FILED
April 4, 2016
Data Center
Missouri Public
Service Commission

MAWC 27

Exhibit No.:	
Issues:	Test Year Water Sales Volumes and Revenues Declining Usage Impact on Revenue Weather impact on Usage and Revenue Economic and Price Impact on Usage and Revenue
Witness:	Gregory P. Roach
Exhibit Type:	Surrebuttal
Sponsoring Party:	Missouri-American Water Company
Case No.:	WR-2015-0301 SR-2015-0302
Date:	March 4, 2016

MISSOURI PUBLIC SERVICE COMMISSION

CASE NO. WR-2015-0301
CASE NO. SR-2015-0302

SURREBUTTAL TESTIMONY

OF

Gregory P. Roach

ON BEHALF OF

MISSOURI-AMERICAN WATER COMPANY

MAWC Exhibit No. 27
Date 3-21-16 Reporter TH
File No WR-2015-0301

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-2015-0301 CASE NO. SR-2015-0302

AFFIDAVIT OF GREGORY P. ROACH

Gregory P. Roach, being first duly sworn, deposes and says that he is the witness who sponsors the accompanying testimony entitled "Surrebuttal Testimony of Gregory P. Roach"; that said testimony and schedules were prepared by him and/or under his direction and supervision; that if inquiries 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.

Gregory P. Roach

State of Indiana
County of Johnson
SUBSCRIBED and sworn to
Before me this 18th **day of** February **2016.**

Dakota M. Rose

Notary Public

My commission expires: May 19, 2022

DAKOTA M. ROSE
Notary Public, State of Indiana
Johnson County
Commission # 653738
My Commission Expires
May 19, 2022

SURREBUTTAL TESTIMONY
Gregory P. Roach
MISSOURI-AMERICAN WATER COMPANY
CASE NO. WR-2015-0301
CASE NO. SR-2015-0302

TABLE OF CONTENTS

I. Introduction 1

II. Overview 2

III. Response to Staff Witness Mr. James A. Busch 3

IV. Response to OPC Witness Ms. Lena M. Mantle 6

V. Response to OPC Witness Mr. Charles R. Hyneman 13

VI. Response to OPC Witness Mr. Geoff Marke 18

VIII. Conclusions and Recommendations 30

SURREBUTTAL TESTIMONY

Gregory P. Roach

I. INTRODUCTION

Q. PLEASE STATE YOUR NAMEAND BUSINESS ADDRESS.

A. My name is Gregory P. Roach, and my business address is 555 E. County Line Road, Suite 201, Greenwood, IN 46143.

Q. HAVE YOU PREVIOUSLY SUBMITTED TESTIMONY IN THIS PROCEEDING?

A. Yes, I have submitted direct, supplemental direct and rebuttal testimony in this proceeding on behalf of Missouri-American Water Company ("MAWC" or "Company").

Q. WHAT IS THE PURPOSE OF YOUR REBUTTAL TESTIMONY?

A. My surrebuttal testimony will respond to the rebuttal testimony of James A. Busch on behalf of the Commission Staff ("Staff"), the rebuttal testimony of Lena M. Mantel on behalf of the Office of the Public Counsel ("OPC"), the rebuttal testimony of Charles R. Hyneman on behalf of the OPC and the rebuttal testimony of Geoff Marke on behalf of the OPC.

II. OVERVIEW

Q. WHAT SUBJECTS WILL YOUR REBUTTAL TESTIMONY ADDRESS?

A. My surrebuttal testimony will respond to assertions by Witnesses Busch, Mantel, Hyneman and Marke related to the MAWC developed Test Year water sales volumes and current rate revenues. Specifically, I will address assertions by these witnesses in their rebuttal testimony related to setting Test Year water sales volumes and revenues, climatic conditions during the 60 month period used by Staff and OPC to set Test Year water sales volumes

and revenues, residential usage per customer in August 2012 as compared to 40 year averages of climatic conditions for June through August, the accuracy of MAWC usage data, the application of non-representative weather data set by the OPC, the cause of changes in revenue from 2010 to 2015, the choice of winter months in modeling non-discretionary residential usage, the process by which the MAWC approach normalizes for 10 years of weather, the role of federal water use regulations in appliance and fixture saturation, and the impact of employment, income and price on MAWC residential customers decisions to consume water.

III. RESPONSE TO EBUTTAL TESTIMONY OF JAMES A BUSCH - STAFF

Q. MR. BUSCH CLAIMS THAT USING THE MOST RECENT 60 MONTHS OF DATA IS THE BEST METHOD OF SETTING TEST YEAR SALES VOLUMES STATING "*STAFF'S METHOD IS THE MOST REASONABLE BECAUSE IT USES THE MOST RECENT DATA TO DETERMINE NORMALIZED USAGE*". PLEASE EXPLAIN WHY STAFF'S APPROACH IS NOT "THE BEST METHOD"?

A. As detailed in my rebuttal testimony, Staff and OPC used similar methods, albeit measured over slightly different time periods, to calculate Test Year sales volumes and resulting Test Year revenue. In setting Test Year sales volumes and revenues, the Commission Staff and OPC used a simple 60 month averaging technique that was not normalized for varying weather conditions, a declining use trend or any other factor. It is a simple, discreet average by month of the 5 years defined by the period October 2010 through September 2015 (Staff) and January 2010 through December 2014 (OPC). As clearly demonstrated by the analysis reported in my rebuttal testimony, the 60 month period used by Staff and OPC was significantly warmer than the 40 year period of 1976 to 2015 that I compared it to. Hence the period of time that Staff and OPC used to set Test Year water sales volumes and revenues in their testimony resulted in significantly higher water sales volumes and

revenues driven primarily by warmer than 40 year average weather as compared to other approaches that would normalize for weather conditions.

Q. IN HIS REBUTTAL TESTIMONY, MR. BUSCH STATES THAT *"IT IS IMPORTANT TO FOCUS ON RECENT USAGE PATTERNS BECAUSE RATES FOR MAWC ARE SET FOR A PERIOD OF TWO TO FOUR YEARS"*. WHAT ARE THE MAJOR FALLACIES WITH THE APPROACH EMPLOYED BY STAFF AND OPC TO SET TEST YEAR WATER SALES VOLUMES AND CURRENT REVENUES?

A. There are two primary deficiencies of employing the simple averaging technique for any period of time, recent or not. First, the simple 60 month averaging technique employed the Commission Staff and OPC to set Test Year sales volumes and revenues is subject to weather sensitive usage overstatement linked to the period over which the usage was averaged. As stated prior, if the period averaged was warmer than normal then sales/revenues would be overestimated for the Test Year and set at a higher than weather normalized level. Conversely, if the period averaged was cooler than normal then sales/revenues would be underestimated for the Test Year and set at a lower than weather normalized level. Second and as importantly, by taking a simple average and failing to bifurcate (or identify) usage that is non-weather sensitive (base) as compared to usage that is weather sensitive, the simple averaging technique employed by the Commission Staff and OPC fails to identify the inherent declining usage trend of residential and commercial non weather sensitive usage (base). Hence by employing a simple 60 month average, the use of "recent data" notwithstanding, will produce results that are dominated by fluctuations in usage related to weather conditions and is incapable of capturing the effect of longer term usage trends which will continue through the Test Year and beyond.

Q. WHAT WERE THE STATISTICAL RESULTS OF YOUR ANALYSIS OF WEATHER EXPERIENCED DURING THE 2010-2015 PERIOD AVERAGED BY COMMISSION STAFF AND OPC TO ARRIVE AT PRO FORMA TEST

YEAR CURRENT WATER VOLUME SALES AND REVENUES AS COMPARED TO A 40 YEAR AVERAGE?

A. The results of my analysis were detailed in my rebuttal Schedule GPR-1R and attached here as Schedule GPR-1SR. That schedule is summarized in table GPR-1SR below. Table GPR-1SR below reports the percentage difference between the 40 year temperature data for the summer subset as compared to the 60 month summer subset temperature data which was experienced during the period used by Commission Staff and OPC to set Test Year water sales volumes and revenue. The table illustrates that the 60 month summer subset period used by Commission Staff and OPC was 13.1% warmer than the 40 year average as compared by Cooling Degree Days. Further this warmer-than-the-40-year-average experienced during the 60 month summer subset period used by Staff and OPC is reflected in higher: 1) Maximum Monthly temperature, 2) Minimum Monthly temperature, 3) Mean Maximum Daily Temperature, 4) Mean Minimum Daily Temperature and 5) Mean Average Daily Temperature. In every significant temperature measurement series, the 60 month summer subset period employed by Staff and OPC was warmer than the 40 year mean for the same summer months.

Table GPR-1SR
Missouri American Water Company
Comparison of 40 Year Weather to 2010-2015
Summer Season (May - Sept)

Time Period Measured'	Cooling Degree Days	Maximum Monthly Temperature	Minimum Monthly Temperature	Mean Maximum Daily Temperature	Mean Minimum Daily Temperature	Mean Average Daily Temperature
Mean % Change Staff to 40 Years	13.1%	2.7%	2.9%	1.6%	2.3%	1.9%
S. Dev % Change Staff to 40 Years	-1.3%	2.6%	1.6%	-0.5%	-5.0%	-2.7%

Q. WHAT DOES THE CLIMITILOGICAL DATA DEMONSTRATE RELATED TO SOLE RELIANCE ON "RECENT" DATA?

A. The climatological data indicates that reliance on any particular period of time, without adjustment for climatological conditions, results in setting Test Year sales volumes and revenues based on customer usage patterns heavily

influenced by the climatological conditions of the period averaged. In the case of the 60 "recent" months averaged by the Staff and OPC, it implies that the water usage of a historically warm period (as compared to the past 40 years) will be used as the basis of setting new rates. Such a process will continue the chronic under recovery of revenue by MAWC and send an unrealistic price signal to MAWC residential customers. In the end, the "recent" nature of the data used to set sales volumes and current revenues is immaterial without making any normalization of the data for climatic conditions.

