APPENDIX A: LOST VALUE OF RECREATION

As shown in Table 21, an estimated $22.3 million in sport fishing revenues was lost in the WBSR watershed due to AMD in 2006. This estimate includes lost angling opportunities in both warm and cold water streams. To perform these calculations, all AMD-impaired streams were taken from Pennsylvania's 305(b) report and were categorized as wild trout (WT), trout stocked fishery (TSF), or warm water fishery (WWF) streams. The use rates were calculated by PAFBC based upon use and harvest information from surveys. Valuation rates were calculated based on figures from the American Fisheries Society (1992).[18] These numbers quantify the amount of money that anglers would have spent for the different types of fishing.

Table 21: Lost value of angling due to abandoned mine drainage in the West Branch Susquehanna River watershed

Stream name	Sub-watershed	Pollutant	Miles	Projected use	Lost value ($)
Bennett Branch Sinnemahoning Creek	8-A	pH-Metals	4.8	TSF	355,133
Bennett Branch Sinnemahoning Creek	8-A	pH-Metals	24	TSF	1,775,664
Bennett Branch Sinnemahoning Creek	8-A	pH-Metals	8.8	TSF	651,077
West Creek	8-A	pH-Metals	3	TSF	221,958
West Creek	8-A	pH-Metals	9	TSF	665,874
Dents Run	8-A	pH	6.5	WT	185,088
Trout Run (Unt)	8-A	pH-Metals	1.2	WT	34,170
Spring Run	8-A	pH-Metals-Sulfates	7.7	WT	219,258
Sinnemahoning Creek	8-A	pH-Metals	6.7	WWF	103,597
Sinnemahoning Creek	8-A	pH-Metals	9.1	WWF	140,706
Montgomery Run	8-B	pH-Metals	1.9	TSF	140,573
Montgomery Run	8-B	pH-Metals	0.7	TSF	51,790
Anderson Creek	8-B	pH-Metals	10.3	TSF	762,056
Montgomert Creek (Unt)	8-B	pH-Metals	1.3	WT	37,018
Woods Run	8-B	pH-Metals	3	WT	85,425
Montgomery Creek (Unt)	8-B	pH-Metals	1.7	WT	48,408
Montgomery Creek (Unt)	8-B	pH	0.5	WT	14,238
North Branch Montgomery Creek (Unt)	8-B	pH	0.9	WT	25,628
Tinker Run	8-B	pH	0.7	WT	19,933
Montgomery Creek (Unt)	8-B	pH	1.5	WT	42,713
Hartshorn Run	8-B	pH-Metals-Sulfates	3	WT	85,425
Kratzer Run	8-B	pH-Metals	5.1	WT	145,223
Irvin Branch	8-B	Metals	1.5	WT	42,713
Little Anderson Creek	8-B	pH-Metals	5.7	WT	162,308
Wilson Run (Unt)	8-B	pH	1.8	WT	51,255
Wilson Run (Unt)	8-B	Metals Hwc	0.8	WT	22,780
North Camp Run	8-B	Metals Hwc-Sulfates	2.8	WT	79,730
Rock Run	8-B	pH-Metals	3	WT	85,425
Bear Run	8-B	pH-Metals	2.9	WT	82,578
South Branch Bear Run	8-B	pH-Metals	5.3	WT	150,918
West Branch Susquehanna River	8-B	pH-Metals	6.8	WWF	105,143
West Branch Susquehanna River	8-B	pH-Metals	72.9	WWF	1,127,193
Lick Run	8-C	pH-Metals	3.7	TSF	273,748
Clearfield Creek	8-C	pH-Metals	27.7	TSF	2,049,412
Little Muddy Run	8-C	Metals	1	TSF	73,986
Brubaker Run	8-C	pH-Metals-Sulfates	2	TSF	147,972
Alder Run	8-C	pH-Metals	10.7	WT	304,683
Sandy Creek	8-C	pH-Metals-Sulfates	4.2	WT	119,595
Big Run	8-C	pH	1	WT	28,475
Deer Creek	8-C	pH-Metals	5	WT	142,375
Surveyor Run	8-C	pH-Metals	4	WT	113,900
Little Surveyor Run	8-C	pH-Metals	2	WT	56,950
Trout Run	8-C	pH	5	WT	142,375
Taylor Springs Run	8-C	Metals Hwc	0.4	WT	11,390
Pine Run	8-C	pH	2.2	WT	62,645

[18] 1992 dollars were inflated to 2006 dollars based upon the Consumer Price Index.

Table 21: Lost value of angling due to abandoned mine drainage in the West Branch Susquehanna River watershed (continued)

