

Exhibit No.:
Issues: Customer Usage Annualization
Witness: Edward L. Spitznagel, Jr.
Exhibit Type: Rebuttal
Sponsoring Party: Missouri-American Water Company
Case No.: WR-2011-0337
SR-2011-0338
Date: January 19, 2012

MISSOURI PUBLIC SERVICE COMMISSION

**CASE NO. WR-2011-0337
CASE NO. SR-2011-0338**

REBUTTAL TESTIMONY

OF

EDWARD L. SPITZNAGEL, JR.

ON BEHALF OF

MISSOURI-AMERICAN WATER COMPANY

BEFORE THE PUBLIC SERVICE COMMISSION
OF THE STATE OF MISSOURI

IN THE MATTER OF MISSOURI-AMERICAN) WATER COMPANY FOR AUTHORITY TO) FILE TARIFFS REFLECTING INCREASED) RATES FOR WATER AND SEWER) SERVICE)	CASE NO. WR-2011-0337 CASE NO. SR-2011-0338
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AFFIDAVIT OF EDWARD L. SPITZNAGEL, JR.

Edward L. Spitznagel, Jr., being first duly sworn, deposes and says that he is the witness who sponsors the accompanying testimony entitled "Rebuttal Testimony of Edward L. Spitznagel, Jr."; that said testimony and schedules were prepared by him and/or under his direction and supervision; that if inquires were made as to the facts in said testimony and schedules, he would respond as therein set forth; and that the aforesaid testimony and schedules are true and correct to the best of his knowledge.

Edward L. Spitznagel, Jr.

Edward L. Spitznagel, Jr.

State of Missouri

County of St. Louis

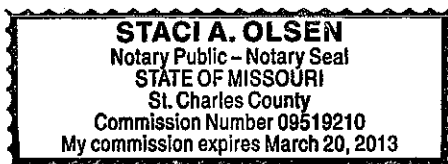
SUBSCRIBED and sworn to

Before me this 19th day of January 2012.

Staci A. Olsen

Notary Public

My commission expires:



1 **REBUTTAL TESTIMONY**

2
3 **EDWARD L. SPITZNAGEL, JR.**

4
5 **WITNESS INTRODUCTION AND PURPOSE**

6
7 **Q. PLEASE STATE YOUR NAME AND BUSINESS ADDRESS.**

8 **A.** My name is Edward L. Spitznagel, Jr., and my business address is Campus Box
9 1146, One Brookings Drive, St Louis, Missouri 63130.

10
11 **Q. WHAT IS YOUR PRESENT POSITION?**

12 **A.** I am Professor of Mathematics in the College of Arts and Sciences at
13 Washington University. I also hold a joint appointment in the Division of
14 Biostatistics of the Washington University School of Medicine.

15
16 **Q. PLEASE REVIEW YOUR EDUCATIONAL BACKGROUND AND WORK
17 EXPERIENCE.**

18 **A.** I hold A Bachelor of Science, summa cum laude, in mathematics, awarded in
19 1962 by Xavier University, Cincinnati, Ohio. I hold a Master of Science (1963)
20 and Ph.D. (1965) in mathematics awarded by the University of Chicago. I have
21 served on the Faculty of Arts and Sciences of Washington University since
22 1969. I have held a joint appointment in the Division of Biostatistics since 1978.
23 From 1965 to 1969, I was on the faculty of Northwestern University. Attached to
24 my testimony is Schedule ELS-1, which provides a more detailed listing of my
25 education and qualifications in the area of mathematics and statistics.

1 **Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?**

2 A. I was asked by Missouri-American Water Company (Company) to review,
3 compare and comment upon the predictions of water utilization for the period
4 rates will be in effect, as offered in the direct testimonies of the Company,
5 Commission Staff and Missouri Industrial Energy Consumers (“MIEC”)
6 witnesses. In addition I was asked to compare the results of my own
7 normalized predictions of water utilization for St. Louis County residential
8 customers to that developed by Company witness Kevin Dunn.

9
10 **Q. WHY DID YOU LIMIT YOUR STUDY TO ST. LOUIS COUNTY RESIDENTIAL**
11 **CUSTOMERS?**

12 A. Because of time constraints, cost considerations and the fact that the Company
13 desired only a “test” of the results of Mr. Dunn’s study, the Company requested
14 that I concentrate my study on St. Louis County, which constitutes about 75%
15 of their residential customers.