IV. RESPONSE TO REBUTTAL TESTIMONY OF LENA M. MANTLE - OPC

Q. HAVE YOU REVIEWED THE REBUTTAL TESTIMONY OF MS. LENA M. MANTLE OF THE OPC?

A. Yes.

Q. WHAT IS YOUR REACTION TO THE ISSUES SHE IDENTIFIES IN HER REBUTTAL TESTIMONY?

A. With the use of graphs and discrete data point comparisons, Ms. Mantle is attempting to create a perception of suspicious data due to occasional billing issues and their supposed impact on Test Year water usage that was employed by myself and Mr. Kevin Dunn of MAWC to develop the Company analysis of base (non-discretionary) and non-base (discretionary) usage employed as the basis of developing test year water sales volumes and current revenues in this case. Unfortunately, Ms. Mantle with her comparisons demonstrates a misunderstanding of the working and results of the analysis employed by MAWC, the nature of the impact of weather in the water industry on discretionary water usage and the impact of quarterly billing on MAWC sales/revenues.

Q. WILL YOU PLEASE EXPLAIN WHY MS. MANTLE'S FOCUS ON MONTHLY VARIATIONS DURING MONTHS OF OUTDOOR

DESCRETIONARY USAGE HAVE NO IMPACT ON THE RESULTS OF YOUR ANALYSIS OF NON-DESCRETIONARY WATER USAGE OR THE DEVELOPMENT OF TEST YEAR WATER SALES VOLUMES AND CURRENT REVENUE?

A. Yes, I will. Reviewing Ms. Mantle's rebuttal testimony beginning on page 17 through page 20, Ms. Mantle illustrates the variations of billing from month to month for the five year period of 2010 to 2014 and highlights two months, August 2012 and June 2013 that appeared to be different from corresponding months in her 5 year analysis. As I explained in my direct and rebuttal testimony, my analysis of water usage for the residential MAWC customers bifurcated usage into two groupings, non-discretionary usage which was estimated analyzing per customer billed usage during the months of February through April and discretionary usage which was estimated as the difference between total annual residential usage and total annual non-discretionary residential usage. Since the billing anomalies of August 2012 and June 2013 do NOT occur during the period of our estimating residential discretionary usage, and that the estimation of residential non-discretionary usage was an annual calculation, the variance of billing to usage from a month during the discretionary period has NO impact on our analysis or estimates.

Q. WILL YOU PLEASE EXPLAIN WHY MONTHLY VARIATIONS IN THE NON-DISCRETIONARY USAGE DOES NOT IMPACT THE RESULTS OF YOUR ANALYSIS OF RESIDENTIAL USAGE FOR MAWC?

A. Yes, I will. As illustrated in my rebuttal testimony, monthly oscillations of usage due to billing fluctuations will resolve themselves over the course of a year. As an example, I will refer to a table that was originally in my rebuttal testimony as Table GPR-2R and here as Table GPR-2SR.

Table GPR-2SR
Missouri American Water Company
Compairson of Usage Per Customer
2013 and 2014

	Monthly	Annual Average	Annual Std Dev.		Monthly	Annual Average	Annual Std Dev.
Jan-13	5,934			Jan-14	5,304		
Feb-13	5,261			Feb-14	5,047		
Mar-13	5,048			Mar-14	5,985		
Apr-13	5,532			Apr-14	6,361		
May-13	5,752			May-14	7,834		
Jun-13	3,771			Jun-14	8,023		
Jul-13	8,815			Jul-14	8,365		
Aug-13	8,309			Aug-14	6,838		
Sep-13	9,581			Sep-14	5,911		
Oct-13	6,250			Oct-14	5,735		
Nov-13	5,427			Nov-14	4,929		
Dec-13	5,273			Dec-14	5,243		
2013		6,246	1,657.7	2014		6,298	1,155.0

Difference 2014 to 2013 (gl)	52
Difference 2014 to 2013 (%)	0.82%

This table clearly illustrates that the unusually low usage per customer value that occurred in June 2013, had no appreciable impact on the annual total usage per customer average of 2013 as compared to 2014 indicating that the unusually low value for June 2013 didn't have any impact on the MAWC estimation of discretionary usage used to set Test Year water sales and current revenues.

Q. BEGINNING ON PAGE 21 THROUGH 25 OF HER REBUTTAL TESTIMONY, MS. MANTLE ALLUDES TO THE IMPACT OF VARIANCES IN CUSTOMER COUNTS ON RESIDENTIAL USAGE PER CUSTOMER NUMBERS THAT WOULD INTRODUCE ERROR INTO THE MAWC DEVELOPED WATER SALES AND CURRENT REVENUES FOR THE TEST YEAR. IS THAT AN ACCURATE ASSESSEMENT OF THE IMPACT OF CHANGING CUSTOMER COUNTS IN 2013?

A. No it isn't. Ms. Mantle fails to understand the impact of variations in total usage per customer for June 2013 on the MAWC process employed to develop Test Year water usage or current revenues. As illustrated in my rebuttal testimony, monthly oscillations of total water usage per customer due

to billing or CUSTOMER COUNT fluctuations will resolve themselves over the course of a year as illustrated by table GPR-2SR above. For purposes of developing Test Year water usage and current revenue, MAWC bifurcates usage per customer into non-discretionary and discretionary components. The non-discretionary usage is estimated based on a 10 year trend of the February through April billed usage per customer values. The non-discretionary usage is estimated as the ANNUAL difference between total usage per customer and the non-discretionary usage. Table GPR-2SR illustrates that that the monthly fluctuation of June 2013 had NO appreciable impact on the 2013 annual total usage per customer and thus would not have introduced error into the Annual estimation of discretionary, non-base usage for the 10 year average. In summary, neither fluctuations of total usage per customer due to billing oscillations or customer counts in June 2013 introduced error into the MAWC estimates of Test Year water usage or current revenues.

Q. DO YOU KNOW THE CAUSE OF THE BILLING OSCILLATIONS AND CUSTOMER COUNT FLUCTUATIONS IN THE JUNE 2013 DATA?

A. Yes, this was a simple function of the implementation of the new SAP Customer Information System CIS system and it had nothing to do with bad or inconsistent data.

Q. YOU EXPLAINED THAT THE JUNE 2013 DATA DID NOT AFFECT YOUR ANALYSIS. WOULD CHANGES IN USAGE PER CUSTOMER DUE TO BILLING OSICILLATIONS AND/OR CUSTOMER COUNT FLUCTATION DUE TO THE IMPLEMENTATION OF SAP IN JUNE 2013 IMPACT THE DEVELOPMENT OF WATER USAGE AND CURRENT REVENUES USING THE SIXTY MONTH AVERAGING TECHNIQUE EMPLOYED BY THE STAFF AND OPC?

A. Yes it would. Because the Staff and OPC performed a simple 5 year monthly average of water usage and revenue to set Test Year water usage and revenue, each month in which the reported billing or customer count

fluctuated would be impacted in the Staff/OPC method. Hence, in addition to the Staff/OPC method being dominated by the monthly climatic conditions during the 60 month period, the Staff/OPC method would fluctuate due to billing oscillations or customer count fluctuations for the months averaged to develop their Test Year water usage and revenue levels. Thus, unlike the MAWC methodology for developing Test Year water usage, which is insulated from the impact of such monthly billing oscillations or customer count fluctuations, the Staff/OPC method is open to error that could be introduced due to such monthly oscillations or fluctuations.

Q. MS. MANTLE PRESENTS WEATHER DATA ON PAGE 20 OF HER REBUTTAL TESTIMONY THAT WOULD APPEAR TO INDICATE THAT THE CLIMATIC CONDITIONS EXPERIENCED DURING AUGUST OF 2012 WAS NOT UNUSUALLY WARM. WHAT IS THE DATA THAT MS. MANDTLE REPORTS AND WHY DOES IT UNDERSTATE CLIMATIC CONDITIONS FOR AUGUST 2012 IN ST. LOUIS?

A. Ms. Mantle introduces a table on page 20 of her testimony that compares August Average Temperature and Precipitation for the period 2010 through 2014 stating that the data is for "National Oceanic and Atmospheric Administration ("NOAA") that includes St. Louis County". Researching the details of this data series on the National Climatic Data Center website per Ms. Mantle's footnote on page 20, I find that the data series is for US Climatological Division 2 which is defined as the "Northeast Prairie" and roughly comprises 20% of the state of Missouri's geographic area including counties from St. Louis along the Eastern border of the state all the way north to Iowa. As such, this Climatological Division is dominated by agricultural areas with the single exception of St, Louis County as illustrated by the map presented in Schedule GPR-2SR. This data, which is an average of all the NOAA weather stations in Climatological Division 2 is dominated by reporting stations in rural counties that DO NOT represent the urban environment which defines the MAWC St. Louis County system, the dominant load center of MAWC. As such, Ms. Mantle is comparing apples and oranges. She is

reporting average weather data for a NOAA Climatological Division dominated by relatively cool rural environments that do not represent the urban heat sink that is the St. Louis metropolis. This comparison is similar to using climatic conditions from upstate New York in the Adirondack mountain area to reflect conditions on the Island of Manhattan. Hence, Ms. Mantle's application of this data to MAWC and St. Louis County lacks merit as such data is not representative of the climatic conditions faced by MAWC residential customers in St. Louis County. Further, this climatic data set, because it is dominated by rural reporting stations, cannot provide any insight into the cause of the unusually high MAWC Residential August 2012 usage per customer value.

