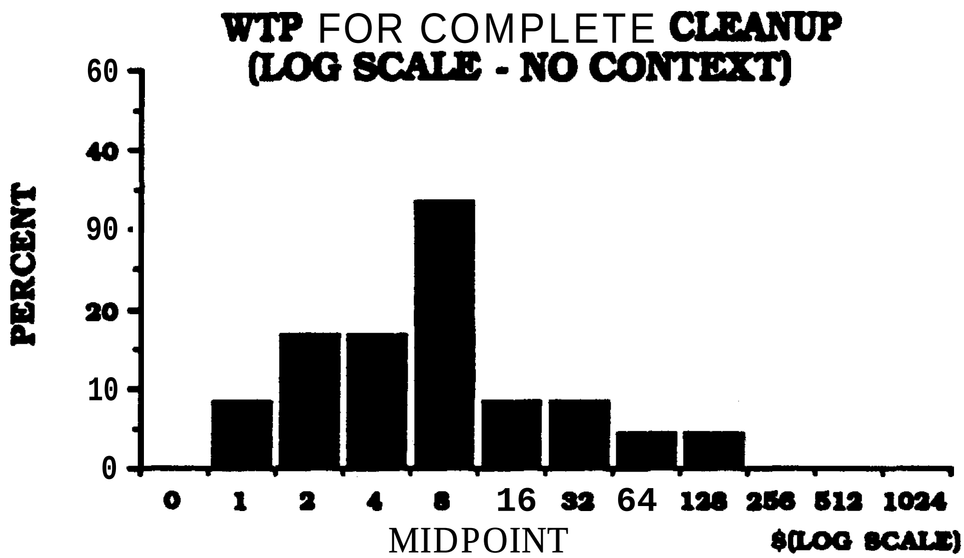


FIGURE 5.3: WTP FOR PUBLIC TREATMENT PROGRAM
OCTOBER 1001- DENVER PRETEST

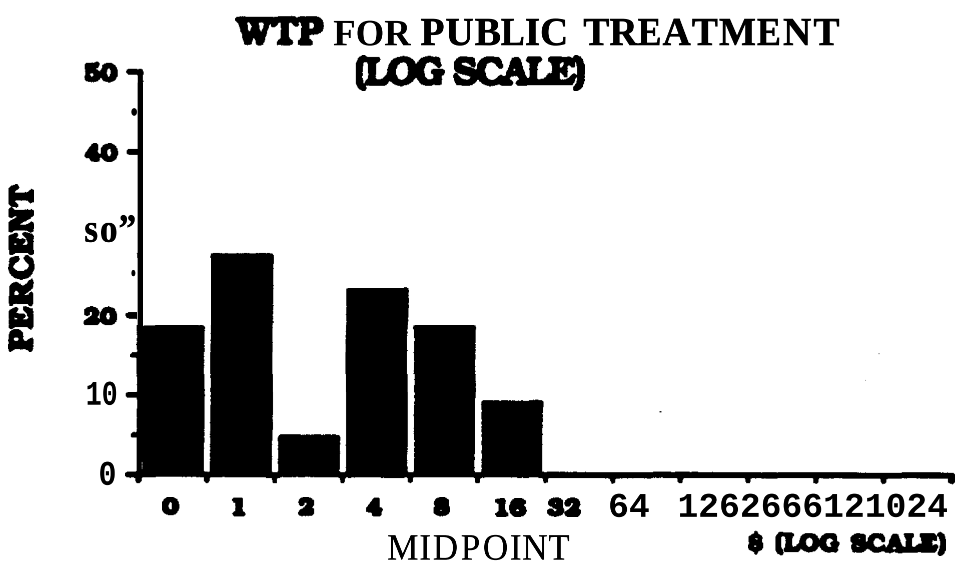


FIGURE 5.4: WTP FOR CONTAINMENT PROGRAM
OCTOBER 1991- DENVER PRETEST

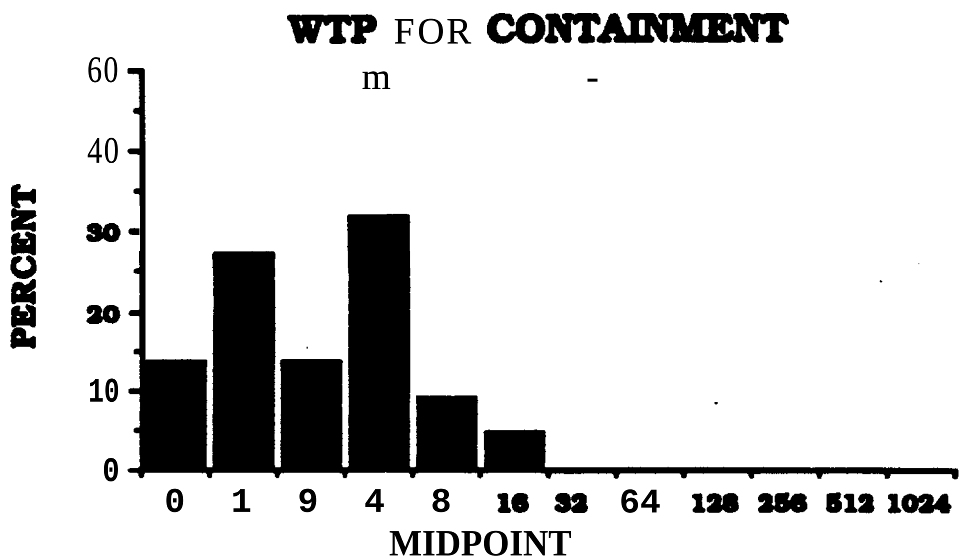


FIGURE 5.5: NATIONAL WTP - FULL CONTEXT
OCTOBER 1991- DENVER PRETEST

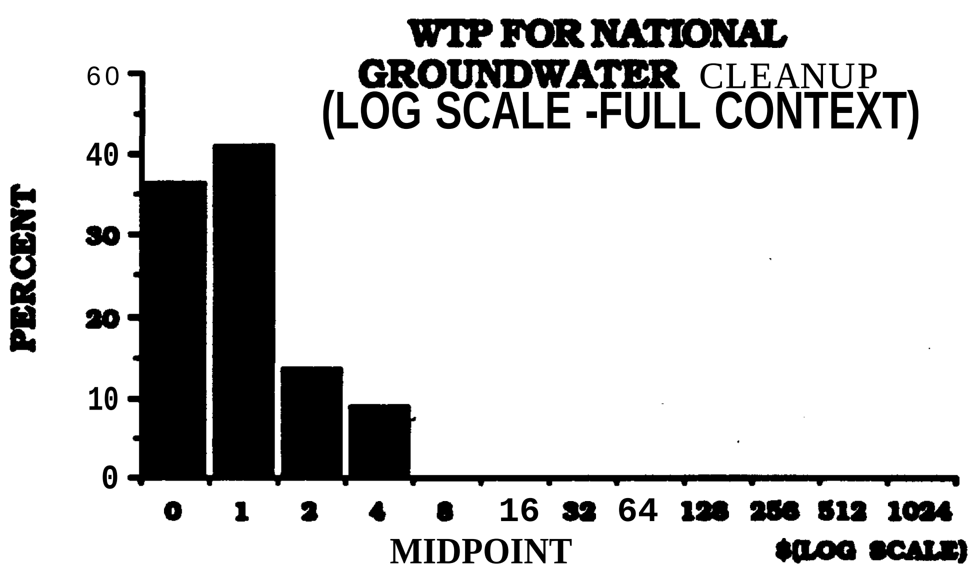


FIGURE 5.6: NATIONAL WTP - NO CONTEXT
OCTOBER 1901- DENVER PRETEST

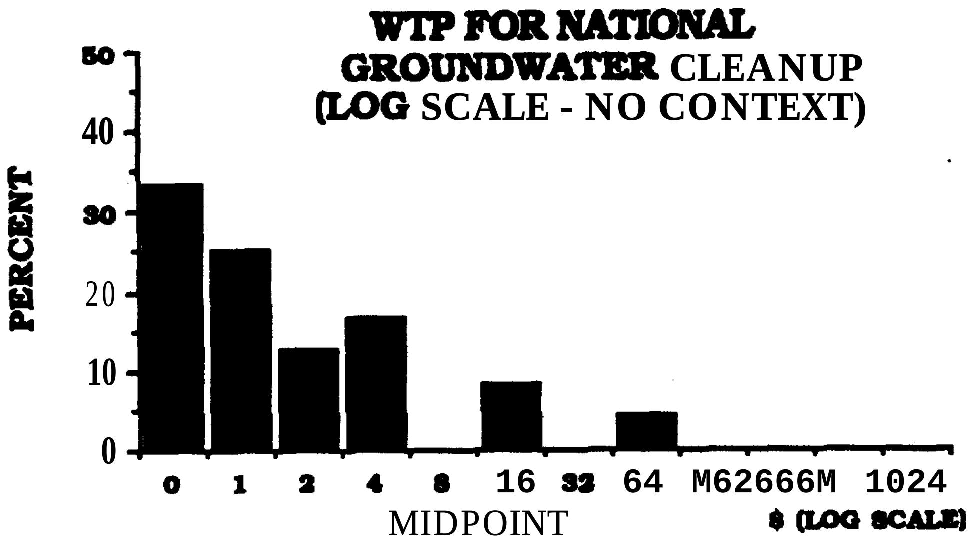


FIGURE 5.7: WTP WITH 1096 WATER SHORTAGE
OCTOBER 1991- DENVER PRETEST

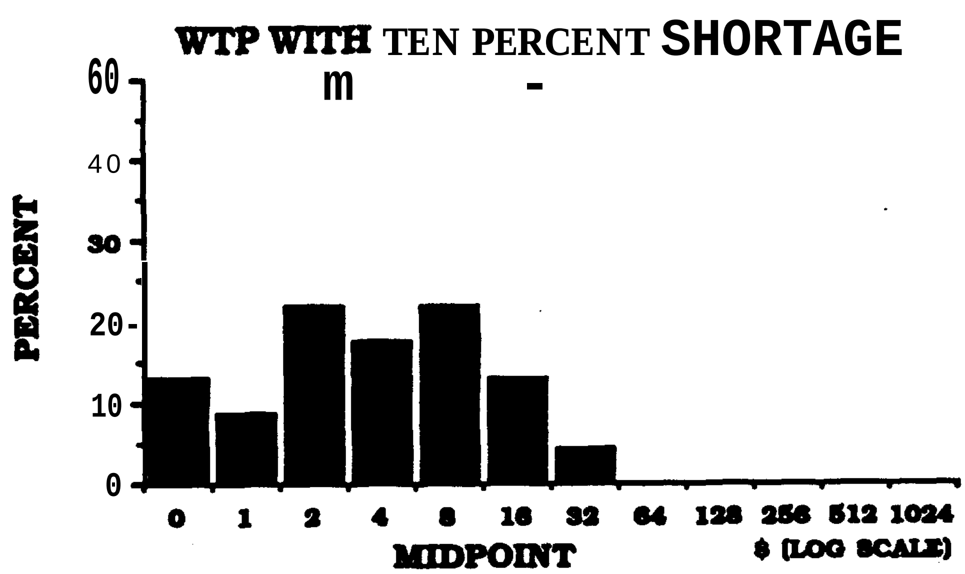
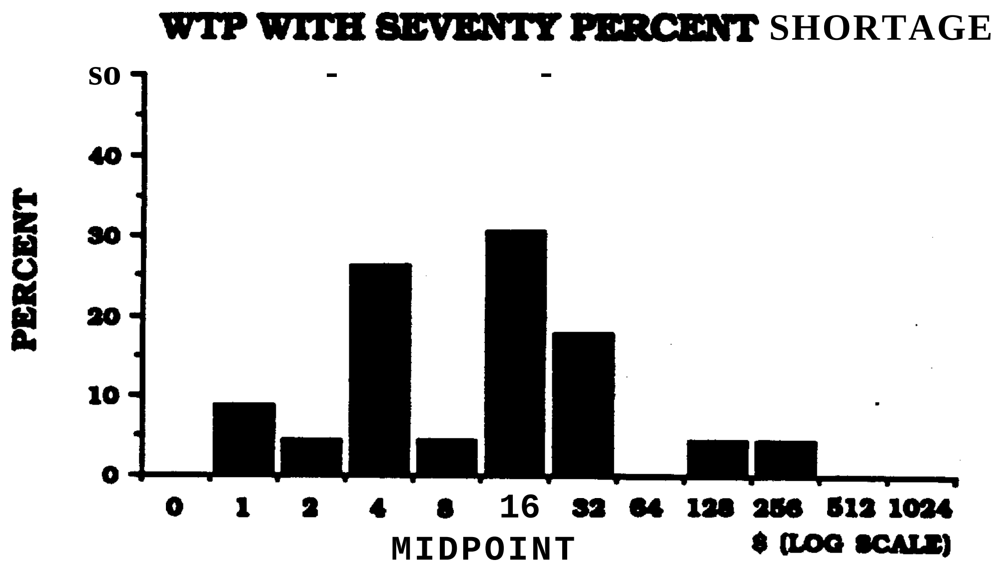


FIGURE 5.8:WTP WITH 70% WATER SHORTAGE
OCTOBER 1991- DENVER PRETEST



5.5 Estimates of Values

Table 5.3 presents the mean willingness to pay for the various scenarios from the Drover pre-test of the shortened instrument. The willingness to pay for complete groundwater cleanup shown is the reduced willingness to pay (the raw willingness to pay adjusted for self-reported embedding). Values for the alternative scenarios are calculated from this reduced WTP based on the adjustments reported in the different versions of the survey.

The full-context Versions A, B, C and D are treated separately from the no-context Version E for WTP for complete groundwater cleanup. There is not a significant statistical differenCE between the means of the context and no context WTP for complete groundwater cleanup (t(28.7) = 0.88, ns) even though the mean WTP is considerably higher (55% higher) in the no-context condition than with full context. However. there is a significant statistical difference between the variances in the two conditions (hence the adjusted t-test above) with the variance in the no-context condition being considerably higher (F (23.89) = 2.24. ns).

Similarly, there is not a significant statistical difference between the means of the willingness to pay for the national groundwater cleanup

TABLE 5.3: WTP FOR DIFFERENT SCENARIOS
DENVER PRETEST - OCTOBER 1991

WTP FOR	MEAN	STD DEV	MIN	MAX	N
COMPLETE CLEANUP WITH 4096 SHORTAGE					
FULL CONTEXT	11.09	21.73	0.10	200.00	90
NO CONTEXT	17.26	32.56	0.50	160.00	24
CONTAINMENT	3.08	3.20	0	12.00	22
PUBLIC TREATMENT	4.28	5.17	0	20.00	22
NATIONAL CLEANUP					
FULL CONTEXT	1.02	1.30	0.02	5.00	22
NO CONTEXT	5.92	16.32	0.01	80.00	24
10% SHORTAGE	**7.31**	**8.95**	**0**	**40**	**23**
70% SHORTAGE	**26.51**	**45.79**	**0.40**	**200.00**	**23**

program (t(23.3) = 1.46, ns), while the variance In the no-context condition is higher than in the full context condition (F(23,21) = 156.30, p < 0.0001).

Following the complete valuation and disembedding question a question asked the individuals to state their component breakdown of their total valuation between use, altruistic, bequest and existence values. Table 5.4 presents the means of these percent breakdowns and the values calculated according to these allocations of values. These are presented for the Ml-context versions only. The non-use value is the sum of the bequest and existence values. This represents one of the three approaches available for measuring non-use values.

TABLE 5.4: COMPONENT PERCENTS AND VALUES
(STD DEV) n = SAMPLE SIZE
FULL CONTEXT VERSIONS
DENVERPRETEST - OCTOBER 1901

VALUE	MEAN PERCENT	MEAN VALUE
USE	35.87% (25.15) n = 91	3.30 (4.92) n = 89
ALTRUIST	18.88 (13.47) n = 91	1.63 (2.14) n = 89
BEQUEST	26.32 (23.79) n = 91	2.46 (3.37) n = 89
EXISTENCE	18.92 (25.91) n = 91	3.77 (21.31) n = 89
NON-USE	45.25 (28.81) n = 91	6.22 (21.30) n = 89

In a similar manner the national groundwater value can be decomposed into use and non-use values as presented in Table 5.5. As above. these values are presented for the full context version only. The national component value question included a category for OTHER uses than the first four listed. The mean total is greater than 100% as some individuals entered values summing more than 100%. The non-use value shown is the sum of the bequest and existence values for each Individual.

TABLE 5.5: COMPONENT PERCENTS AND VALUES FOR NATIONAL CLEANUP PROGRAM - FULL CONTEXT VERS1ON DENVER PRETEST - OCTOBER 1901

v .	MEAN PERCENT	MEAN VALUE
USE	33.04% (27.13) n = 23	0.45 (0.85) n=21
ALTRUIST	13.70 (11.80) n = 23	0.13 (0.19) n = 21
BEQUEST	31.52 (31.20) n = 23	0.26 (0.28) n=21
EXISTENCE	21.74 (29.02) n = 23	0.22 (0.49) n = 21
OTHER	0 (0) n = 23	0 (0) n = 21
TOTAL	100 (0) n = 23	1 06 (1.32) n = 21
NON-USE		0.47 (0.54) n = 21

Table 5.6 presents the three alternative approaches for estimating non-use values from the Denver pm-test. The first approach, percent splits, is the non-use value as presented in Table 5.4 above. The scenario

TABLE 5.6: THREE APPROACHES TO ESTIMATING NON-USE VALUES
DENVER PRETEST - OCTOBER 1991

METHOD	**MEAN NON-USE VALUE (STD DEV) SAMPLE SIZE**
PERCENT SPLITS	**$6.22 (21.30) n = 89**
SCENARIO DIFFERENCE	4.70 (5.88) n = 22
EXTRAPOLATION	4.29 **(13.76) n = 23**

difference approach calculates the mean difference between the complete groundwater cleanup value minus the value for the public water treatment program from Version C. The extrapolation approach is the mean estimated WTP for complete groundwater cleanup if faced with a zero percent water shortage. This is calculated from Version D respondents by fitting a quadratic equation to the WTP values when faced with a 10%, 40% or 70% water shortage. The predicted WTP when facing a zero percent water shortage represents non-use values.

5.6 Final Survey Instruments

The values derived from the Denver pre-test can not be statistically analyzed for comparability to the values derived from pre-testtng of the full information/ full context surveys because of changes made in the scenarios being valued. Changing the magnitude of the water shortage from 50% in the full information survey to 40% for the shortened survey would arguably lower the valuation for complete groundwater cleanup. Confounding this interpretation of the pm-test values is the confusion respondents experienced with the concept of a 50-50 chance of the shortage occurring. From verbal protocols and retrospective reports it was obvious that many individuals were not applying a 50-50 chance to a 50% water shortage but were thinking that the 50-50 chance was the cause of the 50% shortage figure.

If some individuals "properly" calculated the expected water shortage as 25% and some treated it as a 50% water shortage the mean value for complete groundwater cleanup from the full information/full context survey will be comparable to a value for a 40% water shortage scenario as considered in the shortened survey. The mean reduced WTP from the full information/ full context survey of $9.75 for the October pre-test is lower than the mean reduced WTP from the Denver pre-test of $11.09. The results of the Denver pre-test are considerably less than values expected from a limited information/ limited context survey of $17-$18 as discussed in Section 4.8. Thus, it was concluded that the values between the full information/ full context survey and the shortened survey instrument were stable.

Further, the lack of comments in the debriefing survey from the October 1991 Denver pre-test suggesting scenario rejection indicated that the shortened instrument had deleted or appropriately re-worded information or context that was leading to scenario rejection in the full information survey instrument. Thus, we concluded that the shortened instrument retained the Information and context relevant to individuals for constructing values for complete groundwater cleanup which allowed us to proceed to a full national mail survey.

Following the Denver pre-test minor changes were incorporated into the shortened survey instrument prior to mailing. The adjustment schedules used in the valuation questions for alternative scenarios were altered slightly following the Denver pre-test. Respondents uniformly valued containment public treatment and national groundwater cleanup less than complete cleanup: thus, the adjustment scales did not need to include options of over 100% of the value of complete cleanup. For the containment option this scale was presented as 0% to 120%+ in the Denver pre-test instrument. In the mail survey instrument the scale was set from 0% to 100%. For the national groundwater versions (both full context and limited context) the scale for the pre-test ran from 0% to 200%+ and in the final design from 0% to 100%+. For the public treatment version the scale ran from 0% to 100% for both the pre-test and the final version. For the change in degree of water shortage the scales for the pre-test and the final design were identical running from 0% to 100% for the 10% water shortage scenario and from 100% to 400%+ for the 70% water shortage scenario.

In the description of the hypothetical scenario a statement was added that the landfill practices which led to the groundwater contamination were believed to be safe in the past. This was included to further ensure that individual did not scenario reject due to an assignment of responsibility to other parties.

The description of the containment scenario was reworded slightly to emphasize to individuals that this option would not completely clean up the contamination. The description of the water rationing option was changed to include information regarding how much water households typically use for different activities and to emphasize that households would have to reduce water usage if this option were chosen. Providing individuals with information regarding water usage in the household allows them to consider where they would have to decrease their own water usage and thus allows them to better evaluate such an option.

In the containment option description a statement was added that future generations would have to pay for their own operation and maintenance costs to emphasize the allocation of costs across generations if this option were chosen. No substantial changes were made in wording or format for either the public treatment or the national groundwater cleanup versions. Version D of the survey regarding valuation of complete groundwater cleanup if faced with either a 10% or 70% water shortage was reworded to clarify the alternative scenarios being considered and to increase Information and context given to the respondent. A question was added which first presented the new scenario to be valued stating the change in the hypothetical water shortage the community faced. Immediately following this description of the alternative scenario, individuals were asked how satisfied they would be with the rationing option if they faced the level of shortage hypothesized. This reminded individuals of alternative solutions to the complete groundwater cleanup.

Version E was changed to be the exact same as all other versions up to the section on the national groundwater cleanup. Only in the national section is the context changed between versions E and B. Changing context in the initial valuation question would make it impossible to test for effects of context change in the national valuation section so context changes were restricted just to the national section.

Finally, for the mail survey version a question was added in the socio-demographic section of the survey asking individuals their present employment status.

5.7 Conclusion

Changes to the full information/ full context survey instrument were made based on (1) the results of the verbal protocols, retrospective reports and pre-testing, (2) new technical and policy formation provided by the Office of Solid Waste at EPA and (3) reformatting and redesign to make the survey a mailable instrument. Changes made in response to analysis of the full information/full context survey corrected the presentation of information and context which had potentially created confusion and/or scenario rejection (such as the trust fund, repeated referendums and 50-50 chance of water shortage). In addition, information which respondents indicated was not relevant to value construction was deleted or minimized. Changes were made to the hypothetical scenario based on new technical information (size of contamination and degree of water shortage) and new scenarios added (containment and national valuation) in response to technical information from and policy needs of EPA.

The survey was partitioned into five different versions to explore a variety of alternative scenarios and theoretical questions. Separating the valuations of alternative programs snowed the survey to be shortened to a mailable length while retaining all relevant information. Re-testing of the shortened survey instrument with 117 randomly selected individuals in a Denver market research center showed that the shortened survey instruments indeed retained the information and context relevant for value construction as values remained stable between the original pre-test and Denver pre-test.

Chapter VI

Sample Design, Administration and Results of the National Mail Survey

6.1 Introduction

This chapter discusses the descriptive results from the implementation of the contingent valuation survey. Section 6.2 describes the sample design and survey administration. section 6.3 describes the survey response rate and the geographical distribution of the survey. Section 6.4 describes demographic information on the survey respondents. section 6.5 provides simple statistics from the survey including means and distribution of important variables. Section 6.6 concludes the chapter with a description of the facsimile surveys, which are contained in Appendix D.

6.2 Sample Design and Survey Administration

Surveys were designed consistent with the Dillman Total Design Method (Dillman, 1978). The TDM procedure aims to maximize response rates through specific destgn and Implementation strategies. The procedure Includes personalizing the mailing to include a cover letter hand-signed in blue ink, hand-stamped envelope. a follow-up postcard and a second mailing to households that did not respond to the survey following the first mailing. The surveys were printed and folded into a booklet measuring 8 inches by 6 inches. The survey were all twelve pages long, including the cover and space for comments. Each survey had a stamped identification number on the cover for purposes of tracking responses and identifying the surveys by region for data analysis.

All mailings were on Tuesdays so as to avoid havtng respondents receive the survey on days which they either normally receive a lot of junk mail (i.e., Wednesdays) or when they are less likely to examine their mail carefully (Le., Friday evenings). In the first mailing, each household in the sample received a version of the survey, a cover letter, and an addressed, stamped envelope to return the survey to us. For the first mailing only, the package also included a two dollar bill, to thank respondents for their time and to encourage them to fill out and return the survey. This monetary incentive is not part of TDM, but we have found in past survey research that monetary incentives increase response rates significantly (Deane. et al., 1989). One week after the initial mailing, a postcard was sent reminding respondents of the importance of completing and returning the survey. If a response was not received after two weeks, a second survey, cover letter and self-addressed, stamped envelope were mailed. However. this second mailing package did not contain another two dollar bill.

Examples of the mailing enclosures are presented in figures 6.1-6.3. The cover letter (Figure 6.1) is designed to introduce respondents to the topic and to remind respondents of the importance of returning the questionnaire. It describes in general what the survey is about, who should till it out, and who@ conducting the research. Figures 6.2 and 6.3 present the reminder postcard and follow-up letter, respectively.

FIGURE 6.1: COVER LETTER FOR NATIONAL MAIL SURVEY

October 29, 1991

Mr. John Doe
3333 Oak Ave
Somewhere, USA 99999

Dear John Dot:

You arc one of a small number of households nationwide who arc being asked what they think about groundwater contamination. In the United States this is an issue of increasing concern. However, little is known about what people think about groundwater contamination and how they respond to the impact it may have on their lives. In order to better assess what should be done about this problem we need the benefit of your experience.

[n order for the results to truly represent the opinions and experience of people who live in the United States, it is very important that each questionnaire be completed and returned. It will take you about 15 minutes. Your answers will be combined with others in the United States to form a profile of views on groundwater contamination.

Since this questionnaire asks specifically what your household thinks should be done about groundwater contamination, wc ask that it be filled out by an adult in your household. You can be assured of complete confidentiality. In fact. your name will rover be associated with this information. The number on the questionnaire is only so your name can be checked off the list when it is returned.

Since your responses arc so valuable to us, we enclose a $2 as a token of our appreciation.

[f you would like to receive ● free summary of the survey results, please indicate so in the box provided at the end of the survey.

Many thanks for your help with this important effort.

Sincerely,

Gary McClelland
Pro D re o

FIGURE 6.2: REMINDER POSTCARD FOR NATIONAL MAIL SURVEY

November 5, 1991

Last week a questionnaire was mailed to you seeking information which is crucial in evaluating what people think should be done about groundwater contamination in the United States.

If you have already completed and returned the questionnaire, accept our sincere thanks. If not, please do so today. The issue of groundwater contamination is a matter of increasing concern. Therefore, it is extremely important that your answers also be included in the study.

If by some chance you did not receive the questionnaire, or it was misplaced, please write us and we will get another one in the mail to you immediately.

Sincerely,

Gary McClelland
Project Director

FIGURE 6.3: SECOND MAILING LETTER FOR NATIONAL MAIL SURVEY

November 19, 1991

Mr. John Doe
333 Oak Drive
Denver, CO 80236

Dear John Doe:

I am writing to you about our study of what people think should be done about Groundwater Contamination in the United States. To date, wc have not yet received your completed questionnaire.

The large number of questionnaires returned is very encouraging. But whether we will be able to describe accurately what people think about groundwater contamination in the United States depends on you and the others who have not yet responded. This is because our past experiences suggest that those of you who have not yet sent in your questionnaire may have very different opinions compared to those who have responded.

This study has been undertaken in the belief that people's views on groundwater contamination should be incorporated into public management policies. Your opinions will be extremely valuable towards evaluating the worth of such programs. The usefulness of our results depends on how accurately we arc able to describe the views of the people of the United States.

In case our previous correspondence did not reach an adult in your household whose response is needed, a replacement questionnaire is enclosed. We urge you to complete and return it as quickly as possible.

We'll be happy to send you a copy of the results if you want one. Simply put your name, address, and "mpy of results requested" on the back of the return envelope.

Your contribution to the success of this study will be appreciated greatly.

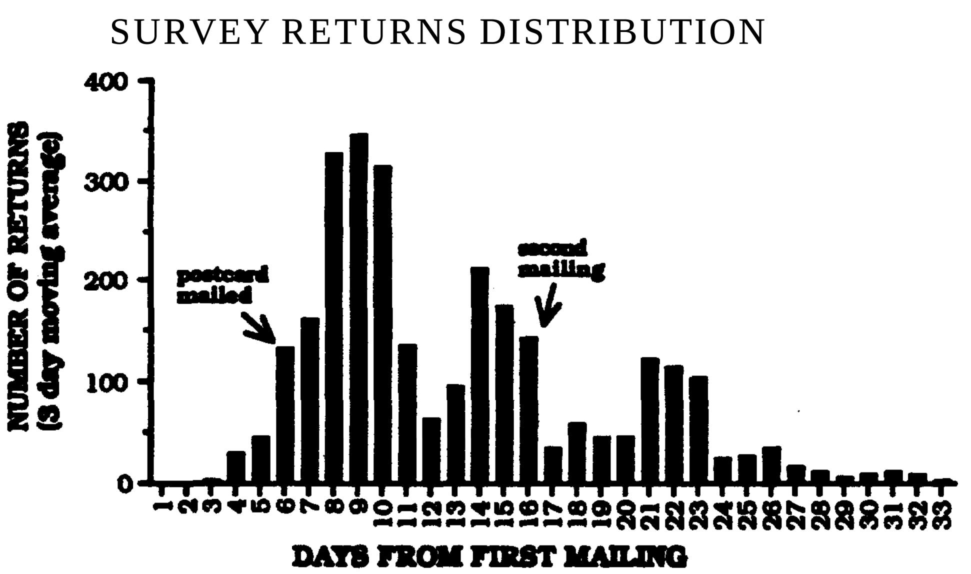
Most sincerely,

Gary McClelland
Project Director

6.3 Survey Response

Five thousand surveys were mailed on Tuesday, October 29, 1991. One week later, November 4, the reminder postcard was mailed to everyone. Two weeks later, on November 19, the second copy of the survey was sent to individuals who had not responded and had not been deleted due to bad addresses. Figure 6.4 shows the distribution of returns. A three day moving average of responses is shown starting from the day the first surveys were mailed. The DAYS FROM FIRST MAILING are counted as working days (excluding weekends and holidays).

FIGURE 6.4: TEMPORAL DISTRIBUTION OF SURVEY RESPONSES
NATIONAL MAIL SURVEY



As can be seen from Figure 6.4 the lag time from the first mailing to the peak of the first responses was about nine working days. From the post card mailing to the next peak is eight days and from the second mailing to the third peak is about five working days.

Table 6.1 indicates the distribution of surveys by survey version and by region. The regions are those as defined for the data analysis (see Chapter VII: Analysis of Results). Anonymity was maintained for the purposes of data analysis. Surveys were numerically coded purely to keep track of the response rate, to prevent mailing duplicate survey to those respondents who returned the survey prior to the second mailing and to aid in the coding of regional dummy variables for data analysis.

TABLE 6.1: SURVEY DISTRIBUTION BY REGION AND VERSION NATIONAL MAIL SURVEY

VERSION	A	B	B	C	D	E	TOTAL
REGION							
LAKES	174	175	129	175	178	175	1006
MIDATLAN	104	103	98	104	105	103	617
MIDWEST	56	56	5	57	55	56	285
MOUNTAIN	31	31	30	32	31	31	186
NEWYORK	95	97	110	97	96	96	591
NORTHEAS	60	60	66	59	5'7	60	362
NORTHWES	32	32	14	32	32	33	175
SOUTH	173	171	21	168	169	170	872
SOUTHWES	97	97	27	99	100	99	519
WEST	78	78	0	77	77	77	387
		900	500	900	900	900	5000

Table 6.2 indicates the response rate by version for the survey. Version B' is the over-sample mailed to zip codes in which groundwater contamination is known to exist because of sites on the NPL.

TABLE 6.2: SURVEY RESPONSE RATES- NATIONAL MAIL SURVEY

VERSIONS	A	B	B	C	D	E	TOTAL
MAILED	900	900	500	900	900	900	5000
SAMPLE SIZE	**816**	**816**	**453**	**816**	**816**	**816**	**4533**
RETURNED	**517**	**523**	**289**	**524**	**509**	**512**	**2874**
% RESPONSE	**63.4%**	**64.1%**	**63.8%**	**64.2%**	**62.4%**	**62.7%**	**63.4%**

The table shows the sample size per version. Bad addresses were allocated proportionately by survey version for purposes of determining survey response rates. From this we can calculate the response rate as the percentage of the sample returned prior to the cutoff date. The differences between response rates by survey version are not statistically reliable (x^2 (d.f. 5) = 0.95, n.s.).

Table 6.3 shows a more detailed breakdown of the survey response. Of the initial 5000 surveys mailed 467 were returned by the postal service as undeliverable (9.34% of the initial mailing). Although it is not possible to determine the characteristics of the group of people who have moved we assume that they represent a random portion of our mailing group and may thus treat the remaining 4533 “good” addresses as a random sample. Of the

TABLE 6.3: ANALYSIS OF GROUNDWATER SURVEY RESPONSE

SURVEYS MAILED	5000	
BAD ADDRESSES	467	
SAMPLE SIZE	4533	
NOT RETURNED	1659	
RETURNED BLANK	187	
RETURNED ANSWERED	2687	
ITEM NON-RESPONSE ANALYSIS		
DID NOT ANSWER WTP QUESTION		141
DID NOT ANSWER WTP QUESTION and/or EMBEDDING QUESTION		372
ANSWERED ENOUGH QUESTIONS TO PERFORM REGRESSION ANALYSIS		1983

4533 "good" addresses in our sample, 1659 did not respond to any of the mailings by the cutoff date of Friday, January 3, 1992. Between the cutoff date and September 1, 1992, an additional 25 surveys were received which have not been included in the data analysis. One hundred and eighty-seven surveys were returned blank. Of the 4533 in the sample 2687 (or 59.26%) were returned with at least one question answered. Counting the "returned blank" as responses to the survey the total response rate (as a portion of the 4533 sample) is 63.40%.

Not all respondents answered all questions to the survey which means that some information will be missing for data analysis which lowers the number of observations used in the analysis. One hundred and forty-one individuals did not answer the WTP question. Three hundred and seventy two individuals did not answer the WTP question and/or the disembedding question making it impossible to calculate a reduced Willingness to pay for these individuals. One thousand nine hundred and eighty three individuals answered all of the questions used in the regression analysis.

Of particular interest is the possibility that there are significant differences between the group who answered all of the questions and those who "self-selected" out of the regression sample by not answering all relevant questions. Of even greater significance is the possibility that individuals who did not answer all of the questions and especially those who did not even answer the survey have different values than those who did answer all of the questions. Simple ignoring these groups and treating the 1983 individuals used in the regression analysis as representative of the entire population may lead to overestimates of values if people failed to respond to the survey simply because they did not put enough value on cleaning up groundwater to make it worth their time to respond to the survey. The question then arises as to whether these non-responding individuals should be treated as having zero values in calculating the value of groundwater cleanup for the population as a whole.