16
17 **Q. PLEASE EXPLAIN HOW YOU PROCEEDED.**

18 A. For ratemaking purposes, revenues need to be set at a normalized level,
19 factoring out the potential or actual results of unusual weather. In addition,
20 non-meteorological predictors, such as the the decline in consumption due to
21 water-conserving plumbing fixtures and appliances and even the month of the
22 year, must be factored into the determination of normal consumption. In
23 previous rate cases, I developed a multivariate model to predict normalized
24 consumption. This model was based on predictors whose variables correlated
25 consistently with utilization, primarily the Palmer Drought Severity Index

1 (“PDSI”) and month of consumption. For the months of January through April,
2 there is no evidence that moisture predicts utilization; for the months of May,
3 June, November and December, it is a weak predictor, and in the months of
4 July and August it is a strong predictor. Because of this, I estimated twelve
5 separate predictive models, one for each month of the year.

6
7 **Q. HOW DID YOU ADAPT THE MEASURE OF DROUGHT SEVERITY TO**
8 **MAKING ESTIMATES ON AN ANNUAL RATHER THAN A MONTHLY**
9 **BASIS?**

10 **A.** Since the monthly predictions of my previous method were combined linearly to
11 obtain daily consumption averaged over a year, I calculated the average value
12 of the PDSI over the eight weather-sensitive months of May through December
13 and used this average value in an annual prediction equation. This effectively
14 produced the same prediction, just with the computations done in a different
15 order. I used ten years of consumption data beginning with the year 1999 and
16 ending with the year 2010, omitting the years 2003 and 2006. In years 2003
17 and 2006 the Company changed its accounting system and, as a result, sales
18 for those years were not recorded on the same basis as all other years. In
19 order to have ten (10) years of consistent data, I added years 1999 and 2000,
20 in place of years 2003 and 2006. The computations can be found in Schedule
21 ELS-2. I then fitted a least-squares regression model to predict consumption in
22 gallons per customer per day(gcd) from the year and the May-December
23 average of PDSI. The model fit the data well, achieving an R-square value of
24 93% (out of a maximum possible 100%). Both predictor variables were highly
25 statistically significant, with P-values of 0.0058 for PDSI and 0.0037 for year.

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Q. ONCE YOU HAD ESTIMATED THE COEFFICIENTS IN THESE MODELS, HOW DID YOU PROJECT UTILIZATION FOR JANUARY 2012 THROUGH DECEMBER 2012?

A. I added two lines of data to correspond to the years 2011 and 2012. In both lines I set the PSDI to the thirty-year average from 1981 to 2010 for the weather-sensitive months of May through December for the St. Louis County climate region. I left the daily consumption missing so the regression coefficients would not be affected by the addition of these two lines of data. I then requested the predicted values, resulting in the same results as if I had evaluated the regression equation with the year values of 2011 and 2012 and the average regional PDSI value, but with no risk of computational error.

Q. WHAT ARE YOUR PREDICTIONS OF DAILY UTILIZATION UNDER AVERAGE WEATHER FOR ST. LOUIS COUNTY RESIDENTIAL CUSTOMERS FOR THE YEAR 2012?

A. For St. Louis County residential customers, I calculated average daily utilization of 232.32 gallons per day for the year 2012.

Q. HOW DO YOUR RESULTS COMPARE TO THOSE OF MR. DUNN?

A. For St. Louis County residential customers, Mr. Dunn’s approach resulted in the determination of 232.19 gallons per day. His predicted consumption level is slightly below what my model predicts. Ostensibly, this difference is because of the difference in weather normalization techniques for the summer months. Mr. Dunn correctly normalizes a base consumption level, which takes into

1 consideration approximately 80% of all consumption. However, his method for
2 estimating the weather impact on the variable consumption component is
3 simply based on a ten-year average, compared with my use of 30 years of
4 weather. Therefore, it appears that his results are very slightly understated.
5 However, they are more accurate than the approaches used by either Staff
6 Witness Jerry Scheible or MIEC witness Brian Collins.