Q. HAVE YOU ANALYZED CLIMATOLOGICAL DATA THAT WOULD EXPLAIN THE CATALYST FOR THE UNUSUALLY HIGH RESIDENTIAL USAGE PER CUSTOMER FOR AUGUST OF 2012?

A. Yes, as explained in my rebuttal testimony, I have analyzed 40 years of daily climatic data downloaded from the National Oceanic and Atmospheric Administration, National Centers for Environmental Information Administration website, for the GHCND:USW00013994 - ST LOUIS LAMBERT INTERNATIONAL AIRPORT, MO US reporting station.

Q. WHAT WAS THE RESULTS OF YOUR ANALYSIS?

A. In considering and explaining usage per customer for August 2012, the analyst cannot ignore the impact of quarterly billing on the MAWC residential usage per customer data series. Due to the quarterly nature of MAWC St. Louis County billing (roughly 74% of MAWC residential customers are on quarterly billing), usage per customer data in August of 2012 would be expected to include billing totals that are approximately 1/6 May, 1/3 June, 1/3 July and 1/6 August. Ms. Mantle failed to take quarterly billing into consideration when she inappropriately compared NOAA Missouri Climate Division 2 climatic data to the August 2012 residential usage per customer values. Any comparison of climatic conditions to MAWC residential usage

per customer must take into consideration that the majority of MAWC residential customers are billed on a quarterly billing cycle. Such a comparison should use climatic data for the two months prior to, as well as August 2012, in order to match the predominantly June-August billing term for the quarterly MAWC residential customers defining the August 2012 usage per customer data point. To that end, I have compared climatic conditions for the 40 year June-August average and the June-August average for the 2010-2015 time frame used by Staff/OPC to the June-August 2012 time frame. The results of that analysis are detailed in Schedule GPR-3SR and summarized below in Table GPR-3SR. That table reports that the June-August 2012 time frame was significantly warmer than either the 40 year average (27.5% warmer by cooling degree days) and that the 2010-2015 time frame used by Staff/OPC (17.8% warmer by cooling degree days). Further, the analysis illustrates that the June-August 2012 period was significantly dryer then either the 40 year average (-40.9% less precipitation) or the Staff/OPC 2010-2015 time period (-37.2% less precipitation). This data fully supports usage being significantly greater than typical due to excessive warm and dry conditions during the June through August 2012 billing period. Hence, as opposed to August 2012 being a supposed "billing error" as claimed by Ms. Mantle and which she is unable to support, the June-August 2012 climatic data clearly indicates that the usage was unusually high because of MAWC quarterly residential customers were responding to significantly warmer and dryer climatic conditions by increasing their discretionary outdoor water usage.

Table GPR-3SR
Missouri American Water Company
Comparison of 40 Year Weather to 2010-2015
June - August

Time Period Measured	Cooling Degree Days	Mean Total Percepitation	Maximum Monthly Temperature	Minimum Monthly Temperature	Mean Maximum Daily Temperature	Mean Minimum Daily Temperature	Mean Average Daily Temperature
Mean % Change 2012 to 40 Years	27.5%	-40.9%	8.0%	3.4%	6.3%	2.7%	4.7%
S. Dev % Change 2012 to 40 Years	39.2%	-41.5%	-10.8%	81.3%	14.7%	51.1%	34.7%
Mean % Change 2012 to Staff	17.8%	-37.2%	6.4%	-0.4%	4.8%	1.1%	3.2%
S. Dev % Change 2012 to 40 Years	45.0%	-33.2%	-14.6%	94.4%	17.9%	67.4%	44.3%

Q. WOULD YOU PLEASE SUMMARIZE YOUR SURREBUTTAL TESTIMONY AS IT APPLIES TO MS. MANTLE'S REBUTTAL TESTIMONY?

A. Yes.

First, Ms. Mantle's statement that monthly billing oscillations and/or fluctuations in monthly customer count would cause error in the MAWC development of Test Year water usage and current revenues is baseless and not supported by an analysis of annual discretionary water usage. Rather, that analysis indicates such oscillations or fluctuations would impact the Staff/OPC analysis without impact to the MAWC methodology.

Second, Ms. Mantle misapplied weather data from a rural dominated National Climatological Division 2 for August 2012 which is not representative of and is inapplicable to the urban dominated climatic conditions faced by customers on the MAWC St. Louis County system.

Third, Ms. Mantle failed to understand that the usage for August of 2012 is composed of total usage from approximately 1/6 May, 1/3 June, 1/3 July and 1/6 August and is not related to climatic conditions experienced solely in August of 2012.

Fourth and finally, when reviewing the climatic conditions for St. Louis (Lambert Field station) the June-August 2012 time frame to the 40 year average of 1976 to 2015 (or the 5 year average of the Staff/OPC 2010-2015) period, the climatic conditions of June-August 2012 were significantly in excess of the multi-year averages and this divergence fully explains why

August 2012 usage per customer results were well in excess of typical August residential total water usage per customer values. In summary, none of the criticisms that Ms. Mantle makes in her rebuttal testimony related to MAWC's processes, data and development of Test Year water usage and current revenues are supported by data or analysis and her claims should be rejected for purposes of determining Test Year water sales volumes or current revenues in this case.

V. RESPONSE TO REBUTTAL TESTIMONY OF CHARLES R. HYNEMAN - OPC

Q. IS ONE OF THE LARGEST CONCERNS FACING MAWC THAT REVENUES BASED ON USAGE PER CUSTOMER FAIL TO CAPTURE THE SYSTEMIC TREND OF A DECLINE IN USAGE PER CUSTOMER?

A. Yes it is. I am concerned that neither Mr. Hyneman nor Ms. Mantle fully appreciate, analyze or properly take into consideration: 1) the nationally recognized phenomenon of declining usage per customer and 2) the need to normalize usage for weather effects.

Q. DOES MR. HYNEMAN PROPERLY RECOGNIZE THESE EFFECTS?

A. To the contrary, he seems to trivialize them; ignoring the effect of weather and the well-recognized trend of declining use per customer and claiming (at p. 40) that the "revenue growth numbers provided by Mr. Roach show a robust increase in revenue growth from 2011 through 2014 of 12%, with an average annual increase during this period of 4%." In fact, Mr. Hyneman goes so far as to assert (at p. 18) that MAWC's "revenues are increasing at an impressive level."

Q. MR. HYNEMAN CLAIMS AT PAGE 20 OF HIS REBUTTAL TESTIMONY THAT MAWC's REVENUES ARE STRONG AND GROWING." IS HIS CLAIM ACCURATE?

A. No, it is not. Based on a chart he presents on page 18, Mr. Hyneman claims that "MAWC's revenue growth in the period 2011 through 2014 have

averaged greater than 3% per year." His claim suffers from several fatal deficiencies. First, Mr. Hyneman fails to normalize his revenue for fluctuations in water sales and revenue related to changes in outdoor discretionary usage for climatic conditions. Second, he gave no effect to the well-recognized trend of reduced water usage per customer. And third, he completely ignored the effect of recent acquisitions, ISRS filings and rate cases that increase total revenue. The last point will be addressed in Ms. Tinsley's surrebuttal testimony. I will address Mr. Hyneman's first two points.

Q. YOU ALSO NOTED THAT MR. HYNEMAN IGNORES THE WELL-RECOGNIZED TREND OF DECLINING USAGE PER CUSTOMER. PLEASE EXPLAIN THE EFFECT OF THAT.

A. As my direct testimony explained in detail, the trend of declining use per customer is well established and acknowledged, having been recognized by none other than the United States Environmental Protection Agency, among others. This trend is the perfectly explainable result of the penetration of low-flow faucets, reduced flow toilets and other highly water efficient appliances such as clothes washers and dishwashers. Just as Mr. Busch and Ms. Mantle incorrectly use five years of usage unadjusted for climatic influences to assert that residential usage per customer is not declining, Mr. Hyneman's assertion that "revenues are increasing at an impressive level" is simply in conflict with, and is masked by climatic induced water usage and revenue. The simple and irrefutable reality is that usage per customer is declining.

Q. PLEASE ADDRESS MR. HYNEMAN'S FAILURE TO REFLECT WEATHER SENSITIVITY.

A. It is beyond dispute that water utility revenue is sensitive to weather. Hot, dry weather results in increased outdoor watering of lawns, gardens and other irrigation activities. Conversely, cooler, wetter weather dampens revenue from those activities. I find it a bit surprising that Mr. Hyneman could look at the revenue shown on his chart on page 18 and not question how revenue could grow by 15% in one year and then decline by 6% in the very next year.

As explained in my response to Ms. Mantle's rebuttal testimony, the answer is largely explained by the fact that 2012 was one of the hottest, driest years on record and outdoor discretionary water usage surged that year. Mr. Hyneman's failure to normalize his usage and hence, revenue, for weather variations from year to year is a gaping deficiency in his logic.

Q. IF THE CUSTOMER COUNT IS INCREASING, WON'T REVENUES INCREASE ACCORDINGLY? WHAT IMPACT DOES THIS HAVE ON RESIDENTIAL USAGE PER CUSTOMER?

A. Ms. Tinsley and Mr. Watkins explain the rate and revenue relationships that result when customers are being added through acquisition. Generally, if customer totals are increasing, we would anticipate that total usage will increase, all things being equal. However, my analysis addresses usage per customer not total water usage. There is no evidence that these customers added by acquisition have significantly difference usage characteristics as compared to the existing MAWC residential customer base. Therefore, if usage per customer is declining for the existing MAWC residential customer base, that is an important consideration related to acquired customers as the expected amount of weather-normalized usage per customer must be properly aligned to the numbers of customers.

