



A & N Technical Services, Inc.

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## Memorandum

**To:** Stephanie Pintar, MPMWD; Joe DiMaggio, California American  
**From:** Tom Chesnutt  
**Date:** September 22, 2011  
**Re:** **Analysis of Non-Residential Water Use Factors**

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### Introduction

A & N Technical Services conducted a technical analysis of Non-Residential Water Use Factors for the Monterey Peninsula Water Management District (MPWMD). MPWMD has used Non-Residential Water Use Factors since 1985 to estimate water demand for new and expanding Commercial, Industrial, and Institutional (CII) uses prior to construction and prior to expansion or change in use to ensure that adequate water supplies exist to meet the project's needs. The factors are "regional averages" based on telephone surveys of businesses and on water consumption records from California American Water (Monterey Division), the local utility. Non-Residential Water Use Factors are based on an amount of water demand per square-foot or other measurement (i.e., hotel room, restaurant seat, commercial washer in a Laundromat, etc.). Most of the 52 individual water factors used by MPWMD to calculate water demand "capacity" were last defined in 1992. The original Non-Residential Water Use Factors were established in 1985 when the District's current Water Permit process was adopted. The factors were partially updated annually until 1988.

MPWMD and California American Water require recalibrated Non-Residential Water Use Factors for permitting and ratemaking purposes. MPWMD will use the updated Water Use Factors to estimate demand prior to issuance of a Water Permit and to calculate CII rations prior to water rationing. California American Water uses the District's Non-Residential Water Use Factors to establish baseline allotments and the base rates for its customers. The District's factors have been used to establish CII allotments since tiered rates were implemented in 2000.

New CII rates were approved by the California Public Utilities Commission (PUC) in 2009 and were implemented in 2010.

### **Tasks**

The analysis focused on three tasks:

Task 1. Review Practices to Water Use Factor Definition. At project conception I reviewed and collected information on the derivation of water use factors currently being employed at the District and California American. As part of the project initiation, I also participated in two Stakeholder meetings.

Task 2. Collect and Analyze Water Consumption and Permit Data. To prepare for the analysis, three types of data: water consumption records from California American Water, Water Permit Data from MPWMD, and weather data from CIMIS were collected, cleaned, and merged. These data were analyzed to inform revised Non-residential Water Use Factors.

Task 3: Develop and Present Recommendations on Non-Residential Water Use Factors.

### Review and Stakeholder Input

The Non-Residential Water Use Factors used to set allotments in the current water rate structure were originally developed for capacity-related calculations by MPWMD in the early 1990's.<sup>1</sup> Their use as a basis for Non-residential water rates bears a resemblance to recent national research on water budgets.<sup>2</sup> This analysis was allowed to consider weather patterns, industry fluctuations, and other factors that may be pertinent to establishing a water use factor for specific types of Non-Residential use.

The approach of this project was presented at a February 11, 2010, public meeting, held at the Seaside Community Center. MPWMD presented the history of the Non-Residential Water Use Factors which originated out of a need to estimate anticipated future water demand to calculate connection charges. These Factors were later adapted by California American for use in determining the base rate for non-residential water users. California American presented an overview of the current approved rate

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<sup>1</sup> See "Calculated Average Consumptions: Commercial Users," MPWMD, July 1992.

<sup>2</sup> See Mayer P., W. DeOreo, T.W. Chesnutt, L. Summers, "Water Budgets and Rates Structures: Innovative Management Tools," *Journal AWWA*, 100:5, pp.117-131, May 2008. 2008 Best Paper Award, AWWA Conservation Division.

structure and their approach to implementing the rate structure using MPWMD's factors. Comments from the public were received.

A second focused stakeholder workshop was held on March 19, 2010, that involved the Hospitality Industry stakeholders—including representatives of hotels, restaurants, and other non-residential customers.

Two questions were initially posed by stakeholders:

- What are Non-Residential Water Use Factors?
- How are Non-Residential Water Use Factors used?