Table 6.4. shows the mean value for the raw WTP for the different segments of the sample who answered at least the WTP question. The "FULL SAMPLE" column shows the mean raw WTP for the entire group of respondents who answered the WTP question. The WTP VALUE ONLY column shows the mean raw WTP for the group of individuals who answered the WTP question but not the disembedding question. The WTP AND DISEMBED column indicates the mean raw WTP for the group of individuals who answered the WTP and the disembedding question but not all of the other questions necessary to be included in the regression analysis. The final column indicates the mean raw WTP for the individuals who answered all of the questions necessary for regression analysis.

TABLE 6.4: RAW **WTP BY PORTION OF SAMPLE FULL SAMPLE, REDUCED WTP SAMPLE, REGRESSION SAMPLE**

	FULL SAMPLE	WTP VALUE ONLY	WTP AND DISEMBED	REGRESSION SAMPLE
mean	**$13.98**	**$6.79**	**$14.29**	**$14.76**
std dev	**35.43**	**12.53**	**48.47**	**34.57**
n	**2546**	**231**	**332**	**1983**

The group answering just the WTP question and not the disembedding question has a significantly lower mean WTP than the other respondents to the survey (both those who answered the WTP and disembedding question and those who are in the regression sample) (t(2543) = 3.032. p < .0025). On the other hand there is not a significant difference between those who answered the WTP and disembedding question and were not in the regression sample and those who were In the regression sample (t(2543) = 0.226, p < .82).

This suggests that individuals with a lower willingness to pay were not willing to continue answering survey questions and were "self-selected" out of further analysis. Treating the remaining respondents in the regression sample as representative of the population would lead to an overestimate of the true mean WTP for groundwater cleanup. While the Individuals who answered the WTP question but not the disembedding question had a positive WTP (mean = $6.79) a conservative approach to estimating the true mean WTP for the entire population would be to treat all non-respondents (those who did not answer the survey and those who did but experienced item non-response) as having zero values. This is consistent with our earlier finding that predicted values for non-respondents using a selection model were quite low relative to respondents.

Finally, since only 141 respondents failed to answer the WTP questions (about 5.2% of respondents). use of a selection moded to attempt to predict the values of these respondents is not appropriate. The small number of non-responses to the WTP question suggests that the cognitive survey design process greatly reduced scenario rejection which occurred in as much as 35% of the sample in previous studies.

6.4 Demographics

Table 6.5 shows the mean and modal responses to the demographic questions at the end of each of the surveys. As the table shows, the average survey respondent was a Caucasian male, about fifty years old, with a middle income and at least a high school education. The cover of the survey asked that 'This survey should be completed by a head of your household. There was no effect of survey version on demographic variables.

6.5 Variable Means and Distributions

Means and frequencies for all variables, by version, are presented with the five survey versions in Appendix A. Table 6.6 lists the versions, any computations performed on a variable, number of responses to the question

TABLE 6.5: RESPONDENT DEMOGRAPHICS - NATIONAL MAIL SURVEY

Variable	Mean or Mode and Percent
Gender	**68% male**
Age	50.9 years
# of Children in Household	1.1
# of Middle-Aged People in Household	1.7
# of Elderly People in Household	0.8
Education Level	Less than Complete High School (10.0%) Completed High School (20.0%) Some College (23.9%) Completed College (18.9%) Post-Graduate Work (19.4%)
Income	Mean = $43,503 Mode = $35,000 Less then $10,000 (8.5%) $10,000-19,999 (16.0%) $20,000-$29,999 (15.5%) $30,000-$39,999 (16.7%) $40,000-$49,999 (12.3%) $50,000-$59,999 (10.4%) Greater than $60,000 (20.6%)
Ethnic Group	89.9% Caucasian 4.6% African American 2.3% Hispanic 1.4% Asian 0.5% Native American 1.3% other
Employment	Employed Full Time (56.1%) Employed Part Time (6.0%) Full Time Homemaker (3.4%) Unemployed (2.1%) Retired (27.3%) Student (1.3%) other (3.9%)

(N), and means and standard deviations for the six WTP values. Reduced WTP, which is WTP for complete clean-up of groundwater at a 40% contamination level, was computed by multiplying respondents' given WTP value (Q11) by the proportion of this value allocated to groundwater clean-up (Q13 x .01). All of the other WTP values were obtained by multiplying the respondents* reduced WTP values by the appropriate proportionns

As Table 6.6 indicates, the standard deviations around all of the WTP means are quite high. The raw means indicate that respondents preferred complete groundwater treatment to either the containment or public treatment options. Preference for complete groundwater treatment over containment, $F(1,403) = 161.48$, $p < .001$, and over public treatment, $F(1,399) = 37.65$, $p < .001$, both were highly reliable.

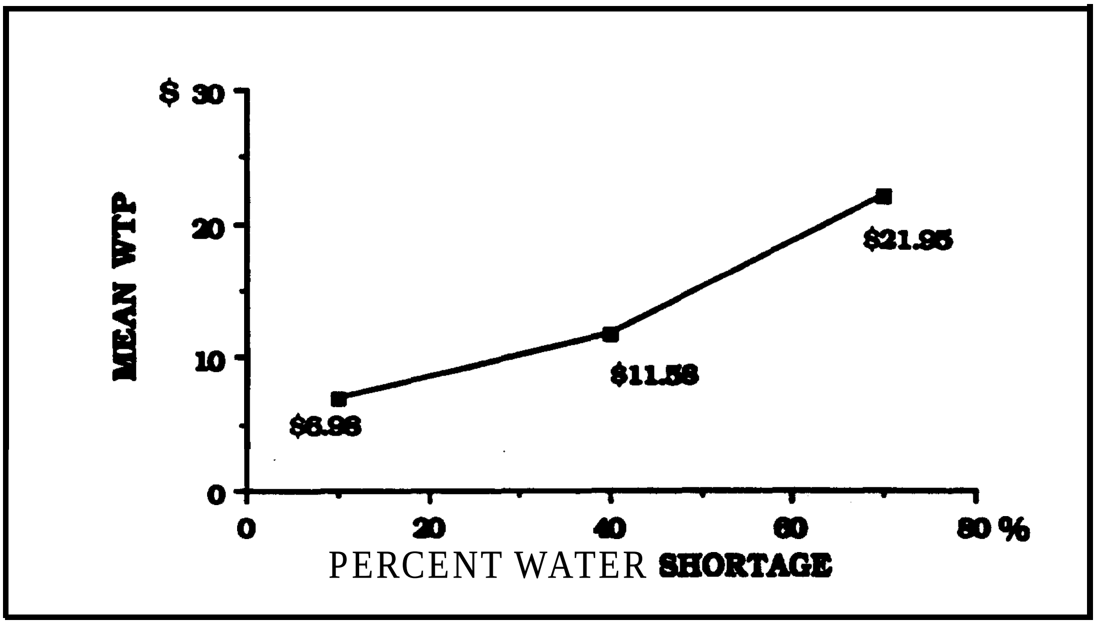
The means also indicate that respondents distinguished between complete groundwater treatments when facing 10%, 40% and 70% water shortfall. As Figure 6.5 shows, respondents valued treatment when facing 70% water shortfall over treatment when facing 40% water shortfall, and treatment when facing 40% water shortfall over treatment when facing 10% water shortfall This linear effect was highly reliable ($F(1,387) = 98.17$, $p < .0001$). As illustrated in Figure 6.5 however, the diffidence in WTP value from 10% water shortfall to 40% water shortfall was less than was the difference in WTP value between 40% water shortfall and 70% water shortfall. This quadratic effect also was reliable ($F(1,387) = 14.70$, $p < .0001$).

TABLE 6.6: WILLINGNESS TO PAY VALUES AND THEIR COMPONENTS

NATIONAL MAIL SURVEY

VARIABLE	VERSION	COMPUTATION	N	MEAN	STD DEV
Reduced WTP: WTP for complete water shortfall	ALL	WTP x Percent for G.W. treatment	2315	11.S8	26.00
	D		2546	13.98	35.44
Percent for G.W.			2343	75.82	35.37
WTP for complete clean-up (10% water shortfall)	D	% for 10% clean-up x Reduced WTP	408	6.98	19.72
Percent for 10%			442	46.52	32.54
WTP for complete clean-up (70% water shortfall)	D	% for 70% clean-up x Reduced WTP	389	-	46.07
% for 70%			414	166.24	72.74
WTP for national complete clcan-up	B B,	% for National x Reduced WTP	1019	2.28	8.70
% for National			1117	12.20	19.46
WTP for containment of GW	A	% for containment x Reduced WTP	404	5.96	11.36
% for containment			445	42.85	34.43
WTP for public treatment of GW	C	% for pub. treatment x Reduced WTP	400	7.98	24.62
% for public treatment			.441	50.30	40.54

FIGURE 6.5: WTP AS A FUNCTION OF PERCENT OF WATER SHORTAGE CAUSED BY GROUNDWATER CONTAMINATION - NATIONAL MAIL SURVEY



Figures 6.6 through 6.9 show the frequency distributions on log scales for the WTP values for complete clean-up (termed "reduced WTP), containment of groundwater, public treatment of groundwater, and national clean-up of groundwater. Reduced WTP is the respondent's value for complete groundwater clean-up at a 40% water shortfall level. Figures 6.10 and 6.11 show the frequency of respondents' reduced WTP values for complete clean-up of groundwater when facing a 10% water shortage and a 70% water shortage.

Figures 6.6 through 6.11 show that all_ distributions are highly variable. The log scale reduces the strong positive skew, but much skew still remains. Note also that even on a log scale the national WTP values are far from normally distributed because of the large number of zero values. Fully 36% of the WTP values for national clean-up were equal to zero.'

FIGURE 6.6: REDUCED WTP FOR COMPLETE GROUNDWATER CLEANUP
NATIONAL MAIL SURVEY

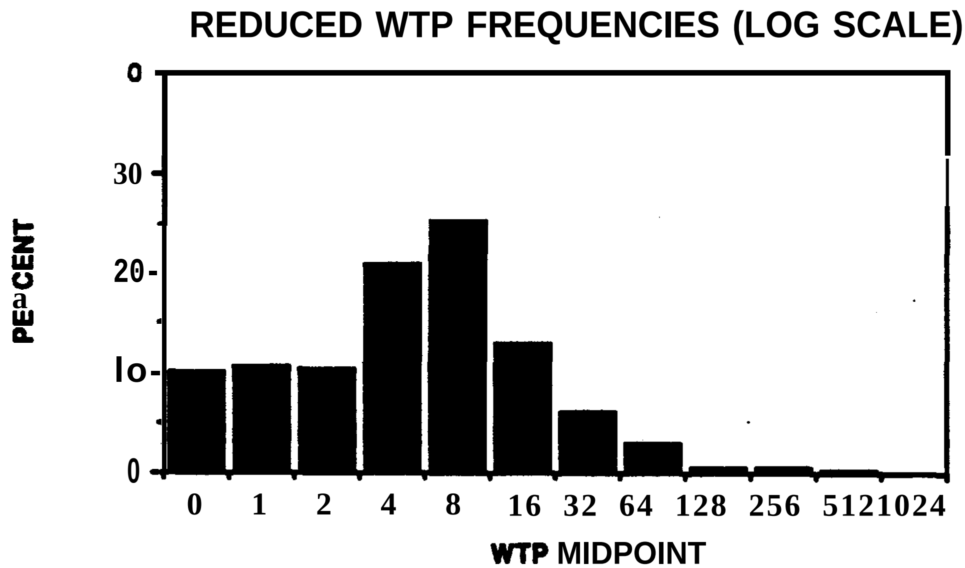


FIGURE 6.7: WTP FOR CONTAINMENT OPTION
NATIONAL MAIL SURVEY

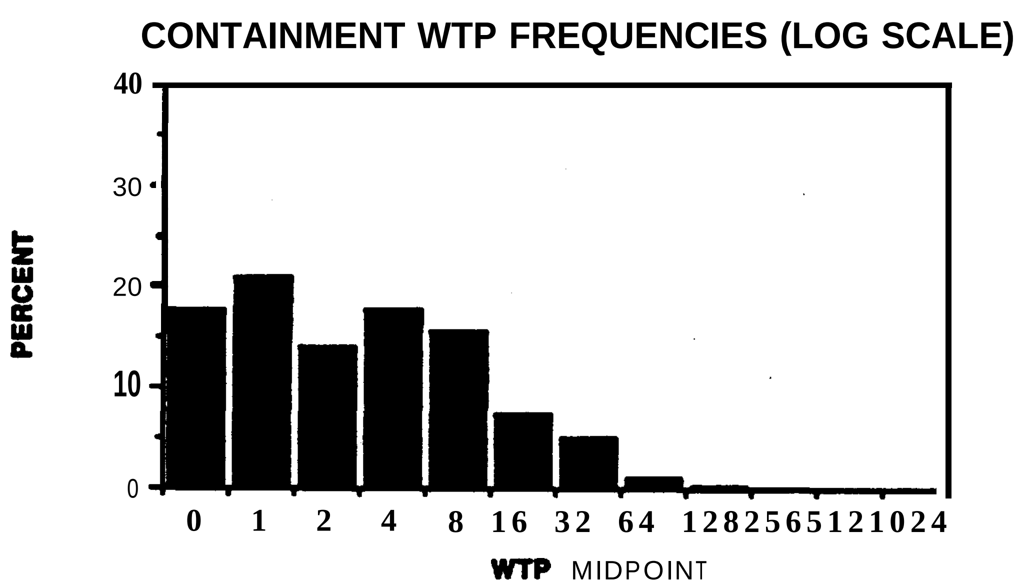


FIGURE 6.8 WTP FOR PUBLIC WATER TREATMENT OPTION
NATIONAL MAIL SURVEY

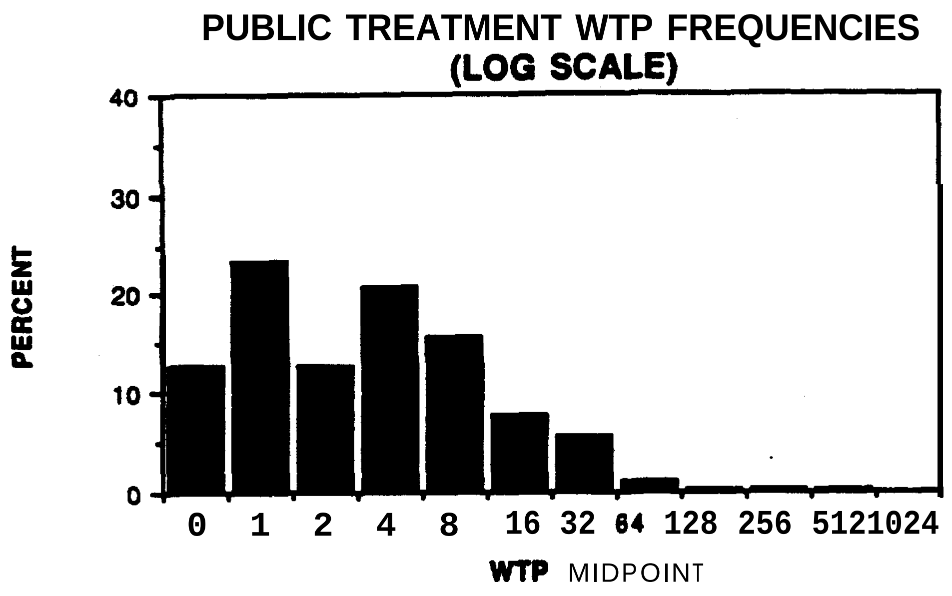


FIGURE 6.9: WTP FOR NATIONAL CLEANUP PROGRAM
NATIONAL MAIL SURVEY

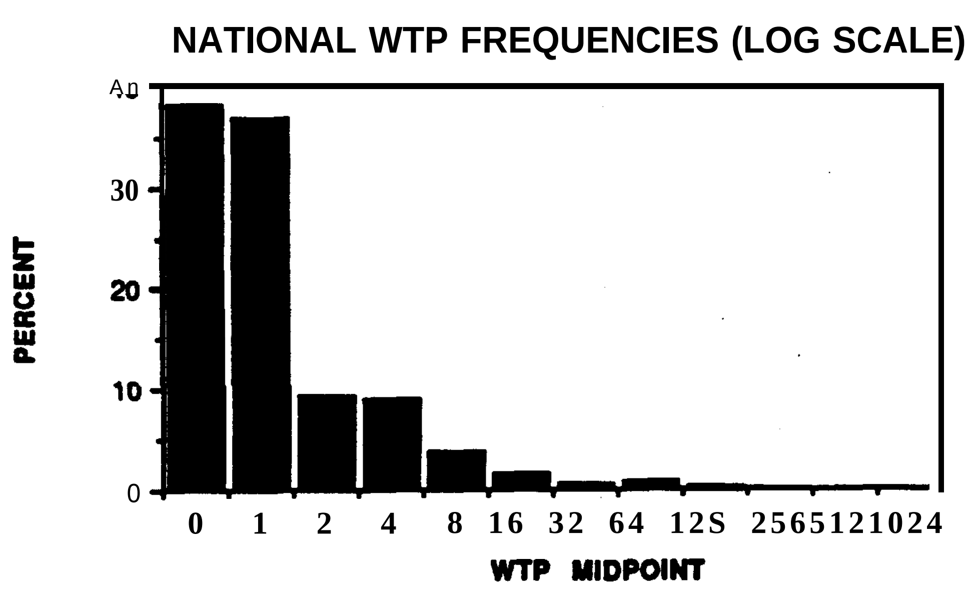


FIGURE 6.10: WTP FOR COMPLETESCLEANUP WHEN FACING A 10% WATER SHORTAGE NATIONAL MAIL SURVEY

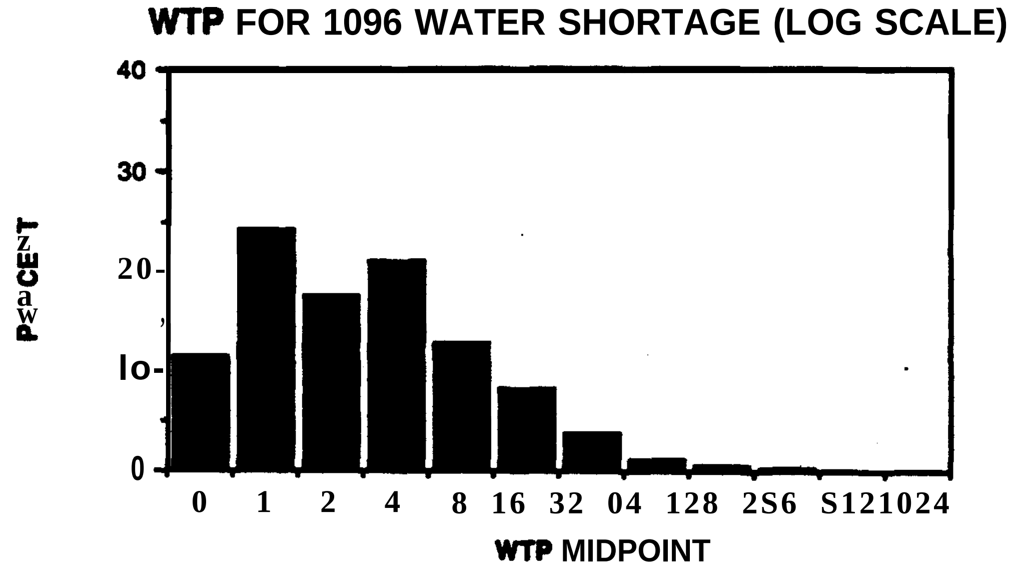
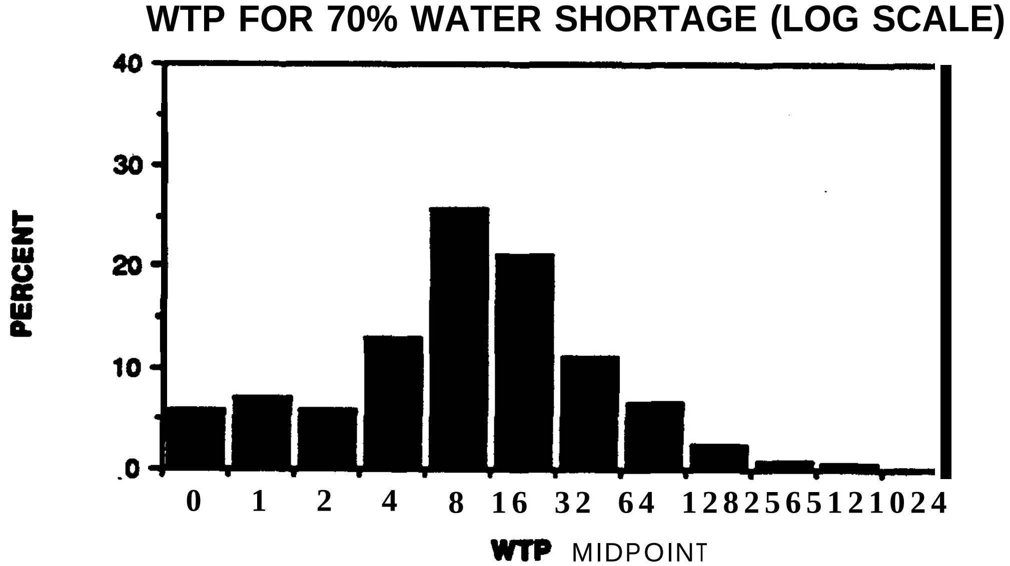


FIGURE 6.11: WTP FOR COMPLETE GROUNDWATER CLEANUP WHEN FACING A 70% WATER SHORTAGE NATIONAL MAIL SURVEY



6.6 Facsimile Surveys

Appendix D presents the facsimile surveys for the national mail survey. The mean response or percent of respondents answering each question or item is presented in parentheses next to or with each question for each of the versions of the survey. The page letter-number in the upper right hand comer of each survey identifies the survey variant as discussed previously. The cover is shown in actual size. 8 inches tall by 6 inches wide, used for printing the national mail survey as suggested by Dillman (1978). The cover was identical for all five versions of the survey.

Chapter VII

Analysis of Results

7.1 Introduction

In this section we discuss the analysis of the data from the survey. This analysis is primarily comprised of regression analysis of the Willingness to pay for the complete groundwater cleanup program under the hypothetical scenario presented in the survey. Regression analysis is usefull both for analyzing errors in bidding (i.e., the problem of large bids discussed previously), which might bias the value estimates, and for developing predictive models for use in benefit-cost analysis. The predicted values from this base regression are then used along with each individual's adjustments for the alternative scenarios to discuss the valuations for the alternative Scenarios.

Two sources of error exist in predicting contingent values with a regression model. These sources of error are measurement error and model error. Measurement error in the dependent variable, WTP, may be present due to the hypothetical nature of the CVM. If all error in the estimated equation is measurement error, the predicted mean bid using the Box-Cox analysis may approximate the true mean WTP if there is skew in the distribution of errors. The raw mean will provide an estimate of the willingness to payif all error is model error. Model error can arise because of errors in functional form or because of excluded explanatory variables and can produce skewed residuals.

It is impossible to know *a priori* how much of the error is model error and how much is measurement error. From laboratory experiments from the effect of context and information, and from the logical inconsistency of some very large bids we know that skewed measurement error is likely to be present, which implies that the raw mean of the CVM bids will likely overestimate true values. In summary, an upper bound estimate of value can be obtained from the raw mean which implicitly assumes that all error in an econometric equation predicting such values is model error. If all error is measurement error, an appropriate estimate of values can be obtained by employing the BOX-COX transformation thereby eliminating skewness in the distribution of residuals in a predictive equation of values. The mean of the predicted values from such an equation will likely be substantially lower than the raw mean and if used for policy purposes assumes that all error in the estimated equation is measurement error in the dependent variable. See Chapter III for a discussion of this issue.

The BOX-COX transformation used in the regression analysis is:

$$WTP' = \begin{cases} \dfrac{WTP^{\alpha-1}}{\alpha\, e^{(1/n)\Sigma \log WTP}} & \text{for } a \neq 0 \\ \log WTP & \text{for } a = 0 \end{cases}$$

where a is chosen to normalize the error distribution in regression analysis (Box and Cox, 1964). $e^{(1/n)\Sigma \log WTP}$ is the geometric mean of the WTP value being estimated. Predicted bids from the regression analysis can be used for policy analysis if all error is assumed to be measurement error.

As discussed below, substantial skew is present in the residuals of the linear regression and the BOX-COX procedure produces an essentially normal distribution of residuals. Thus, the procedure developed above can be defended on purely econometric grounds as an appropriate method for dealing with large outliers which would otherwise bias CVM studies.

7.2 Variables and Summary of Results

The surveys in the Appendix D provide full explanations and context for the variables used in the data analysis. Chapter VI provides the raw data results for the variables below. The independent variables used in the regression are listed in Table 7.1.

Regional dummy variables are defined according to Table 7.2. These were coded from the mailing addresses.

The initial value question in each version of the survey is the individual's willingness to pay for complete cleanup a hypothetical groundwater contamination problem. 'Ibis hypothetical situation involves groundwater contamination from a leaking landfill leading to a potential 40% shortage in domestic water supply. The willingness to pay for complete groundwater cleanup is stated as how much an individual is willing to have his or her monthly water bill increased every month for the next ten years. The dollar values stated are these monthly dollar values. For all versions of the questionnaire this question (Q 11) was identical. The individuals circled a dollar value between $0 and $500 or circled "MORE

TABLE 7.1: INDEPENDENT VARIABLES

INDEPENDENT VARIABLES	EXPLANATION	QUESTION
INCOMEVD	Income in $1000's - taken as median of category	H10
KIDS	1 if respondent has children, 0 if not	H4
AGE	age of survey respondent	H3
WHITE	1 if Caucasian, 0 if not	H8
EDUC	Educational level 1 to 10 (1 =no formal, 10 = advanced)	H5
GENDER	1 for female, 2 for male	H2
REGION	regional dummy variables explained in **Table 7.2**	coded from **address**
LANDFILL	Is respondent aware of a community landfill contaminating groundwater 1 = yes aware 0 = no,not aware	Q1
EXPOSED	Dummy variable for surveys sent to zip codes in which groundwater contamination exists 1 if contamination present -1 if not	Version B
USE	1 if respondent uses groundwater, 0 if not	Q3
SOURCES	Number of sources of groundwater contamination	Q1
RECYCLES	Number of items recycled	H6
OTHENV	Mean attitude toward non-groundwater environmental issues	92
GRNDWTR	Attitude toward groundwater contamination	Q2
COMPLETE	How much respondent is satisfied with complete groundwater cleanup program	Q6
MEANNCOM	Mean of how much respondent is satisfied with cleanup programs other than complete cleanup	Q6-Q10
RESPONS	How responsible respondent feels for helping to pay to cleanup groundwater contamination in his community	Q15

TABLE 7.2 REG1ONAL DUMMY VARIABLES

REGION	
NORTHEAS	1 for live in ME, NH, VT, RI, CT, MA
NEWYORK	**1** for live in NY, NJ
MIDATLAN	1 for live in PA, VA, MD, DE, DC, WV
SOUTH	1 for live in KY, TN, NC, SC, GA, AL, FL, MS
LAKES	1 for live in MI, IL, IN, MN, OH, WI
SOUTHWES	1 for live in NM, TX, OK, AR, LA
MOUNTAIN	1 for live in CO, UT, WY, ND, SD, MT
WEST	1 for live in CA,AZ, NV, HI
NORTHWES	1 for live in AK, ID, OR, WA
MIDWEST	1for live in IA, KS, MO, NE region excluded for regression analysis

THAN $500". For the purposes of data analysis answers of "MORE THAN $500" were set equal to $501. Of the 2546 individuals who answered the WTP question only 5, or less than 2/10 of 1%, answered "MORE THAN $500". More than 93% of the respondents stated a WTP of $30 or less per month.

The reduced willingness to pay for complete groundwater cleanup is the dependent variable in the linear and the Box-Cox regression. To account for potential embedding problems, question Q 12 asked if the bid was entirely just for the described groundwater cleanup or if the bid included values for other environmental or public goods as well. Reduced WTP simply equals the answer for Q 11 if the respondent answered that the total stated value was just for the stated groundwater cleanup program. If the stated value was also for other environmental or public goods the stated WTP was multiplied by the percent indicated in Q 13 to be just for the complete groundwater cleanup to derive the reduced Willingness to pay. (See Chapter VI: Results, Table 6.4). 71% of the respondents stated that their value was entirely just for the program described. For the 29% of the respondents who self-reported embedding the mean stated percent for just the groundwater cleanup program described was 42.5% of their WTP. For the individuals for whom REDWTP could be calculated, accounting for the effects of the self-reported embedding lowered the mean WTP from $14.70 to the reduced WTP of $11.58: a 21.2% adjustment due to embedding (see Table 3.1 for a comparison to other studies using this approach).

The willingness to pay variables are listed in Table 7.3. These are derived by multiplying the reduced WTP (REDWTP) or predicted REDWTP from the regression using the Box-Cox transformation on REDWTP for complete groundwater cleanup by the percent adjustment stated for the each of the alternative scenarios presented.

The REDWTP (willingness to pay for complete groundwater cleanup when facing a 40% shortage) was decomposed into component values by the percent assigned by the individuals to these components. Q 14 asked the respondents to assign percentage splits according to the four components.

TABLE 7.3: WILLINGNESS TO PAY VARIABLES

WTP	EXPLANATION
REDWTP	reduced WTP for complete groundwater cleanup
CONTWTP	WTP for containment program
NATWTP	WTP for national cleanup
PUBWTP	WTP for public treatment program
TENWTP	WTF for complete cleanup with 10% water shortage
SEVENWTP	WTP for complete cleanup With 70% water shortage

When respondents did not enter a value in one or more of the four components, but did answer at least one, their percentage splits were normalized to sum to 100%.

TABLE 7.4: COMPONENT VALUE VARIABLES

COMPONENT VALUE	EXPLANATION
USEVAL	protion of REDWTP indicated for own use
ALTRUIST	portion of REDWTP indicated for others in community
BEQUEST	portion of REDWTP indicated for future generations
EXIST	portion of REDWTP indicated to ensure that ground-water is uncontaminated even if no one ever uses it

As a first step, a linear functional form was estimated for comparison to the Box-Cox regressions. Ordinary least squares was applied to the untransformed reduced willingness to pay using the full set of explanatory variables and regional dummy variables. The mean of predicted values from this linear form will equal the raw mean, which provides an upper bound estimate of values. The R-squared value from the linear regression was 0.07.

As a second step, a Box-Cox estimation procedure was used to transform the dependent variable if an assumption is made that all error is measurement error as discussed above. This procedure significantly increased the R-squared value as would be expected by controlling for the influence of outliers. The Box-Cox estimation was performed on the entire set of explanatory variables and predicted values were retained for each observation. The α value from the Box-Cox transformation was 0.15 suggesting a skew in the distribution of errors approaching the log distribution (a = 0). The R-squared from the regression using the Box-Cox transformation was 0.30.

Table 7.5 presents the mean values for the willingness to pay and the predicted willingness to pay variables for complete groundwater cleanup and the alternative scenarios examined.

TABLE 7.5: **MEAN WTP, STANDARD DEVIATION AND SAMPLE SIZE**

SCENARIO	FULL SAMPLE	REGRESSION SAMPLE	BOX-COX PREDICTIONS
COMPLETE CLEANUP	11.58 (26.00) n = 2315	11.70 (23.30) n = 1983	7.01 (5.29) n = 1983
CONTAINMENT	5.96 (11.36) n = 404	6.38 (11.91) n = 348	3.95 (4.73) n = 348
PUBLIC TREATMENT	7.98 (24.62) n = 400	7.18 (22.98) n = 345	4.02 (3.95) n = 345
NATIONAL NO CONTEXT	2.67 (10.27) n = 393	2.98 (10.95) n = 343	1.34 (2.46) n = 343
CONTEXT	2.03 (7.55) n = 626	2.15 (8.00) n = 542	1.13 (2.31) n = 542
TEN % SHORTFALL	6.98 (19.72) n = 408	7.38 (20.86) n = 355	3.86 (4.40) n = 355
SEVENTY % SHORTFALL	21.95 (46.07) n = 389	22.99 (47.71) n = 345	13.34 (12.74) n = 345

The mean from the raw data is presented in the first column along with the variance and sample size for each variable. The second column presents the mean for the WTP values for observations used in the regression on complete cleanup. The sample size is smaller in the regressions than in the data set due to missing values for some explanatory variables for some of the observations. The “BOX-COX PREDICTIONS” is the mean predicted WTP from the Box-Cox transformation on complete cleanup times the individual's stated adjustment for the scenario being valued.

We will discuss these results in the following order: (7.3) the regression on WTP for complete groundwater cleanup: (7.4) the component values of WTP for complete cleanup: (7.5) two alternatives to complete cleanup- containment and public treatment: (7.6) the WTP for national groundwater cleanup: (7.7) how the degree of water shortage affects the WTP for groundwater cleanup: and (7.8) comparison of three approaches for estimating non-use values for complete groundwater cleanup to test the robustness of our measurement of non-use values.

7.3 Complete Groundwater Cleanup

The first regression (Table 7.6) is an ordinary least squares regression of the untransformed reduced WTP on the full set of explanatory variables. Many of these variables, such as RESPONS. would not be available to policy makers without conducting fbrther in depth surveying. The only explanatory variables significant at the 5% level from this regression are INCOMEVD, WHITE, COMPLETE, RESPONS and NEWYORK.

915 asked individuals to rank on a scale from 1 to 7 how responsible they feel for helping to pay to cleanup such a groundwater contamination problem in their community. The high t-value on RESPONS (6.571) suggests the importance of feelings of moral responsibility in an individual's willingness to pay to cleanup environmental damage. For policy purposes though, it would be difficult if not impossible to derive such an index of responsibility without conducting a similar survey.

INCOMEVD is positive and significant as expected: those with higher income are, on average, willing to pay more. The dummy variable WHITE is significant at the 5% level in this regression but not in the BOX-COX transformation as discussed below. The regional dummy variable NEWYORK is significant but the regional dummy variables (as a group) in the linear regression are not significant (F (9.1957) = 1.29, ns). These regional dummy variables can be expected to capture regional characteristics not accounted for in variables such as INCOMEVD, WHITE. or EDUC that may account for differences in the population composition in different parts of the country.

The second regression (Table 7.7) uses the BOX-COX transformation and produces a considerably higher R-squared value (0.30). The explanatory variables which are significant at the 5% level now also include AGE, EDUC, USE, SOURCES, OTHENV, and GRNDWTR. NEWYORK and WHITE are no longer significant at the 5% level as they possibly were influenced by outliers in the previous regression. In the regression using the Box-Cox transformation the regional variables as a group are significant (F (9,1957) = 2.30, p c 0.014) yet none are individually significant. The negative coefficient on AGE indicates that older people are less willing to pay to clean up groundwater.

The positive and significant coefficients for income and education are plausible in that environmental goods are often believed to be superior goods (those goods having positive income elasticities). It is reasonable to expect an increased willingness to pay as education and income and possibly environmental awareness increase.

SOURCES IS the number of sources of groundwater contamination that an individual indicates exist in his or her community. An increase in

SOURCES may indicate either an increased awareness of potential sources of contamination or a belief that there are numerous groundwater contamination problems in one's community.

OTHENV is the mean attitude of the individual toward other environmental problems such as pollution, saving endangered species and reducing global warming. GRNDWI'R is the individual's response to the same type of scaling question with respect to how concerned he or she is with groundwater pollution. The negative coefficient on OTHENV and the positive coefficient on GRNDWTR are indicative of the relative weights that the individual puts on groundwater pollution relative to other environmental problems. Thus, the more important other environmental problems are relative to groundwater pollution the less an individual is willing to pay to cleanup groundwater pollution. This suggests that these other environmental goods are viewed as substitutes for groundwater cleanup.