Q. DOES MR. HYNEMAN'S APPARENT REFUSAL TO ACCOUNT FOR THE EFFECTS OF WEATHER AND THE TREND IN DECLINING USE PER CUSTOMER INVALIDATE HIS CLAIMS ABOUT REVENUE GROWTH? IF THE CUSTOMER COUNT IS INCREASING, WON'T REVENUES INCREASE ACCORDINGLY?

A. Yes, the failure of Mr. Hyneman to address either the impact of climatic conditions or declining base usage renders his claims of revenue growth without support or merit. Water utility revenue forecasts are properly based on normalized climatic conditions. Climatic conditions, however, are seldom experienced at the normal level. Therefore there is an equal probability that the utility will exceed the forecast due to abnormally warm climate or fall short

of the revenue forecast due to a cooler than average summer. Usage per customer results that capture several years of abnormally hot and dry conditions will represent usage per customer that simply cannot be achieved in a year of average climatic conditions. In addition to that challenge, the failure of a forecast to capture the full effect of a trend of reduced usage per customer (that is masked by usage changes in response to climatic conditions) will result in the adoption of a faulty forecast that improperly captures a usage trend biased by abnormal climate conditions in the historic data set.

As explained in my direct testimony, the variability in customer usage patterns due to climatic conditions can have a substantial effect on a water company's actual revenues. Changes in customer usage patterns can reflect seasonal variation in usage (e.g., from winter to summer) as well long term water use trends (for example as a result of sustained water efficiency and conservation efforts). As demonstrated in my direct testimony, this trend is true for MAWC as well as other water utilities across the country. Although the effect of climatic conditions can be random and work either in favor of or against the Company from a financial standpoint, the declining use per customer is another factor, altogether. My direct testimony demonstrated that our customers are using less water every year. Residential usage per customer is steadily declining by as much as 2.0% annually and MAWC's experience is consistent with a national trend of declining water usage per customer. My Hyneman's failure to recognize the effects of climatic conditions and the trend of declining usage per customer are serious defects in his analysis rendering his conclusions without basis or merit.

Q. ON PAGE 18 MR. HYNEMAN PRESENTS A TABLE DEPICTING THREE YEARS OF REVENUE GROWTH. IS THE APPLICATION OF SIMPLE AVERAGING EXPERIENCED HISTORIC SALES GROWTH A SUPPORTABLE APPROACH TO SETTING NORMALIZED TEST YEAR USAGE?

A. No, it isn't, for at least two primary reasons. First, without taking into consideration the effect of climatic conditions during the period being averaged, the results of employing such a short period can be very misleading. For example, 2012 was the hottest, driest summer on record, leading to a significant increase in water usage per customer for outdoor discretionary water usage. Such a climate induced anomaly will clearly skew the average for the period. Furthermore, the use of a short term such as five years will fail to discern a trend in usage per customer as well as dampen the effects of such a trend. Ms. Tinsley has presented in her surrebuttal testimony MAWC's comments in File No. AW-2015-0282. Pages four and five of those comments contain charts that show irrefutable evidence of both the clear effects of climatic conditions on usage and the undeniable decline in usage per customer. The use of a short term climatic dominated averaging technique is simply not a proper way to recognize long-term effects on usage of weather and conservation. As denoted above, this is fatal flaw that impacts the analysis and conclusions of both Ms. Mantle and Mr. Hyneman.

Q. ON PAGE 40 OF HIS REBUTTAL TESTIMONY, MR. HYNEMAN EXPRESSED "CONCERN" THAT THE TWO MAWC REVENUE SERIES PRESENTED IN THE TABLE ON THAT PAGE "DO NOT MATCH". IS MR HYNEMAN'S CONCERN A VALID CRITICISIM OF YOUR TESTIMONY AND MAWC RECORD KEEPING ?

A. No, it is not. Rather it is an indictment of Mr. Hyneman's lack of thoroughness in his analysis of the evidence presented by MAWC in this case and in its annual report. The data Mr. Hyneman presents for the MAWC annual report is water sales revenue exclusively. The revenue series that Mr. Hyneman has lifted from page 20 of my direct testimony in this proceeding is total revenue for MAWC including waters sales and waste water revenue. As such, Mr. Hyneman is comparing apples to oranges and instead of requesting explanation from MAWC, he chooses to criticize MAWC for allegedly reporting inconsistent revenue numbers. Mr. Hyneman's allegations related

to inconsistent revenue reporting are not supported by the evidence in the case and are without merit.

Q. WOULD YOU PLEASE SUMMARIZE YOUR SURREBUTTAL TESTIMONY AS IT APPLIES TO MR. HYNEMAN'S REBUTTAL TESTIMONY?

A. Yes, I will. First, Mr. Hyneman fails to make any adjustment in his analysis for the effects of climatic conditions on discretionary water usage and hence revenues. What he fails to understand is that the greatest contribution to the percentage "growth" in revenue discussed by Mr. Hyneman are climatic induced fluctuations in water usage, not a trend of revenue growth. With so much of the annual variation in total usage per customer and revenue being driven by climate, neither Mr. Hyneman nor any other witness can make assertions related to long-term usage/revenue growth.

Second, Mr. Hyneman fails to adjust his data set for a historically dry and warm June-August period of 2012 in the St. Louis area that is the largest driver of revenue change during the period analyzed, completely distorting the trend of non-discretionary water usage for MAWC. Without making an appropriate adjustment for historically abnormal climatic conditions (see Table GPR-2SR), the long term trend of non-discretionary water usage remains invisible to the analyst.

Third, due to these prevailing analytical flaws in Mr. Hyneman's rebuttal testimony, his conclusions related to Test Year water sales volumes and current revenues are without support and lack merit.

Fourth, Mr. Hyneman's criticism of MAWC for inconsistent revenue reporting is simply not true.

VI. RESPONSE TO REBUTTAL TESTIMONY OF GEOFF MARKE - OPC

Q. HAVE YOU REVIEWED THE REBUTTAL TESTIMONY OF MR. GEOFF MARKE OF THE OPC?

A. Yes, I have.

Q. GENERALLY WHAT IS YOUR REACTION TO THE ISSUES HE IDENTIFIES IN HIS REBUTTAL TESTIMONY?

A. Through the citation of certain pieces of anecdotal evidence which are not supported by any analytical analysis supporting the conclusions he derives from the anecdotal evidence, Mr. Marke attempts to either obfuscate the basis of the MAWC analysis employed to develop Test Year water sales volumes and revenues or to infer alternative causes for the reductions in usage experienced by MAWC in the historic data set that he claims will not occur in the future. None of Mr. Marke's observations are supported by analytical evidence and they are refuted by evidence previously submitted by MAWC or submitted here in my surrebuttal testimony.

Q. MR. MARKE QUESTIONS THE USAGE OF THE FEBRUARY TO APRIL TIME FRAME FOR ESTIMATING BASE, NON-DISCRETIONARY USAGE FOR THE MAWC SYSTEM. WHY WAS THAT TIME-FRAME CHOSEN TO ESTIMATE BASE USAGE AND WHAT HAS MR. MARKE FAILED TO REALIZE IN HIS CRITIQUE FOR USING THAT PERIOD?

A. Mr. Marke, like Ms. Mantle before him, has completely failed to consider the impact of quarterly billing on the MAWC residential customer base and the billing information available for analysis. When one considers the billing artifact introduced by quarterly billing on the billing data available to be analyzed illustrated in Table GPR-4SR below, the support for the February to April time frame choice is clear. In order to minimize the impact of usage during the holiday months of November and December, as well as the early spring month of May, given the choices of billing months that have very limited discretionary outdoor usage that we could employ to derive the non-discretionary base usage, we choose to use the February through April billing months. By choosing the February through April time frame, MAWC has maximized the ability to gain insight into the trend of base, non-discretionary usage while minimizing the impact of Holiday and spring influences.

Table GPR-4SR
Missouri American Water Company
The Impact of Quarterly Billing

Billing Month	Approximate Composition of Billing Month Reading *				Midpoint
January	1/6 Oct	1/3 Nov	1/3 Dec	1/6 Jan	December
February	1/6 Nov	1/3 Dec	1/3 Jan	1/6 Feb	January
March	1/6 Dec	1/3 Jan	1/3 Feb	1/6 Mar	February
April	1/6 Jan	1/3 Feb	1/3 Mar	1/6 April	March
May	1/6 Feb	1/3 Mar	1/3 April	1/6 May	April

* Approximately, All Things Being Equal Under Typical Billing Conditions

Q. MR. MARKE ALLUDES TO THE IMPACT OF HOLIDAYS AND SCHOOLS ON WATER USAGE. WHAT HAS MR. MARKE FAILED TO REALIZE?

A. Mr. Marke admits that he does not have extensive experience with the water industry and that his professional work has been focused on the power and gas industries. It is this lack of experience which likely accounts for his major, incorrect conclusions. First off, as explained above and in Table GPR-4SR, MAWC has minimized the impact of either autumn or spring shoulder months in its analysis of base, non-discretionary usage to the extent that can be accomplished with the data available for analysis. Second, the portion of February usage which is derived from November and December would tend to increase non-discretionary base usage as more people are home from work for the Holiday period increasing usage for the month of December. Hence it would not lead to additional declining use. Lastly, Mr. Marke alludes to the impact of "school months". I am unsure of the impact Mr. Marke sees with the analysis of "school months". All things being equal, what little additional seasonal usage that may occur during the months of June through August would add to the amount of our estimation of non-base discretionary usage and would be picked up by our projections of non-base Test Year water usage. Thus, all of Mr. Marke's concerns related to the period of February through April being used to estimate base non-discretionary usage are baseless and without merit.