Stream name	Sub-watershed	Pollutant	Miles	Projected use	Lost value ($)
Fork Run	8-C	pH-Metals	3.8	WT	108,205
Sanbourn Run	8-C	pH-Metals-Sulfates	3.3	WT	93,968
North Branch Upper Morgan Run	8-C	pH-Metals	2.7	WT	76,883
Little Muddy Run	8-C	pH	4.5	WT	128,138
Blue Run	8-C	Metals Hwc	1.2	WT	34,170
Clearfield Creek	8-C	pH-Metals	44.2	WWF	683,429
Mosquito Creek	8-D	pH-Metals	6	TSF	443,916
Moshannon Creek	8-D	pH-Metals	26.2	TSF	1,938,433
Black Moshannon Creek	8-D	pH-Metals	1	TSF	73,986
Cold Stream	8-D	pH-Metals	1	TSF	73,986
Laurel Run	8-D	pH-Metals	5.4	TSF	399,524
Birch Island Run	8-D	pH-Metals	6.2	WT	176,545
Little Birch Island Run	8-D	pH-Metals	4.3	WT	122,443
Amos Branch	8-D	pH-Metals	1.6	WT	45,560
Sterling Run	8-D	pH-Metals	7.2	WT	205,020
Saltlick Run	8-D	pH-Metals	1.5	WT	42,713
Curleys Run	8-D	pH-Metals	1.2	WT	34,170
Grimes Run	8-D	pH-Metals-Sulfates	2.3	WT	65,493
Pine Creek	9-A	pH-Metals	4	TSF/WWF	120,261
Otter Run	9-A	pH-Metals	3.8	WT	108,205
Left Fork Otter Run	9-A	pH-Metals	1.5	WT	42,713
Right Fork Otter Run	9-A	pH-Metals	0.4	WT	11,390
Babbs Creek	9-A	pH-Metals	1	WT	28,475
Babbs Creek	9-A	pH-Metals	22	WT	626,450
Wilson Creek	9-A	pH-Metals	2.3	WT	65,493
Cooks Run (Basin)	9-B	pH-Metals	6.8	TSF/WT	365,894
Cooks Run	9-B	pH-Metals	3.3	TSF/WT	177,566
Lick Run	9-B	pH	3.7	WT	105,358
Tangascootack Creek	9-B	pH-Metals	8.4	WT	239,190
Drury Run (Basin)	9-B	pH	14.6	WT	415,735
Stony Run	9-B	pH-Metals	1.3	WT	37,018
Woodley Draft Run	9-B	pH-Metals	1.7	WT	48,408
Sandy Run	9-B	pH-Metals	1	WT	28,475
Two Mile Run	9-B	pH-Metals	1.9	WT	54,103
Middle Branch Two Mile Run	9-B	pH-Metals	2.1	WT	59,798
Crowley Hollow'	9-B	pH-Metals	3.1	WT	88,273
Camp Run	9-B	pH-Metals	2	WT	56,950
Rock Run	9-B	pH-Metals	1.2	WT	34,170
West Branch Susquehanna River	9-B	pH-Metals	50.6	WWF	782,386
Kettle Creek	9-B	pH-Metals	3	WWF	46,387
Beech Creek (Basin)	9-C	pH-Metals	26	TSF/WT	1,399,008
Middle Branch Big Run	9-C	pH-Metals	1.1	WT	31,323
Middle Branch Big Run	9-C	pH-Metals	4.9	WT	139,528
East Branch Big Run	9-C	pH-Metals	4.7	WT	133,833
Logway Run	9-C	pH-Metals	0.8	WT	22,780
North Fork Beech Creek	9-C	pH-Metals	5.9	WT	168,003
Little Sandy Run	9-C	pH-Metals	2.7	WT	76,883
Cherry Run	9-C	pH-Metals	0.9	WT	25,628
Red Run	10-A	pH-Metals	3.9	WT	111,053
Loyalsock Creek	10-B	pH-Metals	6	TSF	443,916
Loyalsock Creek	10-B	pH-Metals	7.4	WT	210,715
West Branch Susquehanna River	10-D	pH-Metals	3	WWF	46,387
Total			614.4		22,346,823

Source: PAFBC (2007). Use rates (the number of trips made to these types of stream per year) for TSF (1,100), WT (500), and WWF (306) were estimated by PAFBC based upon use and harvest information collected through surveys along these types of waterways. Valuations are as follows: TSF $67.26, WT $56.95, WWF $50.53. The lost value for the Pine Creek watershed includes figures for Babb Creek and other nearby waters that are no longer significantly impaired due to successful AMD remediation.

APPENDIX B: DETAILS ON THE HEDONIC PROPERTY PRICE METHOD

The hedonic framework relies on Lancaster's (1966) consumer theory, which states that utility is derived not from the good itself, but from the intrinsic properties or characteristics of the good. Rosen (1974) developed Lancaster's idea into a model in which observed prices of goods and the amounts of characteristics associated with each good identify a set of implicit prices, and the total value of a good depends upon the quantities of each of the various attributes that comprise it. Hedonic models provide us with a method for estimating the marginal implicit prices of characteristics associated with a package of location-specific goods, such as land and housing. The hedonic price function is a reflection of the quantities of the good's characteristics, and comes about through the transactions of buyers and sellers in the market. Since land and housing are fixed in space, the values of environmental and other location-specific characteristics are included in the transaction price, and can be isolated with the hedonic model. When applied to the residential market, the model consists of a vector of a house's attributes, $z = (z_1, ..., z_n)$, and a hedonic price function, *p(z)*. The hedonic price function is the relationship between the market price of a given house and the levels of its attributes. This function describes the equilibrium set of house prices, given the population of buyers and the available housing stock.

The hedonic price function is important to policy analysts because it reveals information on consumers' preferences over *z*. Buyers search the set of available houses, and choose the one that maximizes their indirect utility function, given by $V(W - P(z), z)$, where W is the wealth of the household. By differentiating the hedonic price function with respect to the characteristic in question, we can find the marginal implicit price for the particular characteristic. For each house attribute, z_i, the first-order condition for this maximization is:

$$\frac{\partial P}{\partial z_i} = \frac{\partial V / \partial z_i}{\partial V / dW}$$

In this study, the determinants of residential prices (the z_i's) are grouped into vectors of like variables (Irwin, 2002):

$$P_i = f(H_i, N_i, E_i, \beta, \alpha, \delta),$$

where P_i is the residential sale price of the i^{th} parcel, H_i is a vector of structural characteristics associated with the house, N_i is a vector of location-specific (or neighborhood-level) variables, E_i is a vector of environmental variables including distance to the nearest AMD-impacted stream, and β, α, and δ are the respective parameter vectors to be calculated.