COMPLETE is a 1 to 7 scaling of how satisfied an individual would be with the complete groundwater cleanup program as a method to deal with the groundwater pollution problem in the hypothetical scenario. The positive coefficient indicates that the more satisfied an individual is with the proposed program the more he or she would be willing to pay to have that program implemented. COMPLETE may also be an indication of whether or not the individual believes that such a cleanup program could be workable, which is an important factor in whether or not an individual may reject the scenario offered. MEANNCOM, which is not significant, is a similar aggregated scaling of alternative programs to the complete groundwater cleanup.

It should be noted that neither KIDS nor GENDER were significant in either the linear or Box-Cox regressions. In addition it is interesting that although they had small negative coefficients, neither LANDFILL nor EXPOSED had significant impacts on willingness to pay. This suggests that individuals treated the survey questions as hypothetical and answered them without reference to their own relationship to landfills or exposure to contamination. This is important for the validity of the contingent valuation method in assuring us that the individuals were actually answering the questions with regard to the hypothetical scenario.

EXPOSED is the dummy variable for areas where groundwater contamination is known to exist and SOURCES is the respondents self-reported awareness of sources of groundwater contamination. Although being "EXPOSED" suggests that the individuals may have local experience with groundwater contamination it did not play a significant role in the willingness to pay. This maybe due to a number of factors. First, the individuals may not know that they live close to a source of groundwater contamination and thus this has no effect on their WTP. The Pearson correlation coefficient between EXPOSED and SOURCES is 0.09 which was significantly greater than zero at the 1% level of significance. The small positive correlation provides evidence that individuals had some awareness of local sources of groundwater contamination.

Second, they may know that they live close to a contamination source, yet their willingness to pay to cleanup, given that they have this information, is not significantly different from those people only dealing with this as a purely hypothetical issue. If so, this provides significant validation of the completeness of the information presented to people in the hypothetical condition.

Third, they may know they live near groundwater contamination yet still be treating the survey as a hypothetical exercise in the same vein as

other respondents to the survey. This also provides support for the contingent valuation method because individuals are able to considerthe scenario presented in the survey without interpreting it in terms of their own circumstances.

The a value of 0.15 suggests a skew in the errors approaching a log distribution. The skew of the untransformed REDWTP of 10.23 (with Kurtosis = 142.63) indicates a strongly rightward skewed distribution with a thicker right tail than a normal distribution. The residuals from the linear regression on the untransformed REDWTP have a skew of 9.32 (Kurtosis = 124.23). As discussed above the skew on the residuals of the linear model indicate that the BOX-COX transformation is an appropriate econometric method to deal with large outlying bids without resorting to arbitrary trimming of the right hand tail. The skew of the residuals from the regression on the Box-Cox transformed dependent variable was 0.29 (with Kurtosis = 1.39).

Interpretation of the coefficients in the linear functional form is straightforward for the continuous variables such as age or income. For instance, the coefficient of 0.052 on income suggests that as income increases by $1.000 we would expect that the individual's willingness to pay for the complete groundwater cleanup program would increase by about **5¢.** The same linear interpretation does not hold for the coefficients in the Box-Cox transformation and thus the coefficients are not directly comparable between the two regressions.

Using the Box-Cox transformation, predicted values for WTP were estimated for each individual based on the transformation. The mean predicted WTP from the Box-Cox transformation, $7.01. can be viewed as an appropriate value for policy purposes if all error is assumed to be measurement error. The mean value of REDWTP of $11.58 can be considered an upper bound for policy purposes.

One additional question is the functional form of the WTP equation implied by the BOX-COX transformation which attempts to correct for a skewed error distribution. To address this issue we reestimated the Box-Cox model with the addition of squared terms for all significant variables. The mean of the predicted values in this case was $6.86 (as opposed to $7.01) and the Box-Cox coefficient was .13 (rather than .15). Thus, the impact of using a more flexible fictional form for WTP was fairly small.

TABLE 7.6: LINEAR REGRESSION ON UNTRANSFORMED REDWTP

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	25	73000.37173	2920.01487	5.699	0.0001
Error	1957	1002691.0502	512.36129292		
C Total	1982	1075691.422			

Root MSE	22.63540	R-square	0.0679
Dep Mean	11.70280	Adj R-sq	0.0560
C.V.	193.41868		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for HO: Parameter-0	Prob > |T|
INTERCEP	1	-6.763461	5.64874322	-1.197	0.2313
INCOMEVD	1	0.052187	0.01680193	3.106	0.0019
KIDS	1	-0.721015	1.20841415	-0.597	0.5508
AGE	1	-0.032784	0.03898204	-0.841	0.4005
WHITE	1	-4.483774	1.78162471	-2.517	0.0119
EDUC	1	0.274099	0.31431016	0.872	0.3833
GENDER	1	1.063677	1.16045964	0.917	0.3595
NORTHEAS	1	2.082240	2.93395747	0.710	0.4780
NEwYoRK	1	5.299471	2.66018878	1.992	0.0465
MIDATLAN	1	1.455949	2.59242466	0.562	0.5744
SOUTH	1	-0.704027	2.45371442	-0.287	0.7742
LAKES	1	1.429176	2.36324675	0.605	0.5454
SOUTHWES	1	0.344791	2.65311797	0.130	0.8966
MOUNTAIN	1	2.294621	3.20595526	0.716	0.4742
WEST	1	-1.186594	2.78602501	-0.426	0.6702
NORTHWES	1	-0.618157	3.16203331	-0.195	0.8450
LANDFILL	1	-1.744474	1.26009156	-1.384	0.1664
EXPOSED	1	-0.506656	0.87579951	-0.579	0.5630
USE	1	0.632029	1.07223918	0.589	0.5556
SOURCES	1	0.912289	0.48909623	1.865	0.0623
RECYCLES	1	0.166939	0.25356772	0.658	0.5104
OTHENV	1	-0.931303	0.68753063	-1.355	0.1757
GRNDWTR	1	1.019863	0.53051013	1.922	0.0547
COMPLETE	1	0.831090	0.30137190	2.758	0.0059
MEANNCOM	1	0.3752S1	0.46932833	0.800	0.4240
RESPONS	1	2.191863	0.33355416	6.571	0.0001

TABLE 7.7: LINEAR REGRESSION ON BOX-COX TRANSFORMATION OF REDWTP (a= 0.15)

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	25	29051.93129	1162.07725	34.272	0.0001
Error	1957	66357.51024	33.90777		
C Total	1982	95409.44153			

Root MSE	5.82304	R-square	0.3045
Dep Mean	6.90664	Adj R-sq	0.2956
C.V.	84.31072		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for HO: Parameter-O	Prob > |T|
INTERCEP	1	-5.832276	1.45315957	-4.014	0.0001
INCOMEVD	1	0.026445	0.00432236	6.118	0.0001
KIDS	1	0.016927	0.31086890	0.054	0.9566
AGE	1	-0.040563	0.01002827	-4.045	0.0001
WHITE	1	0.776703	0.45832938	1.695	0.0903
EDuc	1	0.382580	0.08085742	4.732	0.0001
GENDER	1	0.100170	0.29853243	0.336	0.7373
NORTHEAS	1	-0.352492	0.75477114	-0.467	0.6405
NEwYoRK	1	0.938023	0.68434316	1.371	0.1706
MIDATLAN	1	0.453276	0.66691059	0.680	0.4968
SOUTH	1	-1.129931	0.63122688	-1.790	0.0736
LAKES	1	0.151642	0.60795375	0.249	0.8031
SOUTHWES	1	-0.706929	0.68252417	-1.036	0.3004
MOUNTAIN	1	0.320851	0.82474355	0.389	0.6973
WEST	1	-0.195098	0.71671498	-0.272	0.7855
NORTHWES	1	-0.043883	0.81344447	-0.054	0.9570
LANDFILL	1	-0.545102	0.32416310	-1.682	0.0928
EXPOSED	1	-0.229042	0.22530258	-1.020	0.3078
USE	1	0.850450	0.27583740	3.083	0.0021
SOURCES	1	0.424435	0.12582177	3.373	0.0008
RECYCLES	1	0.085447	0.06523121	1.310	0.1904
OTHENV	1	-0.606282	0.17686973	-3.428	0.0006
GRNDWTR	1	0.469827	0.13647564	3.443	0.0006
COMPLETE	1	0.358245	0.07752901	4.621	0.0001
MEANNCOM	1	0.223914	0.12073641	1.855	0.0638
RESPONS	1	1.592300	0.08580801	18.557	0.0001

Variable	Label	N	Mean	Std Dev
REDWTP	reduced wtp	2315	11.5783585	25.9979281
PREDWTP	pred in dollars	1983	7.0077342	5.2925489

7.4 Components of Total Value for Complete Cleanup

Question 14 asked individuals to indicate how much of their willingness to pay just for the stated groundwater cleanup program they would allocate to different components. "THAT YOUR HOUSEHOLD HAS ENOUGH CLEAN WATER TO USE we label USEVAL. This is a use value that would directly enter the household utility function as a consumed commodity. "THAT OTHER HOUSEHOLDS IN YOUR COMMUNITY HAVE ENOUGH CLEAN WATER TO USE we have labelled ALTRUIST for altruistic value. This is essentially a non-use value for the household but households exhibit interdependent utility functions. The household gains value by knowing that other households gain value through having clean water to use. "THAT FUTURE GENERATIONS OF PEOPLE LIVING IN YOUR COMMUNITY WILL HAVE ENOUGH CLEAN WATER TO USE" we label BEQUEST value. Interdependent utility also exists between generations, so the present generation gains value in knowing that future generations have water to use. This is not a use value&K current households and is categorized as a bequest value in the economic literature. 'THAT THE GROUNDWATER IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT' we label EXIST value. This is non-use value and fits accepted definitions of an existence value.

A limited number of people incompletely assigned percentage splits to these values. Forty eight people had percentages summing over 100%. Of these, 17 put 100% for all four of the values. Fourty-eight people entered 0 in at least one of the four spaces but did not enter a positive percent in any of the spaces (27 people entered 0 in all four spaces). A number of people did not enter values adding up to 100%. To account for these discrepancies we normalized the percentages for the allocation of values to sum to 100%. For individuals entering '0' in all four slots we set their percentages as missing values and they were excluded from the calculation of the mean percentage splits. Of the 2090 individuals who entered a non-zero value for at least one of the component values, 1856 (88.8%) entered values that summed to 100% prior to normalization.

There was no significant difference in the allocation of percents to different components by region. There was no effect of survey version on either the component values ($t(1853) = 1.13$, n.s.) nor on percentage splits ($t(1\ 878) = 0.95$, n.s.). Table 7.8 shows the means of the normalized percent splits by component.

TABLE 7.8: PER CENT SPLITS BY COMPONENT (N=2090)
(MEAN NORMALIZED %ALLOCATED TO COMPONENT)

	MEAN	STD DEV	MINIMUM	MAXIMUM
OWNUSE (USEVAL)	**35. 19%**	**26.26**	0	100
COMMUN (ALTRUIST)	20.61%	17.84	0	100
FUTURE (BEQUEST)	25.01%	23.70	0	100
NOUSE (EXIST)	19.20%	28.22	0	100

Table 7.9 shows the means of the component values for the respondents derived from the REDWTP, their stated bids. These means were calculated for each individual by multiplying the REDWTP by the normalized percentage for each component and then taking the means for the component The data shown are for the 1742 individuals for whom we could calculate such component values for both the REDWTP and for the predicted WTP following the Box-Cox transformation.

TABLE 7.9: COMPONENT VALUES OF REDUCED WTP (UPPER BOUND)

VALUE	MEAN	STD DEV	MINIMUM	MAXIMUM	N
USE	4.20	10.03	0	200.40	1742
ALTRUIST	2.45	6.62	0	200.00	1742
BEQUEST	3.35	12.50	0	400.00	1742
EXIST	2.35	6.40	0	75.00	1742
TOTAL (REDWTP)	12.35	22.05	0	400.00	1742

The same procedure was followed to calculate the appropriate values for the component values under an assumption of all error being measurement error. Following the BOX-COX transformation the predicted total willingness to pay was multiplied by the normalized percentages for components for each individual. The means of these individual component values are presented in Table 7.10. As stated above, these are calculated using the same individuals for whom information was available for all component value calculations.

TABLE 7.10: COMPONENT VALUES FROM PREDICTED WTP (LOWER VALUE)

VALUE	MEAN	STD DEV	MINIMUM	MAXIMUM	N
USE	2.43	2.52	0	23.05	1742
ALTRUIST	1.49	1.71	0	16.03	1742
BEQUEST	1.96	2.86	0	54.17	1742
EXIST	1.52	3.08	0	29.76	1742
TOTAL (DPRED)	7.40	5.31	0.20	54.17	1742

The sum of the non-use values, BEQUEST and EXIST comprise roughly 40% of the total value individuals place on groundwater cleanup for the scenario provided. How these values may differ in alternative circumstances is discussed below in the section on three alternative approaches to measuring non-use values.

7.5 Alternative Programs

It is entirely possible that a complete cleanup program as described in the hypothetical scenario would not be possible in actual situations where groundwater contamination has occurred. Such an extensive cleanup maybe either technically impossible or may be prohibitively expensive making it necessary to consider less comprehensive alternatives. Two variants of the survey elicited willingness to pay for alternative programs.

Version A considered willingness to pay for a containment program. In this alternative the groundwater contamination is contained within a limited area by a series of wells in the area to which the contamination was moving. If this program were undertaken the households would have the same quantity of usable water because new, unpolluted, wells would be drilled to replace contaminated wells. Respondents were asked how much they would be willing to pay for such a containment program as a per cent of how much they were willing to pay for complete cleanup. In addition to providing water for use such a program may include values for preventing further groundwater contamination. As stated in the valuation question for this option "This approach does not completely clean up existing contaminated groundwater. It prevents the spread of contamination and will require new wells to be drilled outside of the containment zone." Thus, this option will include use values but is expected to include only some non-use (bequest and existence) values.

Version C considered a public water treatment program. In this alternative hte local government would build and maintain a water treatment plant to remove contaminants from the water supply prior to the water entering the water distribution system. The underground contamination would not be cleaned up or controlled. Respondents were asked how much they would be willing to pay for such a public water treatment program as a per cent of how much they were willing to pay for complete cleanup. As this approach would only assure a clean supply of water for current use it is reasonable to believe that values for this program are primarily for use and altruistic values. There maybe some degree of bequest value if individuals feel that the capital equipment for a water treatment plant is passed on to future generations leaving them primarily with operating, replacement snd maintenance costs for future use.

Two other alternative programs were outlined in the survey but variants to determine WTP for these alternatives were not developed. In the home treatment (HOMETRT) alternative individual households would buy and install their own charcoal filtration systems. In the water rationing (RATION) alternative the local government would institute a water rationing system to reduce water use by the 40% shortage caused by groundwater contamination. Individuals in all versions of the survey were asked to rate how satisfied they are with each alternative on a scale of one to seven with 1 = NOT SATISFIED AT ALL and 7 = EXTREMELY SATISFIED. The mean response to these alternative programs is listed in the Table 7.11.

Within subjects tests show that the complete cleanup is valued more than the containment program (REDWTP > CONTWTP: $t(403) = 12.21$, $p < 0.0001$) and the complete cleanup is more highly valued than the public treatment program (REDWTP > PUBWTP: $t(399) = 6.14$, $p < 0.0001$). As the containment and public treatment valuation options did not occur together in any of the survey versions it is not possible to perform a within subjects test of the valuation of the containment and public treatment programs.

TABLE 7.11: RANKINGS OF ALTERNATIVE PROGRAMS

PROGRAM	- LEVEL OF SATISFACTION	MEAN WTP (RAW DATA)
COMPLETE	4.35 n = 2566	11.70 n = 1983
PUBLTRT	3.74 n = 2561	7.98 n = 400
CONTAIN	3.45 n = 2554	5.96 n = 404
HOMETRT	2.81 n = 2586	N.A.
RATION	2.51 n = 2591	N.A.

The ranking of programs by the mean level of satisfaction corresponds to the ranking of the programs by willingness to pay. In such an ordering complete cleanup would be the most preferred followed by public treatment and then containment. Testing for the difference in mean ranking of public treatment versus containment there is not a statistically significant difference (t(803) = 1.22, ns). *A priori* we expect the containment program to be preferred to the public treatment program as it ensures continued clean water supply in addition to controlling the contamination underground. Public treatment does nothing for underground water pollution. A plausible explanation for the apparent preference of public treatment over containment is that individuals may not believe that the containment option redly solves the problem of contaminated groundwater since it requires continuing operation over time. It is likely that individuals find the public treatment scenario more "understandable" as they quite likely receive water from such a system.

The raw mean of willingness to pay for the containment program for the regression sample, $6.38, was about 55% of the willingness to pay for the complete cleanup program. The mean predicted value for. containment of $3.95 is 56% of the mean predicted WTP for complete groundwater cleanup ($7.01). The lower values for containment probably reflect the desire of individuals as revealed in the initial verbal protocols to have a complete, once and for all, solution to the problem. This also corresponds almost exactly with the percent splits identified previously where use values comprised 56% of the value stated for complete groundwater cleanup. This scenario does not clean up the currently contaminated groundwater, but only protects the groundwater surrounding the area from future contamination. The lower values for containment suggest that individuals acted as if this scenario does not induce bequest or existence values, as we expected ***a priori.***

The raw mean willingness to pay for the regression sample for the containment program of $6.38 provides an upper bound and the mean of the percent adjustments applied to the predicted values following the Box-Cox transformation of $3.95 provides an appropriate estimation of willingness to pay for such a program for policy purposes if the assumption is made that all error is measurement error.

The mean willingness to pay for the public treatment option is $7.18 and the mean WTP following applying the percent adjustment to predicted values from the Box-Cox transformation is $4.02. These are 61% and 58% respectively of the mean reduced willingness to pay and the mean predicted willingness to pay for complete groundwater cleanup. AS before these are upper bounds and appropriate estimates depending on the degree of model error versus measurement error which can not be known *a priori.* These willingness to pay values are higher than the values for containment and lower than for complete cleanup as discussed previously.

The value for public treatment can be regarded as a use value since the source of groundwater contamination is not dealt with in this option. The groundwater problem is left for future generations as this option merely provides treatment for current water use to prevent any shortage in current water supply. In relation to our earlier classifications of value into use, altruistic, bequest and existence, the public treatment program clearly includes use value. The public treatment program would likely include some value for other households in the community for current use which we have labelled altruistic value. Future generations are described as having to pay for themselves, so this value likely does not include bequest value unless. respondents place a bequest value on providing durable capital equipment in the form of the water treatment plant to future generations. It is reasonable to argue that public treatment does not include an existence value as the source of groundwater contamination is not dealt with nor is currently contaminated groundwater cleaned up unless it is pumped for use.

7.6 National Groundwater Cleanup

Versions B and E of the survey contained a section dealing with the "National Groundwater Problem." In both versions subjects were asked how much they were willing to pay to help fund complete groundwater cleanup In other communities across the nation. In Version B subjects Were given information regarding the national extent of groundwater contamination and it was emphasized that such funds would supplement money from local finds for groundwater cleanup. Version E did not provide the information on the number of people affected by groundwater contamination, how much groundwater supplies for domestic water use or ask how likely the individual felt it was that he or she would move to a different community. Version E also did not emphasize that the money they "contributed" would be supplemental to local programs in communities which did not choose to pay for complete groundwater cleanup. Given these differences, Version B is labelled the "FULL CONTEXT' version and Version E the "NO CONTEXT" version of the national willingness to pay question.

Version B, which contained the full context national groundwater question. was also the version used for over-sampling areas known to have groundwater contamination problems as described earlier (see Section 7.3 on complete groundwater cleanup). For data analysis, this stratified random sample for the national survey variant is referred to as Version F or the full context-oversimple version.

Table 7.12 shows the mean willingness to pay for groundwater cleanup by context and by version. The untransformed mean is shown in the second column and the predicted mean following the adjustment to the predicted WTP from the Box-Cox transformation is shown in the third column. The no context and full context means are shown and then the full context versions are split between the random full context (Version B) and the oversimple of areas with contaminated sites (Version F).

Within subjects tests showed that individuals valued the complete cleanup of the local groundwater contamination significantly higher than helping clean up the national groundwater problem (REDWTP > NATWTP: $t(1018) = 13.37$, $p < 0.001$) as would be expected.

TABLE 7.12 NATIONAL WTP BY CONTEXT VS. NO-CONTEXT
CONTEXT DIVIDED INTO RANDOM SAMPLE AND OVER—SAMPLE

	MEAN (std. dev.) n = sample	PREDICTED MEAN (std. dev.) n = sample
NO CONTEXT (VERSION E)	2.67 (10.27) n = 393	1.34 (2.46) n = 343
FULL CONTEXT (VERSIONS B & F)	2.03 (7.55) n= 626	1.13 (2.31) n = 542
RANDOM SAMPLE (VERS1ON B)	1.97 (7.25) n = 401	1.19 (2.41) n = 348
OVER SAMPLE (VERSION F)	2.15 (8.06) n = 225	1.02 (2.11) n = 194

Although the raw WTP dropped by almost 24% from the no context to the full context versions, the difference between the means is not statistically significant at the 5% level ($t(655.6) = 1.06$, ns). The variance has also fallen from the no context to full context version and is statistically significant ($F(392,625) = 1.85$, $p < .01$).

Following the valuation question, an allocation question was asked to determine how individuals constructed their WTP for solving the national groundwater problem. The categories correspond to the USE, ALTRUIST, BEQUEST and EXIST categories used for decomposing the willingness to pay for local groundwater cleanup. In this component allocation question a category was also added for “OTHER”. The primary difference in these categories is that use value is contingent on the individual moving to another community. Use value will therefore incorporate a degree of risk assessment in terms of whether the individual feels he or she will ever move to another community and if so how likely that community would have contaminated groundwater. It seems likely that an individual will choose to move to a community without groundwater contamination given the option and thus may have a very small use value component for helping to clean up the national groundwater contamination problem.

Table 7.13 shows the variables specific to the national groundwater versions. The third and fourth columns indicate the questton number by survey version (Versions B and F are identical).

AS with the component breakdowns for the complete cleanup scenario, the percentages for the component values are normalized. This normalization was undertaken to make the sum of the percents equal to 100%. For individuals who did not enter a value in some components, but did in others, their missing values were set to zero. After setting missing values to zeros the component values were normalized to sum to 100%. Individuals who entered zero in all components were deleted from the calculation of mean component values. Of the 1239 respondents for the national value sections 743 provided some positive value for the component breakdown question allowing us to normalize their percent splits. Four hundred and forty five of these (60%) required no normalization (correctly summed their percentages to 100%). Two individuals entered 100% for all five component values.

The mean component splits are shown in Table 7.14 for the no context version and in Table 7.15 for the full context versions. There was not a significant difference between the regions in terms of component values for willingness to pay for national groundwater cleanup. Of the 743

TABLE 7.13: ADDITIONAL VARIABLES IN THE NATIONAL SURVEY

VARIABLE	EXPLANATION	QUESTION (version B & Version F)	QUESTION (VERSION E)
NATIONAL	% of REDWTP for national groundwater cleanup program	917	**916**
MOVE	Asked how likely individual would move in the next ten years (1 = not likely 7 = certain) (not asked in Version E)	916	**not asked**
DIFFCOMM	Use value - own use value if individuals moved to a different community	Q18	**917**
OTHPPLE	Altruistic value (other people in community)	Q18	917
FUTURGEN	Bequest value (future generations)	918	Q17
NONUSENL	Existence value (non-use - national)	918	917
0THER2	Other uses	**Q18**	**Q17**
NATLRESP	How responsible individual feels for helping to clean up national problem (1= not at all 7 = extremely)	**Q19**	**Q18**

surveys which indicated component values allowing these calculations, 446 were from the full context versions (293 from the random sample Version B and 153 from the over-sample Version F) and 297 were from Version E, the no-context version.

TABLE 7.14: NORMALIZED COMPONENT PERCENTS NO CONTEXT VERSION

	MEAN	STD DEV	MINIMUM	MAXIMUM	N
USE	29.95	26.32	0	100	297
ALTRUIST	20.37	19.18	0	100	297
BEQUEST	26.18	25.07	0	100	297
EXIST	19.00	27.27	0	100	297
OTHER	4.48	17.72	0	100	297

TABLE 7.15: NORMALIZED COMPONENT PERCENTS CONTEXT VERSIONS

	MEAN	STD DEV	MINIMUM	MAXIMUM	N
USE	32.98	28.61	0	100	446
ALTRUIST	20.35	18.65	0	100	446
BEQUEST	26.36	24.76	0	100	446
EXIST	18.49	26.98	0	100	446
OTHER	‘1.82	9.93	0	100	446

Testing for the effect of context on component allocation in the national willingness to pay showed no significant difference in mean percent by component except for the category OTHER where the mean allocated to OTHER in the no context version is higher than in the context version ($t(741) = 2.6134$. $p < 0.009$). This maybe a reflection of the uncertainty that individuals face in the no context version of determining how they are construction their valuations. It is interesting to note that the distribution of component values for the national groundwater program is roughly the same as the distribution of component values for the complete groundwater cleanup program (see Table 7.8). Even though the component breakdown for the complete cleanup did not include the category “OTHER” the similarity in the distributions suggests that individuals maybe constructing their values for national groundwater cleanup under the assumption that they may be living in diffent areas wen If they indicated that they do not expect to move. Otherwise the use potions of the national component allocation would be expected to be much smaller.

Tables 7.16 and 7.17, respectively, present the upper bound and lower willingness to pay for the national groundwater cleanup program calculated from the component breakdowns shown above. The upper bound is calculated from the untransformed willingness to pay and the lower WTP from the predicted willingness to pay following the regression using the Box-Cox transformation under the assumption of all error being measurement error. These values are shown for all survey versions combined.

TABLE 7.16: COMPONENT VALUES OF NATIONAL WTP (UPPER BOUND) ALL VERSIONS

VALUE	MEAN	STD DEV	MINIMUM	MAXIMUM	N
USE	0.82	2.88	0	43.84	675
ALTRUIST	0.63	2.08	0	-25.00	675
BEQUEST	1.16	7.32	0	150.30	675
EXISTENCE	0.70	2.59	0	37.50	675
OTHER	0.06	0.56	0	10.00	675
TOTAL	2.28	8.70	0	150.30	1019

TABLE 7.17: COMPONENT VALUES OF NATIONAL WTP (LOWER VALUE) ALL VERSIONS

VALUE	MEAN	STD DEV	MINIMUM	MAXIMUM	N
USE	0.43	0.83	0	6.98	613
ALTRUIST	0.34	0.65	0	5.72	613
BEQUEST	0.52	1.42	0	20.34	613
EXISTENCE	0.36	0.95	0	9.93	613
OTHER	0.04	0.25	0	3.31	613
TOTAL	1.21	2.37	0	27.12	885

The MOVE question asked how likely it was that the individual would move In the next ten years (1 = not likely, 7 = certain). We would anticipate that individuals would be willing to pay more to solve a national problem if they expected to move in the next ten years to a location than if they were strongly attached to their own locality. The mean response to this question was 2.95 (Std. dev.= 2.21) for the 729 individuals who answered suggesting that for the most part individuals did not see that it was very likely they would be moving to another community much less one with contaminated groundwater.

Individuals were also asked how responsible they felt for cleaning up groundwater contamination problems in other communities. This questton corresponds to the RESPONS question on local complete groundwater cleanup. As with the MOVE variable the NATLRESP (national responsibility) was a 1 to 7 ranking with 1 meaning “NOT AT ALL RESPONSIBLE” and 7 meaning "EXTREMELY RESPONSIBLE". The mean value of 2.59 (std. dev. 1.59, n = 1168) for national responsibility suggests that individuals did not consider themselves responsible for helping to clean up groundwater pollution in communities other than their own. The mean for the similar responsibility question for local groundwater cleanup was 4.15 (std. 1.79, n = 2547). This difference probably reflects in part the difference in scenarios offered the individuals. In the local groundwater contamination the respondents are specifically told that their landfill polluted their water supply. In the national full context version individuals are being asked to help pay for other communities to clean up their groundwater above and beyond what the people in that other community are willing to pay. NATLRESP was not significantly different between the no context and full context versions of the survey (t(1 166) = 0.212, ns).

It is interesting to note the positive correlation between how likely the individual feels he or she will move to another community in the next ten years (MOVE) and the feeling of national responsibility (NA’’P). The Pearson Correlation Coefficient between these variables IS 0.21 which is significantly greater than zero at the 0.001 level of significance (707 df). NATLRESP is also positively and significantly related to predicted national willingness to pay (Pearson Correlation Coefficient of 0.49, significantly greater than zero at 0.001.877 df). The correlation between MOVE and NATLWTP was not significant at the5% level (r = 0.07, 538 df, p < 0.10). These correlations suggest that values for cleaning up groundwater contamination outside of one's area is based on one's feelings of responsibility more so than the likelihood that they will move: yet their feelings of responsibility are closely related to the likelihood that they will move.

Additionally, it is interesting to note that NATLRESP is negatively correlated with the percent component allocation to use values (r = -0.19, 740 df, p < 0.001) and positively correlated with per cent component allocations to bequest value (r = 0.08, 740 df, p < 0.03) and positively correlated with the per cent component allocation to existence value (r = 0.14, 740 df, p < 0.001). Obviously, since the normalized percentages sum to 100, another variable cannot be positively correlated with all of the components. These correations do suggest though that values increase because of feelings of moral responsibility, which are more important for non-use values (bequest and existence values) than for use values (use and altruistic values).

7.7 Variations in Shortages of Supply

The base scenario presented in the survey was for a potential 40% shortage of water supply due to the groundwater contamination. Obviously, not all 'real world groundwater contamination situations will create a 40% shortage in the local water supply. Therefore Version D of the survey presented the respondents with alternative scenarios in which the percentage shortage of the water supplied was varied. The actual groundwater contamination conditions are identical to the original scenario. Just the degree of reliance on groundwater sources for local water supply is varied. Individuals were asked to adjust their WTP bid from the 40% shortage scenario if they faced only a 10% shortfall in their water supply and then if they faced a 70% shortfall in their water supply in the same conditions as the original scenario. The percent stated adjustment to their bid was multiplied by their REDWTP and predicted reduced WTP to derive a willingness to pay if faced with a 10% or 70% water supply shortfall due to groundwater contamination.

Table 7.18 gives the raw means for WTP under the three different conditions. These means are calculated just for the group that completed Version D of the survey to make within subjects comparison between scenarios possible. Three hundred forty four individuals answered all of the relevant questions for Version D. The means presented in this table represent upper bound estimates of the willingness to pay.

TABLE 7.18: WTP AS A FUNCTION OF % WATER SHORTAGE RAW MEANS (UPPER BOUND)

PERCENT SHORTAGE	WTP MEAN	STD DEV	MINIMUM	MAXIMUM	N
10	7.57	21.16	0	320.00	344
40	13.14	28.67	0	400.00	344
70	23.04	47.77	0	600.00	344

The Box-Cox predicted bid for each individual in the 40% scenario was multiplied by that individual's stated percentage adjustments to derive a lower value estimate of the respondents WTP when faced with the 10% and 70% shortage scenarios. Table 7.19 presents these lower value estimates.

TABLE **7.10 WTP AS A FUNCTION OF% WATER** SHORTAGE
PREDICTED MEANS (LOWER VALUE)

PERCENT SHORTAGE	WTP MEAN	STD DEV	MINIMUM	MAXIMUM	N
10	3.96	4.42	0	29.76	344
40	7.19	5.19	0.35	29.76	344
70	13.37	12.75	0.35	76.82	344

It is possible that some error is present in these estimates because of an anchoring and adjustment process beginning from the first value obtained for the 40% shortage scenario. If this has occurred then the calculated WTP in the 10% scenario is likely to be higher than the true WTP and the WTP in the 70% scenario is likely to be lower than the true WTP.

7.8 Three Approaches to Estimating Non-Use Value

7.8.1 Introduction

In the preceding sections we have discussed the results of individual parts of the groundwater survey. In this section we analyze results from different versions of the survey, each of which provide estimates of non-use values using different conceptual approaches. The first approach uses the stated percentage splits allocating the WTP between different component values. The second approach considers the difference between willingness to pay for complete groundwater cleanup and willingness to pay for the public water treatment program. This difference is based on the different component values that make up the WTP in the two scenarios. The third approach extrapolates non-use value based on differences in WTP when faced with different levels of water shortage as examined in Version D.

7.8.2 Percentage Splits

The first approach is applicable to all survey versions as all versions included the basic willingness to pay question followed by the percentage splits question as discussed in Section 7.4. above. For this calculation the individual's predicted WTP is multiplied by each of his or her percentage splits for the components of total value (USE, BEQUEST. ALTRUIST and EXIST). The means of these are replicated below (see Section 7.4 above for a complete explanation).

TABLE 7.20: COMPONENT VALUE - MEAN PREDICTED WTP

VALUE	MEAN (UNTMNSFORMED)	MEAN (PREDICTED)
USE	4.20	2.43
ALTRUIST	2.45	1.49
BEQUEST	3.35	1.96
EXIST	2.35	1.52
TOTAL	12.35	7.40
SUM OF BEQUEST AND EXIST	**5.70**	**3.48**

The mean of the sum of the predicted bequest and existence values is $3.48 with a standard deviation of 3.97 for the 1742 individuals for whom this could be calculated. This number will be compared to the results from the other methods of calculating non-use values.

7.8.3 Scenario Differences

In this approach, each individual's predicted willingness to pay for the public treatment program is subtracted from the willingness to pay for complete groundwater cleanup. Since the public treatment program is expected to include primarily use values and altruistic values the difference between complete cleanup and public treatment will be comprised mainly of bequest and existence values. This figure can be compared to the sum of the bequest and existence values from the percentage splits method as: WTP for Complete Cleanup minus WTP for Public Treatment ≅ Bequest + Existence Value. The mean estimate of the sum of bequest and existence values from the scenario differences approach is $2.81 with a standard deviation of 3.11. This was calculated for 349 individuals for whom the appropriate data were available. The maximum difference in these values was $19.38.