Q. Mr. MARKE CLAIMS THAT THE MAWC ANALYSIS UNDERLYING THE COMPANY PROPOSED TEST YEAR WATER USAGE AND CURRENT REVENUE IS NOT WEATHER NORMALIZED. IS THAT AN ACCURATE ASSERTION RELATED TO THE MAWC ANALYSIS OF BASE AND NON-BASE USAGE?

A. No it certainly is not. As with Ms. Mantle, Mr. Marke fails to understand that the 10 year average non-base, discretionary water usage is normalized to the average non-discretionary water usage over the period 2005 through 2014. Insomuch as MAWC has chosen to normalize non-discretionary water usage to 10 years of data, MAWC has eliminated the impact implicit in the Staff/OPC 60 month averaging method of weather induced, greater-than-normal water usage due to the choice of an abnormally warm period for a simple averaging technique. Rather, with the bifurcated base and non-base analysis sponsored by MAWC, the Company was able to capture the declining trend of non-discretionary indoor usage while eliminating the impact of a few years of abnormally warm or dry weather on total usage by normalizing discretionary outdoor water usage to its average over the 10 year period of 2005-2014. This bifurcation eliminates the climatic induced bias in the Staff/OPC method for setting Test Year water usage and current revenue.

Q. Mr. MARKE CLAIMS ON PAGE 17 OF HIS REBUTTAL TESTIOMONY THAT YOU FAILED TO PROVIDE ANY ANALYTICAL EVIDENCE SUPPORTING OR ILLUSTRATING THE EFFECT OF FEDERAL APPLICANCE AND WATER FIXTURE USAGE REGULATIONS ON MAWC WATER SALES. IS MR. MARKE CORRECT IN HIS CLAIM OF LACK OF ANALYTICAL SUPPORT TYING FEDERAL USAGE REGULATIONS WITH AN IMPACT ON THE MAWC SYSTEM?

A. No. Mr. Marke missed three major areas in my direct testimony that linked federal water usage regulations with an impact on residential water usage on the MAWC system. First, the post-tornado Joplin, MO analysis clearly illustrated the impact of the federal water use regulations on water usage

where the post-tornado rebuild resulted in a 37% acceleration in the rate of residential usage reduction when only a relatively modest 13.8% of the residential dwellings where rebuilt post-tornado. Second, applying the federal water use guidelines in the theoretical family of four analyses for the MAWC residential customer base, MAWC estimated a potential 54,315 annual gallon reduction in usage for a family four. Based on current rates of usage decline, this trend could extend for up to 45 more years at current rates of fixture replacement. Lastly, Mr. Marke attempts to project uncertainty onto the validity of the MAWC analysis of base, non-discretionary residential usage by claiming on page 17 of his rebuttal testimony that it is based on "the isolation of three select months of metered residential data". As illustrated above, those billing months were chosen in order to eliminate the effect of potential discretionary usage being included with the non-discretionary usage. Further, Mr. Marke's lack of experience with quarterly billing did not allow him to understand that the MAWC analysis of base non-discretionary usage is based on data which includes the months of November through April. So too that data, when annualized, is analyzed for a 10 year period. In essence the MAWC analysis of non-discretionary usage is based on 50 observations (5 months x 10 years). In the end, MAWC has analyzed a 10 year data set and produced overwhelming evidence that federal water use regulations have impacted base non-discretionary use over the last 10 years, that the rate of usage decline has been accelerated under conditions of greater fixture replacement rates as illustrated by the post-tornado Joplin, MO analysis and the theoretical family of four analysis indicates the trend could be extend for up to 45 more years.

Q. MR. MARKE IN HIS REBUTTAL TESTIMONY ON PAGES 17-25 GOES TO GREAT LENGTHS TO ILLUSTRATE THE LACK OF STATE OF MISSOURI REGULATORY STANDARDS RELATED TO WATER FIXTURE, APPLIANCE AND CONSTURCTION PRACTICES AS THEY RELATE TO WATER USAGE. MR MARKE CLAIMS THIS LACK OF STATE OF MISSOURI STANDARDS SOMEHOW INVALIDATES THE MAWC

ANALYSIS WHICH ESTIMATES THE RESIDENTIAL USAGE REDUCTIONS IN NON-DISCRETIONARY BASE USAGE. IS THIS ASSERTION CORRECT?

A. Mr. Marke, due to his limited experience in the water industry has missed a critical element of water appliance and fixture usage regulation. As with most consumer manufacturing industries, the production standards for final product are driven by the federal government unless there is a state standard which is more stringent then the federal regulation (such as California for automobiles as an example). Manufacturers prefer to build to one standard in order to standardize and minimize production costs in order to maximize economies of scale. Hence federal water use standards set the level for the production of water using appliances and fixtures installed across the United States while only being impacted by state standards should they require even LOWER usage than the federal standards. Thus, for purposes of our analytical exercises, the dearth of Missouri state standards has NO impact on the results of our analysis or on the declining water use trend in the state of Missouri. All of the effects felt in Missouri are based on federal water usage guidelines that define what type of appliances and fixtures are sold nationwide. The residences of Missouri do not get to purchase water using appliances or fixtures made to some other standard that is somehow LESS efficient. They have the same water using appliance and fixtures as any other resident in any other state. For that reason, Mr. Marke's allusion to lack of State of Missouri water usage regulatory standards somehow undermining the credibility of the MAWC analysis of non-discretionary base usage is at best illogical, has NO analytical support and is without merit. Again, if Mr. Marke were correct, we certainly would not have seen the real-world example of the Joplin MO decline in usage per customer, yet we did.

Q. **MR. MARKE IN HIS REBUTTAL TESTIMONY ON PAGES 26-31 GOES TO GREAT LENGTHS AND REPORTS NUMEROUS INCOME AND EMPLOYMENT TRENDS TO DEMONSTRATE A SUPPOSED CORRELATION OF GENERAL ECONOMIC CONDITIONS TO THE**

DECLINE OF WATER USAGE. HAVE YOU PERFORMED ANALYTICAL ANALYSIS THAT WOULD EITHER SUPPORT OR DISPROVE MR. MARKE'S CLAIMS?

A. In his rebuttal testimony, Mr. Marke cites several economic trends and statistics, most notably during the recession that began in 2008 as the source of declining residential water usage per customer. Unfortunately for Mr. Marke's claims, the alleged correlation between certain economic indices and usage per customer is merely circumstantial. In order to test the validity of Mr. Marke's claim about an economic cause for MAWC residential declining usage, I performed a regression analysis employing MAWC base, non-discretionary usage using the economic variables St. Louis, Missouri Standard Metropolitan Statistical Area ("SMSA") total employment and St. Louis SMSA real personal income per capita ($2009) for the years of 2000 through 2014. In addition, I tested the Time and Binary variables used by MAWC to model and forecast non-discretionary residential usage per customer for setting Test Year waters sales and current revenues. I was not able to model 2015 data as the SMSA specific data is not yet available from the Department of Commerce, Bureau of Economic Analysis. The results of this modeling are reported in Table GPR-5SR below and are very clear. Employment has an extremely weak positive association with the trend of non-discretionary usage per customer. Income has a strong illogical inverse relationship with the trend of non-discretionary usage per customer. This relationship is illogical as it indicates the greater the income per capita over time, the less discretionary residential usage is observed. When included with a model that employs the Time and the Binary variable, neither employment nor income has a significant explanatory relationship with non-discretionary usage per customer. What does this mean from a practical sense? The results demonstrate that neither employment nor income can be used as explanatory or predictive indicator for the trend of non-discretionary usage per customer. Rather, the statistical results demonstrate that the variable Time employed by MAWC to model the trend and project residential non-discretionary usage per customer is by far the strongest explanatory

variable of all the variables tested in my analysis. Further, the statistical results completely disprove Mr. Marke's presumption that the cause of the decline of non-discretionary usage per customer where induced by recession. The regression analysis results completely negate Mr. Marke's claim and even result in an illogical inverse relationship between income and discretionary residential usage per customer.

Table GPR-5SR
Missouri American Water Company
Bases Non-Discretionary Water Usage Modeling
2000-2014 - Summary

	Employment	Income	Employment Income	Employment Income Binary	Time Binary	All
R-Sqaure	0.174	0.613	0.744	0.760	0.829	0.840
T-Statistic						
Time					-7.547	-2.234
Binary				0.862	2.294	1.820
Income		-4.540	-5.174	-5.185		-0.802
Employment	-1.652		2.479	2.297		0.554
Coefficent						
Intercept	17,529.5	14,986.7	3,728.3	4,908.6	16,636.8	13,849.2
Time					-0.273	-0.204
Binary				239.728	524.310	473.508
Income		-0.217	-0.353	-0.361		-0.104
Employment	-0.007		0.010	0.010		0.003

Note:
Employment: St. Louis SMSA Employment Total
Income: St. Louis SMSA Real Personal Income Per Capita ($2009)
Time: Median Day of the Year
Binary: Value of zero in all years but 2014 in which the value is 1.

Q. ON PAGE 26 OF MR. MARKE'S REBUTTAL TESTIMONY HE DISCUSSES THE IMPACT OF PRICE AND ITS RELATIONSHIP WITH THE CHOICE TO CONSUME WATER CLAIMING THAT YOUR REFERENCING PRICE AS A POTENTIAL FACTOR CONTRIBUTING TO DECLINING RESIDENTIAL NON-DISCRETIONARY USAGE PER CUSTOMER IN YOUR DIRECT TESTIMONY WAS NOT SUPPORTED BY A "PRICE ELASTICITY STUDY"

AND THAT HE DOUBTS THE IMPACT OF PRICE ON THE DECISION TO CONSUME LESS WATER SITTING IN GENERAL, WATER IS CONSIDERED TO BE AN INELASTIC GOOD AND NOT THAT RESPONSIVE (AT LEAST IN THE SHORT-TERM) TO CHANGES IN PRICE. ". SINCE DEVELOPING THE ANALYSIS SUPPORTING YOUR DIRECT TESTIMONY, HAVE YOU HAD THE OPPORTUNITY TO ANALYZE THE RELATIONSHIP BETWEEN DISCRETIONARY RESIDENTIAL USAGE PER CUSTOMER AND PRICE?