The subject of hedonics in the literature is replete with research examining housing and land prices in urban and rural areas. This research includes studies of the non-market value of agricultural land (Shi et al., 1997; Ready et al., 1997), open space (Geoghegan et al., 2003; Irwin, 2002), transportation infrastructure (Haider and Miller, 2000), and other environmental amenities (Kim et al., 2003; Bockstael, 1996; Geoghegan et al., 1997; Sengupta and Osgood, 2003).

One recent study (Williamson et al., 2007) used the hedonic method to estimate WTP for AMD remediation in West Virginia. Using 21 years of housing sales data, sale prices of single family homes statistically related to a set of variables that include proximity to AMD-impaired streams. The study found that properties located within one-quarter mile of AMD streams face an implicit cost of $4,783 due to proximity.

Two models were estimated in the current analysis: an unrestricted model containing stream quality–related variables, and a restricted model containing basic hedonic variables. These two models were estimated in order to determine whether or not the stream quality variables resulted in a better statistical model than the basic model.

The unrestricted model is:

LN(SALE PRICE) is a function of: LN(LOT SIZE), LN(PERIMETER), LN(STRUCTURE VALUE), URBAN, BAD SOIL, STREAM 200FT, LN(AMD DISTANCE), (STREAM 200FT * LN(AMD DISTANCE)).

The restricted model is:

LN(SALE PRICE) is a function of: LN(LOT SIZE), LN(PERIMETER), LN(STRUCTURE VALUE), URBAN, BAD SOIL.

Table 22 provides summary statistics for the variables. The log-log specification was chosen to reduce heteroskedasticity in the dataset due to nonlinear relationships between variables. Table 23 summarizes the statistical results.

Table 22: Results of unrestricted hedonic price model

Variable	Coefficient	Standard error	t-statistic	Probability
CONSTANT	18.893	0.390	48.468	0.000
LOT_SIZE	0.160	0.016	9.736	0.000
PERIMETER	-1.896	0.036	-53.014	0.000
STRUCT_VALUE	0.335	0.026	12.941	0.000
INURBAN (0,1)	0.074	0.046	1.604	0.109
BAD_SOIL (0,1)	0.062	0.038	1.635	0.102
STREAM_200FT	0.176	0.179	0.983	0.325
AMD_DISTANCE	0.040	0.020	2.067	0.039
STR200XAMD	-0.029	0.024	-1.195	0.232
# Observations:	1577			
R-squared:	0.71			
Log-Likelihood:	-1689.62			
AIC:	3397.23			

Note: Model estimated in double-logarithmic form using Ordinary Least Squares.

Table 23: Results of restricted hedonic price model

Variable	Coefficient	Standard error	t-statistic	Probability
CONSTANT	19.245	0.361	53.291	0.000
LOT_SIZE	0.155	0.016	9.504	0.000
PERIMETER	-1.907	0.035	-54.022	0.000
STRUCT_VALUE	0.337	0.026	13.053	0.000
INURBAN (0,1)	0.057	0.045	1.264	0.206
BAD_SOIL (0,1)	0.065	0.038	1.698	0.090
# Observations:	1577			
R-squared:	0.70			
Log-Likelihood:	-1692.89			
AIC:	3397.78			

Note: Model estimated in double-logarithmic form using Ordinary Least Squares. F-stat (restricted vs. unrestricted) = 1.16. F-crit (numerator df = 6; denominator df = 1567): 2.10 Do not reject (restricted model performs equally well).

Both models have R-squared values of at least 0.70, which indicate that they are both very good predictors of residential land prices. The t-statistics on the coefficients for the independent variables indicate that many of them are statistically significant at the 1% and 5% levels. Interpreting the coefficients on continuous independent variables in a log-log model is simple: a 1% increase in the amount of the variable results in a (coefficient value) % increase/decrease in the dependent variable. Interpretation of coefficients on the (0,1) variables is a little more difficult: rather than it being a percent change in the variable from 0 to 1, it is: $e^{coefficient}$-1.

An F-test performed on the two models indicates that the restricted model explains the variation in the data equally as well as the unrestricted model. Statistical procedure usually dictates that the simpler model should be chosen when this is the case; however, since our variables of interest are found only in the unrestricted model, the more complex analysis is preferred.

APPENDIX C: IN-WATERSHED WILLINGNESS-TO-PAY QUESTIONNAIRE

Pennsylvania Clean Water Survey 2007

The red-orange color shows the impact of acid mine drainage on the West Branch Susquehanna River just below the confluence with Alder Run.

Introduction

The objective of this survey is to determine the benefits that you would receive from improving water quality in Pennsylvania rivers and streams. This survey will focus on the West Branch Susquehanna River.

Please answer the following questions to the best of your ability. All information gathered in this survey will be kept confidential. The only data released to the public will be in a form where no individual responses are identified.

There are 20 questions in this survey and it should take about 10 minutes to complete. If you have any questions about or problems with this survey, please contact either Amy Wolfe from Trout Unlimited (at 570-726-3118 or awolfe@tu.org) or Alan Collins (at 304-293-4832 ext. 4473 or alan.collins@mail.wvu.edu).