Representatives of the District explained the history of how Non-Residential Water Use Factors were developed for purpose of capacity planning and calculating connection charges. Stakeholders expressed a number of concerns with how the factors had been or could be applied in a water rate structure. A short noninclusive list of these concerns includes:

- Basing allotments on historical use will punish successful, though efficient, businesses. Why punish success?
- Businesses within a business type category can be immensely different. Standardizing by one measurement unit is not fair.
- Basing a revised Water Use Factor on consumption data from 2009 and even 2008 will capture consumption that reflects lower hotel occupancy and lower economic activity.
- Concerns that any error in classification or derived Water Use Factor would have huge economic consequences for businesses when the third rate tier is seven times higher than the first.
- Concerns about the availability and content of existing non-residential water audits.
- Concerns of the level of existing water rates and proposed and future water rates.

## Data, Methods, and Approach

**Consumption Data:** California American supplied monthly meter-read consumption data for non-residential accounts going back to 2001. A separate statistical dataset was created for each month of consumption data provided. These 108 monthly datasets were appended into a single consistent time-series for the statistical analysis.

**Weather Data:** Daily weather data were compiled from a nearby CIMIS station (California Irrigation Management Information System Station 17 in Castroville). The daily values of precipitation and maximum air temperature were averaged over 30 days. A match was made between consumption data and the weather data based on the meter-read date. Thus, a meter read that occurred on January 15

represents consumption that occurred between December 15<sup>th</sup> and January 15<sup>th</sup> and would be matched to the average precipitation and maximum air temperature for the same period. The average values of the precipitation and maximum air temperature values were calculated.

**Deterministic Functions of Calendar Time:** Additional variables were created that were deterministic functions of time—an annual trend term centered on 2005 (the center of the sample period), monthly indicator variables (mo1-mo12 where mo1 equals 1 in the month of January and is zero for all other months), and a set of 12 matched sine and cosine terms that can depict the same monthly variation as a continuous function of time.

**ECU Factors:** California American also supplied data on “Non-Residential ECU Factors” that provide a current definition of the Business Type Code attached to each customer account. Each Business Type Code has an associated water allotment expressed per measurement unit (square feet, rooms, seats, etc.). The matching of the ECU Factors that define allocations to the historical water consumption data was not straightforward for several reasons. First, this flat file of Non-Residential ECU Factors contained information on both active accounts and closed accounts. Second, as the result of a historical data conversion glitch, the basis for determining the customer allotment—the business type code and measured units—were lost for approximately 2,500 ECU Factor records. These records with data lost in the conversion list the Business Type Code as “CONV”. Though these CONV records retain the historically defined water allotments, they do not retain the basis for the allotment (Business Type Code and measurement unit) and thus cannot shed light on historical consumption of specific business types. Third, more than one ECU Factor may be needed to define current allotments for non-residential California American customers. Since different businesses can be connected to the same customer meter (a “mixed meter”), there is not a one-to-one correspondence between this data and the historical time series of water consumption history. To ensure a clean one-to-one match to historical water consumption only a subset of ECU records could be used for matching:

- only ECU Factors for active accounts,
- no “CONV” or “NOALL” ECU Factors, and
- only single ECU Factors were used (no mixed meters).

Thus, readers are cautioned to note that the analysis sample can differ from the population of all nonresidential accounts, since the analysis sample contains no accounts having multiple assigned ECU Factors. It is not known how accounts included in the analysis differ from the accounts excluded due to nonexistent measurement units.

Outdoor water use. The Settlement Agreement explicitly states that: “The Parties agree that outdoor water will be viewed as discretionary use except for properties that have to have water for the business purposes. This means that outdoor water use that is not essential to the business function will be billed at block 2 or 3 rates. For example, water used by a bar or restaurant for outdoor purposes would be billed at the block 2 or 3 rates.” For certain accounts, MPMWD sets a water budget for outdoor water use as a function of irrigable area—the Maximum Applied Water Allowance (MAWA). Water use of business types defined as outdoor water use—Outdoor, Drought or Drip (ODRGH), Outdoor no turf (ONTRF), Outdoor Turf (OTURF) are included in the analysis sample if they are a unique account. Businesses having allotments for both indoor and outdoor uses on the same meter are excluded from the analysis sample. Business having unknown or unmetered outdoor water uses are included in the analysis sample since it is not possible to exclude them.