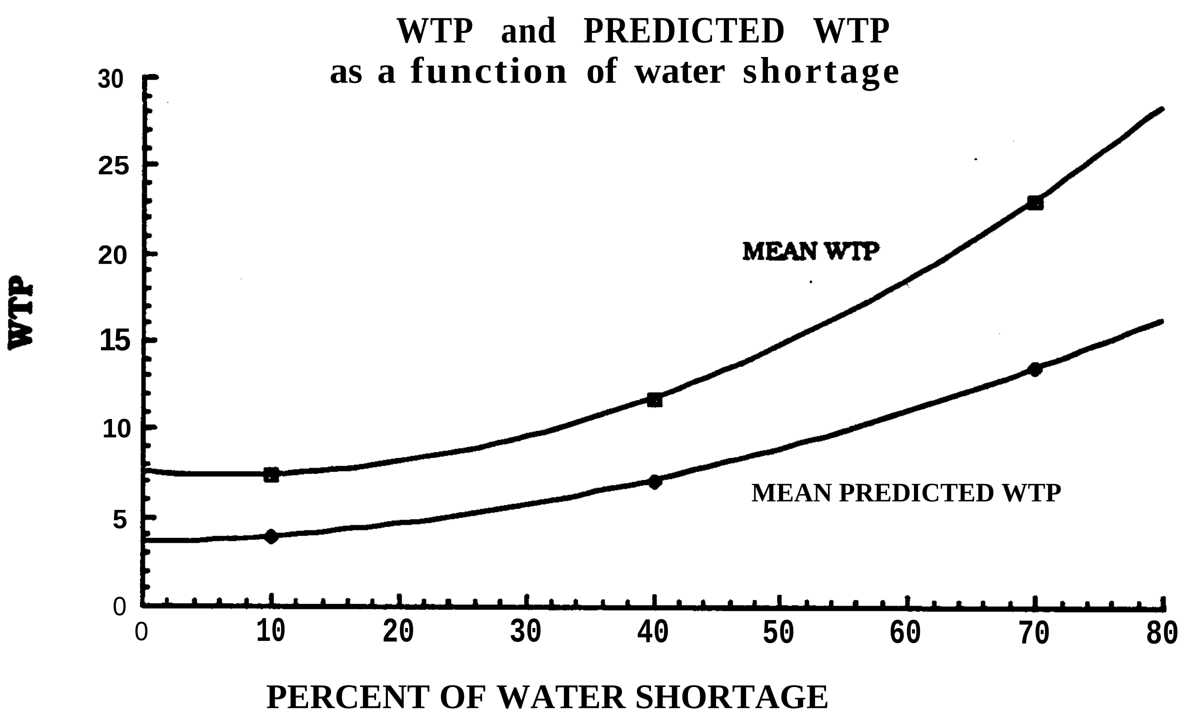
7.8.4 Extrapolation Approach

In this approach the individual's predicted willingness to pay for complete groundwater cleanup in the 40% shortage condition is multiplied by the stated percentage decrease or increase in willingness to pay in the 10% or 70% water shortage condition respectively. With three points indicating the relationship between the willingness to pay for complete groundwater cleanup and the degree of water shortage the individual faces, a second degree polynomial can be fitted. The intercept of this polynomial, where the individual faces no water shortage, will indicate the willingness to pay for water cleanup for purposes other than use, i.e., non-use values. As other individuals in this situation also do not face a water shortfall, this value will be comprised of bequest and existence values only.

As discussed in Chapter VI, the level of water shortage has a statistically significant effect on the WTP for groundwater cleanup. WTP values do increase as the level of water shortage increases ($t(387) = 9.91$, $p < 0.001$). Testing for slope changes is also significant. The slope of between 10 and 40 percent is less than the slope between 40 and 70 percent shortage indicatig a quadratic function ($t(387) = 3.83$, $p < 0.001$).

Figure 7.1 charts the three WTP figures based on different levels of water shortage for both the raw means and the predicted means as derived in the previous section.

FIGURE 7.1: MEAN WTP AS A FUNCTION OF % OF WATER SHORTAGE



Second degree polynomials in the percent water shortage were fitted to each individual's predicted values for a 10%, 40%, and 70% shortage. The constant term for each individual provides an estimate of non-use value since any residual value when use is zero should comprise non-use values. For the 344 predicted value derived from the Box-Cox transformation the mean of these individual intercepts is $3.54(standard deviation $5.86).

7.8.5 Summary

Table 7.21 summarizes the three methods of estimating non-use values for groundwater. The numbers shown are the lower value results as derived above. The data shown for the percent splits approach is for the respondents who did not answer either the public water treatment version (C) or the different degrees of shortage version (D) so that comparisons may be made between groups. The mean and standard deviation for the percent splits approach excluding these other Individuals is virtually identical to that if they are Included (see Table 7.20).

TABLE 7.21: COMPARISON OF DIFFERENT APPROACHES TO ESTIMATING NON-USE VALUES (for predicted values)

METHOD	BEQUEST PLUS EXISTENCE	STANDARD DEVIATION	N
PERCENT SPLITS	3.49	3.97	1126
SCENARIO DIFFERENCES	2.81	3.11	345
EXTRAPOLATION	3.54	5.86	344

The percent splits approach and the extrapolation approach are not statistically different yet the scenario difference approach is less than the other two (Tukey's Studentized Range, a = .05, df = 1812). The lower value for the scenario difference approach is expected if individuals are placing a bequest value on the capital equipment for the public water treatment option. If this occurs the scenario difference approach would be canceling some portion of bequest values and would understate the non-use value total of bequest and existence values.

Three different approaches haveexamined non-use values in this survey. For the specific contingent valuation question at hand these approaches have produced remarkably similar quantitative estimates for non-use values of an exotic commodity. While these values are not exceptionally large they are significantly larger than zero indicating that non-use values are likely to be a valid component of the valuation of such a commodity.

7.9 Conclusion

This chapter has considered the implications of the data from the groundwater survey in terms of individual's willingness to pay for cleanup of contaminated groundwater under a variety of scenarios. Regressions on the reduced willingness to pay for complete groundwater cleanup seine as the basis for the values for alternative scenarios. Using the untransformed reduced WTP as an upper bound estimate and the predicted WTP from the regression using the Box-Cox transformation as a lower value estimate provides a range of valuations for policy purposes. The Box-Cox transformation deals with outliers without arbitrary trimming and significantly increase the explanatory power of the regression (R^2 of .30). The Box-Cox coefficient of 0.15 suggests the nearly log-normal distribution of the errors as seen in other work as discussed in Chapter III.

The regressions showed several socio-demographic and regional variables to be significant in explaining willingness to pay, including income, age and education in the regression using Box-Cox transformation. In addition to these variables, the RESPONS variable is significant in both the untransformed and Box-Cox transformation regression, with t values of 6.57 and 18.56 respectively. The importance of this variable in explaining willingness to pay must be emphasized and requires considerable attention in future research. The interpretation and availability of such a variable in policy analysis are questions yet to be dealt with.

This chapter also brought together three different methods for estimating non-use values. The percent splits approach, scenario difference approach and extrapolation approach provide remarkably internally consistent estimates of non-use values. Such internal consistency both supports the validity of contingent valuation methodology and of each approach individually for estimating non-use values.

Chapter VIII

Conclusions

Several general conclusions can be drawn from the study: 1. Consistent estimate of non-use values were obtained. 2. The strategy of reducing the length of the perfect infromation/full context survey through use of self reports appears to have been successful. 3. The mean of the national sample was very similar to the mean of the Denver samples used in pretesting. This suggests that a strategy of obtaining better values from a smaller number of people using a perfect information/complete context instrument may be desirable. In other words, the national survey may have added little to our knowledge of benefits. 4. However, the national survey produced a large enough data set to estimate econometric models predicting values. This allows use of the Box-Cox procedure to correct for a skewed error distribution. A national sample also maybe needed to estimate regional variations in values. 5. More complex Issues than groundwater cleanup may require more information than a mail survey can present. Door to door surveys or use of market research centers around the country in which respondents can be presented with a nearly unlimited amount of information and context (since they are paid) can provide national data sets in such cases. The expense of these approaches is of serious concern. However, where programs potentially costing hundreds of billions of dollars are at issue, costs of obtaining informed values are trivial by comparison.

Some problems remain unresolved with this study:

1. Although respondents in pretesting seemed comfortable with the notion that the water supply in their own community had been contaminated by their own landfill so that this hypothetical community represented the relevant market area. early attempts by Industrial Economics Inc. to apply this definition of “market area” for estimating benefits of corrective action have proven difficult. For example, water districts often encompass larger areas than individuals might assume to comprise their own community. Thus, additional research into the appropriate market area would be highly desirable. Note that the estimates of national non-use values per household were quite small with a modal value of zero. Thus, non-use values most likely fall off rapidly with distance. Estimation of the appropriate market area could be accomplished in the short run by using small Denver pm-test samples wherein distance to the contaminated groundwater source could be varied in different versions of the existing survey instrument. Other attributes such as extent of the water district, whether the community’s own landfill (or some other source) caused the contamination could also be tested. Similarly, a variation in the size of the contaminated area and the speed at which decontamination occurs (very recent evidence suggests that it may take 30 or more years to decontaminate some aquifers) may be important issues to explore. Since the Denver pretest results were so similar to the national values, these issues could be addressed at relatively low cost using the market research center approach described above.

2. As noted above. national non-use values had a modal value of zero (see chapter 6). Many valid zero bids were also obtained from the containment scenario. Containment may be of great importance since complete cleanup often appears to be infeasible. Where a large numberof valid zero bids are present the Box-Cox procedure developed to account for measurement error fails to be an appropriate model. As a result we applied the reported adjustments by respondents (fraction of value of the complete cleanup value allocated to national or containment scenarios) to obtain estimates of national and containment values. The data suggest, however, that these reported adjustments themselves may show a skewed error distribution even though they were applied to the predicted values which were corrected for skewed error in the values obtained for complete cleanup. It maybe more appropriate to use the adjusted raw values for national and containment scenarios (as shown in Chapter 6) directly and develop an appropriate statistical model which allows for a skewed error distribution and true zero bids. Appendix E describes the development of such an econometric model which we hope to employ in future research.

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APPENDIX A

SURVEY INSTRUMENT FOR OCTOBER 1990 PRETEST

Initials: _____

I. THE ISSUES

We are interested in your opinion about water use and potential groundwater contamination. We need your answers to these questions to help make decisions about future groundwater programs.

Q-1 Have you read or heard anything about groundwater being contaminated somewhere in your state or somewhere in your own county, city, or community? (circle one)

1) NO
2) YES -- IN MY STATE
3) YES -- IN MY COUNTY, CITY, OR COMMUNITY
4) DON'T KNOW

Q-2 Have you read or heard about instances of' groundwater contamination in your county, city, or community coming from any of these specific sources? (Circle all that apply)

1. NO -- HAVENT HEARD
2. YES -- BUT CANT RECALL SPECIFIC SOURCE
3. YES -- SUPERFUND OR OTHER TOXIC OR HAZARDOUS WASTE SITE
4. YES -- A PUBLIC LANDFILL
5. YES -- AGRICULTURAL APPLICATION OF PESTICIDES OR FERTILIZERS
6. YES -- SEPTIC TANKS
7. YES -- LEAKY UNDERGROUND STORAGE TANKS OR LAGOONS
8. YES -- A CHEMICAL SPILL
9. YES -- OTHER (please specify) ______________________________

Q-3 How much do you agree or disagree with the following statement We should protect groundwater at all costs.

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

initials: _

II. PRELIMINARY EVALUATION

Now we are going to present you wtth a hypothetical situation in which part of a city's groundwater supply has been contaminated. and you will be asked to evaluate a particular response option. Later in the survey you will be given a lot of facts and information about groundwater which may or may not assist you in your evaluation. Right now. though. we would like to get a preliminary evaluation from you.

Note that the situation we are going to describe is completely hypothetical. It may differ considerably from your current water use situation and from the groundwater situation in your community. and so we would like you to imagine that you live in the city wtth the groundwater problem described and respond as if you were truly facing this situation.

Imagine your city currently gets 50% of its water from groundwater. You have been getting all of your water from the city's public water supply. Now. suppose it is discovered that over the years toxic chemicals from the municipal landfill have been slowly leaking into the water table and the city's groundwater supply is now contaminated. The contamination has been occurring for a number of years and la the result of standard landfill practices. The area of contamination is about 2 square miles and is away from residential areas.

Scientists believe that drinking the contaminated water increases the rtsk of cancer. They have estimated the level of rtsk to be about 10 additional deaths per million people who drink the water per year.

Q-4 How accurately do you believe scientists can estimate the health&k posed by toxic chemicals'?

NOT AT ALL ACCURATELY						EXTREMELY ACCURATELY
1	2	3	4	5	6	7

The city government decides that, due to the contamination. the groundwater cannot be used as it is. Further, your city's other sources of water have only a 50-50 chance of reliably maktng up the shortfall caused by the groundwater contamination. Thus, although the water supplied to you will remain safe, there is a 50-50 chance of a 50% shortfall in your community's water supply next year.

Q-5 Do you agree or disagree with the city's decision to prohibit use of the groundwater, given the level of health risk estimated by scientists?

1. AGREE
2. DISAGREE
3. NOT SURE

Suppose that your city proposes to pay for a complete groundwater treatment operation to remove all of the contamination in the groundwater right now. leaving no contamination for the future. All of the water at the contaminated groundwater site would be pumped Up from the water table as soon as possible and cleaned by charcoal filters, which trap the contaminants. This cleaned water would then be reinjected back into the water table and stored there for future use. once the possibility of future recontamination has been removed. This would be done by digging Up all of the contaminated soil under the landfill and placing it, as well as all of the material in the old landfill, into a new landfill wtth a sealed bottom liner and a waterproof cover on the top.

Initials: _____

Scientists are satisfied with the quality of drinking water in areas where these methods have been used. This option guarantees that the 50-50 chance of a 50% shortage caused by groundwater contamination is eliminated. In addition. contaminated water would never enter the public water supply and the groundwater in your city would no longer be contaminated and would be available for future use.

A referendum is proposed to the voters of your city which calls for an increase in local water bills to pay for the costs of pumping Up and cleaning the contaminated water and constructing the new landfill. The money generated could be used only to pay for the groundwater treatment program. If the referendum is passed, everyone would pay the higher rate in order to fund the treatment project. It is Important to note that this increase would continue indefinitely into the future until the project is finished. ***At the moment we don't know what the complete groundwater treatment program will cost, so we neeed to find out how much it is worth to people.***

Q-6 Would you consider voting for a referendum to support a permanent water bill increase which would go to funding a complete groundwater treatment operation to make up the potential 50% shortfall due to groundwater contamination, ***if the groundwater treatment could be guaranteed ?***

1. No → **Why?**

2. YES ↓

Q-7 What is the most your household would be willing to pay EACH MONTH on top of your current water bill before you would vote NO on COMPLETE GROUNDWATER TREATMENT? (Circle the best response.)

$.50	$1.50	$4	$10	$30	$75	$200	$500
$.75	$2	$5	$15	$40	$100	$300	MORE THAN $500
$1	$3	$8	$20	$50	$150	$400	DONT KNOW

The amount you indicate will tell us what it is really worth to your household to get this program If the needed groundwater treatment actually cost less than people are willing to pay. you would only have to pay what it would cost. If the groundwater treatment turned out to cost more than people are willing to pay, U would not be done.

initials: ____

III. WATER USE IN YOUR COMMUNITY AND YOUR HOME

Now we are going to present several sets of statements and questions which present information about groundwater, ask you to think about many aspects of water use issues, and ask you to evaluate several different response options. After these sections you will be asked to reconsider the preliminary evaluation of the COMPLETE GROUNDWATER TREATMENT program which you did in Section II. The first set of questions deals wtth water and groundwater use in your community.

Water for residential use can come from many different sources, including surface sources such as reservoirs or lakes and groundwater sources. Groundwater comes from precipitation that falls on the land surface and seeps underground. At some depth underground the soil or rock becomes saturated with water. Groundwater is extracted for human use by digging wells or taking water from naturally occurring springs.

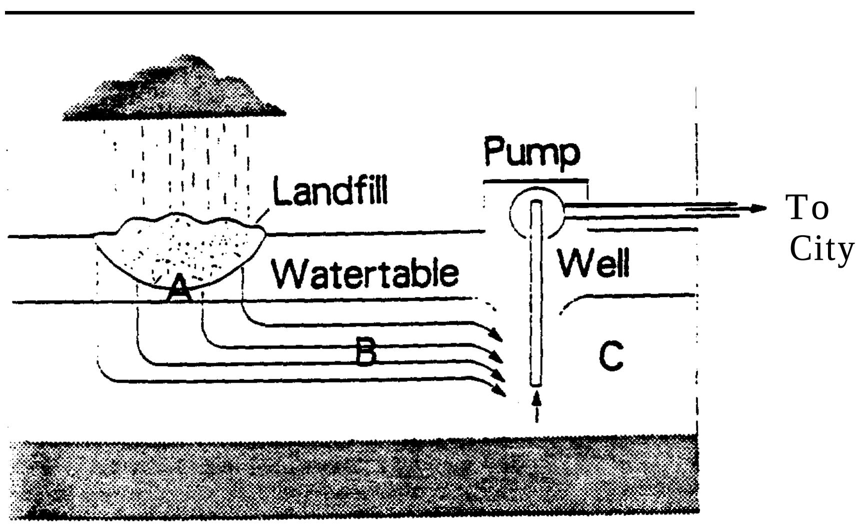
Q-8 Do you or people in your city or community get any part of your water for home use from groundwater?

1. NO --WE DONT USE GROUNDWATER
2. YES -- I USE GROUNDWATER IN MY HOME
3. YES -- SOME PEOPLE IN MY COMMUNITY USE GROUNDWATER BUT I DONT
4. DON-I' KNOW

Q-9 Often. garbage and waste placed in a community's landfill. similar to the one shownin diagram 1 below, can leak out and contaminate groundwater. Does your community have a local landfill?

1. NO
2. YES
3. DONT KNOW

DIAGRAM 1



Solid Rock Layer

initials: ____

When-rainwater seeps through garbage and waste. It dissolves some of the chemicals in the discarded trash. Gradually, this material. which la sometimes toxic. can seep tnto the water table and contaminate the water below, as A shows in diagram 1.

Q-10 Do YOU know if the water under your local landfill is contaminated?

1. NO
2. YES
3. NO-- WE DONT HAVE A LANDFILL
4. DONT KNOW

Once contaminants reach the water table, they spread very slowly underground in the direction water is flowing (see Bin diagram 1). Many people are surprised to learn that the flow la very very slow; usually less than 100 feet per year. After many years, the landfill may eventually contaminate water drawn by a well (see C in diagram 1) which supplies water to the citizens of the community.

Q-11 Does your community currently draw water from wells which are in danger of becoming contaminated?

1. NO
2. YES
3. DON'T KNOW

Because groundwater moves very slowly, the area contaminated by a specific source is usually small, on the order of a square mile or two. Larger areas may be contaminated only if there are multiple sources or if the source is a widespread land-use practice such as agricultural application of fertilizer or pesticides.

Q-12 Are you aware of anyspecific contaminants that are in groundwater that is currently used in your home or by people in your community?

1. NO
2, YES --IN MY HOME
   (Please identify contaminant(s): ____________________)
3. YES --IN MY COMMUNITY
   (Please identify contaminant(s): ____________________)

Q-13 Are you aware of any specific instances of groundwater tn your community that is no longer used because it is contaminated?

1. NO
2. YES (Please explain briefly)____________________________________

____

Q-14 Have your familuy or people in your community ever been bothered by any health problems which you believe have been caused or aggravated by groundwater contamination?

1. NO
2. YES -- MYSELF OR MY FAMILY
   (Please identify problem(s): ____________________)
3. YES -- PEOPLE IN MY COMMUNITY
   (Please identify problem(s): ____________________)

Initials: ____

Q-15 Who is the primary water supplier for the water you currently use in your home?

1. THE CITY OR COUNTY
2. A PRIVATE WATER SUPPLIER
3. OUR PRIVATE WELL -- SKIP TO QUESTION Q-22
4. OTHER (Pease specify) ____________________
5. DONT KNOW

Q-16 Has your community imposed voluntary or mandatory water use restrictions since you've lived there?

1. NO
2. YES -- VOLUNTARY
3. YES -- MANDATORY
4. DONT KNOW

Q-17 Does your household pay a water company or other supplier directly for the water used in your home?

1. NO → PLEASE GO TO QUESTION Q-21
2. YES ↓

Q-18 Are you the person who actually pays your households water bill?

1. NO
2. YES

Q-19 How frequently are you billed?

1. MONTHLY
2. QUARTERLY
3. ANNUALLY
4. OTHER (please specify) ____________________

Q-20 About how much is your average monthly water bill?

DURING THE SUMMER? $__________
DURING THE WINTER? $__________

PLEASE GO TO Q-22

Q-21 How much would you estimate the average household monthly water bill is in your community for people using the public water supply system?

$ ______________

Q-22 Does your household normally use bottled water, trucked-in water, a water purifier, or any other specially treated water for drinking or cooking?

1. NO
2. YES

Initials: _____

IV. OPTION 1: BUYING WATER FROM ANOTHER CITY

Now you will begin to evaluate several responses a city might take instead of COMPLETE GROUNDWATER TREATMENT. For each of these evaluations the situation is identical except for the response option chosen by the city. That is. once again you should imagine that your city currently gets 50% of its water from streams and lakes and 50% d its water from groundwater. You have been getting all of your water from this public water supply. It is discovered that over the years tocix chemicals from the municipal landfill have been slowly leaking into the water table and the city's groundwater supply is now contaminated. The contamination has been occurring for a number of years and is the result of standard landfill practices. The area of contamination la about 2 square miles and la away from residential areas.

The level of risk is also the same as before: scientists believe that drinking the contaminated water increases the risk of cancer. They have estimated the level of risk to be about 10 additional deaths per million people who drink the water per year. You should note. however, that this is about the same level of risk a typical person has of developing cancer from exposure to medical x-rays (see f in diagram 2).

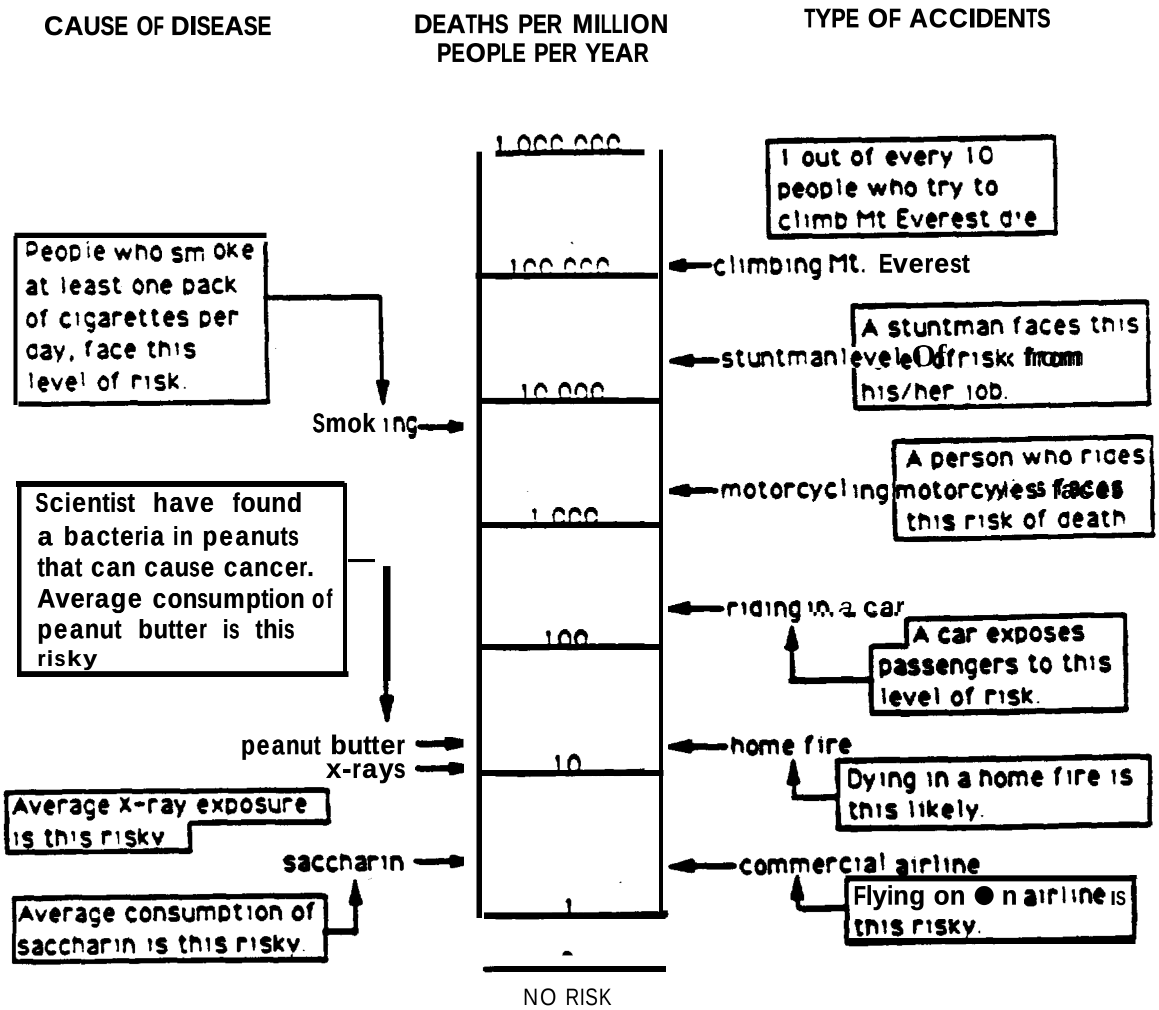


DIAGRAM 2

Just as before, the city government decides that, due to the contamination. the groundwater cannot be used as it is. Further, your city's reservoirs that depend on surface water have only a 50-50 chance of reliably making up the shortfall caused by the groundwater contamination. Thus, although the water supplied to you will remain safe, there is a 50-S0 chance of a 50% shortfall in your community's water supply next year.

Q-23 In the circumstances described above. if your city called for mandatory water restrictions limiting water use to 50% of what you use. by what amount do you think you would: (circle percentage)

1)	**Water your lawn less?**	**0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100**
2)	**Wash your car less?**	**0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100**
3)	**Cut back on water used in cooking, cleaning, and drinking?**	**0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100**

Suppose that rather than COMPLETE GROUNDWATER TREATMENT. your city instead proposes to accept a proposal from a nearby city. which has offered to sell enough of their surplus water to make up your city's potential shortfall for one year. This guarantees that the 50-50 chance of a shortage is eliminated. A referendum is proposed to the votera of your city which calls for a one year increase in local water bills to pay the nearby city for the water. Your city would have to pay the nearby city for the water and would also have to pay for the construction of a pipeline to transport the water. You would have to pay the increased water bill whether or not the 50% shortfall occurred next year.

The money generated through this surcharge could only be used to pay for the water bought for your city for next year. If the referendum is passed, everyone would pay the higher rate in order to fund the proposed water purchase. It is important to note that the surcharge would be canceled at the end of the year. However, another solution would need to be found after that. ***At the moment we don't know how much U would cost to buy the water from the nearby city and build the pipeline, so we need to find out how much it is worth to people.***

initials: ____

Q-24 Would you consider voting for a referendum to support a one-year water bill increase which would go to pay for the water bought to make up the possible 50% shortfall due to the groundwater contamination for the next year?

1. No → **Why?**

2 *YES* ↓

Q-25 What is the most your household would be willing to pay EACH MONTH on top of your current water bill for the next year before you would vote NO on BUYING WATER FROM ANOTHER CITY?
(Circle the best response.)

$.50	$1.50	$4	$10	$30	$75	$200	$500	
$.75	$2	$6	$15	$40	$100	$300	MORE THAN $500	
$1	$3	$8	$20	$50	$150	$400	DONT KNOW	

The amount youindicate will tell US What it is really worth to your household if the needed water actually cost less than people are willing to pay, you would only have to pay what it would cost. If the water turned out to cost more than people are willing to pay, the purchase would not be carried out.

V. OPTION 2 IN-HOME WATER PURIFICATION

Now think back on the situation described above and imagine that your city can no longer buy water from a nearby community to make up its shortfall. ?'list is, either you suffer a shortage or your water supply becomes contaminated and you and/or your community must clean up the water before it is used. There are a range of options which you and your community can undertake to deal wtth the problem. Some protect you and your family right now. Others protect you and future generations by cleaning up the contamination.

Some of the options are private rather than public options. For example, you could install an in-home water purification system. This system Is attached to your incoming water pipe. Water coming into your home la run through a charcoal filter which removes the harmful contaminants. That Is. all the water used in your home is made free of contamination. The system, whick must be installed by a plumber, costs $180.00, but requires occasional maintenance and charcoal replacement. which costs $300.00 per year.

initials: _____

Q-26 How satisfied are you that IN-HOME WATER PURIFICATION would protect your family from groundwater contamination?

NOT SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	?

Q-27 Would you be willing to pay to have IN-HOME WATER PURIFICATION installed in your home. or would you prefer to accept the consequences of the 50-50 chance of a S096 water shortage?

1. PREFER TO PAY FOR IN-HOME WATER PURIFICATION
2. PREFER TO ACCEPT WATER SHORTAGE

VI. OPTION 3: CREATING A FUND FOR FUTURE USE

Suppose that in addition to any private options you take, such as in-home water purification, a group of concerned citizens has decided to set up a fund which would be used in the future to deal with the groundwater contamination. This fund would be set up in a bank account paying 10% interest compounded annually at a very reliable financial institution which is federally insured. It is proposed that local water bills could be increased and the money put into this new fund to pay for groundwater contamination solutions in the future. That is. the funds could be used by future generations to deal with contaminated groundwater any way they wish. The fund would function like a regular savings account. That is, if one dollar were put into the fund today, in fifty years it would be worth $117.36, adjusting for inflation.

Q-28 How satisfied are you that CREATING A FUND FOR FUTURE USE would protect future generations from groundwater contamination?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Q-29 How fair do you believe CREATING A FUND FOR FUTURE USE is to future generations?

NOT AT ALL FAIR						EXTREMELY FAIR
1	2	3	4	5	6	7

imagine that a referendum for an increase in your water bill is proposed. The money raised from this increase will go into a fund that future generations may use to solve groundwater contamination problems. This is on top of any private measures you have taken such as IN-HOME WATER PURIFICATION. If the referendum is passed, *everyone* would be paying higher monthly water bills. The money would be used only for SETTING UP A FUND FOR FUTURE USE to solve groundwater contamination problems and no other purpose. *At the moment we don't know what it will cost in the future to solve groundwater problems, so we need to find out how much it is worth to people today.*

Initials: ____

Q-30 Would you consider voting for a referendum which would require you to pay higher monthly water bills to CREATE A FUND FOR FUTURE USE *if this fund could be guaranteed?*

1. No → **Why?** ____

2. YES ↓

Q-31 What is the most your household is willing to pay EACH MONTH on top of your current water bill before you would vote NO on SETTING UP A FUND FOR FUTURE USE? (Circle the best response.)

$.50	$1.50	$4	$10	$30	$75	$200	$500	
$.75	$2	$5	$15	$40	$100	$300	MORETHAN $500	
$1	$3	$8	$20	$50	$150	$400	DONT KNOW	

The amount you indicate will tell us what it is really worth to your household to set up this find for future use.

VII. OPTION 4 WATER SUPPLY TREATMENT

Suppose that instead of the previous options, your city proposes to build and maintain a water supply treatment facility to clean up the contaminated groundwater. The water at the contaminated groundwater site is pumped up from the water table as it is needed and cleaned by charcoal filters, which trap the contaminantts. before it 1s put in the public water supply. This cleaned water is then distributed through the water system to people's homes. Scientists are satisfied with the quality of drinking water in areas where these methods have been used. This option guarantees that the 50-50 chance of a 50% shortage caused by groundwater contamination is eliminated. However, although the water throughout the public water system would be safe, the groundwater in your city would remain contaminated, and people in the future would have to pay for the operation of the treatment system.

Q-32 How satisfied are you that BUILDING A WATER SUPPLY TREATMENT FACILITY would protect your family from groundwater contamination?

NOT AT ALL SATISFIED ... EXTREMELY SATISFIED

1 2 3 4 5 6 7

Initials: ____

Q-33 How satisfied are you that BUILDING A WATER SUPPLY TREATMENT FACILITY would protect future generations from groundwater contamination?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Q-34 HOW fair do you believe BUILDING A WATER SUPPLY TREATMENT FACILITY is to future generations.?

NOT AT ALL FAIR						EXTREMELY FAIR
1	2	3	4	5	6	7

Imagine that a referendum is proposed to the voters of your city which calls for an increase in local water bills to pay for the cost of building, operating, and maintaining a water supply treatment facility. The money generated could be used only to pay for the treatment facility. If the referendum is passed, everyone would pay the higher rate in order to fund the proposed facility. It is important to note that this increase would continue indefinitely tnto the future. ***At the moment we don't know what the water supply treatment facility will cost so we need to find out how much it is worth to people.***

Q-35 Would you consider voting for a referendum to support a permanent water bill increase shich would go to building, operating. and maintaining a water supply treatment facility to make up the potential 50% shortfall due to groundwater contamination. ***If the water supply treatment could & guaranteed?***

1. No → **Why?**

2. YES ↓

Q-36 What is the most your household would be willing to pay EACH MONTH on top of your current water bill before you would vote NO on WATER SUPPLY TREATMENT? (Circle the best response.)

$.50	$1.50	$4	$10	$30	$75	$200	$500	
$.75	$2	$5	$15	$40	$100	$300	MORE THAN $500	
$1	$3	$8	$20	$50	$150	$400	DONT KNOW	

The amount you indicate will tell us what U is really worth to your household to get this program If the needed facility actually cost less than people are willing to pay, you would only have to pay what it would cost. If the facility -Out to cost more than people are willing to pay, it would not be built.

Initials: _____

VIII. FINAL EVALUATION OF COMPLETE GROUNDWATER TREATMENT

Now that you have evaluated several other options and considered new information about groundwater and water use issues, we would like you to reevaluate the COMPLETE GROUNDWATER TREATMENT option. That is, below is presented the identical scenario which you valued in Section II. We would like you to read through the scenario again and answer the valuation question again in light of the information you have read and the answers you have given since the flint evaluation. You may decide to give the same answer as before or a different answer. It is entirely up to you.

Suppose that your city proposes to pay for a complete groundwater treatment operation to remove all of the contamination in the groundwater right now, leaving no contamination for the future. All of the water at the contaminated groundwater site would be pumped up from the water table as soon as possible and cleaned by charcoal filters, which trap the contaminants. This cleaned water would then be reinfected back into the water table and stored there for future use. once the possibility of future recontamination has been removed. This would be done by digging up all of the contaminated soil under the landfill and placing it. as well as all of the material in the old landfill. into a new landfill with a sealed bottom liner and a waterproof cover on the top.

Scientists are satisfied with the quality of drinking water in areas where these methods have been used. This option guarantees that the 50-50 chance of a 50% shortage caused by groundwater contamination is eliminated. In addition, contaminated water would never enter the public water supply and the groundwater in your city would no longer be contaminated and would be available for future use.

Q-37 How satisfied arc you that COMPLETE GROUNDWATER TREATMENT would protect your family from groundwater contamination?

NOT AT ALL SATISFIED — EXTREMELY SATISFIED

1 2 3 4 5 6 7

Q-36 How satisfied are you that COMPLETE GROUNDWATER TREATMENT would protect future generations from groundwater

NOT AT ALL SATISFIED — EXTREMELY SATISFIED

1 2 3 4 5 6 7

Q-39 How fair do you believe COMPLETE GROUNDWATER TREATMENT is to future generations?

NOT AT ALL FAIR — EXTREMELY FAIR

1 2 3 4 5 6 7

Initials: _____

A referendum is proposed to the voters of your city which calls for an increase in local water bills to pay for the costs of pumping up and cleaning the contaminated water and constructing the new landfill. The money generated could be used only to pay for the groundwater treatment program. If the referendum is passed, everyone would pay the higher rate in order to fund the treatment project. It is important to note that this increase would continue indefinitely into the future until the project is finished. ***At the moment we don't know what the complete groundwater treatment program will cost, so we need to find out how much it is worth to people.***

Q-40 Would you consider voting for a referendum to support a permanent water bill increase which would go to funding a complete groundwater treatment operation to makeup the potential 50% shortfall due to groundwater contamination ***if the groundwater treatment could be guaranteed?***

1. No ⟶ **Why?**

2. YES ↓

Q-41 What is the most your household would be willing to pay EACH MONTH on top of your current water bill before you would vote NO on COMPLETE GROUNDWATER TREATMENT (Circle the best number.)