Section A. First, we would like to find out some general information about your concerns and knowledge of clean water in Pennsylvania along with your outdoor recreation activities.
===

A1. Why is clean water in Pennsylvania rivers and streams important to you? (Please check all reasons that apply)

____ To provide water for drinking and household use.
____ To provide water for industrial or agricultural use.
____ For water-based recreation (swim, boat, fish, etc.).
____ To provide good habitat for fish and wildlife.
____ To protect the environment.
____ It is not really important to me.
____ Other. Please explain ____________________

A2. What outdoor activities do you regularly participate in, i.e. more than once per year? (Please check all that apply)

____ Fishing in a lake, river, or stream
____ Kayaking, canoeing or rafting rivers or streams
____ Swimming or wading in a lake, river, or stream
____ Hiking or biking along a river or stream
____ Picnicking near a river or stream
____ Hunting
____ Bird watching activities
____ None of the above

A3. How would you describe your level of knowledge about Pennsylvania rivers and streams? (Please check one)

____ High
____ Medium
____ Low

A4. In your opinion, how clean are Pennsylvania rivers and streams? (Please check one)

____ Very clean
____ Clean
____ Some are clean, some are polluted
____ Polluted
____ Very polluted
____ Don't know

A5. The state of Pennsylvania has a Growing Greener program that provides funds for environmental protection. In your opinion, how should state government spend Growing Greener funds? (Please check all that apply)

____ To clean up polluted rivers and streams
____ To develop alternative energy sources (wind, solar, etc.)
____ To improve and maintain parks
____ To clean up trash dumps
____ To clean up toxic waste sites
____ To protect farmland and open space from development
____ To promote community revitalization and beautification
____ Other. Please explain ______________________________
____ Don't know

Section B. This section refers to the West Branch Susquehanna River.

===

B1. With what portions of the West Branch Susquehanna River and its stream tributaries are you familiar? Please answer this question in terms of having used or seen these portions of the river before. There is a map on the back of this survey to assist you. (Please check all that apply)

____ The eastern portion of the West Branch Susquehanna River and its stream tributaries upstream (the red shaded area of the map including Blacks, Buffalo, Little Pine, Muncy, Loyalsock, Lycoming, Pigeon, and Pine Creeks)

____ The western portion of the West Branch The West Branch Susquehanna River and its stream tributaries (the blue shaded area of the map including Bald Eagle, Beech, Fishing, Cheat, Clearfield, Kettle, Moshannon, and Sinnemahoning Creeks)

____ I am not familiar with any portion of the West Branch Susquehanna River or its stream tributaries.

B2. In the past five years, about how many visits have you had to any portion of the West Branch Susquehanna River or its stream tributaries for any of the outdoor recreation activities listed in question A2? (Please check one)

____ None
____ Between 1 and 5 visits
____ Between 6 and 20 visits
____ Over 20 visits

5

B3. Based upon what you know about the West Branch Susquehanna River and its stream tributaries, do you think there are environmental problem(s) associated with this river and its stream tributaries? (Please check one)

____ Yes
____ No (please skip to question B4 on the next page)
____ Don't know (please skip to question B4 on the next page)

If you answered yes to Question B3, based upon what you know about the West Branch Susquehanna River and its stream tributaries, what do you think are the main environmental problem(s) associated with this river and its stream tributaries? (Please check all that apply)

_____ Orange colors of the water and rocks along the river
_____ Lack of fish or aquatic life
_____ Trash in the river and along the banks
_____ Abandoned coal mine pollution
_____ Unsafe to swim or wade
_____ Too much dirt and sediment in the water
_____ Pollution from farms or logging operations
_____ Flooding
_____ Other_________________________

=================================

Introduction to Question B4

Acid mine drainage (AMD) from abandoned coal mines has been identified as the primary pollution problem on the West Branch Susquehanna River and its stream tributaries. AMD is caused by the flow of water through abandoned coal mine lands such as surface mines, deep mines, or coal refuse piles. Water polluted by AMD is typically acidic and has high levels of toxic heavy metals such as iron, aluminum, and manganese. AMD-

6

polluted water kills fish and other living things in rivers and creeks. Currently, AMD is responsible for more than 1,000 miles of polluted rivers and streams in the West Branch Susquehanna region.

It has been estimated that up to $250 million may be needed to clean up AMD in the West Branch Susquehanna River and its stream tributaries. If AMD were cleaned up in the West Branch Susquehanna River and its stream tributaries, hundreds of miles of streams would once again support trout populations, or in some areas, warm water fish (like bass). In addition, the rivers and creeks would provide cleaner water for community and industrial water supplies and improve recreational experiences for swimming, canoeing, rafting, etc.

B4. Prior to receiving this survey, were you aware of how much AMD pollution exists in the West Branch Susquehanna River and its stream tributaries? (Please check one)

____ Yes
____ No

B5. One way to provide money for AMD clean up is for the state of Pennsylvania to create a fund through a statewide referendum. Suppose that the following referendum was placed on the next ballot in the state of Pennsylvania:

"Do you favor creation of a fund by the Commonwealth that contains sufficient funds to clean up acid mine drainage in the West Branch Susquehanna River and its stream tributaries?"

How would you vote on this referendum? (Please check one)

____ Yes, I would support a referendum on an AMD clean up fund (Please answer question **B6**)
____ I am unsure how I would vote (Please answer question **B6**)
____ No, I would oppose an AMD clean up fund (Please skip to question **B7**)

7

B6. In order to pay for the clean-up fund described in question **B5**, funding would be needed. What is the **maximum, one time** tax increase that you would be willing to pay to clean up acid mine drainage in the West Branch Susquehanna River and its stream tributaries? (Please circle the highest amount that you would be willing to pay remembering your household budget)

$0	$5	$10	$15	$20
$30	$40	$50	$75	$100
$125	$150	$200	$300	$500
$1,000	Other (please specify) $_______			

If you answered question **B6**, please skip to **B8**.

