COMMONWEALTH OF KENTUCKY

BEFORE THE PUBLIC SERVICE COMMISSION

IN THE MATTER OF:	**)**	
	)	
NOTICE OF ADJUSTMENT OF THE RATES OF	**)**	**CASE NO. 2008-00427**
KENTUCKY-AMERICAN WATER COMPANY	**)**	
EFFECTIVE ON AND AFTER NOVEMBER 30, 2008	**)**	

DIRECT TESTIMONY OF EDWARD L. SPITZNAGEL, JR.

October 31, 2008

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1. Q. Please state your name, business address, and employer.

A. My name is Edward L. Spitznagel, Jr., and my business address is Campus Box 1146, One Brookings Drive, St Louis, Missouri 63130. I am employed by Washington University.

2. Q. What is your present position?

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

3. Q. Please review your educational background and work experience.

A. I hold a Bachelor of Science, summa cum laude, in mathematics, awarded in 1962 by Xavier University, Cincinnati, Ohio. I hold a Master of Science (1963) and Ph.D. (1965) in mathematics awarded by the University of Chicago. I have served on the Faculty of Arts and Sciences of Washington University since 1969. I have held a joint appointment in the Division of Biostatistics since 1978. From 1965 to 1969 I was on the faculty of Northwestern University.

Attached to my testimony is Appendix A, which provides a more detailed listing of my education and qualifications in the area of mathematics and statistics.

4. Q. What is the purpose of your testimony in this case?

A. I have been employed by Kentucky American Water Company to make weather-normalized predictions of water utilization by residential and commercial customers for the period June 2009 to May 2010.

5. Q. What is weather normalization?

A. From one year to the next, variations in temperature and precipitation lead to changes in water consumption. More water will generally be used during hotter, drier periods. The regulatory question is how to reflect those weather-related differences when setting rates.

For ratemaking purposes, revenues need to be set to as "normal" a level as possible, factoring out the potential or actual results of unusual weather conditions. This can be accomplished by building statistical models that predict water utilization from meteorological data and other possible predictors. An estimate of future utilization can then be made by using a long-term average of meteorological data (since there is no better way to forecast next year's weather than as an average) and known values of the other predictors.

6. Q. What are examples of these other, non-meteorological predictors?

A. One is the year itself. Since 1993, the Environmental Protection Agency has required all new toilets manufactured in the United States to use at most 1.6 gallons per flush, which is a reduction of over 50% from the previous 3.5 gallons per flush. In addition, new faucets, showerheads, clothes washing machines, and dishwashers have all been redesigned to use less water. It appears that the introduction of these toilets, other plumbing fixtures, and appliances in new construction and replacement in old construction has led to a gradual decline in water consumption over time for both residential and commercial customer classes.

The graphs in Appendix B show KAWC per-customer daily use of water from 1983 to 2008, both for the weather-insensitive months of January through April (1983-2008), and for the full calendar year January through December (1983-2007). Over those 25-26 years, there has been a gradual but clear reduction in consumption.

Another is the month of the year. While water utilization increases during the warmer summer months, analysis of variance shows that month as a categorical variable is a powerful predictor even after temperature and moisture have been included in the model.

7. Q. What model for water utilization did you employ?

A. In a case before this Commission in 1997, I screened a large number of candidate predictors by examining data from sixteen different operating companies in five states, Kentucky, Missouri, Ohio, Tennessee, and Virginia.

I used as candidate predictors only those variables that correlated consistently with utilization for most or all of these operating companies.

I then fitted the surviving candidates in a multivariate model to predict utilization for Kentucky American Water Company. I found that calendar month was a strong predictor even in the presence of heat and moisture variables. Therefore I included month as a categorical variable. With month included, I added drought severity index, temperature, and calendar year as potential numeric predictors. In that investigation I found that temperature was not a useful additional predictor in the presence of the drought index, the calendar month, and calendar year.

Eleven years have elapsed since that investigation. Therefore in the present case I have re-screened for KAWC the original list of candidate variables explored in the 1997 rate case. Drought severity index, month, and year still are useful predictors, each one adding to the predictive value of the others. In addition, I found a measurement of temperature called cooling degree days to be a useful predictor in the presence of the other three.

The evidence for the usefulness of these four variables, drought severity index, month, year, and cooling degree days can be found in the multivariate analyses in Appendix C.