New Business Types. Potential new business types for evaluation include:

<b>New Business Type</b>	<b>Code</b>
Ice Cream	ICE
Massage Parlor/Studios	MASSA
Funeral Homes/Mortuaries	MORTU
Airport	AIRPT
Cafes/Coffee House	CAFÉ
Tanning Salon	TAN
Pet store/Grooming	PETS
Equestrian/Ranches/Stables	RANC
Tailor/alterations	ALTER
Wholesale Grocers	GROWC

California American was unable to identify all potential candidates of these potential business types in the time frame of this study.

**Permit Data:** Additional data were also supplied from MPWMD generated from the issuance of permits for new construction and remodeling purposes from 1990 to 2005. MPWMD provided Excel spreadsheets showing 368 Non-Residential properties that received Water Permits for New Connection between 1990 and 2005. The spreadsheets include (1) two spreadsheets of current and archived Water Permit data for Non-Residential New Construction Water Permits issued between 1990 and 2005; (2) two spreadsheets showing Non-Residential Water Permits, the factors applied to the permit (i.e. retail, restaurant, bakery, etc.) and the square-footage or other measurement associated with that use; (3) a

spreadsheet showing the variables in the Non-Residential Water Use Factors used, and (4) a description of the fields.

All properties listed on these spreadsheets were required to install ultra-low flush toilets, instant access hot water systems and low-flow showerheads and faucet aerators. All properties were required to have conservation signage and to serve water only upon request. Estimated demand includes minimal associated landscaping that was not permitted.

These Permit data were not used in the analysis for two reasons. First these data, while containing a rich set of details on planned fixtures and uses, did not provide data on the entire population of non-residential customers—only those who had applied for permits. Self-selection of the sample of customers who choose to apply for permits mean that conclusions reached on this sample of customers could not be expected to extend to the sample of customers who have not applied for permits. Second, and more importantly, matching these data to California American consumption data was not possible because the MPWMD data did not contain the California American customer account numbers and the California American consumption did not contain the Assessor's Parcel Number. This data incompatibility should be addressed to improve coordination and water conservation planning between MPWMD and California American.

**Data Cleaning:** Meter-read water consumption data can be complicated to work with. Consumption data provided by California American were stored in units of one thousand gallons to the nearest 250 gallons. These data were reexpressed using the original billing units of hundred cubic feet. Meters can be misread, or wrongly entered; corrections to these billing errors can require an offsetting accounting entry that results in a negative registered consumption. Negative water consumption, however, is both physically impossible and can confound simple statistics. Where possible, negative offsetting accounting entries were combined with preceding large entries to preserve the corrected measure of volumetric consumption. Robust statistical methods were used to assist in identifying and isolating potentially large and possibly erroneous recorded historical consumption. Data cleaning preceded at a customer level to identify about three percent of the customers whose average use per measurement unit exceeded the MPWMD Non-Residential Water Use Factor by more than three: the records for these customers will need to be examined individually for errors in recorded water use or measurement units. They are listed in a separate and nondisclosable Attachment A. Readers are cautioned to note that the analysis sample

has been separated from accounts with suspect data. The mean values of water consumption and consumption per measured unit should be considered as “trimmed” means.

**Methods:** The approach begins with a summary of statistics that describe the historical water use data to reveal broad trends and characterize variability in the distribution of water use across different business types and through time. Next, the basis for the Non-Residential Water Use Factors is examined. Non-Residential Water Use Factors were established in the early 1980’s by calculating an average of water use that was standardized for each type of business. Water use was standardized by one variable—the “Measurement Unit”—that measured the size of the business: area of the building in square feet, number of seats, number of rooms, acres of irrigated area, etc. distributions of water use per measure. Descriptive statistics of the monthly water use per unit were then created. Following the descriptive statistics, regression models were estimated for business types where sufficient data were available. These regression models allow for more formal inference testing, control for weather variations, and detection of ongoing trends in water use per unit.