B7. If your answer is **NO** to question **B5**, which statement best reflects why you would oppose the referendum to create a fund to clean up acid mine drainage in the West Branch Susquehanna River and its stream tributaries? (Please check one)

____ I support AMD clean-up, but I can't afford to pay any more taxes.
____ I support clean-up, but I think someone else other than the state should pay for the clean up.
____ I support clean-up, but don't support any new taxes.
____ I don't support a clean-up fund because there are higher priorities for spending state money.
____ I don't think acid mine drainage is a problem in the West Branch region.
____ Other, please explain ___________________________
____

8

B8. Thinking about your responses to the previous three questions, please indicate how strongly you agree or disagree with each of the following (Please check one level for each)

A. I am confident that I would have picked the same answer if the referendum were actually on the ballot.

Strongly Agree	Agree	Neutral or Unsure	Disagree	Strongly Disagree
___	___	___	___	___

B. I had enough information to decide whether or not to clean-up the West Branch Susquehanna River and its stream tributaries.

Strongly Agree	Agree	Neutral or Unsure	Disagree	Strongly Disagree
___	___	___	___	___

C. I would use a cleaned up West Branch Susquehanna River and its stream tributaries more than I currently use them now.

Strongly Agree	Agree	Neutral or Unsure	Disagree	Strongly Disagree
___	___	___	___	___

Please express any comments or thoughts that you have about water quality in the West Branch Susquehanna River and its stream tributaries.

____
____
____
____

9

Section C: We would like to finish up this survey with some questions about you. These questions are for research purposes only. The information that you provide will remain confidential and will not be shared with any business or other institution. (Please check one response for each question)

C1. What is your gender?
____ Male
____ Female

C2. What is your year of birth? 19______

C3. Including yourself, how many people live in your household? __________

C4. Where do you receive your household water supply? (Please check all that apply)

____ Private water well
____ Municipal or public water system
____ Other, please explain______________________________

C5. What is your zip code? __________

C6. What is the highest level of education that you completed? (Please check one)

____ Eighth grade or less
____ High school diploma or GED
____ Technical school
____ College degree
____ Graduate school

10

C7. What was your total household income for 2006? (Please check one)

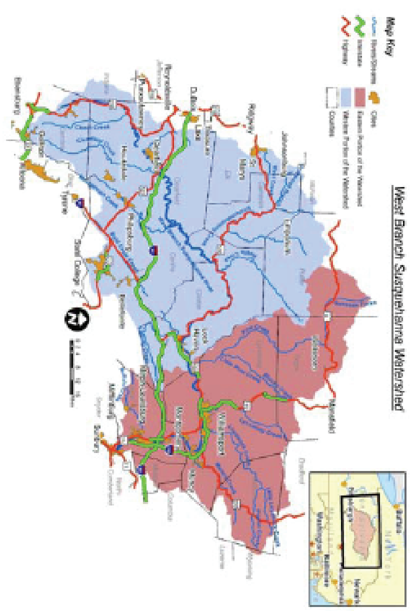
____ Under $10,000
____ $10,000 - $14,999
____ $15,000 - $24,999
____ $25,000 - $34,999
____ $35,000 - $49,999
____ $50,000 - $74,999
____ $75,000 - $99,999
____ $100,000 - $149,999
____ $150,000 - $199,999
____ $200,000 or more
____ I choose not to answer this question.

Thank you for participating in this survey. Your time is appreciated. Please return this survey by folding lengthwise and inserting into the addressed envelope provided. **No postage is required.**

If you would like to be sent a copy of the results, please fill in your name and mailing or email address below:

____
____
____
____

11



12

APPENDIX D: OUT-OF-WATERSHED WILLINGNESS-TO-PAY QUESTIONNAIRE

Pennsylvania Clean Water Survey 2007

The red-orange color shows the impact of acid mine drainage on the West Branch Susquehanna River just below the confluence with Alder Run.

1

Introduction

The objective of this survey is to determine the benefits that you would receive from improving water quality in Pennsylvania rivers and streams. This survey will focus on the West Branch Susquehanna River.

Please answer the following questions to the best of your ability. All information gathered in this survey will be kept confidential. The only data released to the public will be in a form where no individual responses are identified.

There are 20 questions in this survey and it should take about 10 minutes to complete. If you have any questions about or problems with this survey, please contact either Amy Wolfe from Trout Unlimited (at 570-726-3118 or awolfe@tu.org) or Alan Collins (at 304-293-4832 ext. 4473 or alan.collins@mail.wvu.edu).

2

Section A. First, we would like to find out some general information about your concerns and knowledge of clean water in Pennsylvania along with your outdoor recreation activities.

==

A1. Why is clean water in Pennsylvania rivers and streams important to you? (Please check all reasons that apply)

___ To provide water for drinking and household use.
___ To provide water for industrial or agricultural use.
___ For water-based recreation (swim, boat, fish, etc.).
___ To provide good habitat for fish and wildlife.
___ To protect the environment.
___ It is not really important to me.
___ Other. Please explain ____________________

A2. What outdoor activities do you regularly participate in, i.e. more than once per year? (Please check all that apply)

___ Fishing in a lake, river, or stream
___ Kayaking, canoeing or rafting rivers or streams
___ Swimming or wading in a lake, river, or stream
___ Hiking or biking along a river or stream
___ Picnicking near a river or stream
___ Hunting
___ Bird watching activities
___ None of the above

A3. How would you describe your level of knowledge about Pennsylvania rivers and streams? (Please check one)

___ High
___ Medium
___ Low

3

A4. In your opinion, how clean are Pennsylvania rivers and streams? (Please check one)

___ Very clean
___ Clean
___ Some are clean, some are polluted
___ Polluted
___ Very polluted
___ Don't know

A5. The state of Pennsylvania has a Growing Greener program that provides funds for environmental protection. In your opinion, how should state government spend Growing Greener funds? (Please check all that apply)

___ To clean up polluted rivers and streams
___ To develop alternative energy sources (wind, solar, etc.)
___ To improve and maintain parks
___ To clean up trash dumps
___ To clean up toxic waste sites
___ To protect farmland and open space from development
___ To promote community revitalization and beautification
___ Other. Please explain ______________________________
___ Don't know

4

Section B. This section refers to the West Branch Susquehanna River.