8. Q. What are cooling degree days?

A. Cooling degrees are a daily measure of the amount by which the average daily temperature exceeds 65 degrees Fahrenheit. For example, if the average temperature on a summer day is 84 degrees, the cooling degrees for that day are $84 - 65 = 19$. If the average temperature on a winter day is 54 degrees, the cooling degrees for that day are 0. The primary use of cooling degrees is to aid in estimating the amount of electricity that will be used for air conditioning on a given day. Cooling degree days are the sum of cooling degrees over a given time period, such as a month, which is the form in which NOAA reports them. For water consumption, cooling degrees can act as an additional factor explaining outside water usage.

9. Q. What is the drought severity index?

A. There are a total of four drought severity indices provided by NOAA. They are reported on a monthly basis from 1895 to the present. They are: the Palmer Drought Severity Index (PDSI), the Modified Palmer Drought Severity Index (PMDI), the Palmer Hydrological Drought Index (PHDI), and the Palmer "Z" Index (ZNDX). The PDSI and PMDI are very similar to each other, differing only when the weather transitions between wet and dry spells. In my original investigations, both PDSI and PMDI turned out to be excellent predictors, much better than PHDI or ZNDX. Because PDSI worked slightly better than PMDI, I used PDSI in all previous weather normalizations. In the present case, however, PMDI gave predictive models that fitted the data slightly better, so I have shifted over to using PMDI rather than PDSI.

10. Q. Although PMDI is referred to as a drought severity index, low values of PMDI are associated with higher water consumption. Why is that?

A. PMDI and the other three variants are actually measures of available moisture, so high positive values indicate relative abundance of moisture rather than absence of moisture. Thus, people will be induced to use more outside water when PMDI is low, and particularly when it is negative.

11. Q. To summarize, in your weather normalization, what variables were found to predict utilization?

A. The calendar year, the month of the year (as a categorical variable), the Modified Palmer Drought Severity Index (PMDI), and cooling degree days (CDD). For commercial customers, the month of the year was found to interact with PMDI, meaning that the effect of PMDI on consumption varies by month. I therefore accounted for this interaction by running separate models for each month. In these separate models I omitted PMDI for the months of January through April, due to there being no weather-driven consumption during these months. I omitted CDD for the months of November through April because its value is essentially zero during those six months. These separate models are found in Appendix D.

12. Q. Once you had estimated the coefficients in these monthly models, how did you project weather-normalized utilization for June 2009 through May 2010?

A. I put the coefficients from the monthly regressions into Excel spreadsheets, one for each of the two customer classes. I then calculated the monthly mean PMDI and CDD over the 30 year period from January 1978 to December 2007. These spreadsheets are given in Appendix E.

13. Q. Having inserted the mean drought severity indices in the spreadsheets, how did you proceed?

A. I then projected an average daily utilization for each month under average weather. I then computed a weighted average of the 12 projected daily utilizations from June 2009 through May 2010, using as weights the number of days from the preceding month. Using the days from the preceding month allows for the fact that bills in, for example, March include utilization from the latter part of February.