$.50	$1.50	$4	$10		$30	$75	$200	$500
$.75	$2	$5	$15	$40	$100	$300	MORE THAN $500	
$1	$3	$8	$20	$50	$150	$400	DONT KNOW	

The amount youindicate will tell us what it is really worth to your household to get this program If the needed groundwater treatment actually cost less than people are willing to pay, you would only have to pay what it would cost. If the groundwater treatment turned out to cost more than people are willing to pay, it would not done.

Q-42 About what percentage of your answer to Q-41 did you include because of concern for: (please state a percentage from 0% to 100% for each category)

You and your family? --------- %

Future generations? --------- %

Not allowing contaminants to remain in the groundwater independent of any present or future use? --------- %

Other reasons? --------- %
(please specify: ______________)

TOTAL = 100%

Initials: _____

There are many tax programs that could be used to fund the COMPLETE GROUNDWATER TREATMENT program. Suppose that instead of the permanent increase in monthly water bills, the only way to fund the COMPLETE GROUNDWATER TREATMENT program would be to have a one-time increase in water bills. There would be no additional water bill increases after the one-time payment: your water bill would go back to its original level the next month. This one-time increase would have to cover the entire cost of the treatment program. AU other details of the scenario are identical except for the one-time nature of the payment.

Q-43 Again, assume that the groundwater treatment could be guaranteed. Would you consider voting for a referendum to support a one-time Increase in water bills which would go to funding a COMPLETE GROUNDWATER TREATMENT operation to make up the potential 50% shortfall due to groundwater contamination?

1. No → Why?

2. YES ↓

Q-44 What is the most your household would be willing to pay in a one-time water bill increase before you would vote NO on COMPLETE GROUNDWATER TREATMENT? (Circle the best response.)

$1	$5	$15	$40	$100	$300	$2000	$5000	
$2	$s	$20	$50	$150	$500	$3000	MORE THAN $5000	
$3	$10	$30	$75	$200	$1000	$4000	DONT KNOW	

The amount you indicate will tell us what it is really worth to your household to get this program If the needed groundwater treatment actually cost less than people are willing to pay, you would only have to pay what it would cost. If the groundwater treatment turned out to cost more than people are willing to pay, it it would not be done.

(NOTE: If You answered "NO to both questions Q-40 and Q-43, go to question Q-48. Otherwise, continue wtth question *Q-45.)*

Q-45 Does the permanent monthly payment or the one-time payment better reflect your households value for COMPLETE GROUNDWATER TREATMENT?

1. THE PERMANENT MONTHLY PAYMENT
2. THE ONE-TIME PAYMENT
3. THE MONTHLY AND ONE-TIME PAYMENT'S ARE ABOUT THE SAME
4. ANOTHER PAYMENT 1S BETTER ($ ________ PER ________)

initials: ____

Q-46 In questions Q-41 and Q-44 you were asked to state the dollar amounts you would be willing to pay for COMPLETE GROUNDWATER TREATMENT. Would you say that the dollar amounts you stated were

1. JUST FOR THESTATED GROUNDWATER PROGRAM (GO TO Q-48)
2. SOMEWHAT FOR THE GROUNDWATER REFERENDUM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES
3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES
4. OTHER (Please specify) ____________________

Q-47 About what percent of your dollar amount was just for the stated groundwater program?

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Q-46 Now suppose that instead ofjust evaluating a single option, you have the opportunity to choose whichever option you prefer. Please rank the different options below in order from most preferred (= 1) to least preferred (=6). Please give each option a rank

	Rank
NO WATER PROJECTS AT ALL -- ACCEPT SHORTAGE	----
BUY WATER FROM A NEARBY CITY	----
INSTALL IN-HOME WATER PURIFICATION SYSTEM	----
CREATE A FUND FOR FUTURE USE	----
WATER SUPPLY TREATMENT	----
COMPLETE GROUNDWATER TREATMENT	----

Initials: ____

IX. YOUR FINAL OPINIONS AND EVALUATION

Please look back to question 9-7, your preliminary monthly value for COMPLETE GROUNDWATER TREATMENT. and record your answer here: $____________ .

Now record here your answer to question Q-4?. your final monthly value for COMPLETE GROUNDWATER TREATMENT: $ ____________ .

We are interested in the reasons why your preliminary and final values mayor may not differ. Therefore. If your final value Is different from your preliminary value, please take a few minutes to describe in your own words why you decided to change your preliminary value. If your final value is the same as your preliminary value. please take a few minutes to describe in your own words why your value did not change.

____

____

____

____

____

____

____

initials: ____

Now we are going to ask you to look back to some of the specific questions you have answered and tell us whether or not they made a difference in your final evaluation.

Q-49 Questions Q-8 to Q-14 asked you about groundwater use in your own community and any specific contamination or health problems you know about. Did thinking about your local landfill and local groundwater situation lead you to change your preliminary value?

1. NO -NO CHANGE FOR THIS REASON
2. YES-I LOWERED MY VALUE FOR THIS REASON
3. YES -- I RAISED MY VALUE FOR THIS REASON

Why or why not?

Q-50 Before Q-8 you were told what groundwater is. where it comes from, and how it is extracted for human use. Did reading this information lead you to change your preliminary value?

1. NO -NO CHANGE FOR THIS REASON
2. YES -1 LOWERED MYVALUE FOR THIS REASON
3. YES --1 RAISED MY VALUE FOR THIS REASON

Why or why not?

Q-51 After Q- 10 you were told that groundwater in fact moves very, very slowly: usually less than 100 feet per year. Did learning this information lead you to change your preliminary value?

1. NO -NO CHANGE FOR THIS REASON
2. YES -I LOWERED MYVALUE FORTHIS REASON
3. YES --I RAISED MYVALUE FOR THIS REASON

Why or why not?

.   **Initials: _____**

Q-52 Questions Q-17 to Q-21 asked for specific information about your current water bill. Did thinking about your current water bill lead *you* to change your preliminary value?

1. NO - NO CHANGE FOR THIS REASON
2. YES - I LOWERED MY VALUE FOR THIS REASON
3. YES -- I RAISED MY VALUE FOR THIS REASON

Why or why not?

Q-53 Section IV asked you to evaluate a plan in which the city would buy water from another ctty to make up the potential shortfall due to groundwater cent-aUon. Did the possibility of getting water from another source cause you to change your preliminary value?

1. NO -NO CHANGE FOR THIS REASON
2. YES -1 LOWERED MYVALUE FORTHIS REASON
3. YES -- I RAISED MY VALUE FOR THIS REASON

Why or why not?

Q-54 Question Q-23 asked you to think about what you would do if your city imposed mandatory water use restrictions. Did the possibility of conserving water so that less of the contaminated groundwater would have to be replaced cause you to change your preliminary value?

1. NO -NO CHANGE FOR THIS REASON
2. YES -I LOWERED MY VALUE FOR THIS REASON
3. YES --I RAISED MY VALUE FOR THIS REASON

Why or why not?

Q-55 Section V brought up the possibility of private options for cleaning the contaminated water. Did learning about these private options cause you to change your preliminary value?

1. NO - NO CHANGE FOR THIS REASON
2. YES - I LOWERED MY VALUE FOR THIS REASON
3. YES -- I RAISED MY VALUE FOR THIS REASON

Why or why not?

Initials: _____

Q-56 Before Question Q-28 you read that one dollar put into a bank account today would be worth $117.36 in fifty years. Did learning that your payments could be earning interest and increasing in value over the years cause you to lower your preliminary value?

1. NO -NO CHANGE FORTHIS REASON
2. YES- I LOWERED MY VALUE FOR THIS REASON
3. YES -- I RAISED MY VALUE FOR THIS REASON

Why or why not?

Q-57 Section VII presented the option of water supply treatment. which would clean the contaminated water as is is needed rather than cleaning it up all at once. Did thinking about this option cause you tho change your preliminary value?

1. NO -NO CHANGE FOR THIS REASON
2. YES - I LOWERED MY VALUE FOR THIS REASON
3. YES -- I RAISED MY VALUE FOR THIS REASON

Why or why not?

Q-58 Diagram 2 presented a 'risk ladder' which compared the rtsk of drinking the contaminated groundwater wtth several other risks. Did learning about these risk comparisons cause you to change your preliminary value?

1. NO -NO CHANGE FOR THIS REASON
2. YES - I LOWERED MY VALUE FOR THIS REASON
3. YES -- I RAWED MY VALUE FOR THIS REASON

Why or why not?

Q-59 Did going through the information and response options in the surveys make you any more or less optimistic about our ability to deal with groundwater contamination problems now and in the future?

1. NO - MADE NO DIFFERENCE
2. YES -- MADE ME MORE OPTIMISTIC
3. YES -- MADE ME LESS OPTIMISTIC

(NOTE: If your preliminary and final values were Identical, please STOP and wait for the next survey section. Otherwise, continue with question Q-60.)

Initials: ,_

Q-60 Are there any other factors we may have overlooked which contributed to a difference between your preliminary and final values?

1. NO
2. YES

IF YES: Please describe briefly ______________________________

Q-61 Which value do you think best represents your true monthly value for the COMPLETE GROUNDWATER TREATMENT program:

1. MY PRELIMINARY VALUE
2. MY FINAL VALUE
3. AN INTERMEDIATE OR OTHER VALUE: $ ________ PER MONTH

Q-62 Which value would you like government policymakers to use to make decisions about how much people value groundwater protection?

1. MY PRELIMINARY VALUE
2. MY FINAL VALUE
3. AN INTERMEDIATE OR OTHER VALUE: $ ________ PER MONTH

Initials: _____

X. ABOUT YOU

Finally, we would like to ask you a few questions about yourself.

Q-63 Your sex:

1. FEMALE
2. MALE

Q-64 Your age: __________ YEARS

Q-65 Including yourself, how many members in your household arc in each age group? (If none. write "0")

_ UNDER 18 YEARS OF AGE
_ 18-64
_ 65 AND OVER

Q-66 How much formal education have you completed? (circle number)

1. NO FORMAL EDUCATION
2. SOME GRADE SCHOOL
3. COMPLETED GRADE SCHOOL
4. SOME HIGH SCHOOL
5. COMPLETED HIGH SCHOOL
6. TRADE SCHOOL
7. SOME COLLEGE
8. COMPLETEDCOLLEGE
9. SOME GRADUATE WORK
10. ADVANCED COLLEGE DEGREE

Q-67 In the pasta. has your household submitted any of the following materials for recycling? (circle all that apply)

1. NEWSPAPER
2. GLASS
3. ALUMINUM OR OTHER METALS
4. PLASTIC
5. OTHER (please specify) ______________________________

Q-68 In the past year. have you held membership or donated time or money to any environmental organizations or groups (such as Greenpeace or the Sierra Club)?

1. NO
2. YES -- ONE GROUP
3. YES-TWO OR THREE GROUPS
4. YES - MORE THAN THREE GROUPS

Q-69 How would you describe your racial or ethnic background? (circle one)

1. WHITE OR CAUCASIAN
2. BLACK OR AFRICAN AMERICAN
3. HISPANIC OR MEXICAN AMERICAN
4. ASIAN OR PACIFIC ISLANDER
5. NATIVE AMERICAN INDIAN
6. OTHER (please specify) ____________________

Initials: ____

Q-70 What is your total annual household income before taxes and other deductions? (circle one)

1. UNDER $9,999
2. $10,000 -19,999
3. $20,000 - 29,999
4. $30,000 -39,999
5. $40,000 - 49,999
6. $50,000 -59,999
7. $60,000 -69,999
8. $70,000 -79.999
9. $80,000 -89,999
10. $90,000 -99,999
11. $100,000 -119,999
12. $120,000 -139,999
13. $140,000 -159.999
14. $160,000 -179,000
15. $180,000 -199,999
16. $200,000 and OVER

IS there anything we have overlooked? Please use the space below to write any comments or suggestions you may have about the survey. We will also be happy to answer any questions you may have about the survey or our research when everyone has finished.

APPENDIX B

SURVEY INSTRUMENT FOR DECEMBER 1990 PRETEST

Initials: _____

I. THE ISSUES

We are interested in your opinion about water use and potential groundwater contamination. We need your answers to these quest.ions to help make decisions about future groundwater programs.

Q-1 Have you read *or* heard anything about groundwater being contaminated somewhere in your state or somewhere in your own county, city, or community? (circle one)

1) NO
2) YES -- IN MY STATE
3) YES -- IN MY COUNTY, CITY, OR COMMUNITY
4) DONT KNow

Q-2 Have you read or heard about instances of groundwater contamination in your county, city, or community coming from any of these specific sources? [Circle all that apply)

1. NO -- HAVENT HEARD
2. YES -- BUT CANT RECALL SPECIFIC SOURCE
3. YES -- SUPERFUND OR OTHER TOXIC ORHAZARDOUS WASTE SITE
4. YES --A PUBLIC LANDFILL
5. YES -- AGRICULTURAL APPLICATION OF PESTICIDES OR FERTILIZERS
6. YES -- SEPTIC TANKS
7. YES -- LEAKY UNDERGROUND STORAGE TANKS ORLAGOONS
8. YES --A CHEMICAL SPIIL
9. YES -- OTHER (please specify) ______________________________

Q-3 How much do you agree or disagree with the following statement: "We should protect groundwater at all costs."

Strongly Disagree						Strongly Agree
1	2	3	4	5	6	7

initials: ____

II. WATER USE IN YOUR COMMUNITYfAND YOUR HOME

Water for residential use can come from many differnt sources. including surface sources such as reservoirs or lakes and groundwater sources. Groundwater comes from precipitation that falls on the land surface and seeps underground. At some depth underground the soil or rock becomes saturated with water. Groundwater is extracted for human use by digging wells or taking water from naturally occurring springs.

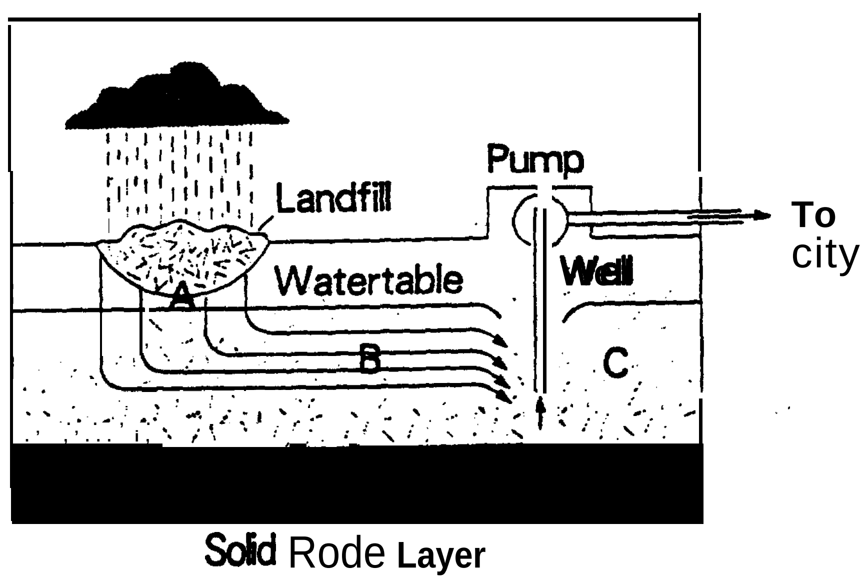
Q-4 **Do you or people in your city or community get any part of your water for home use from groundwatcr?**

1. NO -WE DONT USE GROUNDWATER
2. YES -- I USE GROUNDWATER IN MY HOME
3. YES - SOME PEOPLE IN MY COMMUNITY USE GROUNDWATER BUT I DONT
4. DONT KNOW

Q-5 **Often, garbage and waste placed in a community's landfill, similar to the one shown in diagram 1 below, can leak out and contaminate groundwater. Does your community have a local landfill?**

1. NO
2. YES
3. DONT KNOW

DIAGRAM 1



Initials: _____

When rainwater seeps through garbage and waste, it dissolves some of the chemicals in the discarded trash. Gradually, this material, which is sometimes toxic. can seep into the water table and contaminate the water below. as A shows in diagram 1.

Q-6 Do you know if the water under your local landfill is contaminated?

L NO
2. YES
3. NO -- WE DONT HAVE A LANDFILL
4. DONT KNOW

Once contaminants reach the water table, they spread very slowly underground in the direction water is flowing (see B in diagram 1). Many people are surprised to learn that the flow is very very slow usually less than 100 feet per year. After many years. the landfill may eventually contaminate water drawn by a well (see C in diagram 1) which supplies water to the citizens of the community.

Q-7 Does your community currently draw water from wells which are in danger of becoming contaminated?

1. NO
2. YES
3. DONT KNOW

Because groundwater moves very slowly, the area contaminated by a specific source is usually small, on the order of a square mile or two. Larger areas may be contaminated only if there are multiple sources or if the source is a widespread land-use practice such as agricultural application of fertilizer or pesticides.

Q-8 Are you aware of any specific contaminants that are in groundwater that is currently used in your home or by people in your community?

1. NO
2. YES-- IN MY HOME
   (Please identify contaminant(s): __________________)
3. YES --IN MY COMMUNITY
   (Please identify contaminant(s): __________________)

Q-9 Are you aware of any specific instances of groundwater in your community that is no longer used because it is contaminated?

1. NO
2. YES (Please explain briefly)______________________________________

____

Q-10 Have your family or people in your community ever been bothered by any health problems which you believe have been caused or aggravated by groundwater contamination?

1. NO
2. YES -- MYSELF OR MY FAMILY
   (Please identify problem(s): __________________)
3. YES -- PEOPLE IN MY COMMUNITY
   (Please identify problem(s): __________________)

Initials: _____

Q-11 Who is the primary water supplier for the water you currently use in your home?

1. THE CITY OR COUNTY
2. A PRIVATE WATER SUPPLIER
3. OUR PRIVATE WELL -- SKIP TO QUESTION 9-22
4. OTHER (Please specify) ______________________
5. DONT KNOW

Q-12 Has your community imposed voluntary or mandatory water use restrictions since you've lived there?

1. NO
2. YES -- VOLUNTARY
3. YES -- MANDATORY
4. DONT KNOW

Q-13 Does your household pay a water company or other supplier directly for the water used in your home?

1. No → PLEASE GO TO QUESTION Q-17
2. YES ↓

Q-14 Are you the person who actually pays your household's water bill?

1. NO
2. YES

Q-15 How frequently are you billed?

1. MONTHLY
2. QUARTERLY
3. ANNUALLY
4. OTHER (please specify) ______________________

Q-16 About how much is your average monthly water bill?

DURING THE SUMMER? $__________
DURING THE WINTER? $__________

PLEASE GO TO Q-18

Q-17 How much would you estimate the average household monthly water bill is in your community for people using the public water supply system?

$______________

Q-18 Does your household normally use bottled water, trucked-in water. a water purifier, or any other specially treated water for drinking or cooking?

1. NO
2. YES

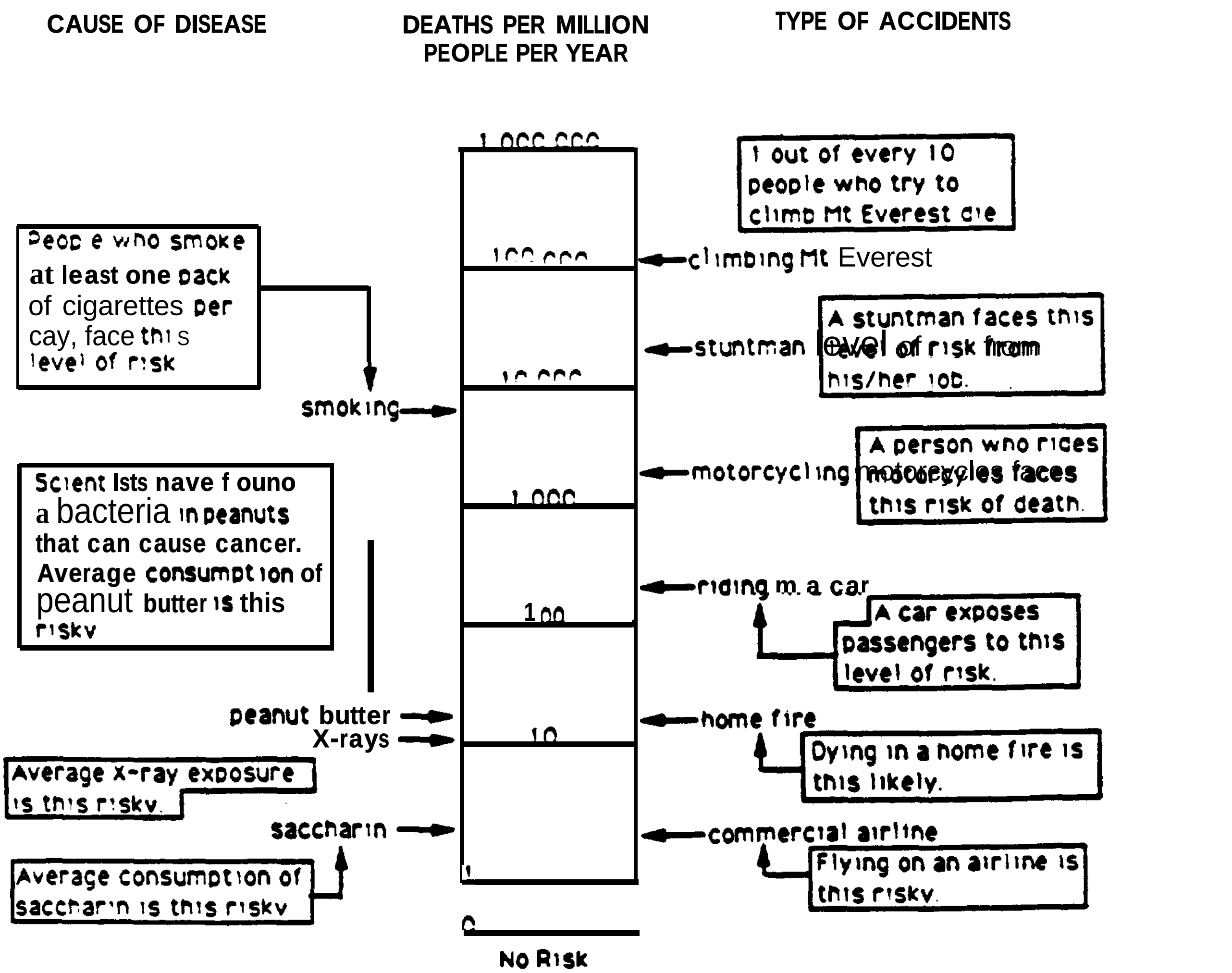
Initials: _____

III. OPTION 1: BUYING WATER FROM ANOTHER CITY

The previous sections have asked about the water and groundwater situation in your community and in your own household. Now, however, we are going to ask you to respond to some situations that are completely hypothetical. We will describe a situation in which groundwater has been contaminated and you will be asked to evaluate the potential responses that a city or community might make. The situation described may differ considerably from your current water use situation and from the groundwater situation in your community, and so we would like you to imagine that you live in the city with the groundwater problem described and respond as if you were truly facing this situation.

Imagine your city currently gets 50% of its water from streams and lakes and 50% of its water from groundwater. Now, suppose it is discovered that over the years leachate from the municipal landfill has been slowly leaking into the water table and the city's groundwater supply is now contaminated with a toxic chemical. The contamination has been occurring for a number of years and is the result of standard landfill practices. The area of contamination is about 2 square miles and is away from residential areas.

Scientists believe that drinking the contaminated water increases the risk of cancer. They have estimated the level of risk to be about 10 additional deaths per million people who drink the water per year. This is about the same level of risk a typical person has of developing cancer from exposure to medical x-rays (see diagram 2).



Initials: _____

Q-19 How accurately do you believe scientists can estimate the health risk posed by toxic chemicals?

NOT AT ALL ACCURATELY						EXTREMELY ACCURATELY
1	2	3	4	5	6	7

The city government decides that, due to the contamination, the groundwater cannot be used as it is. Further, your city's reservoirs that depend on surface water have only a 50-50 chance of reliably making up the shortfall caused by the groundwater contamination. Thus. although the water supplied to you will remain safe, there is a 50-50 chance of a 50% shortfall in your community's water supply next year.

Q-20 Do you agree or disagree with the city's decision to prohibit use of the groundwater, given the level of health risk estimated by scientists?

1. AGREE
2. DISAGREE
3. NOT SURE

Q-21 *In* the circumstances described above. If your city called for mandatory water restrictions limit ing water use to 50% of what you use. by what amount do you think you would: (circle percentage)

1)	Water your lawn less?	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	10
2)	Wash your car less?	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	10
3)	Cut back on water used in cooking, cleaning. and drinking?	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	10

Suppose that your city proposes to accept a proposal from a nearby city,which has offered to sell enough of their surplus water to make up your city's potential shortfall for one year. This guarantees that the 50-50 chance of a shortage is eliminated. A referendum is proposed to the voters of your city which calls for a one year increase in local water bills to pay the nearby city for the water. Your city would have to pay the nearby city for the water and would also have to pay for the construction of a pipeltne to transport the water. You would have to pay the increased water bill whether or not the 50% shortfall occurred next year.

The money generated through this surcharge could only be used to pay for the water bought for you; city for next year. If the referendum is passed. everyone would pay the higher rate in order to fund the proposed water purchase. It is important to note that the surcharge would be canceled at the end of the year. However, another solution would need to be found after that. *At the moment we don't know how much it would cost to buy the water from the nearby city and build the pipeline, so we need to find out how much it is worth to people.*

Initials: ____

Q-22 Would you consider voting for a referendum to support a one-year water bill increase which would go to pay for the water bought to make up the possible 50% shortfall due to the groundwater contamination for the next year?

1. No → **Why?**

2. YES ↓

Q-23 What is the most your household would be willing to pay EACH MONTH on top of your current water bill for the nat year before you would vote NO on BUYING WATER FROM ANOTHER CITY?
(Circle the best response.)

$.50	$1.50	$4	$10	$30	$75	$200	$500		
*.75	$2	$5	$15	$40	$100	$300	MORE THAN $500		
$1	$3	$8	$20	$50	$150	$400	DONT KNOW		

The amount you indicate will tell us what it is really worth to your household. If the needed water actually cost less than people are willing to pay, you would only have to pay what it would cost. If the water turned out to cost more than people are willing to pay. the purchase would not be carried out.

IV. OPTION 2 IN-HOME WATER PURIFICATION

Now think back on the situation described above and imagine that your city can no longer buy water from a nearby community to make up its shortfall. That is. either you suffer a shortage *or* your water supply becomes contaminated and you and/or your community must clean up the water before It is used. There are a range of options which you and your community can undertake to deal with the problcm. Some protect you and your family right now. Others protect you and future generations by cleaning up the contamination.

Some of the options are private rather than public options. For example, you could install an in-home water purification system. This system is attached to your incoming water pipe. Water coming into your home is run through a charcoal filter which removes the harmful contaminants. That is. all the water used in your home is made free of contamination. The system, which must be installed by a plumber. costs $180.00, but requires occasional maintenance and charcoal replacement, which costs $300.(X) per year.

Initials: _____

Q-24 How satisfied are you that IN-HOME WATER PURIFICATION would protect your family from groundwater contamination?

NOT SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Q-25 Would you be willing to pay to have IN-HOME WATER PURIFICATION installed in your home. or would you prefer to accept the consequences of the 50-50 chance of a 50% water shortage?

1. PREFER TO PAY FOR IN-HOME WATER PURIFICATION
2. PREFER TO ACCEPT WATER SHORTAGE

V. OPTION 3: CREATING A FUND FOR FUTURE USE

Suppose that in addition to any private options you take, such as in-home water purification. a group of concerned citizens has decided to set up a fund which would be used in the future to deal with the groundwater contamination. This fund would be set up In a bank account paying 10% interest compounded annually at a very reliable financial institution which is federally insured. It ts proposed that local water bills could be increased and the money put into this new fund to pay for groundwater contamination solutions in the future. That is. the funds could be used by future generations to deal with contaminated groundwater any way they wish. The fund would function like a regular savings account. That is. if one dollar were put into the fund today, in filly years it would be worth $117.36, adjusting for inflation.

Q-26 How satisfied are you that CREATING A FUND FOR FUTURE USE would protect future generations from groundwater contamination?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Q-27 How fair do you believe CREATING A FUND FOR FUTURE USE is to future generations?

NOT AT ALL FAIR						EXTREMELY FAIR
1	2	3	4	5	6	7

Imagine that a referendum for an increase in your water bill is proposed. The money raised from this increase will go tnto a fund that future generations may use to solve groundwater contamination problems. This is on top of any private measures you have taken such as IN-HOME WATER PURIFICATION. If the referendum is passed. everone would be paying higher monthly water bills. The money would be used@ for SETTING UP A FUND FOR FUTURE USE to solve groundwater contamination problems and no other purpose. *At the moment we don't know what it will cost in the future to solve groundwater problems, so we need to find out how much it is worth to people today.*

Initials: _____

Q-28 Would you consider voting for a referendum which would require you to pay higher monthly water bills to CREATE A FUND FOR FUTURE USE ***if this fund could be guaranteed.?***

1. No → **Why?**

2. YES ↓

Q-29 What is the most your household is willing to pay EACH MONTH on top of your current water bill before you would vote NO on SETTING UP A FUND FOR FUTURE USE? (Circle the best response.)

$.50	$1.50	$4	$10	$30	$75	$200	$500	
$.75	$2	$5	$15	$40	$100	$300	MORE THAN $500	
$1	$3	$8	$20	$50	$150	$400	DONT KNOW	

The amount you indicate sill tell us what it is really worth to your household to set up this fund for future use.

VI. OPTION 4: WATER SUPPLY TREATMENT

Suppose that instead of the previous options, your city proposes to build and maintain a water supply treatment facility to clean up the contaminated groundwater. 'The water at the contaminated groundwater site is pumped up from the water tableas it is needed and cleaned by charcoal filters, which trap the contaminant is, before it is put in the public water supply. This cleaned water is then distributed through the water system to people's homes. Scientists are satisfied with the quality of drinking water in areas where these methods have been used. This option quarantees that the 50-50 chance of a 50% shortage caused by groundwater contamination is eliminated. However, although the water throughout the public water system would be safe, the groundwater in your city would remain contaminated, and people in the future would have to pay for the operation of the treatment system.

How satisfied are you that BUILDING A WATER SUPPLY TREATMENT FACILITY would protect your faintly from groundwater contamination?

NOTAT ALL SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Initials: ____

Q-31 How satisfied are you that BUILDING A WATER SUPPLY TREATMENT FACILITY would protect future generations from groundwater contamination?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Q-32 How fair do you believe BUILDING A WATER SUPPLY TREATMENT FACILITY is to future generations?

NOT AT ALL FAIR						EXTREMELY FAIR
1	2	3	4	5	6	7

Imagine that a referendum is proposed to the voters of your city which calls for an Increase in local water bills to pay for the cost of building, operating, and maintaining a water supply treatment facility. The money generated could be used only to pay for the treatment facility. If the referendum is passed, everyone would pay the higher rate in order to fund the proposed facility. It is important to note that this increase would continue indefinitely tnto the future. ***At the moment we don't know what the water supply treatment facility will cost, so we need to find out how much it is worth to people.***

Q-33 Would you consider voting for a referendum to support a permanent water bill increase which would go to building, operating. and maintaining a water supply treatment facility to make up the potential 50% shortfall due to groundwater contamination. ***If the water supply treatment could be guaranteed.?***

1. No → **Why?** ____

2. YES ↓

Q-34 What is the most your household would be willing to pay EACH MONTH on top of your current water bill before you would vote NO on WATER SUPPLY TREATMENT? (Circle the best response.)

$.50	$1.50	$4	$10	$30	$75	$200	$500
$.75	$2	$5	$15	$40	$100	$300	MORE THAN $500
$1	$3	$8	$20	$50	$150	$400	DONT KNOW

The amount you indicated will tell us what it is really worth to your household to get this program if the needed facility actually cost less than people are willing to pay you would only have to pay what it would cost. If the facility turned out to cost more than people are willing to pay, u would not be built.

Initials: ____

VII. OPTIONS: COMPLETE GROUNDWATER TREATMENT

Suppose that instead of previous options your city proposes to pay for a complete groundwater treatment 'operation to remove all 'of 'the contamination in the groundwater right now, leaving no contamination for the future. All of the water at the contaminated groundwater site would be pumped up from the water table as soon as possible and cleaned by charcoal filters, which trap the contaminants. This cleaned water would then be reinfected back tnto the water table and stored there for future use, once the possibility of future recontamination has been removed. This would be done by digging up all of the contaminated soil under the landfill and placing It, as well as all of the material in the old landfill, into a new landfill with a sealed bottom liner and a waterproof cover on the top.

Scientists are satisfied with the quality of drinking water in areas where these methods have been used. This option quarantees that the 50-50 chance of a 50% shortage caused by groundwater contamination is eliminated. In addition, contaminated water would never enter the public water supply and the groundwater in your city would no longer be contaminated and would be available for future use.

Q-35 How satisfied are you that COMPLETE GROUNDWATER TREATMENT would protect your family from groundwater contamination?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Q-36 How satisfied are you that COMPLETE GROUNDWATER TREATMENT would protect future generations from groundwater contamination?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED
1	2	3	4	5	6	7

Q-37 How fair do you believe COMPLETE GROUNDWATER TREATMENT is to future generations?

NOTAT ALL FAIR						EXTREMELY FAIR
1	2	3	4	5	6	7

Initials: _ .

A referendum is proposed to the voters of your city which calls for an increase in local water bills to pay for the costs of pumping up and cleaning the contaminated water and constructing the new landfill. The money generated could be used only to pay for the groundwater treatment program. If the referendum is passed, everyone would pay the higher rate in order to fund the treatment project. It is important to note that this increase would continue indefinitely into the future until the project is finished. *At the moment we don't know what the completer groundwater treatment program will cost so we need to find out how much it is worth to people.*

Q-38 Would you consider voting for a referendum to support a permanent water bill increase which would go to funding a complete groundwater treatment operation to make up the potential 50% shortfall due to groundwater contamination. *if the groundwater treatment could be guaranteed 7*

1. No → Why?

2. YES ↓

Q-39 What is the most your household would be willing to pay EACH MONTH on top of your current water bill before you would vote NO on COMPLETE GROUNDWATER TREATMENT? (Circle the best number.)

$.50	$1.50	$4	$10	$30	$75	$200	$500
$.75	$2	$5	$15	$40	$100	$300	MORE THAN $500
$1	$3	$8	$20	$50	$150	$400	DONT KNOW

The amount *you indicate will tell us what it is really worth* to *your household* to *get this program If the needed groundwater treatment actually cast less than people are willing to pay, you would only have to pay what it would cost. If the groundwater treatment turned out to cost more than people are willing to pay, it would* not done.

Q-40 About what percentage of your answer to Q-39 did you Include because of concern for: (please state a percentage from 0% to 100% for each category)

You and your family? ________ %

Future generations? ________ %

Not allowing contaminants to remain in the groundwater independent of any present or future use? ________ %

Other reasons? ________ %
(Please specify: ________________)

TOTAL = 100%

Initials: ____

There are many tax programs that could be used to fund the COMPLETE GROUNDWATER TREATMENT program. Suppose that instead of the permanent increase in monthly water bills. the only way to fund the COMPLETE GROUNDWATER TREATMENT program would be to have a one-time increase in water bills. There would be no additional water bill increases after the one-time payment: your water bill would go back to its original level the next month. This one-time increase would have to cover the entire cost of the treatment program. All other details of the scenario are identical except for the one-time nature of the payment.