### Statistical Analysis

Table 1 displays descriptive statistics from the historical water consumption data by Business Type Code over the entire analysis sample—the number of customers, the median (50th percentile) use, the mean (average) use in hundred cubic feet per month, and the standard deviation of use. From this table we can conclude that water use does vary greatly across different types of business and even within a type of business. We can also conclude that there are a number of Business Types that have a very limited number of customers upon which to base conclusions.

**Table 1: Number of Customers, Median Use, Mean Use, Std. Deviation of Use by Business Type Code, for the Years 2001-2009**

Business Type	Business Type Code	Number of Customers	Median Use (ccf/month)	Mean Use (ccf/month)	Std. Deviation Use (ccf/month)
Auto Repair	AUTO1	39	3	6.997093	12.15924
Auto Sales	AUTO2	9	5	24.54836	32.47775
Bakery	BAKE	12	8	15.64309	16.60547
Bank	BANK	19	1	6.143865	14.83454
Bar	BAR	4	11	16.19576	19.27904
Beauty Shop	BEAUT	55	3	5.2158	11.17648
Child Care	CHILD	4	16.5	21.68633	15.54965
Church	CHRCH	20	6	11.56636	18.09139
Convenience Store	CONVS	6	4	6.167733	6.705311
Deli/Sandwich Shop	DELI	20	7	9.092302	9.737259
Dental Office	DENTL	11	4	7.028103	10.73908
Dorm	DORM	3	15	18.15895	15.59736
Dry Cleaners	DRYCL	8	25.1	25.17129	19.48299
Fish Market	FISH	8	5	18.61377	27.95348
Gas Station	GAS	11	2	11.76803	23.6774
Grocery - Super Market	GROC	15	11.5	59.62933	82.60086
Grocery-Family	GROCF	5	6	7.265502	6.517499
Gym	GYM	20	2	12.81444	35.84253
Hotel - Bed & Breakfast	HTLBB	27	16	24.74372	34.52887
Hotel - Luxury	HTLLX	12	133.3	278.5747	371.3804
Hotel - Standard	HTLST	24	16	40.91257	49.95187
Laundromat	LANDY	26	35.1	211.0266	522.6517
Medical	MEDIC	64	3	9.954789	22.07247
Meeting Hall	METHL	13	4	30.91417	55.3079
Motel	MOTEL	20	60.7	79.48367	69.20462
Nursing/Convalescent Home	NRSHM	23	21.1	38.40309	46.86289
Nursery - Plant	NUSRY	6	9	16.05881	19.55052
Open space - drought/drip	ODRGH	86	1	10.58873	31.5531
Office - general	OFFCE	281	2	8.621582	26.83613
Open space - non-turf	ONTRF	163	3	23.49795	54.90311
Open space - turf	OTURF	72	8	99.9364	527.4319
Pizza - take out/delivery	PIZZA	4	8	10.92432	21.05514
Swimming Pool	POOL	3	17	19.02348	13.79893
Public restroom	RESRM	32	2	17.20976	77.25723
Retail - general	RETAL	293	2	6.353992	24.06152
Restaurant - 24-hour	RST24	1	133.3	135.91	22.38662
Restaurant - with bar	RSTBR	32	46.1	93.52037	290.9344
Restaurant - fast food	RSTFF	33	19	28.04633	26.21363
Restaurant - full service	RSTFS	85	27.1	54.57888	82.95061
School	SCHL	50	7	34.81946	98.54861
Self Storage	SLFST	6	0	2.490722	4.338348
Spa	SPA	6	6	6.980328	4.022912
Theater	THETR	2	7	7.215385	4.104027
Veterinary	VET	9	7	7.121955	6.242845
Wine tasting room	WINE	4	1	1.179167	1.416129
Warehouse	WRHSE	74	1	3.0824	6.367411



Table 2 examines the variation of mean water use through time. The most recent two years of mean water use, 2008 and 2009, appear somewhat lower; this is consistent with Stakeholder assertions of depressed economic activity in these years. Since explicit per-customer measures of economic activity were not available for this analysis, these two years that reflect the effects of the down business cycle will be excluded from the analysis sample.