==

B1. With what portions of the West Branch Susquehanna River and its stream tributaries are you familiar? Please answer this question in terms of having used or seen these portions of the river before. There is a map on the back of this survey to assist you. (Please check all that apply)

____ The eastern portion of the West Branch Susquehanna River and its stream tributaries upstream (the red shaded area of the map including Blacks, Buffalo, Little Pine, Muncy, Loyalsock, Lycoming, Pigeon, and Pine Creeks)

____ The western portion of the West Branch The West Branch Susquehanna River and its stream tributaries (the blue shaded area of the map including Bald Eagle, Beech, Fishing, Cheat, Clearfield, Kettle, Moshannon, and Sinnemahoning Creeks)

____ I am not familiar with any portion of the West Branch Susquehanna River or its stream tributaries.

B2. In the past five years, about how many visits have you had to any portion of the West Branch Susquehanna River or its stream tributaries for any of the outdoor recreation activities listed in question A2? (Please check one)

____ None
____ Between 1 and 5 visits
____ Between 6 and 20 visits
____ Over 20 visits

B3. Based upon what you know about the West Branch Susquehanna River and its stream tributaries, do you think there are environmental problem(s) associated with this river and its stream tributaries? (Please check one)

____ Yes
____ No (please skip to question B4 on the next page)
____ Don't know (please skip to question B4 on the next page)

If you answered yes to Question B3, based upon what you know about the West Branch Susquehanna River and its stream tributaries, what do you think are the main environmental problem(s) associated with this river and its stream tributaries? (Please check all that apply)

_____ Orange colors of the water and rocks along the river
_____ Lack of fish or aquatic life
_____ Trash in the river and along the banks
_____ Abandoned coal mine pollution
_____ Unsafe to swim or wade
_____ Too much dirt and sediment in the water
_____ Pollution from farms or logging operations
_____ Flooding
_____ Other________________________

==============================

Introduction to Question B4

Acid mine drainage (AMD) from abandoned coal mines has been identified as the primary pollution problem on the West Branch Susquehanna River and its stream tributaries. AMD is caused by the flow of water through abandoned coal mine lands such as surface mines, deep mines, or coal refuse piles. Water polluted by AMD is typically acidic and has high levels of toxic heavy metals such as iron, aluminum, and manganese. AMD-

polluted water kills fish and other living things in rivers and creeks. Currently, AMD is responsible for more than 1,000 miles of polluted rivers and streams in the West Branch Susquehanna region.

It has been estimated that up to $250 million may be needed to clean up AMD in the West Branch Susquehanna River and its stream tributaries. If AMD were cleaned up in the West Branch Susquehanna River and its stream tributaries, hundreds of miles of streams would once again support trout populations, or in some areas, warm water fish (like bass). In addition, the rivers and creeks would provide cleaner water for community and industrial water supplies and improve recreational experiences for swimming, canoeing, rafting, etc.

B4. Prior to receiving this survey, were you aware of how much AMD pollution exists in the West Branch Susquehanna River and its stream tributaries? (Please check one)

____ Yes
____ No

B5. One way to provide money for AMD clean up is for the state of Pennsylvania to create a fund through a statewide referendum. Suppose that the following referendum was placed on the next ballot in the state of Pennsylvania:

"Do you favor creation of a fund by the Commonwealth that contains sufficient funds to clean up acid mine drainage in the West Branch Susquehanna River and its stream tributaries?"

How would you vote on this referendum? (Please check one)

____ Yes, I would support a referendum on an AMD clean up fund (Please answer question B6)
____ I am unsure how I would vote (Please answer question B6)
____ No, I would oppose an AMD clean up fund (Please skip to question B7)

B6. In order to pay for the clean-up fund described in question B5, funding would be needed. What is the **maximum, one time** tax increase that you would be willing to pay to clean up acid mine drainage in the West Branch Susquehanna River and its stream tributaries? (Please circle the highest amount that you would be willing to pay remembering your household budget)

$0	$5	$10	$15	$20
$30	$40	$50	$75	$100
$125	$150	$200	$300	$500
$1,000	Other (please specify) $_______			

If you answered question B6, please skip to B8.

B7. If your answer is **NO** to question B5, which statement best reflects why you would oppose the referendum to create a fund to clean up acid mine drainage in the West Branch Susquehanna River and its stream tributaries? (Please check one)

____ I support AMD clean-up, but I can't afford to pay any more taxes.
____ I support clean-up, but I think someone else other than the state should pay for the clean up.
____ I support clean-up, but don't support any new taxes.
____ I don't support a clean-up fund because there are higher priorities for spending state money.
____ I don't think acid mine drainage is a problem in the West Branch region.
____ Other, please explain ____________________________
____

B8. Thinking about your responses to the previous three questions, please indicate how strongly you agree or disagree with each of the following (Please check one level for each)

A. I am confident that I would have picked the same answer if the referendum were actually on the ballot.

Strongly Agree	Agree	Neutral or Unsure	Disagree	Strongly Disagree
___	___	___	___	___

B. I had enough information to decide whether or not to clean-up the West Branch Susquehanna River and its stream tributaries.

Strongly Agree	Agree	Neutral or Unsure	Disagree	Strongly Disagree
___	___	___	___	___

C. I would use a cleaned up West Branch Susquehanna River and its stream tributaries more than I currently use them now.

Strongly Agree	Agree	Neutral or Unsure	Disagree	Strongly Disagree
___	___	___	___	___

Please express any comments or thoughts that you have about water quality in the West Branch Susquehanna River and its stream tributaries.