7
8 **Q. WHY ARE THE METHODS USED BY MR. SCHEIBLE AND MR. COLLINS**
9 **LIKELY TO RESULT IN INACCURATE ESTIMATES?**

10
11 A. Mr. Scheible proposes using a four-year average to estimate future water
12 consumption. Mr. Collins uses a six-year average to estimate the same. Mr.
13 Scheible's use of an average of the previous four-years to predict future
14 consumption and Mr. Collins use of a six-year average are likely to result in an
15 overestimation of future water consumption. This is because the historical
16 average method fails to take into account declining water consumption trends.

17
18 **Q. CAN YOU DEMONSTRATE THESE OVERESTIMATES FOR PREVIOUS**
19 **YEARS?**

20 A. Yes, I have shown details in Schedule ELS-3 that demonstrate how Mr.
21 Scheible's proposed four-year average method leads to overestimation of water
22 consumption when compared to actual consumption data. We have
23 consumption data for the years 1990 through 2010. Therefore we can calculate
24 the difference between four-year averages and actual consumption two years
25 beyond those averages, to determine the accuracy of his methodology. We

1 can do this a total of sixteen times, beginning with the average consumption
2 over 1990-1993 used to estimate consumption in 1995 and ending with
3 average consumption over 2005-2008 used to estimate consumption in 2010.
4 Of those sixteen times, ten overestimates of consumption resulted, while only
5 six underestimates resulted. The most extreme overestimate was 40.677 gcd,
6 while the most extreme underestimate was -7.467. Over the sixteen
7 calculations, the average error of estimate was a positive 9.894 gcd. This is a
8 substantial bias, and because it is positive, its inaccuracy works to the
9 disadvantage of Missouri-American Water Company because it tends to
10 overstate normal consumption.

11 I have prepared a similar analysis in Schedule ELS-4 that demonstrates how
12 Mr. Collins' proposed six-year average method also leads to overestimation of
13 water consumption. Using the same consumption data for the years 1990
14 through 2010, we can calculate the difference between six-year averages and
15 actual consumption two years beyond those averages, to determine the
16 accuracy of his methodology. We can do this a total of fourteen times,
17 beginning with the average consumption over 1990-1995 used to estimate
18 consumption in 1997 and ending with average consumption over 2003-2008
19 used to estimate consumption in 2010. Of those fourteen times, nine
20 overestimates of consumption resulted, while only five underestimates resulted.
21 The most extreme overestimate was 38.800 gcd, while the most extreme
22 underestimate was -9.791. Over the fourteen calculations, the average error of
23 estimate was a positive 12.274 gcd. This is an even larger bias than that
24 resulting from the four-year averages of Mr. Scheible and therefore has a
25 greater likelihood of overstating normal consumption.

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Q. DO YOU HAVE ANY OTHER OBSERVATIONS REGARDING THE USE OF SIMPLE HISTORICAL AVERAGES IN DETERMINING NORMALIZED CONSUMPTION?

A. Yes. Not only does the use of a simple historical average ignore declining water consumption, it leads to widely varying degrees of results depending upon the historical period selected. This is demonstrated by the fact that, while both Mr. Scheible and Mr. Collins used the same general method, selection of a four-year period by Mr. Scheible and a six-year period by Mr. Collins resulted in consumption levels that differed by almost 5%, or almost 12 gcd.

Q. DOES THIS CONCLUDE YOUR REBUTTAL TESTIMONY?

A. Yes, it does.

Edward L. Spitznagel, Jr.

Born: Cincinnati, Ohio, September 4, 1941.

Education:

Xavier University, 1959-1962
Awarded Bachelor of Science Degree (Summa cum Laude), 1962
University of Chicago, 1962-1965
Awarded Master of Science Degree, 1963
Awarded Ph.D. in Mathematics, 1965

Scholarships and Fellowships:

Xavier University, 1959-1962
Honorary Woodrow Wilson Fellow, 1962-1963
National Science Foundation Fellow, 1962-1965

Positions:

Assistant Professor of Mathematics
Northwestern University, 1965-1969
Associate Professor of Mathematics
Washington University, 1969-1980
Professor of Mathematics
Washington University, 1980-present
Joint appointment, Division of Biostatistics,
Washington University School of Medicine, 1978-present

Consulting Experience:

Littton Industries (USACDCEC, Fort Ord, CA)
Price Waterhouse (Advanced Auditing Methods, NY)
Mallinckrodt, Inc.
St. Louis County Juvenile Court
Monsanto Company
American Red Cross
Carboline Corporation
Regional Justice Information Service
Harris-Stowe State College
Equal Employment Opportunity Commission
American Optometric Association
Petrolite Corporation
U.S. Army Atmospheric Sciences Laboratory (White Sands, NM)
St. Louis County Water Company
Gateway Medical Research, Inc.
MasterCard
Simmons Market Research Bureau
Transactional Data Solutions
Missouri-American Water Company
Capital City Water Company
Kentucky-American Water Company
Tennessee-American Water Company
Iowa-American Water Company
New Jersey-American Water Company
Anheuser-Busch, Inc.
Partek, Inc.
Santa Clara County Mental Health Administration (San Jose, CA)
and many law firms

Publications:

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2. Hall subgroups of certain families of finite groups. *Math. Z.* **97**, 259-290 (1967).
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23. Interfacing SAS with Mark IV. *Proceedings of the Fourth Annual Conference of SAS Users Group International*, 41-44 (1979).
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Schedule ELS-1

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235. Older Youth Leaving the Foster Care System: Who, What, When, Where, and Why? *Child Youth Serv Rev* **30**, 735-745 (2008). (With McCoy et al.)
236. The clinical significance of preschool depression: impairment in functioning and clinical markers of the disorder. *J Affect Disord* **112**, 111-119 (2009). (With Luby et al.)
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244. Alcohol use among older adults in the National Epidemiologic Survey on Alcohol and Related Conditions: a latent class analysis. *J Stud Alcohol Drugs* **70**, 829-838 (2009). (With Sacco and Bucholz)
245. Exposure to bioterrorism and mental health response among staff on capitol hill. *Biosecur Bioterror* **7**, 148-158 (2009). (With North et al.)
246. Children's mental health service use and maternal mental health: a path analytic model. *Child Youth Serv Rev* **31**, 378-382 (2009). (With Pfefferle.)
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250. Infant head growth in male siblings of children with and without autism spectrum disorders. *J Neurodev Disord* **2**, 39-46 (2010). (With Constantino et al.)
251. Predictors of sexual debut at age 16 or younger. *Arch Sex Behav* **39**, 664-673 (2010). (With Cavazos-Rehg et al.)
252. The Benefit of Adjuvant Chemotherapy in Elderly Patients with Stage III Colorectal Cancer is Independent of Age and Comorbidity. *J Geriatr Oncol* **1**, 48-56 (2010). (With Wildes et al.)

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255. Predictive capability of historical data for diagnosis of dizziness. *Otol Neurotol* **32**, 284-290 (2011). (With Zhao et al.)
256. Substance use and the risk for sexual intercourse with and without a history of teenage pregnancy among adolescent females. *J Stud Alcohol Drugs* **72**, 194-198 (2011). (With Cavazos-Rehg et al.)
257. Low-frequency repetitive transcranial magnetic stimulation to the temporoparietal junction for tinnitus. *Arch Otolaryngol Head Neck Surg* **137**, 221-228 (2011). (With Piccirillo et al.)
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259. Number of sexual partners and associations with initiation and intensity of substance use. *AIDS Behav* **15**, 869-874 (2011). (With Cavazos-Rehg et al.)
260. Postoperative myocardial injury after major head and neck cancer surgery. *Head Neck* **33**, 1085-1091 (2011). (With Nagele et al.)
261. Use of the modified SNOT-16 in primary care patients with clinically diagnosed acute rhinosinusitis. *Arch Otolaryngol Head Neck Surg* **137**, 792-797 (2011). (With Garbutt and Piccirillo.)
262. Prevalence and Correlates of Psychotropic Medication Use in Adolescents with an Autism Spectrum Disorder with and without Caregiver-Reported Attention-Deficit/Hyperactivity Disorder. *J Child Adolesc Psychopharmacol* **Epub ahead of print** (2011). (With Frazier et al.)