Q-41 Again. assume that the groundwater treatment could be quaranteed. Would you consider voting for a referendum to support a one-time increase in water bills which would go to funding a COMPLETE GROUNDWATER TREATMENT operation to make up the potential 50% shortfall due to groundwater contamination?

1. NO → Why?

2. YES ↓

Q-42 What is the most your household would be willing to pay in a one-time water bill increase before you would vote NO on COMPLETE GROUNDWATER TREATMENT ? (Circle the best response.)

$1	$5	$15	$40	$100	$300	$2000	$5000
$2	$8	$20	$50	$150	$500	$3000	MORE THAN $5000
$3	$10	$30	$75	$200	$1000	$4000	DONT KNOW

The amount you indicate will tell us what it is really worth to your household to get this program. If the needed groundwater treatment actually cost fess than people are willing to pay, you would only have to pay what it would cost. If the groundwater treatment turned out to cost more than people are willing to pay, it would not done.

(NOTE: If you answered "NO" to both questions Q-38 and Q-41, go to question Q-46. Otherwise, continue with question Q-43.)

Q-43 Does the permanent monthly payment or the one-time payment better reflect your households value for COMPLETE GROUNDWATER TREATMENT ?

1. THE PERMANENT MONTHLY PAYMENT
2. THE ONE-TIME PAYMENT
3. THE MONTHLY AND ONE-TIME PAYMENTS ARE ABOUT THE SAME
4. ANOTHER PAYMENT IS BETTER ($ ________ PER ________)

Initials: _____

VIII. ABOUT YOUR EVALUATION OF COMPLETE GROUNDWATER TREATMENT

We arc interested in how you decided upon the monthly value you stated for complete groundwater treatment. If you were willing to vote yes on COMPLETE GROUNDWATER TREATMENT . what reasoning or strategies dtd you use to arrive at your dollar value? If you voted noon COMPLETE GROUNDWATER TREATMENT. why did you vote no? What, if anything. would it take for you to change your mind and vote yes? Please take a few minutes to describe your reasoning in your own words in the space below.

Initials: ____

Q-41 In questions Q-39 and Q-42 YOU were asked to state the dollar amounts you would be willing to pay for COMPLETE GROUNDWATER TREATMENT. Would you say that the dollar amounts you stated were

1. JUST FOR THE STATED GROUNDWATER PROGRAM (GO TO Q-46)

2. SOMEWHAT FOR THE GROUNDWATER REFERENDUM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES
3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENIAL CAUSES
4. OTHER (please specify) ____________________

Q-45 About what percent of your dollar amount was just for the stated groundwater program?

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Q-46 Now suppose that instead of just evaluating a single" option. you have the opportunity to choose whichever opUon you prefer. Please rank the different options below in order from most preferred (= 1) to least preferred (=6). Please give each option a rank.

	Rank
NO WATER PROJECTS AT ALL -- ACCEPT SHORTAGE	----
BUY WATER FROM A NEARBY CITY	----
INSTALL IN-HOME WATER PURIFICATION SYSTEM	----
CREATE A FUND FOR FUTURE USE	----
WATER SUPPLY TREATMENT	----
COMPLETE GROUNDWATER TREATMENT	----

Initials: _____

When thinking about your value for COMPLETE GROUNDWATER TREATMENT. some information may have been more relevant than other information. Certain items may have caused you to think 'Oh. my value was too high. I have to lower it to take this into account. Or some items may have caused YOU to think 'Oh. my value was too low. 1 have to raise it to take this into account." We are now going to ask you to look back to some of the specific questions you have answered and tell us whether or not you took this information tnto account when determining your value for COMPLETE GROUNDWATER TREATMENT.

Q-47 Questionns Q-4 to Q-10 asked you about groundwater use in your own community and any specific contamination or health problems you know about. Did thinking about your local landfill and local groundwater situation have any affect on your value for COMPLETE GROUNDWATER TREATMENT?

1. NO - NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

____

____

Before Q-4 you were told what groundwater is, where it comes from, and how it is extracted for human use. Did readtng this information have any affect on your value for COMPLETE GROUNDWATER TREATMENT?

1. NO -NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

____

____

Q-49 After Q-6 You were told that groundwater in fact moves very. very slowly: usually less than 100 feet per year. Did learning this information have any affect *on your* value for COMPLETE GROUNDWATER TREATMENT?

1. NO - NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INN) ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

____

____

Initials: _

Q-50 Questions Q-13 to Q-17 asked for specific information about your current water bill. Did thinking about your current water bill have any affect on your value for COMPLETE GROUNDWATER TREATMENT?

1. NO - NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

Q-51 Section III asked you to evaluate a plan in which the city would buy water from another city to make up the potential shortfall due to groundwater contamination. Did thinkings about the possibility of getting water from another source have any affect on your value for COMPLETE GROUNDWATER TREATMENT?

1. NO- NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

Q-52 Question Q-2 1 asked you to think about what you would do if your city imposed mandatory water use restrictions. Did thinking about the possibility of conserving water so that less of the contaminated groundwater would have to be replaced have any affect on your value for COMPLETE GROUNDWATER TREATMENT?

1. NO - NO ACCOUNT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

Initials: _____

Q-53 **Section IV brought Up the possibility of private options for cleaning the contaminated water. Did thinking about these private options have any affect on your value for COMPLETE GROUNDWATER TREATMENT?**

1. NO- NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

Q-54 **Before Question Q-26 you read that one dollar put into a bank account today would be worth $117.36 in filly years. Did thinking about the fact that your payments could be earning interest and increasing in value over the years have any affect on your value for COMPLETE GROUNDWATER TREATMENT?**

1. NO -NO AFFECT AT ALL
2. YES-I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

Q-55 **Section VI presented the option of water supply treatment. which would clean the contaminated water as it is needed rather than cleaning it up all at once. Did thinking about this option have any affect on your value for COMPLETE GROUNDWATER TREATMENT?**

1. NO - NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE ARER TAKING THIS INTO ACCOUNT

Why **or why not?**

Initials: . _ .

Q-56 Diagram 2 presented a "risk ladder" which comparedthe risk of drinking the contaminated groundwater With several other risks. Did thinking about these risk comparisons have any affect on your value for COMPLETE GROUNDWATER TREATMENT?

1. NO- NO AFFECT AT ALL
2. YES - I LOWERED MY VALUE AFTER TAKING THIS INTO ACCOUNT
3. YES -- I RAISED MY VALUE AFTER TAKING THIS INTO ACCOUNT

Why or why not?

Q-57 Did going though the information and response options in the surveys make you any more or less optimistic about our ability to deal with groundwater contamination problems now and in the future?

1. NO -- MADE NO DIFFERENCE
2. YES -- MADE ME MORE OPTIMISTIC
3. YES -- MADE ME LESS OPTIMISTIC

initials: ____

X. ABOUT YOU

Finally, we would like to ask you a few questions about yourself.

Q-59 Your sex:

1. P E W
2. MALE

Q-60 Your age: __________ YEARS

Q-61 including yoursel, how many members in your household are in each age group? (If none. write "0")

___ UNDER 18 YEARS OF AGE
___ 18-64
___ 65 AND OVER

Q-62 How much formal education have you completed? (circle number)

1. NO FORMAL EDUCATION
2. SOME GRADE SCHOOL
3. COMPLETED GRADE SCHOOL
4. SOME HIGH SCHOOL
5. COMPETED HIGH SCHOOL
6. TRADE SCHOOL
7. SOME COLLEGE
8. COMPLETED COLLEGE
9. SOME GRADUATE WORK
10. ADVANCED COLLEGE DEGREE

Q-63 In the past month. has your household submitted any of the following materials for recycling? (circle all that apply)

1. NEWSPAPER
2. GLASS
3. ALUMINUM OR OTHER METALS
4. PLASTIC
5. OTHER (Pi-S-
____

Q-64 In the past year, have you held membership or donated time or *money* to any environmental organizations or groups [such as Greenpeace or the Serra Club)?

1. NO
2. YES -- ONE GROUP
3. YES -- TWO OR THREE GROUPS
4. YES -- MORE THAN THREE GROUPS

Q-65 How would you describe your racial or ethnic background? (circle one)

1. WHITE OR CAUCASIAN
2. BLACK OR AFRICAN AMERICAN
3. HISPANIC OR MEXICAN AMERICAN
4. ASIAN OR PACIFIC ISLANDER
5. NATIVE AMERICAN INDIAN
6. OTHER [PI-S-
____

Initials: _____

Q-66 **What is your total annual household income before taxes and other deductions? (circle one)**

1. UNDER $9,999
2. $10,000 - 19,999
3. $20,000 - 29,999
4. $50,000 - 59,999
5. $40,000 - 49,999
6. $50,000 - 59,999
7. $60,000 - 69,999
8. $70,000 - 79,999
9. $80,000 - 89,999
10. $90,000 - 99,999
11. $100,000 - 119,999
12. $120,000 - 139,999
13. $140,000 - 159,999
14. $160,000 - 179,000
15. $180,000 - 199,999
16. $200,000 and OVER

IS there anything we have overlooked? Please use the space below to write any comments or suggestions you may have about the survey. We@ also be happy to answer any questions you may have about the survey or our research when everyone has finished.

APPENDIX C

VERBAL PROTOCOLS

Valuation

Our water bill is about $15-$20 (answer R gave). I feel it is pretty important for the people to be drinking safe water. A $15 to $20 increase per month to ensure that we would have enough water and it would be safe would be okay. Peoples' health is more important than going ahead and letting people use water that is not safe.

$5/month for 50 years is a lot of money. $2 or $3 would be big money too but I would consider voting if it was going to cost me $2/year which is $6 or $7 for my household.

(complete groundwater treatment) This is a big one. it's got to be worth more, $8-10/month

If my water bill is only S20 it could double and it wouldn't affect me a whole lot. I would say that should certainly cover another 50%. I thought about the baseball vote just recently and that that would be about S 10/year is what I was told and voted no on that one but I would double my water bill because my health is very important to me. I splurge, I'd go to S25.

I would say $5 and not have to worry about it. i was thinking that it was a good start in terns of setting up a plan to solve the water problems. I remember having skepticisms about how the money would be used.

When i looked at the dollar amount I was thinking in terms of not so much what i could econom-ically afford but generai. What 1 would want to pay over an indefinite time. I could blow S20 a month and it wouldn't have a big economic impact on myself, i think if everybody spent that amount of money you would have a good amount of money to start cleaning up the water, As far as trying to think in terms of well, here's how much i think it might cost and if everybody put in this much you would have enough. Not in those terms.

I put down S 10 because I used to donate that much every month to United Way. It would be my charitable contribution in a way. I didn't spend a whole lot of time in thought about those questions.

Mental Model of Trust Fund

No. Just in the sense that I don't know if...I don't know in a sense that it would be there. They might spend it on something else. Priorities get mixed up.

Well, again, when are they going to dip into it to use it. I don't know. What I stated before was that local government and unions, people want to dip into this fund that sits thereto use it and will make it Up later and whether or not that happens is..we sure hope so but to take it in and say it cannot be touched and we are going to let it grow for x amount of years you have to trust that that is going to happen.

I think it's a crock...it's like freezing your body to see if there is something in the future to handle it. I'm not a big believer in that.

I don't lend much credence to guarantees through government systems or whoever is handling the water. If they could give some feedback on what money they received and what sort of use the money is going towards I would be a lot more satisfied. Until then I would be willing to risk only a bit until we find out what will happen with that.

I'd like to believe it, but when they start talking about the S&L scandal, I don't know.

Psycho-Economics

(worth of $1 in bank for 50 years) probably 10 cents

I don't think it would be there the way my bank has service charges, They'd take it. In SO years, 1 should know, I'd guess S25.

S 100 for S 1 after 50 years? I don't really believe that.

Comparison Risks

Well, I've been told that x-rays/a lot of x-rays aren't good for you/ten out of a million would be less than one percent. I would say it's about the same.....In retrospect it seems like I was pretty carried away on saving 10 lives . . ..it suddenly occurs to me that I jumped on a bandwagon where for these other things, x-rays and such that I don't think twice about it. Ten out of a million people seemed to really get my attention in answering the survey. And it was a huge concern to me. If I had looked at this (risk ladder) before i gave my answers to all of those questions I would have said Oh, shit, screw it, I want to give them a nickel. I own a motorcycle that is 100 times more dangerous, who cares? I ride my bike anyway. It doesn't slow me down. I'd jump at the chance to climb Mt. Everest. I guess I can really see a huge difference in my perspective.

I think if you do both at the same time your chances are really high. If you are saying I just smoke cigarettes or I just drink water I would have to say they are about the same.

I remembered they measured the health risk of radon gas, this many chest x-rays, 200 per year is equal to this level of radon in the air.

Whose Responsibility?

hm, I'm kind of irate that I am stuck in this situation, I am forced to pay for something that I thought would be safe all along. I was really kind of bothered by the fact that I have to pay for water that was contaminated by somebody else. Through somebody else's negligence. Like most people I guess the consumer has to pay for it so I will just toss upset in there. I realize I have to pay for it anyway whether it's out of my pocket or some other way.

Interesting Mental Models

I just imagine this green stuff that was in 55-gallon drums that's ail, seeping into the ground, I had a definite picture in my head.

Our community has a landfill. I never use it. I put my trash on the curb.

(Wash car less? R answered 100%) I would still get it washed at the car wash, 100% less.

Emotional Involvement

Some paragraphs were a little long, I wished they weren't that dry. I thought they could have been a little lighter. Gotten more involved. I felt like I was reading a dictionary rather than something to do with my community.

Sensitivity to Higher Risk

(Would YOU pay more for higher risk?) Well no, because if everyone in the city paid S 10 a month that would create a huge amount of money and make a huge difference.

(pay more for higher risk?) No. No. But if they said your personal friend was affected and was one of 25, maybe.

Why Zero Bid?

. ..mandatory water usage would be a better idea. Mandatory water restrictions/ effective but unpopular however, a suitable solution in my opinion. I thought of my sister in California who has mandatory water restrictions. I know it's not ail that hard.

I would say not, take a chance that it wouldn't run out/be needed.

I decided that I wouldn't vote for it because I don't make that much money and I don't want to pay any more . . ..I think that the government should use my tax money. They should use the money I already pay.

Don't pay for an extra year of procrastination. All you are doing (by buying water from another community) is buying yourself a year.

Meaning of Questions

(S gave $15-$20 to original question but only $10 to referendum question). Ya, I was thinking about (what other people would pay). In general I think 1 would be wilting to pay more than other people. I think I lowered my dollar amount to make it acceptable. I would want something like that to pass.

Yes, I did think about (what other people would do) and also about how are they going to do this so it can get passed. The people that get it on (the ballot) are going to want it passed, I was thinking about what other people might vote for.

i don't know exactly what referendum means.

I was thinking that I am not registered to vote. I have put it off for years; I'm not voting. We decided we would get registered and vote.

I was thinking about if I actually would vote. Recently I decided I would vote in the next election because I didn't vote lost year.

Percentage Splits

I am a pretty selfish person, 9096 about the family and me and divided up the other 10%. I thought about dividing up after.

I'd say I don't quite understand the last part . . ..future use. The only reason I care about it being in the ground is because we are going to use it.

Family 100%, future generations 100%, Not allowing contaminants to remain 100%.

Mental Model of Groundwater

Probably not very fast. Probably depends on where the water comes from. 2 feet/second. 2 hours . . .. Maybe 10 miles.

Very surprised (to learn groundwater speed). I didn't realize that.

Extremely surprised, Think about a potted plant, pour it in and it runs out immediately,

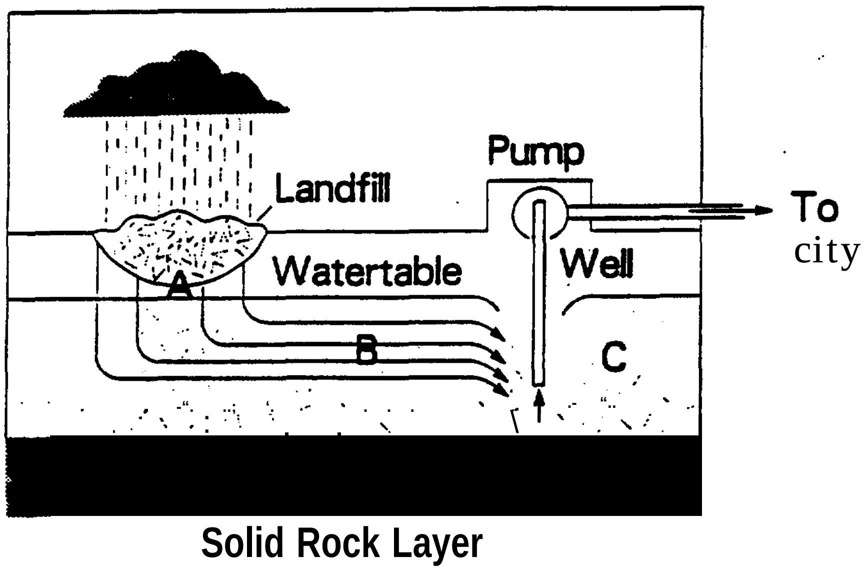
30 miles an hour/ tops. it shoots out of there pretty quick,

Urn, I'd say pretty quick. Like in miles per hour? It's got to be quicker than people would guess. Not nearly as quick as a river but I know it flows out of the fields.

It seems like it could go through a mile in a matter of an hour if the water is moving that fast . . ..I would have to guess on something that is fairly shallow like a city water supply it could goat the most maybe 10 or 15 miles.

Not surprised, I thought it moved slower. I had a geology class recently and that was part of the aquifer and aquafluids so I was aware on how groundwater works and functions.

GROUNDWATER CONTAMINATION: WHAT IS YOUR OPINION?



This survey should b. completed by a head of your household.

Please return survey to:
Center for Economic Aalysis
University of Colorado
Boulder, Colorado 80309-0257

APPENDIX D

FACSIMILE SURVEYS

THE ISSUES

About 50% of the water used by the U.S. population for drinking, cooking, bathing and other home purposes comes from groundwater. We are interested in your views on what, if anything, should be done to clean up contaminated groundwater which can no longer be used without treatment.

Q1 Are you aware of groundwater contamination in your community coming from any of these specific sources? (Circle the best answer)

1. No (44.47%)

2. YES (Circle all that apply)

A. SUPERFUND SITE (2.07%)	B. HAZARDOUS WASTE SITE (12.01%)	C. LANDFILL (57.56%)
D. SEPTIC TANK (13.870A)	E. AGRICULTURAL RUNOFF (17.39%)	F. INDUSTRY (20.29%)

G. OTHER (Please Specify) ________________ (.007%0)

Q2 Because the rest of this survey concerns only groundwater contamination, it is useful to understand how important you feel cleaning up contaminated groundwater is in comparison to other issues. From least to most concerned, how do you rate the issues listed below? (Circle number of best response for each issue.)

	NOT AT ALL CONCERNED						GREATLY CONCERNED	
Improving public roads	1	2	3	4	5	6	7	(4.42)
Improving the education system	1	2	3	4	5	6	7	(5.99)
Reducing air pollution	1	2	3	4	5	6	7	(5.72)
Saving endangered species	1	2	3	4	5	6	7	(4.61)
Reducing global warming	1	2	3	4	5	6	7	(4.95)
Promoting recycling	1	2	3	4	5	6	7	(5.53)
Cleaning up rivers and lakes	1	2	3	4	5	6	7	(6.06)
Cleaning up groundwater	1	2	3	4	5	6	7	(6.01)

Water for residential use can come from many different sources, including rivers, lakes, and groundwater. Groundwater comes from rain and snow that falls on the land and seeps underground. At some depth underground the soil or rock becomes saturated with water, and this water can then be pumped to the surface.

Q3 Does your household get any part of its water from groundwater?

1. NO -WE DON'T USE GROUNDWATER AT ALL	(29%)
2. YES - PART OF OUR WATER COMES FROM GROUNDWATER	(16.4%)
3. YES - ALL OF OUR WATER COMES FROM GROUNDWATER	(34.3%)
4. DON'T KNOW	(20.3%)

Q4 Sometimes, garbage and waste placed in a community's landfill, similar to the one shown on the cover of this survey, can leak out and contaminate groundwater. Does your community have a landfill?

1. NO	(33.1 %)
2. YES	(58.5%)
3. DON'T KNOW	(8.4%)

Rainwater seeping through a landfill may dissolve some of the chemicals in the discarded trash. This material, which can be toxic, may seep into the water table and contaminate the water below (as A shows on the front cover). Once contaminants reach the water table, they spread very slowly underground in the direction water is flowing (see B on the front cover). Many people are surprised to learn that this flow is very very slow; usually less than 100 feet per year. After many years, the landfill may contaminate water drawn by a well supplying water to the citizens of the community (see C on the front cover).

Q5 Does your community currently draw water from wells which have been or are in danger of becoming contaminated?

1. NO	(46.2%)
2. YES - CONTAMINATED BY A LANDFILL	(6.9%)
3. YES - CONTAMINATED BY ANOTHER SOURCE (please specify)	__(6.1%)__
4. DON'T KNOW	(40.8%)

HOW COMMUNITIES CAN RESPOND TO CONTAMINATED GROUNDWATER

In the rest of the survey, we would like you to consider an imaginary situation Suppose that you live in a community which has groundwater contamination as the result of a leaking public landfill. Contaminants have been found in groundwater which normally supply 40% of the water used by the community. Contamination covers approximately five acres underground (in an area 700 feet long and 390 feet wide and 25 feet deep). The other 60% of the water supply is from uncontaminated surface water sources. In answering the following questions, you should assume that:

- The contamination is the result of standard public landfill practices used in the past that were believed to be safe at the time. No private company or party is at fault.

- Scientists estimate that drinking the contaminated water would increase the risk of cancer, resulting in about 10 additional deaths per million people who drink the water per year (about the same level of risk a typical person has of developing cancer from exposure to routine medical x-rays).

- Local government has concluded that the water must not be used for drinking or cooking unless it is treated to remove the contaminants. It could, however, be used as is for such purposes as bathing, washing clothes, or watering lawns.

There are many ways a community might respond to such a groundwater problem. For each of the following cleanup options please circle the number indicating how satisfied you are with that solution.

Q6 COMPLETE CLEANUP. The water bills of current users would be increased to pay for a complete groundwater cleanup. An underground concrete wall would be built around the landfill down to the solid rock layer to seal it off from the groundwater. All contaminated water would be pumped up and cleaned. The clean water would be reinfected back underground for use now and in the future. This would benefit your household and future generations by ensuring that about the same amount of clean water is available as before the contamination occurred. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(4.46)

Q7 CONTAINMENT. Wells would be drilled in the area to which contaminated groundwater is moving. Contaminated water would be pumped up to stop it from spreading further. This water would be cleaned and pumped back underground into the containment area. This approach does not complete clean up the contamination. Your household would have the same amou of clean water to use since new supply wells would be drilled outside of the containment area. The water bills of current users would be increased to pay for the containment system. Future generations would pay for operation and maintenance costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.46)

Q8 PUBLIC TREATMENT. The local government would increase water bills of users to pay for the construction, maintenance and operation of a water treatment plant to remove contaminants from the water as needed. Contaminants would remain in the ground yet never enter the public wate supply. Future generations would have to pay for their own treatment costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.67)

Q9 HOME TREATMENT. Each household purchases and installs its own charcoal filtration system to remove contaminants before the water is used in the home. These systems typically cost $180 to install and an additional $25 per month for maintenance. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMEMLY SATISFIED	
1	2	3	4	5	6	7	(2.87)

Q10 WATER RATIONING. The local government would ‘institute a mandatory water conservation program to avoid having to make up the 40% shortfall. The contaminated water would not be cleaned up nor used. Surface water from lakes and streams provides the 60% of available clean water. Water bills would not increase but everyone would have to cut their water use by 40%. Realizing that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen, how satisfied are you with water rationing as an option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.46)

HOW MUCH IS IT WORTH TO YOU TO COMPLETELY CLEAN UP CONTAMINATED GROUNDWATER?

Your answers to the next questions are very Important. We do not yet know how much It will cost to clean up contaminated groundwater. However, to make decisions about new groundwater cleanup programs that could cost you money, decision makers want to learn how much clean groundwater is worth” to people like you.

Q11 Suppose that the complete cleanup program described in Q6 could be achieved in your imaginary community. What would a complete cleanup program be worth to your household, if you faced the hypothetical problem of 40% of your water supply coming from contaminated groundwater as we have described? In answering, you should assume that:

- The money would be used only in this hypothetical community for sealing off the landfill, cleaning the contaminated water and for purchasing clean water until the cleanup is completed. The cost of the project (unknown at this time) would be spread out over a ten year period.
- If the program turns out to cost less than people are willing to pay, each household would only pay a share of what it costs. If it turns out to cost more than people are willing to pay, the program would not be carried out.
- Scientists are satisfied that water cleaned and reinfected using these methods will be contaminant-free and safe to drink.
- The program would also provide benefits to future generations. New families moving in or just starting out would not have to pay any money to ensure the groundwater they used was clean.

Now, what is the most your household would be willing to pay each month on top of your current water bill for the next 10 years for the complete groundwater cleanup program? (Circle the best response.)

(12.23)

$0	$1.50	$4	$10	$30	$75	$200
$0.50	$2	$5	$15	$40	$100	$500
$1	$3	$8	$20	$50	$150	MORE THAN $500

Q12 Some people tell us it is difficult to think about paying to reduce just one environmental problem. Would you say that the dollar amount you stated your household would be willing to pay for complete groundwater cleanup (Q1 1) is: . (Circle number)

1. JUST FOR THE STATED GROUNDWATER PROGRAM (Go to Q 14)
2. SOMEWHAT FOR THE GROUNDWATER PROGRAM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES
3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENTAL OR OTHER WORTHWHILE PUBLIC CAUSES
4. OTHER (Please specify)________________________

1- 71 .5%, 2-1 6.3%, 3-10.50A, 4-1 .7%

Q13 About what percent of your dollar amount is just for the stated complete groundwater cleanup program? (Circle percent)

(76.1 2°/0)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Q14 Of the amount you would pay just for the complete groundwater cleanup program, about what percent would be to ensure

(36.32)%	THAT YOUR HOUSEHOLD HAS ENOUGH CLEAN WATER TO USE
(21 .43)%	THAT OTHER HOUSEHOLDS IN YOUR COMMUNITY HAVE ENOUGH CLEAN WATER TO USE
(23.94)%	THAT FUTURE GENERATIONS OF PEOPLE LIVING IN YOUR COMMUNITY WILL HAVE ENOUGH CLEAN WATER TO USE
(18.31)%	THAT THE GROUNDWATER IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT
= 100%	TOTAL

Q15 On a scale from 1 to 7, how responsible would you feel for helping to pay to clean up such a groundwater contamination problem in your community.

NOT AT ALL RESPONSIBLE						EXTREMELY RESPONSIBLE	
1	2	3	4	5	6	7	(4.15)

HOW MUCH IS IT WORTH TO YOU TO PREVENT FURTHER SPREADING OF CONTAMINATED GROUNDWATER?

Suppose that a complete groundwater cleanup is not technically possible in your imaginary community. So, your community proposes a CONTAINMEN PROGRAM like that described in Q7 in which groundwater would be contained and isolated, and movement of the groundwater would be controlled.

Q16 What would a containment program iike that described in Q7 be worth to your household if you faced the hypothetical problem of 40% of your water supply coming from contaminated groundwater as we have described? in answering you should assume that:

- The money would be used for design, construction, operation, and maintenance of the groundwater containment system. initial costs for design and construction would be spread out over a ten year period. Future generations would have to pay for their own operation and maintenance costs.
- if the program turned out to cost less than people were willing to pay, each household would pay a share of what it cost. if it turned out to cost more than people were willing to pay, the program would not be carried out.
- Scientists are satisfied that contaminated groundwater can be contained to prevent further spreading and that groundwater outside this zone would be contaminant-free and safe to drink.
- This approach does not completely clean up the existing contaminated groundwater. it prevents the spread of the contamination and wiii require new wells to be drilled outside of the containment zone.

Now, of the dollar amount You would have paid just for complete groundwater cleanup, what percent would you be willing to pay for the containment program described above? (Circle percent)

(42.85%)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

ABOUT YOU AND YOUR HOUSEHOLD

H1 Who is the primary water supplier for the water you currently use in your home?

1. THE CITY OR COUNT (69.3%)
2. A PRIVATE WATER SUPPLIER (8.7%)
3. OUR PRIVATE WELL (18.2%)
4. OTHER (Please specify)__________ (3.8%)

H2 Your gender:

1. FEMALE (33%)
2. MALE (67%)

H3 Your age: (50.91 YEARS

H4 Including yourself, how many members in your household are in each age group? (If none, write “0”)

____ UNDER 18 YEARS OF AGE (1.09)
____ 18-64 (1.87)
____ 65 AND OVER (.85)

H5 How much formal education have you completed? (circle number)

1. NO FORMAL EDUCATION (.2%)
2. SOME GRADE SCHOOL (1.3%)
3. COMPLETED GRADE SCHOOL (3.4?40)
4. SOME HIGH SCHOOL (5.7%)
5. COMPLETED HIGH SCHOOL(18.4%)
6. TRADE SCHOOL (7%)
7. SOME COLLEGE (27%)
8. COMPLETED COLLEGE (18.8%)
9. SOME GRADUATE WORK (5.9?40)
10. ADVANCED COLLEGE DEGREE(12.40A)

H6 Do you recycle or take special precautions in disposing of any of the following materials? (circle appropriate response for each)

1. NEWSPAPER YES NO DON'T KNOW (72.1% Yes)
2. GLASS YES NO DON'T KNOW (56.9’% Yes)
3. ALUMINUM OR OTHER METALS YES NO DON'T KNOW (76.7% Yes)
4. PLASTIC YES NO DON'T KNOW (54.2% Yes)
5. PAINTS AND PAINT THINNERS YES NO DON'T KNOW (46.7% Yes)
6. USED ENGINE OIL AND COOLANT/ANTIFREEZE YES NO DON'T KNOW (62.1% Yes)
7. HOUSEHOLD CHEMICALS YES NO DON’T KNOW (40.6% Yes)
8. OTHER (please specify) __________(2.3%)

H7 In the past year, have you held membership or donated time or money to any environmental organizations or groups?

1. No (71 .6%)
2. YES - ONE GROUP (20.3%)
3. YES - TWO OR THREE GROUPS (6.5%)
4. YES - MORE THAN THREE GROUPS (1 .5%)

H8 How would you describe your racial or ethnic background? (circle one)

1. WHITE OR CAUCASIAN (90.5%)
2. BLACK OR AFRICAN AMERICAN (4.3%)
3. HISPANIC OR MEXICAN AMERICAN (2.2%)
4. ASIAN OR PACIFIC ISLANDER (1.1%)
5. NATIVE AMERICAN INDIAN (.6%)
6. OTHER (please specify) ______(1 .3%)______

H9 What is your present employment? (Circle the best answer)

1. EMPLOYED FULL TIME (56.8°4)
2. EMPLOYED PART TIME (6.6)
3. FULL TIME HOMEMAKER (3.2%)
4. UNEMPLOYED (1.9%)
5. RETIRED (25.8%)
6. STUDENT (1.3%)
7. OTHER (Please specify)(4 . 4 %)_____

H10 What is your total annual household income before taxes and other deductions? (circle one)

1. UNDER $9,999 (8.5%)
2. $10,000-19,999 (17.8%)
3. $20,000-29,999 (15%)
4. $30,000-39,999 (16.2%)
5. $40,000-49,999 (12.2%)
6. $50,000-59,999 (11.7%)
7. $60,000-69,999 (4.2%)
8. $70,000-79,999 (2.6%)
9. $80,000-89,999 (2.1%)
10. $90,000-99,999 (3.1%)
11. $100,000-119,999 (3.8%)
12. $120,000-139,999 (1.4%)
13. $140,000-159,999 (o%)
14. $160,000-179,000 (.2%)
15. $180,000-199,999 (.2%)
16. $200,000 and OVER (.9%)

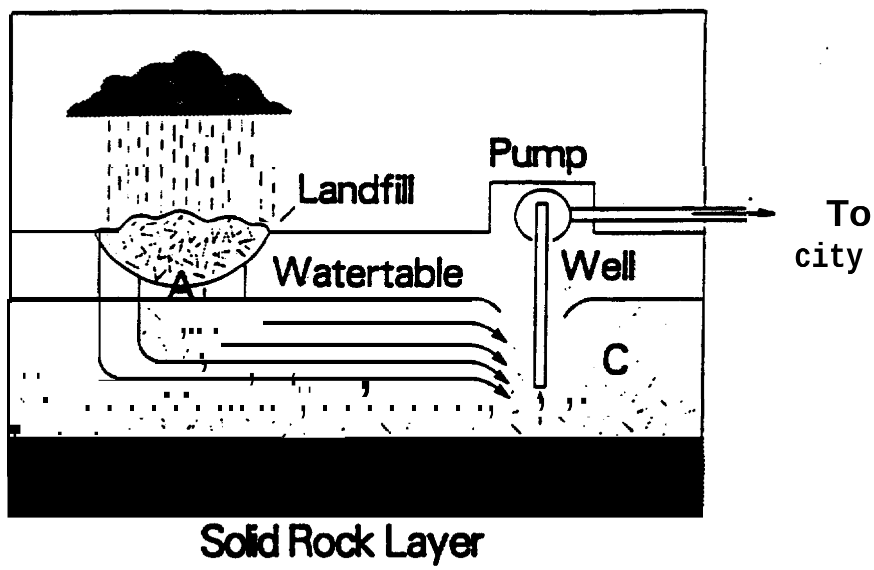
Is there anything we have overlooked? Please use the space below to write any comments or suggestions you may have about the survey.

YOUR PARTICIPATION IS GREATLY APPRECIATED!

☐ **Check this box if you would like a summary of the results.**

(If different from mailing label, list your name and address here.)

GROUNDWATER CONTAMINATION: WHAT IS YOUR OPINION?



This survey should be completed by a head of your household.

Please return survey to:
Center for Economic Analysis
University of Colorado
Boulder. Colorado 80309-0257

THE ISSUES

About 50% of the water used by the U.S. population for drinking, cooking, bathing and other home purposes comes from groundwater. We are interested in your views on what, if anything, should be done to clean up contaminated groundwater which can no longer be used without treatment.

Q1 Are you aware of groundwater contamination in your community coming from any of these specific sources? (Circle the best answer)

1. NO (48.9%)

2. YES (Circle all that apply) (51.1%)

A. SUPERFUND SITE (3.48%) B. HAZARDOUS WASTE SITE (9.20%) C. LANDFILL (61.14%)
D. SEPTIC TANK (13.50?4) E. AGRICULTURAL RUNOFF (19.01%) F. INDUSTRY (20.24%)
G. OTHER (Please Specify) (9 . 0 0 / 0) ________

Q2 Because the rest of this survey concerns only groundwater contamination, it is useful to understand how important you feel cleaning up contaminated groundwater is in comparison to other issues. From least to most concerned, how do you rate the issues listed below? (Circle number of best response for each issue.)