____
____
____
____

Section C: We would like to finish up this survey with some questions about you. These questions are for research purposes only. The information that you provide will remain confidential and will not be shared with any business or other institution. (Please check one response for each question)

C1. What is your gender?
____ Male
____ Female

C2. What is your year of birth? 19______

C3. Including yourself, how many people live in your household? ___________

C4. What is your race? (Please check one)

____ African-American
____ Asian
____ Caucasian (White)
____ Hispanic
____ Other

C5. What is your zip code? __________

C6. What is the highest level of education that you completed? (Please check one)

____ Eighth grade or less
____ High school diploma or GED
____ Technical school
____ College degree
____ Graduate school

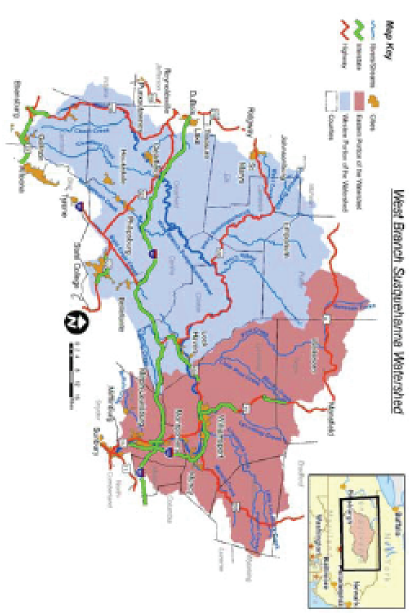
C7. What was your total household income for 2006? (Please check one)

____ Under $10,000
____ $10,000 - $14,999
____ $15,000 - $24,999
____ $25,000 - $34,999
____ $35,000 - $49,999
____ $50,000 - $74,999
____ $75,000 - $99,999
____ $100,000 - $149,999
____ $150,000 - $199,999
____ $200,000 or more
____ I choose not to answer this question.

Thank you for participating in this survey. Your time is appreciated. Please return this survey by folding lengthwise and inserting into the addressed envelope provided. **No postage is required.**

If you would like to be sent a copy of the results, please fill in your name and mailing or email address below:

____
____
____
____



APPENDIX E: DETAILS ON THE WILLINGNESS-TO-PAY MODEL

A Tobit model was used to apply WTP estimates to the general population and to account for protest responses.

Tobit models are based on economic behavior that yields numerous zero (or other limit) outcomes (Wooldridge, 2006). When employing a Tobit model, a latent variable (y^*) format was assumed:

$y^* = \beta X + u$ where u is an error term with a normal distribution $(0, \sigma^2)$
$y = y^*$ if $y^* > 0$
$y = 0$ if $y^* \leq 0$

In this study, the latent variable (y^*) represents a respondent's true value of AMD restoration in the WBSR watershed and y represents a respondent's stated value from the CVM question. When $y^* > 0$, a respondent is able to express her/his monetary value from restoration as a WTP (i.e., s/he does not claim a property right to clean water). When $y^* \leq 0$, a respondent claims a property right to clean water in the WBSR watershed and expresses a zero response within a WTP format in the CVM question. In this case, a respondent wishes to express her/his true value as a willingness-to-accept or a negative y^*. In order to estimate positive WTP values from these protest values, only predicted y values from the Tobit model were utilized.

Tobit analyses of survey data for the CVM question were conducted with the software package LIMDEP (Greene, 2002). A log likelihood function was formed that included respondents with a stated positive value in the CVM question plus respondents with zero values but who were designed as protest responses. Maximum likelihood estimation (MLE) was used to derive β and σ (standard deviation of u) estimates.

The matrix of independent variables included knowledge, use, and demographic variables (Table 24). Other independent variables considered in modeling of WTP included: knowledge variables (river pollution levels, environmental problem in WBSR, and enough information given in the CVM question); recreational use variables (various outdoor activities); and demographic characteristics (gender, age, income). None of these other variables were important in explaining variation in WTP.

Three separate Tobit models were estimated: (1) using survey data from inside the WBSR watershed; (2) using survey data from outside the watershed; and (3) using pooled data from both samples. A likelihood ratio test was used to determine if the sample can be pooled inside and outside the watershed. This test utilized a null hypothesis that coefficients (β) were equal inside and outside. A chi-square statistic (χ^2) for the likelihood ratio test gave a statistically significant result to not accept the null hypothesis:

$\chi^2_{df=10} = 33.3$ ($\chi^2_{.01,df=10} = 23.2$)

Thus, separate models were estimated for survey data using data inside and outside the watershed because the coefficients were not statistically equal.

Since Tobit models rely on an assumption of homoskedasticity[19] (Wooldridge 2006), this assumption was tested and rejected in favor of models adjusted for heteroskedasticity both inside and outside the watershed. Multiplicative heteroskedasticity on variance term was assumed using the following variables: Inside (UNSURE and COLLEGE); and Outside (UNSURE, FAMILIAR, and CURRENT).