14. Q. What are your projections of daily utilization under average weather for the two customer classes?

A. For residential customers: 157.71 gallons / customer / day

For commercial customers: 1,348.34 gallons / customer / day

15. Q. Does this conclude your 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:
- Litton 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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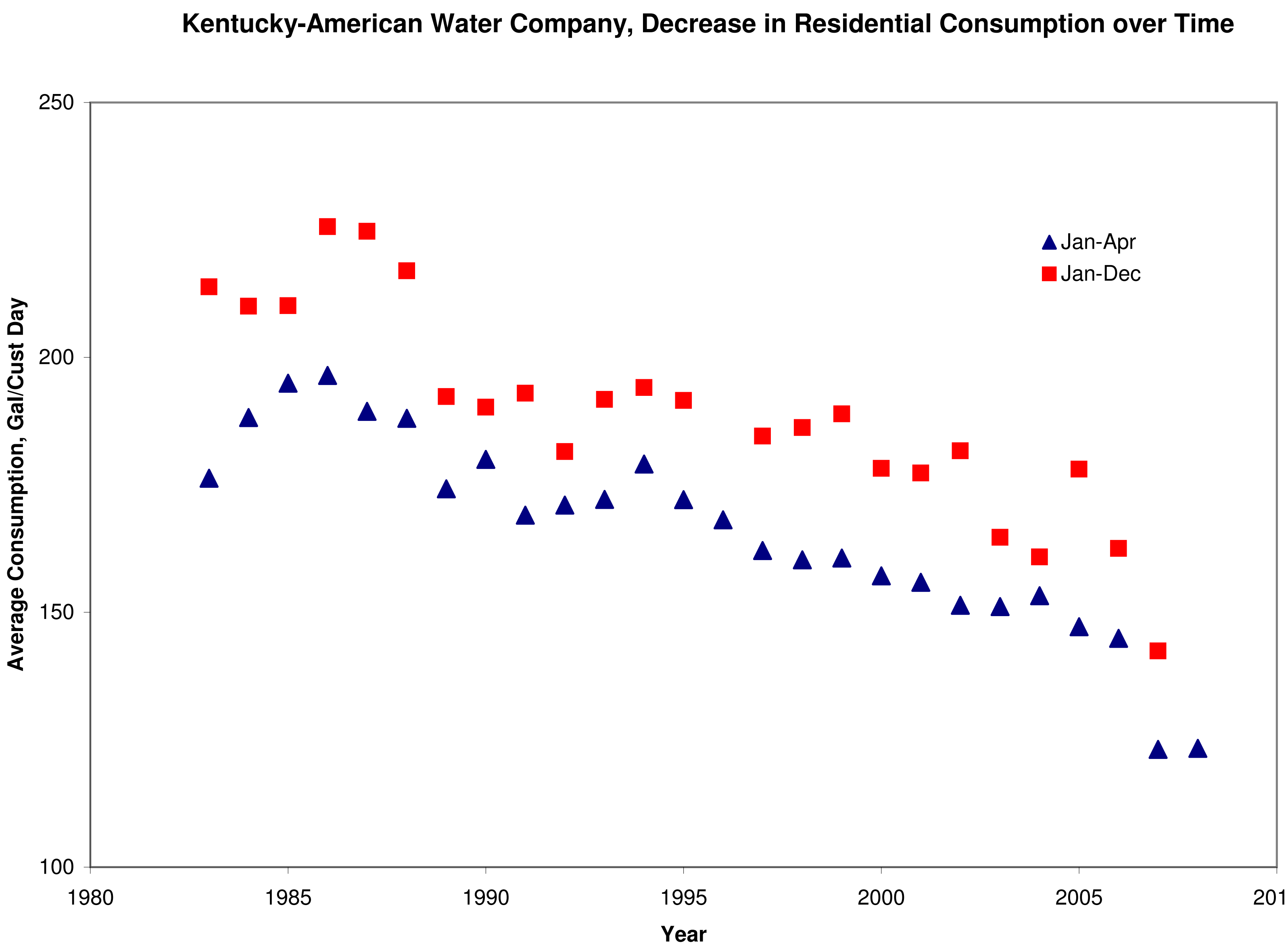
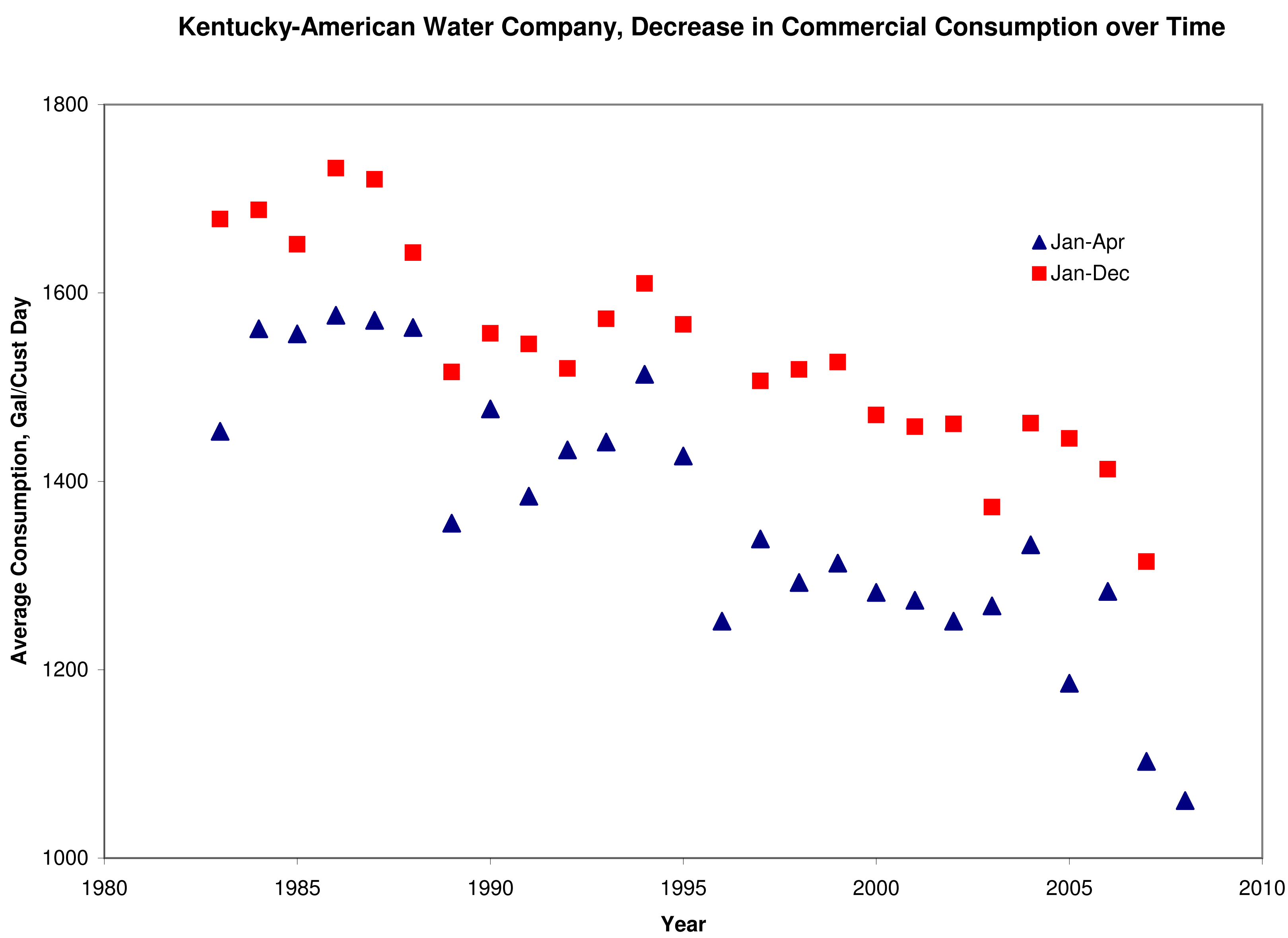