A. Mr. Marke's claims about the relationship of residential water consumption and price caused me to consider the relationship of price and residential water consumption on the MAWC system. The results of that analysis are detailed in Table GPR-6SR below. Table GPR-6SR formatted similarly to Table GPR-5SR, reports the r-square, t-statistics and coefficients for several regression models that I ran testing the relationship of price and usage per customer. I choose to model this relationship over the time period of 2005 to 2015 as that data was on hand and did not require new data base queries to obtain the data. Price in this analysis was defined as the simple derivation of total residential revenue divided by the total water unit sales for a particular year. For purposes of modeling, I scaled price into real 2009 dollars and expressed all my time series in log form in order to get a percentage change relationship between non-discretionary usage per customer and the explanatory variables including price and time. The results as reported in Table GPR-6SR clearly illustrate that 1) residential non-discretionary water consumption is relatively inelastic to price (0.2% change in consumption for a 1% change in the real price), 2) that similarly to the economic variable income, the relationship between price and non-discretionary water consumption changes sign and produces an illogical result (consumption increases with increases in price) when time is included with price in modeling and 3) that models containing time and the binary variable (the variables employed by MAWC to measure the trend and forecast non-discretionary residential water usage for purposes of setting Test Year water sales volumes and current revenues) continue to produce the best statistical characteristics.

In general, the results confirm that the correlation of price to base non-discretionary water usage is statistically significant but relatively inelastic in the decision to consume water and any effect of increases in price on the decision to consumer water are incorporated by the time variable that MAWC has used to trend and forecast Test Year water sales volumes and current revenues.

Table GPR-6SR
Missouri American Water Company
Bases Non-Discretionary Water Usage Modeling with Price
2005-2015 - Summary

	Price	Time Price	Time Binary	All
R-Sqaure	0.563	0.780	0.896	0.974
T-Statistic				
Time		-2.812	-8.293	-8.147
Binary			3.908	7.174
Price	-3.407	1.726		4.536
Coefficent				
Intercept	8.9	54.1	31.4	57.6
Time		-4.334	-2.143	-4.660
Binary			0.101	0.100
Price	-0.201	0.341		0.332

Note:
Log-Log Analysis - Price, Time and Usage all natural log indices.
Pice estimated as simple average of total residential sales revenue divided by total residential sales volumes.

Q. WHAT ARE THE IMPLICATIONS OF THE RESULTS OF YOUR STATISTICAL MODELING REPORTED IN TABLES GPR-5SR AND GPR-6SR AS THEY RELATE TO MR. MARKE'S REBUTTAL TESTIMONY AND

TO MAWC'S MODELING APPROACH FOR SETTING TEST YEAR WATER SALES VOLUMES AND CURRENT REVENUES?

A. The statistics paint a very clear and concise picture affirming the MAWC approach to modeling and forecasting Test Year residential water sales volumes and current revenue. Further, the results of this analysis debunk Mr. Marke's claims related to the impact of changes on income and employment being the main drivers behind reductions in non-discretionary usage per customer. In summary, the statistical results reported in Tables GPR-5SR and GPR-6SR indicate the following: 1) that neither real income per capita nor employment have a significant statistical explanatory relationship with non-discretionary water usage per customer, 2) that real income has a perverse illogical inverse relationship with water consumption (the more income a person has the less water they consume), 3) that real price has a statistically significant but inelastic relationship with water consumption (a 1% change in price results in a 0.2% change in consumption), 4) that the Time and Binary variables used by MAWC to model and forecast discretionary residential water usage by customer have by far the best statistical properties, resulting in the least statistical forecast error and explain the majority of the variance over time of water usage and 5) that this modeling confirms the original rate of declining use for non-discretionary water usage of -1.94% per year reporting a rate of decline (with a log-log model using the same parameters) of -2.14% per year. Lastly, as discussed in my direct testimony, this statistical analysis affirms that the time variable employed by MAWC in its modeling and forecasting of non-discretionary water use stands as a statistically significant proxy for the influence of the methodical year to year impact of continued penetration of higher efficiency appliances and water fixtures as older units are retired in existing homes and are the only units that can be installed in new housing units. As such, the time variable has all the explanatory power that an appliance saturation or water fixture survey study would bring to the analysis of declining usage of non-discretionary residential water usage.

Q. WOULD YOU PLEASE SUMMARIZE YOUR SURREBUTTAL TESTIMONY AS IT APPLIES TO MR. MARKE'S REBUTTAL TESTIMONY?

A. Yes, First, Mr. Marke failed to realize the impact of quarterly billing when choosing "winter" months for purposes of modeling and estimating non-discretionary residential water use. As a result he failed to realize the MAWC's choice of the billing month's February through April included data from December through April and reflects what is referred to as meteorological "winter". Further, Mr. Marke fails to realize that the modeling data set employed by MAWC incorporates 5 months times 10 years for 50 total observations and is not limited to "3 months". Second Mr. Marke, like Ms. Mantle, fails to realize that with the application of the MAWC bifurcated base and non-base usage components of total residential usage per customer, that MAWC did normalize non-base usage to the 10 years of data used in its data set. Hence unlike the Staff/OPC method that is totally dependent on the climatic conditions of the 60 months they averaged, the MAWC method adjusts for the weather occurring during the 10 year historic data set. Third, Mr. Marke fails to understand that like most manufacturing industries, in order to minimize production model types and hence cost of production, the production of water using appliances and fixtures is dependent on either federal or the most stringent state regulations (normally California) not the state of Missouri. Thus, the water using appliances and fixtures installed in Missouri are not dependent on any state of Missouri program or regulation. Those state regulations (unless more stringent then federal standards) are irrelevant in the final decisions as to what water appliance and fixture will be installed. Fourth, contrary to Mr. Marke's suggestion, statistically speaking, neither real income per capita nor employment were found to have a significant impact on the trend of non-discretionary residential usage per customer. Thus, the recession had no statistical impact on the decision to reduce non-discretionary residential consumption. Fifth, the impact of price is significant but inelastic. Finally, none of the causes of reductions in discretionary residential usage per customer referenced by Mr. Marke are even close to the statistical significance of the Time variable which

encapsulates the methodical year to year advancement in the greater penetration of more efficient water using appliances and fixtures. As Mr. Marke fails to make even one credible and analytically verifiable argument supporting his alternative explanations and theories, his observations are without support or merit and should be rejected by this Commission.

VII. CONCLUSIONS AND RECOMMENDATIONS

Q. WHAT ARE THE CONCLUSIONS AND RECOMMENDATIONS BASED ON YOUR SURREBUTTAL TESTIMONY AS IT APPLIES TO SETTING TEST YEAR RESIDENTIAL WATER SALES REVENUE AND CURRENT RATE REVENEUE AS IT RELATES TO THE REBUTTAL TESTIMONY OF MR. BUSCH OF STAFF, AND MS. MANTLE, MR. HYNEMAN AND MR. MARKE OF THE OPC?

A. Quite simply, all of the witnesses whose testimony I address either overtly or tacitly take the insupportable positions that 1) weather can be ignored when examining use per customer data for a water utility and 2) that there is no long term trend of declining water use per customer. Given the deficiencies noted in my surrebuttal testimony for each of their observations and claims, coupled with the total lack of analytical support for ANY of their positons, I recommend that the Commission reject their positions when determining test year residential water sales volumes and current revenue and rely on the analysis and testimony of MAWC in this case.

Q. DOES THIS CONCLUDE YOUR SURREBUTTAL TESTIMONY?

A. Yes, it does.

Missouri American Water Company
Comparison of 40 Year Weather to 2010-2015
Summer Season (May - Sept)

Time Period Measured	Cooling Degree Days	Maximum Monthly Temperature	Minimum Monthly Temperature	Mean Maximum Daily Temperature	Mean Minimum Daily Temperature	Mean Average Daily Temperature
Mean 1976-2015	314.7	95.4	52.1	84.0	64.9	74.4
STDV 1976-2015	148.0	5.0	8.2	5.6	5.9	5.7
SD as % Mean 76-15	47.0%	5.2%	15.8%	6.7%	9.2%	7.7%
Mean 10-2010 - 9-2015	355.9	98.0	53.6	85.4	66.4	75.9
STDV 10-2010 - 9-2015	146.0	5.1	8.4	5.6	5.6	5.6
SD as % Mean 76-15	41.0%	5.2%	15.6%	6.6%	8.5%	7.3%
Mean % Change Staff to 40 Years	13.1%	2.7%	2.9%	1.6%	2.3%	1.9%
STD % Change Staff to 40 Years	-1.3%	2.6%	1.6%	-0.5%	-5.0%	-2.7%

U.S. CLIMATOLOGICAL DIVISIONS

01 – ALABAMA
01 NORTHERN VALLEY
02 APPALACHIAN MOUNTAIN
03 UPPER PLAINS
04 EASTERN VALLEY
05 SOUTHERN PLATEAU
06 PRAIRIE
07 COASTAL PLAIN
08 GULF