Table 24: Variable definitions and expected impacts

Name	Definition	Expected Impact
Dependent		
WTP	Positive values to a maximum one-time tax increase for watershed clean-up and protest zero responses	N/A
Independent		
Knowledge		
AWARE	Respondent awareness of AMD in WBSR prior to survey, yes=1, no=0 (means: 0.5 inside; 0.13 outside)	-
FAMILIAR	Respondent familiar with WBSR prior to survey, 1=no, 0=yes (means: 0.22 inside; 0.72 outside)	-
KNOW	Respondent level of knowledge about Pennsylvania rivers and streams, 1= high, 0=medium or low (means: 0.12 inside; 0.09 outside)	+
Use		
CURRENT	Visits to WBSR in the past five years, 0=none, 1= 1 to 5, 2= 6 to 20 , 3= over 20 (means: 1.4 inside; 0.49 outside)	+
FUTURE	Respondent would use a cleaned up WBSR more than current use. 1=strongly agree or agree, 0=otherwise (means: 0.24 inside; 0.4 outside)	+
RIVER	Respondent participates in river-based recreation, 1=yes, 0=no (means: 0.15 inside; 0.13 outside)	+
Demographics		
COLLEGE	Respondent education level, 1=college degree, 0=less than college (means: 0.41 inside; 0.48 outside)	+
WELL	Respondent uses private well for household water supply, 1=yes, 0=no (means: 0.41 inside)	+
Other		
UNSURE	Respondent was unsure about referendum response, 1=yes, 0=no (means: 0.38 inside; 0.39 outside)	-

Table 25 presents four sets of Tobit model results: initial and heteroskedastic-adjusted models for inside and outside the watershed survey data. All models were statistically significant based on Lagrangian Multiplier (LM) tests. Adjustments for heteroskedasticity improved the LM test statistics but decreased the statistical significance of variable coefficients. Variables with coefficients that are statistically different from zero in the adjusted models included COLLEGE, WELL, and UNSURE (inside) and COLLEGE and FUTURE (outside).

[19] This assumption is that variance of the error term (σ^2) does not change over the range of observed data. Violation of this assumption means that variance does change, i.e., variance is heteroskedastic.

Table 25: Tobit model results, unadjusted and adjusted for heteroskedasticity

	Inside the watershed (N = 95)		Outside the watershed (N= 80)	
Variable	Coefficients	Adjusted coefficients	Coefficients	Adjusted coefficients
CONSTANT	-0.796	-1.675	-28.541	-14.147
AWARE	-19.477	-1.414	-46.518	35.047
FAMILIAR	-20.292	-9.814	13.131	12.267
KNOW	15.651	6.709	56.798*	-0.291
CURRENT	-0.045	4.133	26.106*	-0.668
FUTURE	19.743	7.712	61.581**	49.799**
RIVER	21.218	10.292	32.440	34.714
COLLEGE	48.484***	34.624***	51.256***	34.725**
WELL	24.807**	18.527*		
UNSURE	-29.274**	-17.901*	-16.368	1.32
Sigma	50.753***	33.468***	85.338***	33.05***
Heteroskedasticity variables				
FAMILIAR				0.661***
CURRENT				0.653***
COLLEGE		0.790***		
UNSURE		-0.905***		-0.750***
LM TEST	48.09***	70.89***	59.88***	472.9***

Note: Statistical significance levels: *** = p < .01 , ** = p < .05 , * = p < .10. The variable WELL was not included in the outside-the-watershed questionnaire.

Predicted y values were computed using the heteroskedastic-adjusted coefficients for each respondent with a positive CVM response or a protest response. After including respondents with a true zero response, WTP estimates for sample respondents inside and outside the watershed were derived:

Inside: Mean WTP = $25 +/- 3.25[20] Number of observations = 127
Median WTP = $22

Outside: Mean WTP = $34 +/- 5.43[21] Number of observations = 99
Median WTP = $36

These WTP estimates were on a per-household basis and represent a maximum one-time payment for restoration of damages caused by AMD in the WBSR watershed. Both inside and outside WTP estimates have very similar mean and median values so that the predicted y's from the Tobit model were not skewed. Also, mean WTP for WBSR restoration was about one-third higher among respondents outside the watershed than inside. This result was explained by several factors: higher education levels among outside respondents, and familiarity with the WBSR watershed increased WTP among respondents outside the watershed but decreased WTP for inside respondents, perhaps due to a greater acceptance of the problem by people living in the watershed.

[20] 90% confidence interval.
[21] 90% confidence interval.

Respondents were assumed to be the percentage of the affected population that is represented by the survey sample. These percentages were set at the survey response rates: 15.88% inside and 12.60% outside the watershed.

Non-respondents were assumed to be the remaining percentage of the affected population, and were assumed to be represented by characteristics of those who did not respond to the survey. These characteristics were derived primarily from assumptions about non-respondents, survey data, or census information (Table 26). Non-respondents from both inside and outside the watershed were assumed to unaware of AMD in WBSR prior to survey (AWARE=0), have a low or medium level of knowledge about Pennsylvania rivers and streams (KNOW=0), not be a current or future recreational user of the WBSR watershed (CURRENT=0 and FUTURE=0), not to participate in river-based recreation (RIVER=0), and to be unsure about their response to the referendum (UNSURE=1). Familiarity with the WBSR watershed was derived from survey averages, and the percentage of college graduate came from 2000 census data. Information about private well usage in the WBSR watershed was obtained from Clemens (2007).

The Tobit model constructed to calculate WTP for respondents was used to predict WTP for non-respondents. With variable levels set at values in Table 26, predicted y values from inside and outside Tobit models were computed at \$10.4 and \$15.2, respectively. Adjusting for the same percentage of true “\$0” as in the survey, non-respondent WTP estimates were computed at \$8 inside and \$12 outside the watershed. These WTP estimates were regarded as reasonable, being approximately one-third the size of respondent WTP estimates.

Table 26: Variable values used for computation of non-respondent willingness-to-pay

Variable	Inside value	Outside value
AWARE	0.00	0.00
FAMILIAR	0.22	0.7
KNOW	0.00	0.00
CURRENT	0.00	0.00
FUTURE	0.00	0.00
RIVER	0.00	0.00
COLLEGE	0.183	0.259
WELL	0.329	-
UNSURE	1.00	1.00