	NOT AT ALL CONCERNED						GREATLY CONCERNED	
Improving public roads	1	2	3	4	5	6	7	(4.54)
Improving the education system	1	2	3	4	5	6	7	(5.83)
Reducing air pollution	1	2	3	4	5	6	7	(5.79)
Saving endangered species	1	2	3	4	5	6	7	(4.67)
Reducing global warming	1	2	3	4	5	6	7	(5.01)
Promoting recycling	1	2	3	4	5	6	7	(5.55)
Cleaning up rivers and lakes	1	2	3	4	5	6	7	(6.07)
Cleaning up groundwater	1	2	3	4	5	6	7	(5.95)

Water for residential use can come from many different sources, including rivers, lakes, and groundwater. Groundwater comes from rain and snow that falls on the land and seeps underground. At some depth underground the soil or rock becomes saturated. with water, and. this water can then be pumped to the surface.

Q3 Does your household get any part of its water from groundwater?

1. NO -WE DON'T USE GROUNDWATER AT ALL (28.5%)
2. YES - PART OF OUR WATER COMES FROM GROUNDWATER(22.0%)
3. YES - ALL OF OUR WATER COMES FROM GROUNDWATER (32.4%)
4. DON'T KNOW (17.2%)

Q4 Sometimes, garbage and waste placed in a community's landfill, similar to the one shown on the cover of this survey, can leak out and contaminate groundwater. Does your community have a landfill?

1. NO (27.1 %)
2. YES (62.4%)
3. DON'T KNOW (10.2%)

Rainwater seeping through a landfill may dissolve some of the chemicals in the discarded trash. This material, which can be toxic, may seep into the water table and contaminate the water below (as A shows on the front cover). Once contaminants reach the water table, they spread very slowly underground in the direction water is flowing (see B on the front cover). Many people are surprised to learn that this flow is very very slow; usually less than 100 feet per year. After many years, the landfill may contaminate water drawn by a well supplying water to the citizens of the community (see C on the front cover).

Q5 Does your community currently draw water from wells which have been or are in danger of becoming contaminated?

1. NO (51.9%)
2. YES - CONTAMINATED BY A LANDFILL (6.1%)
3. YES - CONTAMINATED BY ANOTHER SOURCE (Please specify)(5.4%).
4. DON'T KNOW (34.69%)

HOW COMMUNITIES CAN RESPOND TO CONTAMINATED GROUNDWATER

In the rest of the survey, we would like you to consider an imaginary situati Suppose that you live in a community which has groundwater contamination as the result of a leaking public landfill. Contaminants have been found in groundwater which normally supply 40% of the water used by the community. Contamination covers approximately five acres underground (in an area 700 feet long and 390 feet wide and 25 feet deep). The other 60% of the water supply is from uncontaminated surface water sources. In answering the following questions, you should assume that:

- **The contamination is the result of standard public landfill practices used in the past that were believed to be safe at the time. No private company or party is at fault.**
- **Scientists estimate that drinking the contaminated water would increas the risk of cancer, resulting in about 10 additional deaths per million people who drink the water per year (about the same level of risk a typical person has of developing cancer from exposure to routine medical x-rays).**
- **Local government has concluded that the water must not be used for drinking or cooking unless it is treated to remove the contaminants. It could, however, be used as is for such purposes as bathing, washing clothes, or watering lawns.**

There are many ways a community might respond to such a groundwater problem. For each of the following cleanup options please circle the number indicating how satisfied you are with that solution.

Q6 COMPLETE CLEANUP. The water bills of current users would be increased to pay for a complete groundwater cleanup. An underground concrete wall would be built around the landfill down to the solid rock layer to seal it off from the groundwater. All contaminated water would be pumped up and cleaned. The clean water would be reinfected back underground for use now and in the future. This would benefit your household and future generations by ensuring that about the same amount of clean water is available as before the contamination occurred. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(4.39)

Q7 **CONTAINMENT.** Wells would be drilled in the area to which contaminated groundwater is moving. Contaminated water would be pumped up to stop it from spreading further. This water would be cleaned and pumped back underground into the containment area. This approach does not completely clean up the contamination. Your household would have the same amount of clean water to use since new supply wells would be drilled outside of the containment area. The water bills of current users would be increased to pay for the containment system. Future generations would pay for operation and maintenance costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.49)

Q8 **PUBLIC TREATMENT.** The local government would increase water bills of users to pay for the construction, maintenance and operation of a water treatment plant to remove contaminants from the water as needed. Contaminants would remain in the ground yet never enter the public water supply. Future generations would have to pay for their own treatment costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.80)

Q9 **HOWM TREATMENT.** Each household purchases and installs its own charcoal filtration system to remove contaminants before the water is used in the home. These systems typically cost $180 to install and an additional $25 per month for maintenance. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.77)

Q1O **WATER RATIONING.** The local government would institute a mandatory water conservation program to avoid having to make up the 40°A shortfall. The contaminated water would not be cleaned up nor used. surface water from lakes and streams provides the 60% of available clean water. Water bills would not increase but everyone would have to cut their water use by 40%. Realizing that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen, how satisfied are you with water rationing as an option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.53)

HOW MUCH IS IT WORTH TO YOU TO COMPLETELY CLEAN UP CONTAMINATED GROUNDWATER?

Your answers to the next questions are very important. We do not yet know how much it will cost to clean up contaminated groundwater. However, to make decisions about new groundwater cleanup programs that could cost you money, decision makers want to learn how much clean groundwater is worth to people like you.

Q11 Suppose that the complete cleanup program described in Q6 could be achieved in your imaginary community. What would a complete cleanup program be worth to your household, if you faced the hypothetical problem of 40% of your water supply coming from contaminated groundwater as we have described? In answering, you should assume that:

- The money would be used only in this hypothetical community for sealing off the landfill, cleaning the contaminated water and for purchasing clean water until the cleanup is completed. The cost of the project (unknown at this time) would be spread out over a ten year period.
- If the program turns out to cost less than people are willing to pay, each household would only pay a share of what it costs. If it turns out to cost more than people are willing to pay, the program would not be carried out.
- Scientists are satisfied that water cleaned and reinfected using these methods will be contaminant-free and safe to drink.
- The program would also provide benefits to future generations. New families moving in or just starting out would not have to pay any money to ensure the groundwater they used was clean.

Now, what is the most your household would be willing to pay each month on top of your current water bill for the next 10 years for the complete groundwater cleanup program? (Circle the best response.)

(12.26)

$0	$1.50	$4	$10	$30	$75	$200
$0.50	$2	$5	$15	$40	$100	‘ ?$500
$1	$3	$8	$20	$50	$150	MORE THAN $500

Q12 Some people tell us it is difficult to think about paying to reduce just one environmental problem. Would you say that the dollar amount you stated your household would be willing to pay for complete groundwater cleanup (Q11) is: (Circle number)

1. JUST FOR THE STATED GROUNDWATER PROGRAM (Go to Q 14)

2. SOMEWHAT FOR THE GROUNDWATER PROGRAM AND SOMEWHAT A GENERAL CONTRIBUTION TO AU ENVIRONMENTAL CAUSES

3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENTAL OR OTHER WORTHWHILE PUBLIC CAUSES

4. OTHER (Please specify)________________________

1 -69.5%, 2-1 6.3%, 3-1 1.0%, 4-3.2%

Q13 About what percent of your dollar amount is just for the stated complete groundwater cleanup program? (Circle percent) (75.93%)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Q14 Of the amount you would pay just for the complete groundwater cleanup program, about what percent would be to ensure

(33.41) % THAT YOUR HOUSEHOLD HAS ENOUGH CLEAN WATER TO USE
(20.62) % THAT OTHER HOUSEHOLDS IN YOUR COMMUNITY HAVE ENOUGH CLEAN WATER TO USE
(24.13) % THAT FUTURE GENERATIONS OF PEOPLE LIVING IN YOUR COMMUNITY WILL HAVE ENOUGH CLEAN WATER TO USE
(21.83) % THAT THE GROUNDWATER IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT
= 100 % TOTAL

Q15 On a scale from 1 to 7, how responsible would you feel for helping to pay to clean up such a groundwater contamination problem in your community.

NOT AT ALL RESPONSIBLE						EXTREMELY RESPONSIBLE	
1	2	3	4	5	6	7	(4.26)

ABOUT THE NATIONAL GROUNDWATER PROBLEM

To plan new groundwater cleanup programs, decision makers want to know ho much it is worth to you to help solve groundwater problems, not just in your community, but across the entire nation. According to the Environmental Protection Agency (EPA) there are about 6000 landfills in the U.S. of which about 2000 are or will leak contaminants into the groundwater. There also are about 2400 other types of sites leaking contaminants. On average these sites are about the size described in the previous section.

The Environmental Protection Agency estimates that in the U. S.:

- groundwater supplies about 53% of the water used for domestic purposes such as cooking, bathing, and drinking

- in 1987 about 6% of the people supplied by public groundwater systems were using water that violated EPA standards.

Q16 How likely do you feel it is that you will move to another community in the next ten years?

NOT AT ALL LIKELY						CERTAIN	
1	2	3	4	5	6	7	(2.85)

Suppose that each community across the country makes certain that no one is drinking contaminated water. Some communities might choose to fund complete groundwater cleanup, but others may choose other programs such as a water supply treatment, containment, or mandatory water conservation. However, some contaminants in some communities would remain in the groundwater indefinitely.

Q17 What would it be worth to your household to help fund complete groundwater cleanup for communities other than yours which do not choose to pay for it? In answering, you should assume that:

- The money would be used only to increase local programs to the level of complete groundwater cleanup programs as described in Q6. The money paid for these programs would su<u>pplement</u>, not replace, whatever people living in the affected communities were willing to pay.

■ If the supplemental programs to bring complete cleanup to all sites across the country turn out to cost less than people are willing to pay, each household would only pay a share of what it costs. If they turn out to cost more than people are willing to pay, the programs would not be performe

Now, of the dollar amount you would have paid just for complete groundwater cleanup in your community how much, in addition, would you pay to help fund supplemental complete groundwater cleanup in other communities across the country. (Circle the best percent response).
(11.29%)

No MORE		A LITTLE MORE	HALF AGAIN	AS MUCH		EQUAL AMOUNT	MORETHAN EQUAL
0%	5%	10%	25%	50%	75%	100%	100%+

Q18 Of the extra amount you would pay just to help fund supplemental complete groundwater treatment programs across the nation, about what percent would be to ensure

(32.72) % THAT YOUR HOUSEHOLD WILL HAVE CLEAN WATER TO USE IF YOU MOVE TO A DIFFERENT COMMUNITY

(21 .38) % THAT OTHER PEOPLE ACROSS THE COUNTRY WILL HAVE ENOUGH CLEAN WATER TO USE

(26.30) % THAT FUTURE GENERATIONS OF PEOPLE ACROSS THE COUNTRY WILL HAVE ENOUGH CLEAN WATER TO USE

(17.59) % THAT GROUNDWATER ACROSS THE NATION IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT

(2.01) % OTHER (Please describe:____________________)

= 100 % TOTAL

Q19 On a scale from 1 to 7, how responsible do you feel for helping to pay to clean up groundwater contamination problems in other communities across the nation?

NOT AT ALL RESPONSIBLE						EXTREMELY RESPONSIBLE	
1	2	3	4	5	6	7	(4.26)

ABOUT YOU AND YOUR HOUSEHOLD

H1 Who is the primary water supplier for the water you currently use in your home?

1. THE CITY OR COUNTY (71.4%)
2. A PRIVATE WATER SUPPLIER (7.5%)
3. OUR PRIVATE WELL (16%)
4. OTHER (Please specify) ______(5.1%)______

H2 Your gender:

1. FEMALE (30%)
2. MALE (70%)

H3 Your age: ____ (52.12)_YEARS

H4 Including yourself, how many members in your household are in each age group? (If none, write "0")

(.96) UNDER 18 YEARS OF AGE
(1.75) 18-64
(.83) 65 AND OVER

H5 How much formal education have you completed? (circle number)

1. NO FORMAL EDUCATION (.2%)
2. SOME GRADE SCHOOL (1.5%)
3. COMPLETED GRADE SCHOOL (1.3%)
4. SOME HIGH SCHOOL (5.3%)
5. COMPLETED HIGH SCHOOL (20.4%)
6. TRADE SCHOOL (6.6%)
7. SOME COLLEGE (23.6%)
8. COMPLETED COLLEGE (20.6%)
9. SOME GRADUATE WORK (8.1%)
10. ADVANCED COLLEGE DEGREE (12.5%)

H6 Do you recycle or take special precautions in disposing of any of the following materials? (circle appropriate response for each)

1. NEWSPAPER	YES NO DON'T KNOW (73.1% yes)
2. GLASS	YES NO DON'T KNOW (6006% yes)
3. ALUMINUM OR OTHER METALS	YES NO DON'T KNOW (83.4% yes)
4. PLASTIC	YES NO DON'T KNOW (58.1% yes)
5. PAINTS AND PAINT THINNERS	YES NO DON'T KNOW (49.2% yes)
6. USED ENGINE OIL AND COOLANT/ANTIFREEZE	YES NO DON'T KNOW (62.7% yes)
7. HOUSEHOLD CHEMICALS	YES NO DON'T KNOW (44.5% yes)
8. OTHER (please specify) ______(5.3% yes)________	

H7 In the past year, have you held membership or donated time or money to any environmental organizations or groups?

1. NO (70.970)
2. YES -- ONE GROUP (19.5'%0)
3. YES - TWO OR THREE GROUPS (8.3'%)
4. YES - MORE THAN THREE GROUPS (1 .30A)

H8 How would you describe your racial or ethnic background? (circle one)

1. WHITE OR CAUCASIAN (90.5%)
2. BLACK OR AFRICAN AMERICAN (5.7%)
3. HISPANIC OR MEXICAN AMERICAN (1.9%)
4. ASIAN OR PACIFIC ISLANDER (11%)
5. NATIVE AMERICAN INDIAN (0%)
6. OTHER (please specify) ________(.8%)________

H9 What is your present employment? (Circle the best answer)

1. EMPLOYED FUU TIME (53.7%)
2. EMPLOYED PART TIME (7.6%)
3. FULL TIME HOMEMAKER (4.3%)
4. UNEMPLOYED (1 .3%)
5. RETIRED (27.8%)
6. STUDENT (1 .3%)
7. OTHER (Please specify)(5 . 1 %) ________

H10 What is your total annual household income before taxes and other deductions? (circle one)

1. UNDER $9,999 (8.7%)
2. $10,000- 19,999 (13.6%)
3. $20,000-29,999 (15%)
4. $30,000 - 39,999 (16.6%)
5. $40,000 -49,999 (14.1%)
6. $50,000-59,999 (1 1.5%)
7. $60,000-69,999 (4.7%)
8. $70,000-79,999 (4.4%)
9. $80,000-89,999 (3.3%)
10. $90,000-99,999 (1 .9%)
11. $100,000 " 119,999 (3.3%)
12.. $120,000-139$999 (*9%)
13. $140,000-159,999 (.5%)
14. $160,000-179,000 (O%)
15. $180,000-199,999 (.2%)
16. $200,000 and OVER (1 .4%)

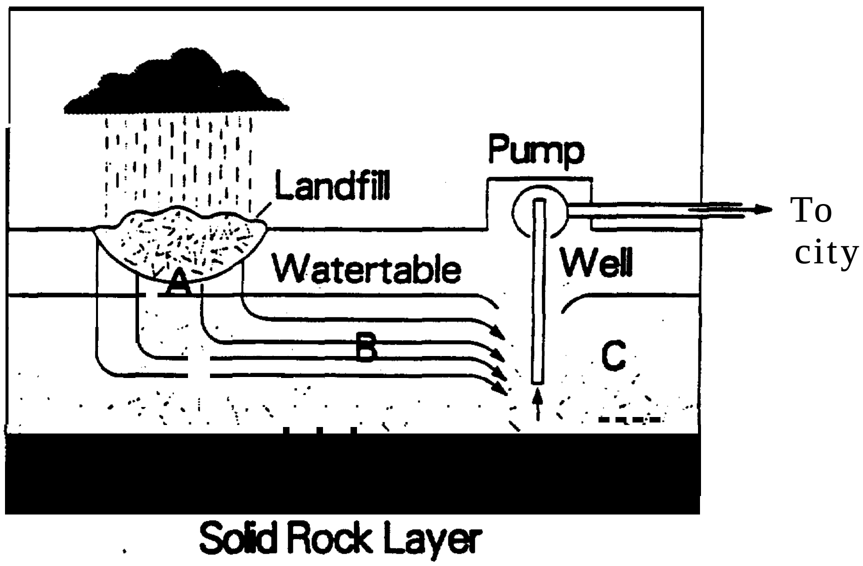
Is there anything we have overlooked? Please use the space below to write any comments or suggestions you may have about the survey.

YOUR PARTICIPATION IS GREATLY APPRECIATED!

n Check this box if you would like a summary of the results.

(If different from mailing label, list your name and address here.)

GROUNDWATER CONTAMINATION: WHAT IS YOUR OPINION?



This survey should be completed by a head of your household

Please return survey to:
Center for Economic Analysis
University of Colorado
Boulder, Colorado 80309-0287

THE ISSUES

About 50% of the water used by the U.S. population for drinking, cooking, bathing and other home purposes comes from groundwater. We are interested in your views on what, if anything, should be done to clean up contaminated groundwater which can no longer be used without treatment.

Q1 Are you aware of groundwater contamination in your community coming from any of these specific sources? (Circle the best answer)

1. No (49%)

2. YES (Circle all that apply) (51%)

A. SUPERFUND SITE (3.9%)	B. HAZARDOUS WASTE SITE (10.2%)	C. LANDFILL (59.2%)
D. SEPTIC TANK (11.4%)	E. AGRICULTURAL RUNOFF (19.6%)	F. INDUSTRY (21.4%)

G. OTHER (Please Specify)(6.9%)__

Q2 Because the rest of this survey concerns only groundwater contamination, it is useful to understand how important you feel cleaning up contaminated groundwater is in comparison to other issues. From least to most concerned, how do you rate the issues listed below? (Circlenumber of best response for each issue.)

	NOT AT ALL CONCERNED 1	2	3	4	5	6	GREATLY CONCERNED 7	
Improving public roads	1	2	3	4	5	6	7	(4.37)
Improving the education system	1	2	3	4	5	6	7	(5.94)
Reducing air pollution	1	2	3	4	5	6	7	(5.73)
Saving endangered species	1	2	3	4	5	6	7	(4.61)
Reducing global warming	1	2	3	4	5	6	7	(4.96)
Promoting recycling	1	2	3	4	5	6	7	(5.62)
Cleaning up rivers and lakes	1	2	3	4	5	6	7	(6.00)
Cleaning up groundwater	1	2	3	4	5	6	7	(6.00)

Water for residential use can come from many different sources, including rivers, lakes, and groundwater. Groundwater comes from rain and snow that falls on the land and seeps underground. At some depth underground the soil or rock becomes saturated with water, and this water can then be pumped to the surface.

Q3 Does your household get any part of its water from groundwater?

1. NO -- WE DONT USE GROUNDWATER AT ALL (28.5%)
2. YES - PART OF OUR WATER COMES FROM GROUNDWATER (17.3?40)
3. YES - ALL OF OUR WATER COMES FROM GROUNDWATER (34.470)
4. DONT KNOW (19.80/o)

Q4 Sometimes, garbage and waste placed in a community's landfill, similar to the one shown on the cover of this survey, can leak out and contaminate groundwater. Does your community have a landfill?

1. NO (28.3%)
2. YES (59.9%)
3. DON'T KNOW (11.8%)

Rainwater seeping through a landfill may dissolve some of the chemicals in the discarded trash. This material, which can be toxic, may seep into the water table and contaminate the water below (as A shows on the front cover). Once contaminants reach the water table, they spread very slowly underground in the direction water is flowing (see B on the front cover). Many people are surprised to learn that this flow is very very slow; usually less than 100 feet per year. After many years, the landfill may contaminate water drawn by a well supplying water to the citizens of the community (see C on the front cover).

Q5 Does your community currently draw water from wells which have been or are in danger of becoming contaminated?

1. NO (49.6%)
2. YES - CONTAMINATED BY A LANDFILL (7.3%)
3. YES - CONTAMINATED BY ANOTHER SOURCE (Please specify) .(7 . 3 %)
4. DON'T KNOW (35.9"/0)

HOW COMMUNITIES CAN RESPOND TO CONTAMINATED GROUNDWATER

In the rest of the survey, we would like you to consider an imaginary situatio Suppose that you live in a community which has groundwater contamination as the result of a leaking public landfill. Contaminants have been found in groundwater which normally supply 40% of the water used by the community. Contamination covers approximately five acres underground (in an area 700 feet long and 390 feet wide and 25 feet deep). The other 60% of the water supply is from uncontaminated surface water sources. In answering the following questions, you should assume that:

- The contamination is the result of standard public landfill practices used in the past that were believed to be safe at the time. No private company or party is at fault.

- Scientists estimate that drinking the contaminated water would increase the risk of cancer, resulting in about 10 additional deaths per million people who drink the water per year (about the same level of risk a typical person has of developing cancer from exposure to routine medical x-rays).

- Local government has concluded that the water must not be used for drinking or cooking unless it is treated to remove the contaminants. It could, however, be used as is for such purposes as bathing, washing clothes, or watering lawns.

There are many ways a community might respond to such a groundwater problem. For each of the following cleanup options please circle the number indicating how satisfied you are with that solution.

Q6 COMPLETE CLEANUP. The water bills of current users would be increased to pay for a complete groundwater cleanup. An underground concrete wall would be built around the landfill down to the solid rock layer to seal it off from the groundwater. All contaminated water would be pumped up and cleaned. The clean water would be reinfected back underground for use now and in the future. This would benefit your household and future generations by ensuring that about the same amount of clean water is available as before the contamination occurred. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(4.27)

Q7 CONTAINMENT. Wells would be drilled in the area to which contaminated groundwater is moving. Contaminated water would be pumped up to stop it from spreading further. This water would be cleaned and pumped back underground into the containment area. This approach does not complete clean up the contamination. Your household would have the same amount of clean water to use since new supply wells would be drilled outside of the containment area. The water bills of current users would be increased to pay for the containment system. Future generations would pay for operation and maintenance costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3:47)

Q8 PUBLIC TREATMENT. The local government would increase water bills of users to pay for the construction, maintenance and operation of a water treatment plant to remove contaminants from the water as needed. Contaminants would remain in the ground yet never enter the public water supply. Future generations would have to pay for their own treatment costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.86)

Q9 HOME TREATMENT. Each household purchases and installs its own charcoal filtration system to remove contaminants before the water is used in the home. These systems typically cost $180 to install and an additional $25 per month for maintenance. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.85)

Q10 WATER RATIONING. The local government would institute a mandatory water conservation program to avoid having to make up the 40% shortfall. The contaminated water would not be cleaned up nor used. Surface water from lakes and streams provides the 60% of available clean water. Water bills would not increase but everyone would have to cut their water use by 40%. Realizing that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen, how satisfied are you with water rationing as an option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.46)

HOW MUCH IS IT WORTH TO YOU TO COMPLETELY CLEAN UP CONTAMINATED GROUNDWATER?

Your answers to the next questions are very important We do not yet know how much it will cost to clean up contaminated groundwater. However, to make decisions about new groundwater cleanup programs that could cost you money, decision makers want to learn how much clean groundwater is worth to people like you.

Q11 Suppose that the complete cleanup program described in Q6 could be achieved in your imaginary community. What would a complete cleanup program be worth to your household, if you faced the hypothetical problem of 40% of your water supply coming from contaminated groundwater as we have described? In answering, you should assume that:

- The money would be used only in this hypothetical community for sealing off the landfill, cleaning the contaminated water and for purchasing clean water until the cleanup is completed. The cost of the project (unknown at this time) would be spread out "over a ten year period.
- If the program turns out to cost less than people are willing to pay, each household would only pay a share of what it costs. If it turns out to cost more than people are willing to pay, the program would not be carried out.
- Scientists are satisfied that water cleaned and reinfected using these methods will be contaminant-free and safe to drink.
- The program would also provide benefits to future generations. New families moving in or just starting out would not have to pay any money to ensure the groundwater they used was clean.

Now, what is the most your household would be willing to pay each month on top of your current water bill for the next 10 years for the complete groundwater cleanup program? (Circle the best response.)

(16.31)

$0	'$1 .50	$4	$10	$30	$75	$200
$0.50	$2	$5	$15	$40	$100	'$500
$1	$3	$8	$20	$50	$150	MORE THAN $S00

Q12 Some people tell us it is difficult to think about paying to reduce just one environmental problem. Would you say that the dollar amount you stated your household would be willing to pay for complete groundwater cleanup (Q11) is: , (Circle number)

1. JUST FOR THE STATED GROUNDWATER PROGRAM (Go to Q 14)

2. SOMEWHAT FOR THE GROUNDWATER PROGRAM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES

3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENTAL OR OTHER WORTHWHILE PUBLIC CAUSES

4. OTHER (Please specify)________________________

1-69.1% 2-1 8.1% 3-9.5'%0, 4-3.3%

Q13 About what percent of your dollar amount is just for the stated complete groundwater cleanup program? (Circle percent)
(76.630A)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Q14 Of the amount you would pay just for the complete groundwater cleanup program, about what percent would be to ensure

(35.11) % THAT YOUR HOUSEHOLD HAS ENOUGH CLEAN WATER TO USE
(21.01) % THAT OTHER HOUSEHOLDS IN YOUR COMMUNITY HAVE ENOUGH CLEAN WATER TO USE
(23.53) % THAT FUTURE GENERATIONS OF PEOPLE LIVING IN YOUR COMMUNITY WILL HAVE ENOUGH CLEAN WATER TO USE
(20.35) % THAT THE GROUNDWATER IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT
= 100 % TOTAL

Q15 On a scale from 1 to 7, how responsible would you feel for helping to pay to clean up such a groundwater contamination problem in your community. (4.2)

NOT AT ALL RESPONSIBLE ... EXTREMELY RESPONSIBLE

1 2 3 4 5 6 7

HOW MUCH IS IT WORTH TO YOU TO HAVE A CLEAN SUPPLY OF WATER?

Suppose that a complete groundwater cleanup is not technically possible in your imaginary community. So, your community proposes a PUBLIC TREATMENT PROGRAM like that described in Q8, in which groundwater would be treated and cleaned as it was pumped to the surface for use. The water underground would still be contaminated.

Q16 What would a public treatment program like that described in Q8 be worth to your household if you faced the problem of 40% of your water supply coming from contaminated groundwater as we have described? In answering you should assume that:

- **The money would be used for design, construction, operation, and maintenance of the water supply treatment system. Initial costs for design and construction would be spread out over a ten year period. Future generations would have to pay for their own treatment costs.**
- **If the program turned out to cost less than people were willing to pay, each household would pay a share of what it cost. If it turned out to cost more than people were willing to pay, the program would not be carried out.**
- **Scientists are satisfied that contaminated groundwater can be treated and cleaned so that it would be contaminant-free and safe to drink.**
- **This approach does not clean up all of the existing contaminated groundwater. It only cleans water that is to be used as it is pumped up and used for the public water supply.**

Now, of the dollar amount you would have paid just for complete groundwater cleanup, what percent would you still be willing to pay for the public treatment program described above? (50.30)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

ABOUT YOU AND YOUR HOUSEHOLD

H1 Who is the primary water supplier for the water you currently use in your home?

1. THE CITY OR COUNTY (76.1?40)
2. A PRIVATE WATER SUPPLIER (7.4%)
3. OUR PRIVATE WELL (14.9?40)
4. OTHER (Please specify) (1 .5%)________

H2 Your gender:

1. FEMALE (31%)
2. MALE (69%)

H3 Your age: ____(50.31)_ YEARS

H4 Including yourself, how many members in your household are in each age group? (If none, write "0")

(1.16) UNDER 18 YEARS OF AGE
(1.16) 18-64
(.78) 65 AND OVER

H5 How much formal education have you completed? (circle number)

1. NO FORMAL EDUCATION (.2%)
2. SOME GRADE SCHOOL (1.3%)
3. COMPLETED GRADE SCHOOL (3.4%)
4. SOME HIGH SCHOOL (4.4%)
5. COMPLETED HIGH SCHOOL (17.2%)
6. TRADE SCHOOL (8.8%)
7. SOME COLLEGE (26.7%)
8. COMPLETED COLLEGE (20.6%)
9. SOME GRADUATE WORK (4.6%)
10. ADVANCED COLLEGE DEGREE (12.6%)

H6 Do you recycle or take special precautions in disposing of any of the following materials? (circle appropriate response for each)

1. NEWSPAPER YES NO DON'T KNOW (75.3% yes)
2. GLASS YES NO DON'T KNOW (60.9% yes)
3. ALUMINUM OR OTHER METALS YES NO DON'T KNOW (81.2% yes)
4. PLASTIC YES NO DON'T KNOW (68.1% yes)
5. PAINTS AND PAINT THINNERS YES NO DON'T KNOW (48.8% yes)
6. USED ENGINE OIL AND COOLANT/ANTIFREEZE YES NO DON'T KNOW (62.3% yes)
7. HOUSEHOLD CHEMICALS YES NO DON'T KNOW (43.7% yes)
8. OTHER (please specify) ________________________

H7 In the past year, have you held membership or donated time or money to any environmental organizations or groups?

1. NO (70%)
2. YES -- ONE GROUP (22.4%)
3. YES - TWO OR THREE GROUPS (6.7%)
4. YES - MORE THAN THREE GROUPS (.8%)

H8 How would you describe your racial or ethnic background? (circle one)

1. WHITE OR CAUCASIAN (88.5%)
2. BLACK OR AFRICAN AMERICAN (5.7°/0)
3. HISPANIC OR MEXICAN AMERICAN (3.6%)
4. ASIAN OR PACIFIC ISLANDER (1.3°/0)
5. NATIVE AMERICAN INDIAN (00/')
6. OTHER (please specify) ______(1 .0%)__________

H9 What is your present employment? (Circle the best answer)

1. EMPLOYED FULL TIME (59%)
2. EMPLOYED PART TIME (5.2%)
3. FULL TIME HOMEMAKER (1.5%)
4. UNEMPLOYED (2.5%)
5. RETIRE D(27.7%)
6. STUDENT (1.5%)
7. OTHER (Please specify)__________(2.7%)_____

H10 What is your total annual household income before taxes and other deductions? (circle one)

1. UNDER $9,999 (8.6?40)
2. $10,000 - 19,999 (14.796)
3. $20,000 - 29,999 (16.8'%0)
4. $30,000 - 39,999 (17.1%)
5. $40,000 - 49,999 (10.0%)
6. $50,000-59,999 (10.5'Mo)
7. $60,000-69,999 (4.4%)
8. $70,000-79,999 (5.60/e)
9. $80,000 - 89,999 (4.9%)
10. $90,000 - 99,999 (1.4%)
11. $100,000 - 119,999 (3.3%)
12. $120,000-139,999 (*2%)
13. $140,000-159,999 (.7%)
14. $160,000-179,000 (.5%)
15. $180,000-199,999 (.2'%)
16. $200,000 and OVER (.9%)

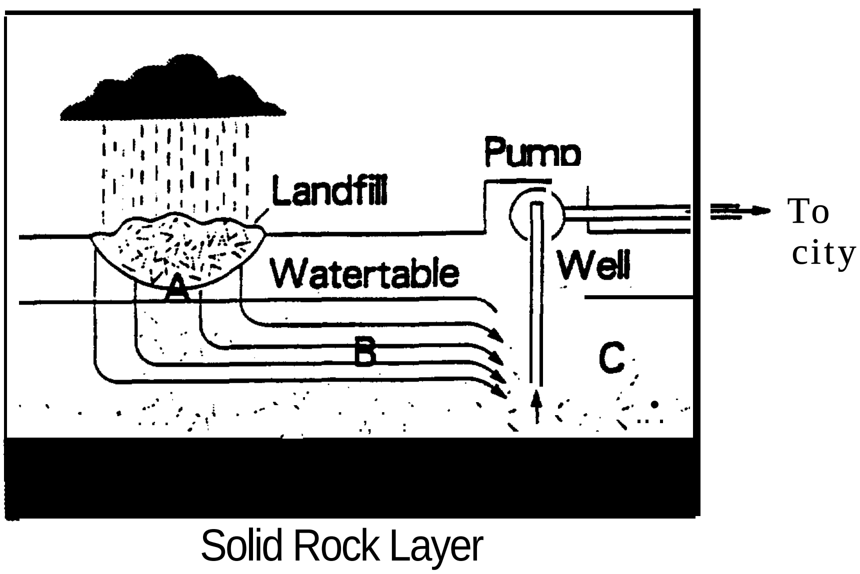
Is there anything we have overlooked? Please use the space below. to write any comments or suggestions you may have about the survey.

YOUR PARTICIPATION IS GREATLY APPRECIATED!

☐ **Check this box if you would like a summary of the results.**

(If different from mailing label, list your name and address here.)

GROUNDWATER CONTAMINATION: WHAT IS YOUR OPINION?



This survey should be completed by a head of your household.

Please return survey to:
Center for Economic Analysis
University of Colorado
Boulder, Colorado 80309-0257

THE ISSUES

About 50°A of the water used by the U.S. population for drinking, cooking, bathing and other home purposes comes from groundwater. We are interested in your views on what, if anything, should be done to clean up contaminated groundwater which can no longer be used without treatment.

Q1 Are you aware of groundwater contamination in your community coming from any of these specific sources? (Circle the best answer)

1. NO (48%)

2. YES (Circle all that apply) (5296)

A. SUPERFUND SITE (4.8%) B. HAZARDOUS WASTE SITE (9.5%) C. LANDFILL (58.1 '/')

D. SEPTIC TANK (16.2%) E. AGRICULTURAL RUNOFF (20°/0) F. INDUSTRY (21 .5%)

G. OTHER (Please Specify) (6.9%) ________

Q2 Because the rest of this survey concerns only groundwater contamination, it is useful to understand how important you feel cleaning up contaminated groundwater is in comparison to other issues. From least to most concerned, how do you rate the issues listed below? (Circle number of best response for each issue.)

	NOT AT ALL CONCERNED						GREATLY CONCERNED	
Improving public roads	1'	2	3	4	5	6	7	(4.5)
Improving the education system	1	2	3	4	5	6	7	(5.9)
Reducing air pollution	1	2"	3	4	5	6	7	(5.7)
Saving endangered species	1	2	3	4	5	6	7	(4.7)
Reducing global warming	1	2	3	4	5	6	7	(4.9)
Promoting recycling	1	2	3	4	5	6	7	(5.6)
Cleaning "up rivers and lakes	1	2	3	4	5	6	,7	(6.1)
Cleaning up groundwater	1	2	3	4	5	6	7	(6.0)

Water for residential use can come from many different sources, including rivers, lakes, and groundwater. Groundwater comes from rain and snow that falls on the land and seeps underground. At some depth underground the soil or rock becomes saturated with water, and this water can then be pumped to the surface.

Q3 Does your household get any part of its water from groundwater?

1. NO -WE DON'T USE GROUNDWATER AT ALL (28.5%)
2. YES - PART OF OUR WATER COMES FROM GROUNDWATER (18.1%)
3. YES - ALL OF OUR WATER COMES FROM GROUNDWATER (31 .1%)
4. DON'T KNOW (22.3%)

Q4 Sometimes, garbage and waste placed in a community's landfill, similar to the one shown on the cover of this survey. can leak out and contaminate groundwater. Does your community have a landfill?