Kentucky-American Water Company, Decrease in Residential Consumption over Time
Average Consumption, Gal/Cust Day
250
200
150
100
1980
1985
1990
1995
2000
2005
2010
Year
Jan-Apr
Jan-Dec


Kentucky-American Water Company, Decrease in Commercial Consumption over Time
Average Consumption, Gal/Cust Day
Year
Jan-Apr
Jan-Dec
1800
1600
1400
1200
1000
1980
1985
1990
1995
2000
2005
2010

Check Correlations between Weather Variables and Consumption

The GLM Procedure

Class Level Information

Class	Levels	Values
month	12	1 2 3 4 5 6 7 8 9 10 11 12

Data for Analysis of residential

Number of Observations Read	120
Number of Observations Used	119

Data for Analysis of commercial

Number of Observations Read	120
Number of Observations Used	118

NOTE: Variables in each group are consistent with respect to the presence or absence of missing values.

Check Correlations between Weather Variables and Consumption

The GLM Procedure

Dependent Variable: residential

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	36	0.08917269	0.00247702	22.12	<.0001
Error	82	0.00918379	0.00011200		
Corrected Total	118	0.09835648			

R-Square	Coeff Var	Root MSE	residential Mean
0.906627	6.080935	0.010583	0.174034

Source	DF	Type I SS	Mean Square	F Value	Pr > F
pmdi	1	0.01157142	0.01157142	103.32	<.0001
cdd	1	0.05377306	0.05377306	480.13	<.0001
year	1	0.00630149	0.00630149	56.26	<.0001
month	11	0.01496445	0.00136040	12.15	<.0001
pmdi*month	11	0.00202102	0.00018373	1.64	0.1027
year*month	11	0.00054126	0.00004921	0.44	0.9336

Source	DF	Type III SS	Mean Square	F Value	Pr > F
pmdi	1	0.00163710	0.00163710	14.62	0.0003
cdd	1	0.00252455	0.00252455	22.54	<.0001
year	1	0.00409656	0.00409656	36.58	<.0001
month	11	0.00852995	0.00077545	6.92	<.0001
pmdi*month	11	0.00170386	0.00015490	1.38	0.1966
year*month	11	0.00054126	0.00004921	0.44	0.9336

Check Correlations between Weather Variables and Consumption

The GLM Procedure

Dependent Variable: commercial

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	36	4.73897499	0.13163819	17.18	<.0001
Error	81	0.62078405	0.00766400		
Corrected Total	117	5.35975904			