02 – ARIZONA
01 NORTHWEST
02 NORTH EAST
03 NORTH CENTRAL
04 EAST CENTRAL
05 SOUTHWEST
06 SOUTH CENTRAL
07 SOUTHEAST

03 – ARKANSAS
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

04 – CALIFORNIA
01 NORTH COAST DRNG
02 SACRAMENTO DRNG
03 NORTH LAHONTAN BASINS
04 CENTRAL COAST DRNG
05 SAN JOAQUIN DRNG
06 SOUTH COAST DRNG
07 SOUTHEAST DESERT BASINS

05 – COLORADO
01 ARKANSAS DRAINAGE BASIN
02 CO DRAINAGE BASIN
03 NO PLATTE DRAINAGE BASIN
04 PLATTE DRAINAGE BASIN
05 RIO GRANDE DRNG BASIN

06 – CONNECTICUT
01 WEST-NORTHWEST
02 CENTRAL
03 COASTAL

07 – DELAWARE
01 NORTHERN
02 SOUTHERN

08 – FLORIDA
01 NORTHWEST
02 NORTH
03 NORTH CENTRAL
04 SOUTH CENTRAL
05 EAST COAST & SW COAST
06 LOWER EAST COAST
07 KEYS

09 – GEORGIA
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

10 – IDAHO
01 PANHANDLE
02 NORTH CENTRAL PRAIRIES
03 NORTH CENTRAL CANYONS
04 CENTRAL MOUNTAINS
05 SOUTHWESTERN VALLEYS
06 SOUTHERN MTN HIGHLANDS
07 CENTRAL PLAINS
08 NORTHEASTERN VALLEYS
09 UPPER SNAKE RIVER PLAINS
10 EASTERN HIGHLANDS

11 – ILLINOIS
01 NORTHWEST
02 NORTHEAST
03 WEST
04 CENTRAL
05 EAST
06 WEST SOUTHWEST
07 EAST SOUTHEAST
08 SOUTHWEST
09 SOUTH
10 SOUTHEAST

12 – INDIANA
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

13 – IOWA
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

14 – KANSAS
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

15 – KENTUCKY
01 WESTERN
02 CENTRAL
03 BLUE GRASS
04 EASTERN

16 – LOUISIANA
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

17 – MAINE
01 NORTHERN
02 SOUTHERN INTERIOR
03 COASTAL

18 – MARYLAND AND DC
01 WESTERN SHORE
02 CENTRAL EASTERN SHORE
03 LOWER EASTERN
04 UPPER SOUTHERN
05 NORTHEASTERN SHORE
06 NORTHERN PIEDMONT
07 APPALACHIAN MOUNTAIN
08 ALLEGHENY PLATEAU

19 – MASSACHUSETTS
01 WESTERN
02 CENTRAL
03 COASTAL

20 – MICHIGAN
01 WEST UPPER
02 EAST UPPER
03 NORTHWEST LOWER
04 NORTH EAST LOWER
05 WEST CENTRAL LOWER
06 CENTRAL LOWER
07 EAST CENTRAL LOWER
08 SOUTHWEST LOWER
09 SOUTH CENTRAL LOWER
10 SOUTH EAST LOWER

21 – MINNESOTA
01 NORTHWEST
02 WEST CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

22 – MISSISSIPPI
01 UPPER DELTA
02 NORTH CENTRAL
03 NORTHEAST
04 LOWER DELTA
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST
10 COASTAL

23 – MISSOURI
01 NORTHWEST PRAIRIE
02 NORTHEAST PRAIRIE
03 WEST CENTRAL PLAINS
04 WEST OZARKS
05 EAST OZARKS
06 BOOTHEEL

24 – MONTANA
01 WESTERN
02 SOUTH WESTERN
03 NORTH CENTRAL
04 CENTRAL
05 SOUTH CENTRAL
06 NORTH EASTERN
07 SOUTH EASTERN

25 – NEBRASKA
01 PANHANDLE
02 NORTH CENTRAL
03 NORTHEAST
04 EAST CENTRAL
05 SOUTHWEST
06 SOUTH CENTRAL
07 SOUTHEAST

26 – NEVADA
01 NORTHWESTERN
02 NORTHEASTERN
03 SOUTH CENTRAL
04 EXTREME SOUTHERN

27 – NEW HAMPSHIRE
01 NORTHERN
02 SOUTHERN

28 – NEW JERSEY
01 NORTHERN
02 SOUTHERN
03 COASTAL

29 – NEW MEXICO
01 NORTHWESTERN PLATEAU
02 NORTHERN MOUNTAINS
03 NORTHEASTERN PLAINS
04 SOUTHWESTERN MOUNTAINS
05 CENTRAL VALLEY
06 CENTRAL HIGH PLAINS
07 SOUTHWESTERN PLAINS
08 SOUTHERN DESERT

30 – NEW YORK
01 WESTERN PLATEAU
02 LAKE ONTARIO PLAINS
03 NORTHERN MOUNTAINS
04 CENTRAL PLATEAU
05 HUDSON VALLEY
06 NORTHERN VALLEY
07 CHAMPLAIN VALLEY
08 ST. LAWRENCE VALLEY
09 GREAT LAKES
10 EASTERN LAKES

31 – NORTH CAROLINA
01 SOUTHERN MOUNTAINS
02 NORTHERN MOUNTAINS
03 NORTHERN PIEDMONT
04 CENTRAL PIEDMONT
05 SOUTHERN PIEDMONT
06 SOUTHERN COASTAL PLAIN
07 CENTRAL COASTAL PLAIN
08 NORTHERN COASTAL PLAIN

32 – NORTH DAKOTA
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

33 – OHIO
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

34 – OKLAHOMA
01 PANHANDLE
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

35 – OREGON
01 COASTAL AREA
02 WILLAMETTE VALLEY
03 SOUTHWESTERN VALLEYS
04 NORTHERN CASCADES
05 HIGH PLATEAU
06 NORTH CENTRAL
07 SOUTH CENTRAL
08 NORTHEAST
09 SOUTHEAST

36 – PENNSYLVANIA
01 PCOCONO MOUNTAINS
02 EAST CENTRAL MOUNTAINS
03 SOUTH CENTRAL MOUNTAINS
04 LOWER SUSQUEHANNA
05 UPPER SUSQUEHANNA
06 LOWER SUSQUEHANNA
07 NORTH CENTRAL MOUNTAINS
08 SOUTH CENTRAL PLATEAU
09 NORTHWEST PLATEAU

37 – RHODE ISLAND
01 ALL

38 – SOUTH CAROLINA
01 MOUNTAIN
02 NORTHWEST
03 NORTH CENTRAL
04 NORTHEAST
05 WEST CENTRAL
06 CENTRAL
07 SOUTHERN

39 – SOUTH DAKOTA
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 BLACK HILLS
05 SOUTHWEST
06 CENTRAL
07 EAST CENTRAL
08 SOUTH CENTRAL
09 SOUTHEAST

40 – TENNESSEE
01 EASTERN
02 CUMBERLAND PLATEAU
03 MIDDLE
04 WESTERN

41 – TEXAS
01 HIGH PLAINS
02 LOW ROLLING PLAINS
03 NORTH CENTRAL
04 EAST TEXAS
05 TRANS PECOS
06 EDWARDS PLATEAU
07 SOUTH CENTRAL
08 LOWER COAST
09 SOUTHERN
10 LOWER VALLEY

42 – UTAH
01 WESTERN
02 CENTRAL
03 NORTH CENTRAL
04 SOUTH CENTRAL
05 NORTHERN MOUNTAINS
06 UINTA BASIN
07 SOUTHEAST

43 – VERMONT
01 NORTHEASTERN
02 WESTERN
03 SOUTHEASTERN

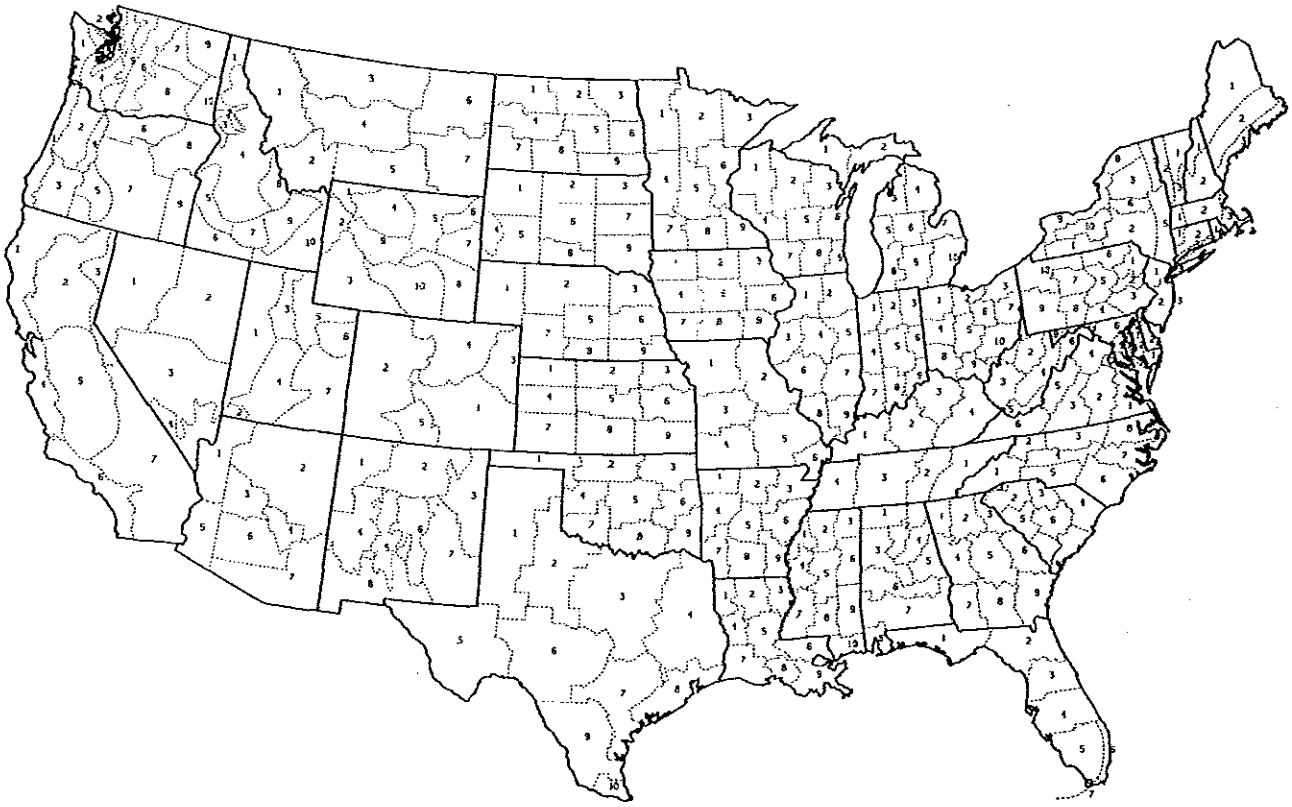
44 – VIRGINIA
01 TIDEWATER
02 EASTERN PIEDMONT
03 WESTERN PIEDMONT
04 NORTHERN
05 CENTRAL BLUEMONT
06 SOUTHWESTERN MOUNTAIN