Schedule ELS-2

St Louis quarterly projections, omitting data from 2003 and 2006

The REG Procedure
 Model: MODEL1
 Dependent Variable: resdaily

Number of Observations Read	12
Number of Observations Used	10
Number of Observations with Missing Values	2

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	4902.53067	2451.26533	45.49	<.0001
Error	7	377.21310	53.88759		
Corrected Total	9	5279.74377			

Root MSE	7.34082	R-Square	0.9286
Dependent Mean	256.94910	Adj R-Sq	0.9081
Coeff Var	2.85691		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > t
Intercept	1	279.32623	3.67968	75.91	<.0001
pdsi5_12	1	-4.13563	1.05737	-3.91	0.0058
since_2000	1	-3.43734	0.80479	-4.27	0.0037

year	resdaily	p
1999	287.354	289.396
2000	273.989	273.934
2001	281.165	268.703
2002	271.307	273.899
2004	245.209	255.326
2005	267.914	270.307
2007	265.361	260.310
2008	226.399	231.010
2009	222.311	225.086
2010	228.482	221.519
2011	.	235.754
2012	.	232.317

Schedule ELS-3**Demonstration of the Tendency of Four-Year Averages to Over-Estimate Future Consumption**

Year	Water Sales (1000 gal)	Total (Quarterly) Bills	Actual Daily Consumption per Customer	Four-Year Averages	Over or Under Estimates
1990	27,779,574	1,091,005	279.040		
1991	29,576,416	1,102,850	293.898		
1992	29,599,456	1,115,902	289.892		
1993	26,337,508	1,127,562	255.977		
1994	29,729,856	1,138,888	286.074		
1995	28,771,525	1,141,771	276.154	279.702	3.548
1996	29,250,936	1,154,046	277.010	281.460	4.450
1997	29,698,300	1,161,224	280.274	277.024	-3.250
1998	28,162,554	1,158,121	266.493	273.804	7.311
1999	30,760,506	1,173,121	287.354	279.878	-7.476
2000	29,511,009	1,177,143	273.989	274.983	0.993
2001	30,367,468	1,183,624	281.165	277.783	-3.383
2002	31,454,872	1,270,557	271.307	277.028	5.721
2003	27,889,513	1,255,656	243.409	277.250	33.841
2004	29,482,896	1,283,524	251.041	278.454	27.413
2005	32,063,233	1,285,386	273.364	267.468	-5.896
2006	33,071,276	1,362,792	265.943	261.731	-4.212
2007	31,515,189	1,320,220	261.602	259.780	-1.821
2008	27,219,145	1,313,949	226.399	258.439	32.040
2009	26,485,800	1,305,628	222.311	262.987	40.677
2010	27,300,873	1,309,461	228.482	256.827	28.345
				Mean Overestimate:	9.894

Schedule ELS-4

Demonstration of the Tendency of Six-Year Averages to Over-Estimate Future Consumption

Year	Water Sales (1000 gal)	Total (Quarterly) Bills	Actual Daily Consumption per Customer	Six-Year Averages	Over or Under Estimates
1990	27,779,574	1,091,005	279.040		
1991	29,576,416	1,102,850	293.898		
1992	29,599,456	1,115,902	289.892		
1993	26,337,508	1,127,562	255.977		
1994	29,729,856	1,138,888	286.074		
1995	28,771,525	1,141,771	276.154		
1996	29,250,936	1,154,046	277.010		
1997	29,698,300	1,161,224	280.274	280.173	-0.101
1998	28,162,554	1,158,121	266.493	279.834	13.342
1999	30,760,506	1,173,121	287.354	277.564	-9.791
2000	29,511,009	1,177,143	273.989	273.664	-0.326
2001	30,367,468	1,183,624	281.165	278.893	-2.272
2002	31,454,872	1,270,557	271.307	276.879	5.572
2003	27,889,513	1,255,656	243.409	277.714	34.305
2004	29,482,896	1,283,524	251.041	276.764	25.723
2005	32,063,233	1,285,386	273.364	270.620	-2.744
2006	33,071,276	1,362,792	265.943	268.044	2.102
2007	31,515,189	1,320,220	261.602	265.713	4.111
2008	27,219,145	1,313,949	226.399	264.372	37.972
2009	26,485,800	1,305,628	222.311	261.111	38.800
2010	27,300,873	1,309,461	228.482	253.626	25.145
				Mean Overestimate:	12.274