R-Square	Coeff Var	Root MSE	commercial Mean
0.884177	6.065099	0.087544	1.443411

Source	DF	Type I SS	Mean Square	F Value	Pr > F
pmdi	1	0.19592765	0.19592765	25.56	<.0001
cdd	1	2.35512157	2.35512157	307.30	<.0001
year	1	0.54682733	0.54682733	71.35	<.0001
month	11	1.41806834	0.12891530	16.82	<.0001
pmdi*month	11	0.18736468	0.01703315	2.22	0.0207
year*month	11	0.03566542	0.00324231	0.42	0.9417

Source	DF	Type III SS	Mean Square	F Value	Pr > F
pmdi	1	0.01678251	0.01678251	2.19	0.1428
cdd	1	0.04516086	0.04516086	5.89	0.0174
year	1	0.27673486	0.27673486	36.11	<.0001
month	11	0.70628864	0.06420806	8.38	<.0001
pmdi*month	11	0.17328131	0.01575285	2.06	0.0332
year*month	11	0.03566542	0.00324231	0.42	0.9417

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, JANUARY

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	354.18768	354.18768	5.63	0.0451
Error	8	503.68773	62.96097		
Corrected Total	9	857.87541			

Root MSE	7.93479	R-Square	0.4129
Dependent Mean	151.82400	Adj R-Sq	0.3395
Coeff Var	5.22631		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	179.79600	12.05747	14.91	<.0001
since_90	1	-2.07200	0.87359	-2.37	0.0451

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, FEBRUARY

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	615.62616	615.62616	16.82	0.0034
Error	8	292.75968	36.59496		
Corrected Total	9	908.38584			

Root MSE	6.04938	R-Square	0.6777
Dependent Mean	152.48350	Adj R-Sq	0.6374
Coeff Var	3.96723		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	189.36133	9.19245	20.60	<.0001
since_90	1	-2.73169	0.66601	-4.10	0.0034

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, MARCH

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	249.77178	249.77178	20.73	0.0019
Error	8	96.37631	12.04704		
Corrected Total	9	346.14809			

Root MSE	3.47088	R-Square	0.7216
Dependent Mean	148.62230	Adj R-Sq	0.6868
Coeff Var	2.33537		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	172.11205	5.27425	32.63	<.0001
since_90	1	-1.73998	0.38213	-4.55	0.0019

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, APRIL

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	375.60961	375.60961	39.87	0.0002
Error	8	75.37318	9.42165		
Corrected Total	9	450.98279			

Root MSE	3.06947	R-Square	0.8329
Dependent Mean	148.53730	Adj R-Sq	0.8120
Coeff Var	2.06646		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	177.34278	4.66427	38.02	<.0001
since_90	1	-2.13374	0.33794	-6.31	0.0002

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, MAY

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	1252.42213	417.47404	3.76	0.0786
Error	6	665.62752	110.93792		
Corrected Total	9	1918.04964			

Root MSE	10.53271	R-Square	0.6530
Dependent Mean	164.88810	Adj R-Sq	0.4794
Coeff Var	6.38779		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	196.85948	22.25119	8.85	0.0001
pmdi	1	-2.30730	1.73755	-1.33	0.2325
cdd	1	0.01417	0.09564	0.15	0.8871
since_90	1	-2.53224	1.36350	-1.86	0.1127

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, JUNE

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	3949.42452	1316.47484	15.79	0.0030
Error	6	500.09780	83.34963		
Corrected Total	9	4449.52231			

Root MSE	9.12960	R-Square	0.8876
Dependent Mean	188.53990	Adj R-Sq	0.8314
Coeff Var	4.84227		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	138.14032	20.67165	6.68	0.0005
pmdi	1	-5.25250	1.59857	-3.29	0.0167
cdd	1	0.28877	0.06418	4.50	0.0041
since_90	1	-1.26680	1.10331	-1.15	0.2946

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, JULY

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2861.75693	953.91898	5.75	0.0338
Error	6	995.51168	165.91861		
Corrected Total	9	3857.26860			

Root MSE	12.88094	R-Square	0.7419
Dependent Mean	210.56100	Adj R-Sq	0.6129
Coeff Var	6.11744		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	197.89006	39.74973	4.98	0.0025
pmdi	1	-5.16630	2.52564	-2.05	0.0868
cdd	1	0.09163	0.08632	1.06	0.3293
since_90	1	-1.54331	1.55494	-0.99	0.3593