1. NO (30.8%)
2. YES (58.6%)
3. DON'T KNOW (1 0.6)

Rainwater seeping through a landfill may dissolve some of the chemicals in the discarded trash. This material, which can be toxic, may seep into the water table and contaminate the water below (as A shows on the front cover). Once contaminants reach the water table, they spread very slowly underground in the direction water is flowing (see B on the front cover). Many people are surprised to learn that this flow is very very slow; usually less than 100 feet per year. After many years, the landfill may contaminate water drawn by a well supplying water to the citizens of the community (see C on the front cover).

Q5 Does your community currently draw water from wells which have been or are in danger of becoming contaminated?

1. NO (48.1%)
2. YES - CONTAMINATED BY A LANDFILL (8.8%)
3. YES - CONTAMINATED BY ANOTHER SOURCE (Please specify) ___(6.1%)______
4. DON'T KNOW (36.9%)

HOW COMMUNITIES CAN RESPOND TO CONTAMINATED GROUNDWATER

In the rest of the survey, we would like you to consider an imaginary situation. Suppose that you live in a community which has groundwater contamination as the result of a leaking public landfill. Contaminants have been found in groundwater which normally supply 40% of the water used by the community. Contamination covers approximately five acres underground (in an area 700 feet long and 390 feet wide and 25 feet deep). The other 60°A of the water supply is from uncontaminated surface water sources. In answering the following questions, you should assume that:

- The contamination is the result of standard public landfill practices used in the past that were believed to be safe at the time. No private company or party is at fault.
- Scientists estimate that drinking the contaminated water would increase the risk of cancer, resulting in about 10 additional deaths per million people who drink the water per year (about the same level of risk a typical person has of developing cancer from exposure to routine medical x-rays).
- Local government has concluded that the water must <u>not</u> be used for drinking or cooking unless it is treated to remove the contaminants. It could, however, be used as is for such purposes as bathing, washing clothes, or watering lawns.

There are many ways a community might respond to such a groundwater problem. For each 'of the following cleanup options please circle the number indicating how satisfied you are with that solution.

Q6 <u>COMPLETE CLEANUP</u>. The water bills of current users would be increased to pay for a complete groundwater cleanup. An underground concrete wall would be built around the landfill down to the solid rock layer to seal it off from the groundwater. All contaminated water would be pumped up and cleaned. The clean water would be reinfected back underground for use now and in the future. This would benefit your household and future generations by ensuring that about the same amount of clean water is available as before the contamination occurred. How satisfied are you with this option?

NOT AT ALL " SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(4.34)

Q7 **CONTAINMENT.** Wells would be drilled in the area to which contaminated groundwater is moving. Contaminated water would be pumped up to stop it from spreading further. This water would be cleaned and pumped back underground into the containment area. This approach does not completely clean up the contamination. Your household would have the same amount of clean water to use since new supply wells would be drilled outside of the containment area. The water bills of current users would be increased to pay for the containment system. Future generations would pay for operation and maintenance costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.40)

Q8 **PUBLIC TREATMENT.** The local government would increase water bills of users to pay for the construction, maintenance and operation of a water treatment plant to remove contaminants from the water as needed. Contaminants would remain in the ground yet never enter the public water supply. Future generations would have to pay for their own treatment costs. How satisfied are you with this option?

NOT AT AU SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.77)

Q9 **HOME TREATMENT.** Each household purchases and installs its own charcoal filtration system to remove contaminants before the water is used in the home. These systems typically cost $180 to install and an additional $25 per month for maintenance. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.89)

Q1 O **WATER RATIONING.** The local government would institute a mandatory water conservation program to avoid having to make up the 40% shortfall. The contaminated water would not be cleaned up nor used. Surface water from lakes and streams provides the 60°A of available clean water. Water bills would not increase but everyone would have to cut their water use by 40%. Realizing that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen, how satisfied are you with water rationing as an option?

NOT AT AU SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.61)

HOW MUCH IS IT WORTH TO YOU TO COMPLETELY CLEAN UP CONTAMINATED GROUNDWATER?

Your answers to the next questions are very important. We do not yet know how much it will cost to clean up contaminated groundwater. However, to make decisions about new groundwater cleanup programs that could cost you money, decision makers want to learn how much clean groundwater is worth' to people like you.

Q11 Suppose that the complete cleanup program described in Q6 could be achieved in your imaginary community. What would a complete cleanup program be worth to your household, if you faced the hypothetical problem of 40% of your water supply coming from contaminated groundwater as we have described? In answering, you should assume that:

- The money would be used only in this hypothetical community for sealing off the landfill, cleaning the contaminated water and for purchasing clean water until the cleanup is completed. The cost of the project (unknown at this time) would be spread out over a ten year period.
- If the program turns out to cost less than people are willing to pay, each household would only pay a share of what it costs. If it turns out to cost more than people are willing to pay, the program would not be carried out.
- Scientists are satisfied that water cleaned and reinfected using these methods will be contaminant-free and safe to drink.
- The program would also provide benefits to future generations. New families moving in or just starting out would not have to pay any money to ensure the groundwater they used was clean.

Now, what is the most your household would be willing to pay each month on top of your current water bill for the next 10 years for the complete groundwater cleanup program? (Circle the best response.)
(13.94)

$0	$1.50	$4	$10	$30	$75	\ $200
$0.50	$2	$5	$15	$40	$100	$500
$1	$3	$8	$20	$50	$150	MORE THAN $500

Q12 Some people tell us it is difficult to think about paying to reduce just one environmental problem. Would you say that the dollar amount YOU stated your household would be willing to pay for complete groundwater cleanup (QI 1) is: (Circle number)

1. JUST FOR THE STATED GROUNDWATER PROGRAM (Go to Q 14)

2. SOMEWHAT FOR THE GROUNDWATER PROGRAM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES

3. BASICALLY A CONTRIBUTION TO ALL ENVIRONMENTAL OR OTHER WORTHWHILE PUBLIC CAUSES

4. OTHER (Please specify) ____________________________

1 -66'/0, 2-20"?'0, 3-1 0.7%, 4-3.3%

Q13 About what percent of your dollar amount is just for the stated complete groundwater cleanup program? (Circle percent)

(76.68%)

NONE		SOME			HALF			MOST		ALL
o%	10%	20%	300/0	40%	500/0	60%	70%	80%	90%	100%

Q14 Of the amount you would pay just for the complete groundwater cleanup program, about what percent would be to ensure

(37.96) % THAT YOUR HOUSEHOLD HAS ENOUGH CLEAN WATER TO USE
(25.62) % THAT OTHER HOUSEHOLDS IN YOUR COMMUNITY HAVE ENOUGH CLEAN WATER TO USE
(30.49) % THAT FUTURE GENERATIONS OF PEOPLE LIVING IN YOUR COMMUNITY WILL HAVE ENOUGH CLEAN WATER TO USE
(24.77) % THAT THE GROUNDWATER IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT
= 100 % TOTAL

Q15 On a scale from 1 to 7, how responsible would you feel for helping to pay to clean up such a groundwater contamination problem in your community.

NOT AT ALL RESPONSIBLE						EXTREMELY RESPONSIBLE	
1	2	3	4	5	6	7	(4.2)

WHAT IF YOU DEPENDED LESSOR MORE ON GROUNDWATER

Dependency on groundwater is different for every location at which contamination has occurred. Some areas use groundwater for all of their domestic water supply while others use none. To plan new groundwater cleanup programs that could cost you money, decision makers want to learn how much clean groundwater is worth to people like you in these different situations.

WHERE GROUNDWATER SUPPLIES 10% OF DOMESTIC WATER

Q16 Consider an imaginary leaking landfill identical to that described above except that now groundwater supplies 10*A of the domestic water supply instead of 40%. Remembering that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen how satisfied are you with water rationing as an option where water use would have to be cut by 10% ?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.64)

Q17 What would a complete cleanup program like that described in Q6 be worth to your household if your imaginary community faced a groundwater problem where 10% of the local domestic water supply comes from groundwater which was contaminated and could not be used without treatment? In answering you should assume that:

- The hypothetical situation is now one in which only 10% of the water you use in your community comes from groundwater resources. The other 90% of your water comes from surface water sources such as lakes and streams.
- The complete cleanup program is identical to the program described in the previous section.

Now, of the dollar amount you would have paid just for complete groundwater cleanup when faced with 40'% of your water supply contaminated, what percent would you still be willing to pay for complete groundwater cleanup if faced with 10% of your water supply coming from contaminated groundwater?

NONE		SOME			HALF			MOST (46.51%)		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

WHERE GROUNDWATER SUPPLIES 70% OF DOMESTIC WATER

Q1 a **Consider an imaginary leaking landfill identical to that described abo except that now groundwater supplies 70% of the domestic water supply instead of 40%. Remembering that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen how satisfied are you with water rationing as an option where water** use would **have to be cut by** 70%?

NOT AT AU SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.35)

Q19 What would a complete cleanup program like that described in Q6 be **worth to your household if your imaginary community faced a groundwater problem where 70% of the local domestic water supply comes from groundwater which was contaminated and could not be used without treatment? In answering you should assume that:**

- **The hypothetical situation is now one in which 70% of the water you use in your community comes from groundwater resources. The other 30% of your water comes from surface water sources such as lakes and streams.**

m **The complete cleanup program is identical to the program described in the previous section.**

Now, of the dollar amount you would have paid just for complete groundwater cleanup when faced· with 40% of your water supply contaminated, what percent would you be willing to pay for complete groundwater cleanup if faced with 70% of your water supply coming from contaminated groundwater? (Circle the best per cent response)

(1 66.24%)

SAME				TWICE AS MUCH		3 TIMES AS MUCH		MORE THAN 4X AS MUCH
100%	125%	150°A	175%	200?/0	250%	30096	350”!	400%+

ABOUT YOU AND YOUR HOUSEHOLD

HI Who is the primary water supplier for the water you currently use in your home?

1. THE CITY OR COUNTY (73.7%)
2. A PRIVATE WATER SUPPLIER (6.6%)
3. OUR PRIVATE WELL (1 5.6%)
4. OTHER (Please specify) (4.1%)

HZ Your gender:

1. FEMALE (31%)
2. MALE (690/o)

H3 Your age: ____(50.31)_ YEARS

H4 Including yourself, how many members in your household are in each age group? (If none, write "O")

(1.1 2) UNDER 18 YEARS OF AGE
(1.85) 18-64
(.69) 65 AND OVER

H5 How much formal education have you completed? (circle number)

1. NO FORMAL EDUCATION (.2%)
2. SOME GRADE SCHOOL (1 .1%)
3. COMPLETED GRADE SCHOOL (3%) ,
4. SOME HIGH SCHOOL (5.4?40)
5. COMPLETED HIGH SCHOOL (24.1%)
6. TRADE SCHOOL (6.9%)
7. SOME COLLEGE (23.3%)
8. COMPLETED. COLLEGE (17%)
9. SOME GRADUATE WORK (6.5%)
10. ADVANCED COLLEGE DEGREE (12.5%)

H6 Do you recycle or take special precautions in disposing of any of the following materials? (circle appropriate response for each)

1. NEWSPAPER	YES NO DON'T KNOW (73% yes)
2. GLASS	YES NO DON'T KNOW (61.6% yes)
3. ALUMINUM OR OTHER METALS	YES NO DON'T KNOW (64.1% yes)
4. PLASTIC	YES NO DON? KNOW (55.4% yes)
5. PAINTS AND PAINT THINNERS	YES NO DON'T KNOW (49.796 yes)
6. USED ENGINE OIL AND COOLANT/ANTIFREEZE	YES NO DON'T KNOW (65.2% yes)
7. HOUSEHOLD CHEMICALS	YES NO DON'T KNOW (46% yes)
8. OTHER (please specify)	___________(4.8% yes)________

H7 In the past year, have you held membership or donated time or money to any environmental organizations or groups?

1. NO
2 . YES - ONE GROUP (70.4%)
3. YES - TWO OR THREE GROUPS (20%)
4. YES - MORE THAN THREE GROUPS (8.3%)

H8 How would you describe your racial or ethnic background? (circle one)

1. WHITE OR CAUCASIAN (88%)
2. BLACK OR AFRICAN AMERICAN (4.6%)
3. HISPANIC OR MEXICAN AMERICAN (3.3%)
4. ASIAN OR PACIFIC ISLANDER (2.070)
5. NATIVE AMERICAN INDIAN (.7?40)
6. OTHER (please specify) (1 . 5 %)_____

H9 What is your present employment? (Circle the best answer)

1. EMPLOYED FULL TIME (55.3°/0)
2. EMPLOYED PART TIME (5.8%)
3. FULL TIME HOMEMAKER (4.3°/0)
4. UNEMPLOYED (2.8%)
5. RETIRED (27.5%)
6. STUDENT (1 .1%)
7. OTHER (Please specify)(3 . 2 %)______

HI O What is your total annual household income before taxes and other deductions? (circle one)

1. UNDER $9,999 (9.9%)
2.$10,000 - 19,999 (14.9'%0)
3.$20,000-29,999 (17.5?40)
4. $30,000-39,999 (1 5.8%)
5.$40,000-49,999 (12.5%)
6. $50,000-59,999 (9.2%)
7. $60,000 -69,999 (6.6%)
8. $70,000-79,999 (2.6%)
9. $80,000-89,999 (2.1 %)
10. $90,000-99,999 (2.4%)
11. $100,000-119,999 (2.1%)
12. $120,000-139,999 (2.1%)
13. $140,000 " 159,999 (.9%)
14. $160,000-179,000 (.2%)
15. $180,000-199,999 (.7%)
16. $200,000 and OVER (.5%)

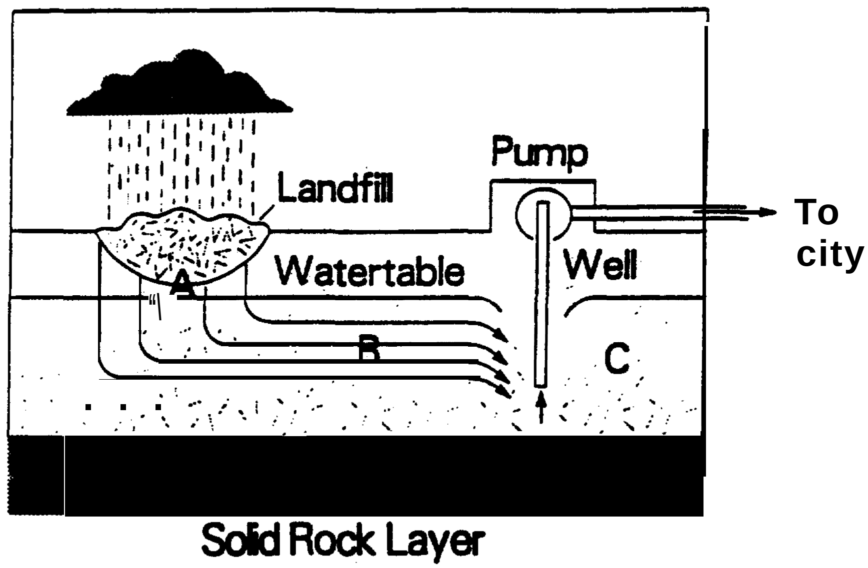
Is there anything we have overlooked? Please use the space below to write any comments or suggestions you may have about the survey.

YOUR PARTICIPATION IS GREATLY APPRECIATED!

☐ Cheek **this box if you would like a summary of the results.**

(If different from mailing label, list your name and address' here.)

GROUNDWATER CONTAMINATION: WHAT IS YOUR OPINION?



This survey should be completed by a head of your household.

Please return survey to:
Center for Economic Analysis
University of Colorado
Boulder, Colorado 80309-0257

THE ISSUES

About 50% of the water used by the U.S. population for drinking, cooking, bathing and other home purposes comes from groundwater. We are interested in your views on what, if anything, should be done to clean up contaminated groundwater which can no longer be used without treatment.

q1 Are you aware of groundwater contamination in your community coming from any of these specific sources? (Circle the best answer)

1. NO (49940)
2. YES (Circle all that apply)

A. SUPERFUND SITE (4%) B. HAZARDOUS WASTE SITE (12%) C. LANDFILL (58%)

D. SEPTIC TANK (12%) E. AGRICULTURAL RUNOFF (16%) F. INDUSTRY (20%)

G. OTHER (Please Specify) ________(6%)_____

Q2 Because the rest of this survey concerns only groundwater contamination, it is useful to understand how important you feel cleaning up contaminated groundwater is in comparison to other issues. From least to most concerned, how do you rate the issues listed below? (Circle number of best response for each issue.)

	NOT AT ALL CONCERNED						GREATLY CONCERNED
Improving public roads	1	2	3	4	5	6	7 (4.48)
Improving the education system	1	2	3	4	5	6	7 (5.99)
Reducing air pollution	1	2	3	4	5	6	7 (5.74)
Saving endangered species	1	2	3	4	5	6	7 (4.65)
Reducing global warming	1	2	3	4	5	6	7 (4.89)
Promoting recycling	1	2	3	4	5	6	7 (5.66)
Cleaning” up rivers and lakes	1	2	3	4	5	6	7 (6.07)
Cleaning up groundwater	1	2	3	4	5	6	7 (6.05)

Water for residential use can come from many different sources, including rivers, lakes, and groundwater. Groundwater comes from rain and snow that falls on the land and seeps underground. At some depth underground the soil or rock becomes saturated with water, and this water can then be pumped to the surface.

Q3 Does your household get any part of its water from groundwater?

1. NO -WE DON'T USE GROUNDWATER AT ALL (26.7%)
2. YES - PART OF OUR WATER COMES FROM GROUNDWATER (16.2%)
3. YES - ALL OF OUR WATER COMES FROM GROUNDWATER (35.5%)
4. DON'T KNOW (21.6%)

Q4 Sometimes, garbage and waste placed in a community's landfill, similar to the one shown on the cover of this survey, can leak out and contaminate groundwater. Does your. community have a landfill?

1. NO (27.9%)
2. YES (59.3%)
3. DON'T KNOW (12.8%)

Rainwater seeping through a landfill may dissolve some of the chemicals in the discarded trash. This material, which can be toxic, may seep into the water table and contaminate the water below (as A shows on the front cover). Once contaminants reach the water table, they spread very slowly underground in the direction water is flowing (see B on the front cover). Many people are surprised to learn that this flow is very very slow; usually less than 100 feet per year. After many years, the landfill may contaminate water drawn by a well supplying water to the citizens of the community (see C on the front cover).

Q5 Does your community currently draw water from wells which have been or are in danger of becoming contaminated?

1. NO (51 .8%)
2. YES - CONTAMINATED BY A LANDFILL (6.4%)
3. YES - CONTAMINATED BY ANOTHER SOURCE (Please specify) (7.7%) _
4. DON'T KNOW (34%)

HOW COMMUNITIES CAN RESPOND TO CONTAMINATED GROUNDWATER

In the rest of the survey, we would like you to" consider an imaginary situatio Suppose that you live in a community which has groundwater contamination as the result of a leaking public landfill. contaminants have been found in groundwater which normally supply 40% of the water used by the community. Contamination covers approximately five acres underground (in an area 700 feet long and 390 feet wide and 25 feet deep). The other 60% of the water supply is from uncontaminated surface water sources. In answering the following questions, you should assume that:

- The contamination is the result of standard public landfill practices used in the past that were believed to be safe at the time. No private company or party is at fault.

- Scientists estimate that drinking the contaminated water would increase the risk of cancer, resulting in about 10 additional deaths per million people who drink the water per year (about the same level of risk a typical person has of developing cancer from exposure to routine medical x-rays).

- Local government has concluded that the water must not be used for drinking or cooking unless it is treated to remove the contaminants. It could, however, be used as is for such purposes as bathing, washing clothes, or watering lawns.

There are many ways a community might respond to such a groundwater problem. For each of the following cleanup options please circle the number indicating how satisfied you are with that solution.

Q6 COMPLETE CLEANUP. The water bills of current users would be increased to pay for a complete groundwater cleanup. An underground concrete wall would be built around the landfill down to the solid rock layer to seal it off from the groundwater. All contaminated water would be pumped up and cleaned. The clean water would be reinfected back underground for use now and in the future. This would benefit your household and future generations by ensuring that about the same amount of clean water is available as before the contamination occurred. How satisfied are you with 'this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(4.42)

Q7 **CONTAINMENT.** Wells would be drilled in the area to which contaminated groundwater is moving. Contaminated water would be pumped up to stop it from spreading further. This water would be cleaned and pumped back underground into the containment area. This approach does not complete clean up the contamination. Your household would have the same amount of clean water to use since new supply wells would be drilled outside of the containment area. The water bills of current users would be increased to pay for the containment system. Future generations would pay for operation and maintenance costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.5)

Q8 **PUBLIC TREATMENT.** The local government would increase water bills of users to pay for the construction, maintenance and. operation of a water treatment plant to remove contaminants from the water as needed. Contaminants would remain in the ground yet never enter the public water supply. Future generations would have to pay for their own treatment costs. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(3.76)

Q9 **HOME TREATMENT.** Each household purchases and installs its own charcoal filtration system to remove contaminants before the water is used in the home. These systems typically cost $180 to install and an additional $25 per month for maintenance. How satisfied are you with this option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.78)

Q10 **WATER RATIONING.** The local government would institute a mandatory water conservation program to avoid having to make up the 40°A shortfall. The contaminated water would not be cleaned up nor used. Surface water from lakes and streams provides the 60% of available clean water, Water bills would not increase but everyone would have to cut their water use by 40%. Realizing that, on average, households use half of their domestic water outdoors, one third in the bathroom and the rest in the kitchen, how satisfied are you with water rationing as an option?

NOT AT ALL SATISFIED						EXTREMELY SATISFIED	
1	2	3	4	5	6	7	(2.56)

HOW MUCH IS IT WORTH TO YOU TO COMPLETELY CLEAN UP CONTAMINATED GROUNDWATER?

Your answers to the next questions are very important We do not yet know how much it will cost to clean up contaminated groundwater. However, to make decisions about new groundwater cleanup programs that could cost you money, decision makers want to learn how much clean groundwater is worth-to people like you.

Q11 Suppose that the complete cleanup program described in Q6 could be achieved in your imaginary community. What would a complete cleanup program be worth to your household, if you faced the hypothetical problem of 40% of your water supply coming from contaminated groundwater as we have described? In answering, you should assume that:

- The money would be used only in this hypothetical community for sealing off the landfill, cleaning the contaminated water and for purchasing clean water until the cleanup is completed. The cost of the project (unknown at this time) would be spread out over a ten year period.
- If the program turns out to cost less than people are willing to pay, each household would only pay a share of what it costs. If it turns out to cost more than people are willing to pay, the program would not be carried out.
- Scientists are satisfied that water cleaned and reinfected using these methods will be contaminant-free and safe to drink.
- The program would also provide benefits to future generations. New families moving in or just starting out would not have to pay any money to ensure the groundwater they used was clean.

Now, what is <u>the most</u> your household would be willing to pay <u>each</u> month On top Of your current water bill for the next 10 years for the complete groundwater cleanup program? (Circle the best response.)

(14.15)

$0	$1.50	$4	$10	$30	$75	$200
$0.50	$2	$5	$15	$40	$100	$500
$1	$3	$8	$20	$50	$150	MORE THAN $S00

Q12 Some people tell us it is difficult to think about paying to reduce just one environmental problem. Would you say that the dollar amount you stated your household would be willing to pay for complete groundwater cleanup (Q11) is: (Circle number)

1. JUST FOR THE STATED GROUNDWATER PROGRAM (Go to Q 14)
2. SOMEWHAT FOR THE GROUNDWATER PROGRAM AND SOMEWHAT A GENERAL CONTRIBUTION TO ALL ENVIRONMENTAL CAUSES
3. BASICALLY A CONTRIBUTION TO AU ENVIRONMENTAL OR OTHER WORTHWHILE PUBLIC CAUSES
4. OTHER (Please specify)____________________

1 -68.2%, 2-1 5.6%, 3-11%, 4-5.2%

Q13 About what percent. of your dollar amount is just for the stated complete groundwater cleanup program? (Circle percent)
(73.73%)

NONE		SOME			HALF			MOST		ALL
0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%

Q14 Of the amount you would pay just for the complete groundwater cleanup program, about what percent would be to ensure

(41 .46) %	THAT YOUR HOUSEHOLD HAS ENOUGH CLEAN WATER TO USE
(25.92) %	THAT OTHER HOUSEHOLDS IN YOUR COMMUNITY HAVE ENOUGH CLEAN WATER TO USE
(31 .84) %	THAT FUTURE GENERATIONS OF PEOPLE LIVING IN YOUR COMMUNITY WILL HAVE ENOUGH CLEAN WATER TO USE
(27.05) %	THAT THE GROUNDWATER IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT
= 100 %	TOTAL

Q15 On a scale from 1 to 7, how responsible would you feel for helping to pay to clean up such a groundwater contamination problem in your community.

NOT AT ALL RESPONSIBLE						EXTREMELY RESPONSIBLE
1	2	3	4	5	6	7 (4.12)

ABOUT THE NATIONAL GROUNDWATER PROBLEM

To plan new groundwater cleanup programs, decision makers want to know how much it is worth to you to help solve groundwater problems, not just in your community, but across the entire nation.

Q16 What would it be worth to your household to help fund complete groundwater cleanup for communities other than yours which have groundwater contamination? These are communities that you or your family may move to someday. In answering, you should assume that if the programs turn out to cost less than people are willing to pay, each household would only pay a share of what it costs. If they turn out to cost more than people are willing to pay, the programs would not be carried out.

Now, of the dollar amount you would have paid just for complete groundwater cleanup in your community (Q13) how much, in addition.would you pay to help fund complete groundwater cleanup in other communities across the country. (Circle the best percent response).

(13.56?4)

NO MORE		A LITTLE MORE		HALF AGAIN AS MUCH		EQUAL AMOUNT	MORE THAN EQUAL
0%	5%	10%	25%	50%	75%	100%	100%+

Q17 Of the extra amount you would pay just to help fund complete groundwater treatment programs across the nation, about what percent would be to ensure.

(31 .85) % THAT YOUR HOUSEHOLD WILL HAVE CLEAN WATER TO USE IF YOU MOVE TO A DIFFERENT COMMUNITY
(24.36) % THAT OTHER PEOPLE ACROSS THE COUNTRY WILL HAVE ENOUGH CLEAN WATER TO USE
(25.74) % THAT FUTURE GENERATIONS OF PEOPLE ACROSS THE COUNTRY WILL HAVE ENOUGH CLEAN WATER TO USE
(26.14) % THAT GROUNDWATER ACROSS THE NATION IS UNCONTAMINATED EVEN IF NO ONE EVER USES IT
(10.92) % OTHER (Please describe:____________________)
= 100 % TOTAL

Q18 On a scale from 1 to 7, how responsible do you feel for helping to pay to clean up groundwater contamination problems in other communities across the nation?

NOT AT ALL RESPONSIBLE						EXTREMELY RESPONSIBLE	
1	2	3	4	5	6	7	(2.6)

ABOUT YOU AND YOUR HOUSEHOLD

H1 Who is the primary water supplier for the water you currently use in your home?

1. THE CITY OR COUNTY (71.7%)
2. A PRIVATE WATER SUPPLIER (7.4%)
3. OUR PRIVATE WELL (18.9%)
4. OTHER (Please specify) __(1.9%)______

H2 Your gender:

1. FEMALE
2. MALE

H3 Your age: ___________YEARS

H4 Including yourself, how many members in your household are in each age group? (If none, write "0")

______ UNDER 18 YEARS OF AGE
______ 18-64
______ 65 AND OVER

H5 How much formal education have you completed? (circle number)

1. NO FORMAL EDUCATION (0%)
2. SOME GRADE SCHOOL (1.5%)
3. COMPLETED GRADE SCHOOL (2.4%)
4. SOME HIGH SCHOOL (8%)
5. COMPLETED HIGH SCHOOL (18.9%)
6. TRADE SCHOOL (9.996)
7. SOME COLLEGE (21 .7%)
8. COMPLETED COLLEGE (17.8%)
9. SOME GRADUATE WORK (6.296)
10. ADVANCED COLLEGE DEGREE (13.5%)

H6 Do you recycle or take special precautions in disposing of any of the following materials? (circle appropriate response for each)

1. NEWSPAPER YES NO DON'T KNOW (74% yes)
2. GLASS YES NO DON'T KNOW (66.4% yes)
3. ALUMINUM OR OTHER METALS YES NO DON'T KNOW (63.7% yes)
4. PLASTIC YES NO DON'T KNOW (60.2% yes)
5. PAINTS AND PAINT THINNERS YES NO DON'T KNOW (48.2% yes)
6. USED ENGINE OIL AND COOLLANT/ANTIFREEZE YES NO DON'T KNOW (63.1% yes)
7. HOUSEHOLD CHEMICALS YES NO DON'T KNOW (44.5% yes)
8. OTHER (please specify) ____________(4.2% yes)_________

H7 In the past year, have you held membership or donated time or money to any environmental organizations or groups?

1. NO (76.8%)
2. YES -- ONE GROUP (1 5.6%)
3. YES - TWO OR THREE GROUPS (6%)
4. YES - MORE THAN THREE GROUPS (1 .7°/0)

H8 How would you describe your racial or ethnic background? (circle one)

1. WHITE OR CAUCASIAN (89.5%)
2. BLACK OR AFRICAN AMERICAN (4.5%)
3. HISPANIC OR MEXICAN AMERICAN (1 .3%)
4. ASIAN OR PACIFIC ISLANDER (2.1%)
5. NATIVE AMERICAN INDIAN (1 .3%)
6. OTHER (please specify) _______(1 .3%)_________

H9 What is your present employment? (Circle the best answer)

1. EMPLOYED FULL TIME (55.7'%)
2. EMPLOYED PART TIME (5.8%)
3. FULL TIME HOMEMAKER (5.1'%0)
4. UNEMPLOYED (2.396)
5. RETIRED (26.9%)
6. STUDENT (.4%)
7. OTHER (Please specify)_______(3.8%)______

H10 What is your total annual household income before taxes and other deductions? (circle one)

1. UNDER $9,999 (7.9%)
2. $10,000 - 19,999 (18.9%)
3. $20,000 - 29,999 (15%)
4. $30,000 - 39,999 (14.7%)
5. $40,000 - 49,999 (11 .7%)
6. $50,000 - 59,999 (10.7%)
7. $60,000 - 69,999 (5.6%)
8. $70,000 - 79,999 (4.7%)
9. $80,000 - 89,999 (3.7%)
10. $90,000 - 99,999 (2.3%)
11. $100,000 - 119,999 (1.9%)
12. $120,000 - 139,999 (.7%)
13. $140,000 - 159,999 (.7%)
14. $160,000 - 179,000 (.5%)
15. $180,000 - 199,999 (0%)
16. $200,000 and OVER (.9%)

Is there anything we have overlooked? Please use the space below to write any comments or suggestions you may have about the survey.

YOUR PARTICIPATION IS GREATLY APPRECIATED!

☐ **Check this box if you would like a summary of the results.**

(If different from mailing label, list your name and address here.)

APPENDIX E

MODELING WILLINGNESS-TO-PAY WITH TRUE ZERO BIDS AND RIGHT-SKEWED ERRORS

Modeling Willingness-to-Pay with True Zero Bids and Right-Skewed Errors

Introduction

It is often the case that it is likely that an individual has a positive value of an environmental action, and a bid of $0 is assumed to mean that the individual does not desire to reveal his or her true bid. This situation would occur, for example, if the environmental action was a local cleanup of the air or water, of obvious value to the responndent, but the issue of ***responsibility*** causes scenario rejection and a zero "protest" bid. This was the case in the study of Denver's "Brown Cloud." Thus, a two equation selection/bid scenario is the appropriate economic model. The parameters of the bid equation are then estimated by least squares corrected for the sample selection induced by the refusal to reveal bids.

In surveys about national environmental action, however, where the benefit of a remedial action is potentially far removed from the respondent (both geographically and conceptually), there is a possibility that individuals have a true WTP of $0, that is, they report $0 and in fact they would not be willing to pay anything for the action. In this case the two equation selection/bid model is not appropriate, and a new model is needed.

With all WTP data, whether observed zeroes are true or hide a positive bid, whether experimental or from the field, and whether they are obtained **from hypothetical or real situations, the bulk of the evidence suggests that right-skewed errors are present. This has meant that some transformation of the bids is desirable, and either the log normal distribution has been** assumed **or the** Box-CoX transformation used. In the case of scenario rejection (protest zeroes), this has meant thatthe log of bids is the dependent variable in the sample selection corrected regression of bid data on demographic and other variables, or a Box-Cox transformation is applied and the Box-Cox parameter estimated along with the usual slope coefficients. Therefore, an important direction for future research is to analyze national level data or any situation where both true zeroes occur and bids are right-skewed. This section outlines the economic model and econometric procedure for the case of true zeroes and right-skewed bids.

The Economic Model

Suppose that WTP is a linear function of a vector of individual household characteristics, x. a (row) vector of coefficients, $\boldsymbol{\beta}$, snd a random error:

(1) $$\mathbf{W = \beta x + \varepsilon} .$$

Here $\boldsymbol{\varepsilon}$ represents *heterogeneity* error. That is, individuals with characteristics x have mean bid $\boldsymbol{\beta x}$ but actual bid W, and the difference is due to unmeasured attributes and heterogeneous tastes for the environment. Another form of error is also present In individual's revealed WTP, their bids (B). This error causes two effects on observed bids: a right skew for positive bids, as discussed above, and the reporting of a zero bid if the desired bid (W) is negative. That is, individuals may well have a negative desired willingness-to-pay for an environmental action from which they feel they derive no benefit. Conceptually, given continuous preferences, these individuals would be better off if the environment could be "sold off" and they receive compensation for it.

Let v be this measurement or reporting error. Then a model for observed bids that incorporates both effects is:

$$(2)\quad B = \begin{cases} We^{v} & \text{if } We^{v} > 0 \\ 0 & \text{if } We^{v} \leq 0 \end{cases}$$

Equations 1 and 2 area model of the formation of WTP and the mechanism for revealing it. In the next section, stochastic assumptions about ε and v are made, and estimation discussed.

Estimation

Since the formation of WTP (equation 1) is in the form of a conventional regression model, we assume the distribution of ε is normal, with zero mean and unknown variance σ_ε^2. To accommodate the right skew of bid errors, v is also assumed to normally distributed, with zero mean and unknown variance σ_v^2, and that the covariance between ε and v is σ_{ev}.

The likelihood of a sample of observations has two forms of expressions, or regimes, one for B = O and one for B > 0. Since B = 0 whenever $W \leq O \Rightarrow \beta\chi + \varepsilon \leq 0 \Rightarrow \varepsilon \leq -\beta\chi$, this event occurs with probability $\Phi(-\beta\chi/\sigma_\varepsilon^2)$, where $\Phi(.)$ is the cumulative distribution function of a standard normal random variable. Since $e^{v} > 0$, this means that B > 0 whenever W > 0 $\Rightarrow \varepsilon > -\beta x$. Also, when B > 0, 1n $B = \ln \beta x + v$. The increment to the likelihood for this type of observation is $\int_{-\beta x}^{\infty} \phi(\varepsilon, v = 1nB - \ln\beta x) d\varepsilon$, shere $\phi(.,.)$

is the bivariate normal density function. The likelihood function is the product over all observations in both regimes:

$$(3) \quad L = \prod_{0} \Phi(-\beta x/\sigma_{\varepsilon}^{2}) \prod_{1} \int_{-\beta x}^{\infty} \phi(\varepsilon, \nu = \ln B - \ln \beta x) \, d\varepsilon.$$

Maximizing this likelihood produces consistent estimates of β, from which WTP can be predicted from a sample of data which contain true zero bids.