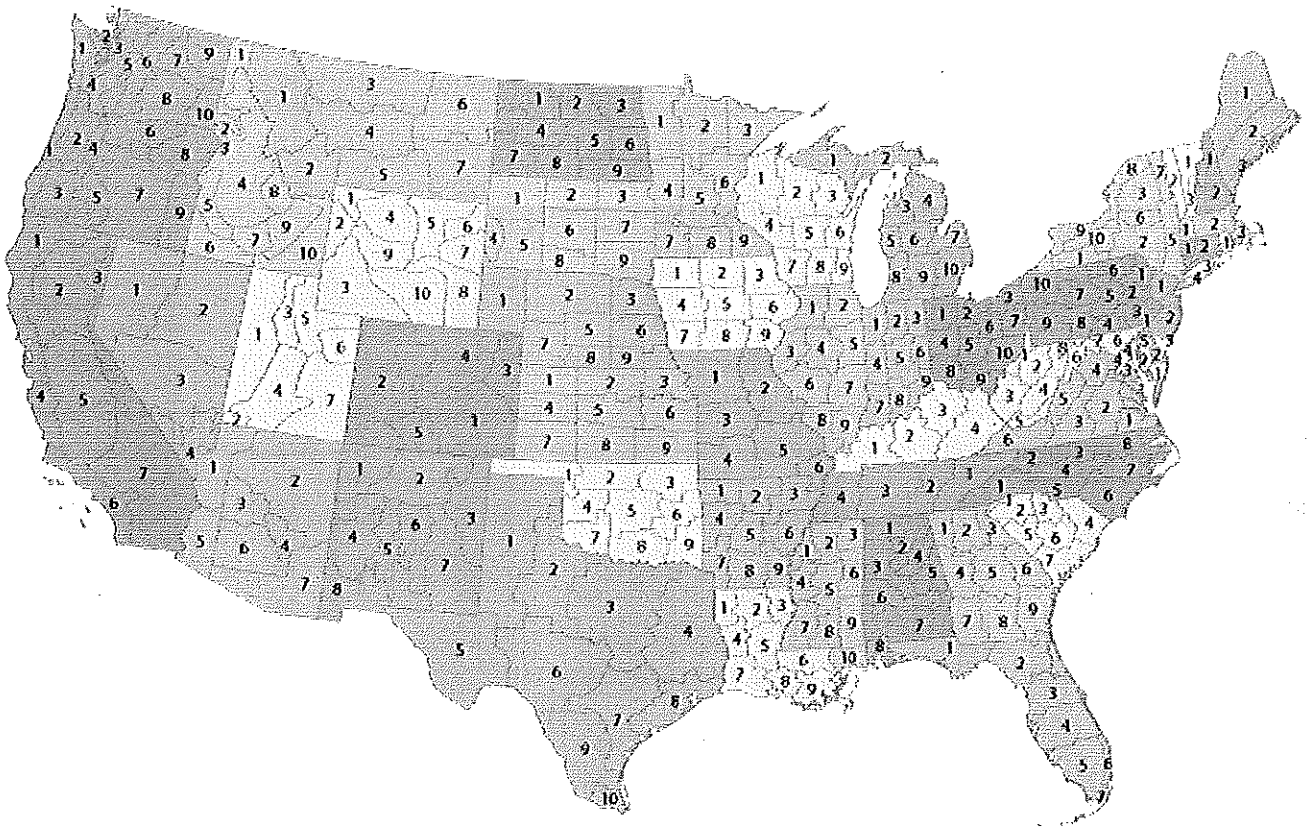
45 – WASHINGTON
01 WEST OLYMPIC COASTAL
02 NE OLYMPIC SAN JUAN
03 PUGET SOUND LOWLANDS
04 E OLYMPIC COAST FOOTHILLS
05 CASCADE MOUNTAINS WEST
06 EAST SLOPE CASCADES
07 OKANOGAN RIVER BASIN
08 CENTRAL BASIN
09 NORTHEASTERN
10 PALOUSE BLUE MOUNTAINS

46 – WEST VIRGINIA
01 NORTHWESTERN
02 NORTH CENTRAL
03 SOUTHWESTERN
04 CENTRAL
05 SOUTHERN
06 SOUTH EASTERN

47 – WISCONSIN
01 NORTHWEST
02 NORTH CENTRAL
03 NORTHEAST
04 WEST CENTRAL
05 CENTRAL
06 EAST CENTRAL
07 SOUTHWEST
08 SOUTH CENTRAL
09 SOUTHEAST

48 – WYOMING
01 YELLOWSTONE DRAINAGE
02 SNAKE DRAINAGE
03 GREEN AND BEAR DRAINAGE
04 BIG HORN
05 POWDER, MISSOURI DRNG
06 BELLE FOURCHE DRAINAGE
07 CHEYENNE & NIOBRARA DRNG
08 LOWER PLATTE
09 WIND RIVER
10 UPPER PLATTE





- History
- Former Dataset (Drd964x)
- Current Dataset (nClimDiv)
- Drd964x vs. nClimDiv
- Discovery Tool
- References

History of the U.S. Climate Divisional Dataset

For many years the Climate Divisional Dataset was the only long-term temporally and spatially complete dataset from which to generate historical climate analyses (1895-2013) for the contiguous United States (CONUS). It was originally developed for climate-division, statewide, regional, national, and population-weighted monitoring of drought, temperature, precipitation, and heating/cooling degree day values. Since the dataset was at the divisional spatial scale, it naturally lent itself to agricultural and hydrological applications.

There are 344 climate divisions in the CONUS. For each climate division, monthly station temperature and precipitation values are computed from the daily observations. The divisional values are weighted by area to compute statewide values and the statewide values are weighted by area to compute regional values. (Karl and Koss, 1984).

In March 2015, historical data for thirteen Alaskan climate divisions were added to the nClimDiv database and will be updated each month with the CONUS nClimDiv data. The Alaska nClimDiv data were created and updated using similar methodology as that for the CONUS, but with a different approach to establishing the underlying climatology. The Alaska data are built upon the 1971-2000 PRISM averages whereas the CONUS values utilize a base climatology derived from the nClimDiv

dataset. More information on this new dataset can be access here: Alaska FAQ's

- NCEI
- About
- Site Map

- Privacy
- FOIA
- Information Quality
- Disclaimer

- Department of Commerce
- NOAA
- NESDIS

Department of Commerce > NOAA > NESDIS > NCEI > NCDC

Missouri American Water Company
Comparison of 40 Year Weather to 2010-2015
June - August

Time Period Measured	Cooling Degree Days	Mean Total Percepitation	Maximum Monthly Temperature	Minimum Monthly Temperature	Mean Maximum Daily Temperature	Mean Minimum Daily Temperature	Mean Average Daily Temperature
Mean 1976-2015	314.7	3.7	95.4	52.1	84.0	64.9	74.4
STDV 1976-2015	148.0	2.4	5.0	8.2	5.6	5.9	5.7
SD as % Mean 76-15	47.0%	65.0%	5.2%	15.8%	6.7%	9.2%	7.7%
Mean 10-2010 - 9-2015	355.9	4.1	98.0	53.6	85.4	66.4	75.9
STDV 10-2010 - 9-2015	146.0	2.7	5.1	8.4	5.6	5.6	5.6
SD as % Mean 76-15	41.0%	65.3%	5.2%	15.6%	6.6%	8.5%	7.3%
Mean 2012	524.9	2.2	1.7	2.2	105.7	59.7	93.1
STDV 2012	136.9	1.4	2.4	1.4	3.3	8.6	3.9
SD as % Mean 2012	26.1%	60.6%	141.4%	60.6%	3.1%	14.4%	4.2%
Mean % Change 2012 t0 40 years	27.5%	-40.9%	8.0%	3.4%	6.3%	2.7%	4.7%
STD % Change 2012 to 40 Years	39.2%	-41.5%	-10.8%	81.3%	14.7%	51.1%	34.7%
Mean % Change 2012 to Staff	17.8%	-37.2%	6.4%	-0.4%	4.8%	1.1%	3.2%
STD % Change 2012 to Staff	45.0%	-33.2%	-14.6%	94.4%	17.9%	67.4%	44.3%