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, AUGUST

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2906.74306	968.91435	3.77	0.0785
Error	6	1543.82903	257.30484		
Corrected Total	9	4450.57209			

Root MSE	16.04072	R-Square	0.6531
Dependent Mean	211.40900	Adj R-Sq	0.4797
Coeff Var	7.58753		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	222.33542	29.13235	7.63	0.0003
pmdi	1	-6.17731	2.91485	-2.12	0.0784
cdd	1	0.05558	0.09262	0.60	0.5704
since_90	1	-2.68115	2.01794	-1.33	0.2323

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, SEPTEMBER

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	4093.38845	1364.46282	8.24	0.0151
Error	6	993.58055	165.59676		
Corrected Total	9	5086.96900			

Root MSE	12.86844	R-Square	0.8047
Dependent Mean	204.83500	Adj R-Sq	0.7070
Coeff Var	6.28234		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	190.85013	21.79794	8.76	0.0001
pmdi	1	-1.45765	2.04033	-0.71	0.5018
cdd	1	0.27028	0.08280	3.26	0.0172
since_90	1	-2.32687	1.45029	-1.60	0.1597

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, OCTOBER

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	9
Number of Observations with Missing Values	1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	2019.75625	673.25208	1.72	0.2776
Error	5	1955.62317	391.12463		
Corrected Total	8	3975.37942			

Root MSE	19.77687	R-Square	0.5081
Dependent Mean	191.54844	Adj R-Sq	0.2129
Coeff Var	10.32474		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	236.61404	30.05564	7.87	0.0005
pmdi	1	-1.77539	2.86595	-0.62	0.5627
cdd	1	0.25862	0.54894	0.47	0.6574
since_90	1	-4.12329	2.61620	-1.58	0.1758

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, NOVEMBER

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	994.20201	497.10100	15.10	0.0029
Error	7	230.43175	32.91882		
Corrected Total	9	1224.63375			

Root MSE	5.73749	R-Square	0.8118
Dependent Mean	163.06570	Adj R-Sq	0.7581
Coeff Var	3.51852		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	190.49152	8.68834	21.92	<.0001
pmdi	1	-1.84398	0.62697	-2.94	0.0217
since_90	1	-2.17533	0.68212	-3.19	0.0153

Run regressions by month: Lexington, AUG1998-JUL2008
Residential Model, DECEMBER

The REG Procedure
Model: MODEL1
Dependent Variable: residential

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	430.70206	215.35103	17.67	0.0018
Error	7	85.32354	12.18908		
Corrected Total	9	516.02559			

Root MSE	3.49129	R-Square	0.8347
Dependent Mean	153.84350	Adj R-Sq	0.7874
Coeff Var	2.26937		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	181.23849	5.51586	32.86	<.0001
pmdi	1	-0.18351	0.41740	-0.44	0.6734
since_90	1	-2.18856	0.43555	-5.02	0.0015

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, JANUARY

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	9
Number of Observations with Missing Values	1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	30661	30661	4.82	0.0642
Error	7	44547	6363.91212		
Corrected Total	8	75208			

Root MSE	79.77413	R-Square	0.4077
Dependent Mean	1203.92278	Adj R-Sq	0.3231
Coeff Var	6.62618		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1464.95017	121.85700	12.02	<.0001
since_90	1	-19.57705	8.91902	-2.19	0.0642

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, FEBRUARY

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read 10
Number of Observations Used 10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	19891	19891	2.98	0.1223
Error	8	53316	6664.44563		
Corrected Total	9	73207			

Root MSE	81.63606	R-Square	0.2717
Dependent Mean	1263.19870	Adj R-Sq	0.1807
Coeff Var	6.46265		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1472.82187	124.05165	11.87	<.0001
since_90	1	-15.52764	8.98783	-1.73	0.1223

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, MARCH

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	23385	23385	5.30	0.0503
Error	8	35287	4410.87246		
Corrected Total	9	58672			

Root MSE	66.41440	R-Square	0.3986
Dependent Mean	1262.95240	Adj R-Sq	0.3234
Coeff Var	5.25866		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1490.24151	100.92128	14.77	<.0001
since_90	1	-16.83623	7.31198	-2.30	0.0503

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, APRIL

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	1	17482	17482	3.41	0.1020
Error	8	41020	5127.52660		
Corrected Total	9	58503			

Root MSE	71.60675	R-Square	0.2988
Dependent Mean	1272.52950	Adj R-Sq	0.2112
Coeff Var	5.62712		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1469.04933	108.81142	13.50	<.0001
since_90	1	-14.55702	7.88364	-1.85	0.1020

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, MAY

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	71157	23719	6.65	0.0245
Error	6	21386	3564.33230		
Corrected Total	9	92543			

Root MSE	59.70203	R-Square	0.7689
Dependent Mean	1375.36810	Adj R-Sq	0.6534
Coeff Var	4.34080		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1673.09939	126.12536	13.27	<.0001
pmdi	1	3.16295	9.84887	0.32	0.7590
cdd	1	0.65740	0.54212	1.21	0.2708
since_90	1	-26.39666	7.72867	-3.42	0.0142

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, JUNE

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	114601	38200	31.77	0.0004
Error	6	7214.74617	1202.45769		
Corrected Total	9	121816			

Root MSE	34.67647	R-Square	0.9408
Dependent Mean	1493.35400	Adj R-Sq	0.9112
Coeff Var	2.32205		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1584.51318	78.51601	20.18	<.0001
pmdi	1	-27.14363	6.07178	-4.47	0.0042
cdd	1	0.77769	0.24376	3.19	0.0188
since_90	1	-20.64507	4.19064	-4.93	0.0026

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, JULY

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	130214	43405	23.20	0.0011
Error	6	11225	1870.81826		
Corrected Total	9	141439			

Root MSE	43.25296	R-Square	0.9206
Dependent Mean	1640.61150	Adj R-Sq	0.8810
Coeff Var	2.63639		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1869.34272	133.47576	14.01	<.0001
pmdi	1	-30.83078	8.48086	-3.64	0.0109
cdd	1	0.20893	0.28986	0.72	0.4982
since_90	1	-23.41891	5.22134	-4.49	0.0042

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, AUGUST

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	135511	45170	5.97	0.0311
Error	6	45397	7566.24330		
Corrected Total	9	180909			

Root MSE	86.98416	R-Square	0.7491
Dependent Mean	1743.61340	Adj R-Sq	0.6236
Coeff Var	4.98873		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1981.19332	157.97622	12.54	<.0001
pmdi	1	-48.38909	15.80636	-3.06	0.0222
cdd	1	-0.07637	0.50227	-0.15	0.8841
since_90	1	-19.22159	10.94268	-1.76	0.1295

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, SEPTEMBER

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	75646	25215	1.44	0.3223
Error	6	105370	17562		
Corrected Total	9	181016			

Root MSE	132.52071	R-Square	0.4179
Dependent Mean	1689.02930	Adj R-Sq	0.1268
Coeff Var	7.84597		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1508.01292	224.47779	6.72	0.0005
pmdi	1	18.02103	21.01156	0.86	0.4240
cdd	1	1.71602	0.85265	2.01	0.0908
since_90	1	-6.32000	14.93521	-0.42	0.6869

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, OCTOBER

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	9
Number of Observations with Missing Values	1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	39860	13287	1.04	0.4493
Error	5	63629	12726		
Corrected Total	8	103489			

Root MSE	112.80894	R-Square	0.3852
Dependent Mean	1649.92578	Adj R-Sq	0.0163
Coeff Var	6.83721		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1900.31724	171.43993	11.08	0.0001
pmdi	1	-2.85603	16.34760	-0.17	0.8682
cdd	1	0.65843	3.13120	0.21	0.8418
since_90	1	-21.39566	14.92302	-1.43	0.2111

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, NOVEMBER

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	36696	18348	5.02	0.0444
Error	7	25565	3652.13903		
Corrected Total	9	62261			

Root MSE	60.43293	R-Square	0.5894
Dependent Mean	1413.81870	Adj R-Sq	0.4721
Coeff Var	4.27445		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1667.31802	91.51422	18.22	<.0001
pmdi	1	-1.82330	6.60386	-0.28	0.7904
since_90	1	-20.26142	7.18478	-2.82	0.0258

Run regressions by month: Lexington, AUG1998-JUL2008
Commercial Model, DECEMBER

The REG Procedure
Model: MODEL1
Dependent Variable: commercial

Number of Observations Read	10
Number of Observations Used	10

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	2	84766	42383	2.28	0.1730
Error	7	130258	18608		
Corrected Total	9	215024			

Root MSE	136.41245	R-Square	0.3942
Dependent Mean	1309.30470	Adj R-Sq	0.2211
Coeff Var	10.41869		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	1636.70581	215.51704	7.59	0.0001
pmdi	1	32.84177	16.30861	2.01	0.0839
since_90	1	-26.73595	17.01779	-1.57	0.1602

		Projections of Residential Water Utilization, Gallons per Day, Kentucky-American									
	Slope of	**Slope of**	**Slope of**		**30-yr Avg**	**30-yr Avg**	**Days**	**2008**	**2009**	**2010**	**2011**
Month	**PMDI**	**CDD**	**SINCE_90**	**Intercept**	**PMDI**	**CDD**		**Gal/Day**	**Gal/Day**	**Gal/Day**	**Gal/Day**
Jan	0	0	-2.07200	179.7960	0.34333	1.333	31	142.50	140.43	138.36	136.28
Feb	0	0	-2.73169	189.3613	0.17300	0.000	31	140.19	137.46	134.73	132.00
Mar	0	0	-1.73998	172.1121	-0.19033	5.133	28	140.79	139.05	137.31	135.57
Apr	0	0	-2.13374	177.3428	-0.22900	6.733	31	138.94	136.80	134.67	132.53
May	-2.30730	0.01417	-2.53224	196.8595	0.20700	87.300	30	152.04	149.51	146.97	144.44
Jun	-5.25250	0.28877	-1.26680	138.1403	0.19700	217.600	31	177.14	175.87	174.61	173.34
Jul	-5.16630	0.09163	-1.54331	197.8901	-0.00700	339.567	30	201.26	199.72	198.17	196.63
Aug	-6.17731	0.05558	-2.68115	222.3354	-0.08767	311.433	31	191.93	189.24	186.56	183.88
Sep	-1.45765	0.27028	-2.32687	190.8501	-0.12533	137.400	31	186.29	183.96	181.63	179.31
Oct	-1.77539	0.25862	-4.12329	236.6140	0.42600	19.833	30	166.77	162.64	158.52	154.40
Nov	-1.84398	0	-2.17533	190.4915	0.58167	0.200	31	150.26	148.09	145.91	143.74
Dec	-0.18351	0	-2.18856	181.2385	0.63900	0.400	30	141.73	139.54	137.35	135.16
				Annual projections:				160.93	158.59	156.34	154.05
KAWC2008.XLS			**Projection: Jun 2009 to May 2010**						157.71		

		Projections of Commercial Water Utilization, Gallons per Day, Kentucky-American									
Month	Slope of PMDI	Slope of CDD	Slope of SINCE_90	Intercept	30-yr Avg PMDI	30-yr Avg CDD	Days	2008 Gal/Day	2009 Gal/Day	2010 Gal/Day	2011 Gal/Day
Jan	0	0	-20.35988	1464.950	0.34333	1.333	31	1,098.47	1,078.11	1,057.75	1,037.39
Feb	0	0	-18.45448	1472.822	0.17300	0.000	31	1,140.64	1,122.19	1,103.73	1,085.28
Mar	0	0	-19.28145	1490.242	-0.19033	5.133	28	1,143.18	1,123.89	1,104.61	1,085.33
Apr	0	0	-25.52727	1469.049	-0.22900	6.733	31	1,009.56	984.03	958.50	932.98
May	3.16295	0.65740	-19.09350	1673.099	0.20700	87.300	30	1,387.46	1,368.37	1,349.28	1,330.18
Jun	-27.14363	0.77769	-22.18255	1584.513	0.19700	217.600	31	1,349.11	1,326.92	1,304.74	1,282.56
Jul	-30.83078	0.20893	-20.83576	1869.343	-0.00700	339.567	30	1,565.46	1,544.62	1,523.79	1,502.95
Aug	-48.38909	-0.07637	-12.20628	1981.193	-0.08767	311.433	31	1,741.94	1,729.73	1,717.53	1,705.32
Sep	18.02103	1.71602	8.45983	1508.013	-0.12533	137.400	31	1,893.81	1,902.27	1,910.73	1,919.19
Oct	-2.85603	0.65843	-23.71941	1900.317	0.42600	19.833	30	1,485.21	1,461.49	1,437.77	1,414.05
Nov	-1.82330	0	-18.73424	1667.318	0.58167	0.200	31	1,329.04	1,310.31	1,291.57	1,272.84
Dec	32.84177	0	-17.97324	1636.706	0.63900	0.400	30	1,334.17	1,316.20	1,298.23	1,280.25
				Annual projections:				1,374.30	1,356.21	1,339.40	1,321.96
KAWC2008.XLS			**Projection: Jun 2009 to May 2010**						1,348.34		