**Table 2: Mean and Standard Deviation of Monthly Use by Business Type Code for the Years 2001-2009**

Business Type (BT)	BT Code	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Auto Repair	AUTO1	Mean	9.32	6.87	6.47	6.57	6.25	7.39	7.05	6.97	
		Std. Dev.	17.46	8.93	9.67	10.49	10.80	11.85	12.45	14.22	11.32
Auto Sales	AUTO2	Mean	31.12	24.10	26.57	27.82	24.25	26.53	27.40	19.24	16.00
		Std. Dev.	48.36	33.32	32.73	28.67	29.51	35.42	32.63	25.02	24.20
Bakery	BAKE	Mean	26.35	24.34	17.50	17.56	15.39	12.97	13.12	10.83	13.74
		Std. Dev.	18.37	18.69	15.77	17.55	15.86	15.36	15.80	11.84	17.27
Bank	BANK	Mean	10.39	8.89	6.98	5.17	6.91	6.53	5.59	4.75	5.24
		Std. Dev.	16.99	17.19	13.91	11.66	21.53	18.74	12.27	11.23	10.79
Bar	BAR	Mean	26.18	20.62	18.95	17.67	21.34	13.67	9.75	12.42	9.14
		Std. Dev.	48.96	13.24	14.68	13.29	16.41	8.75	2.86	8.28	4.04
Beauty Shop	BEAUT	Mean	4.94	4.58	8.70	6.82	3.91	4.30	4.87	4.75	5.17
		Std. Dev.	4.16	5.68	29.20	18.73	3.57	4.09	4.36	4.38	5.63
Child Care	CHILD	Mean	21.43	18.00	21.85	24.20	21.67	21.27	21.38	20.42	23.68
		Std. Dev.	10.37	9.15	18.20	10.95	13.06	13.68	12.64	15.82	25.83
Church	CHURCH	Mean	14.52	14.48	8.66	14.39	12.24	12.60	10.29	8.94	9.80
		Std. Dev.	18.24	22.33	8.39	20.95	22.98	25.87	12.45	10.29	11.88
Convenience Store	CONVS	Mean	5.17	5.88	6.42	5.96	4.61	6.20	4.92	4.71	9.47
		Std. Dev.	1.20	1.51	2.99	2.31	2.27	3.45	5.57	5.93	12.16
Deli/Sandwich Shop	DELI	Mean	6.78	5.86	6.96	10.16	12.12	8.66	8.78	9.09	9.07
		Std. Dev.	4.95	4.18	4.78	9.22	19.43	6.51	7.36	7.79	6.54
Dental Office	DENTL	Mean	3.88	3.71	7.03	6.47	6.46	8.32	5.90	6.87	10.43
		Std. Dev.	5.29	3.55	9.45	6.74	6.50	9.00	7.35	9.42	19.00
Dorm	DORM	Mean	15.03	13.07	15.68	20.70	24.33	19.86	18.18	18.74	17.61
		Std. Dev.	8.77	7.01	12.75	20.20	25.56	17.23	12.87	14.68	10.83
Dry Cleaners	DRYCL	Mean	35.55	34.99	30.73	23.88	21.34	20.53	22.96	21.29	19.82
		Std. Dev.	28.37	26.29	21.97	15.15	14.74	14.07	16.78	14.70	14.14
Fish Market	FISH	Mean	22.91	26.75	18.35	16.59	20.93	16.66	18.78	17.95	14.92
		Std. Dev.	24.85	27.56	23.19	18.90	26.52	28.51	28.38	34.76	30.17
Gas Station	GAS	Mean	10.38	13.19	14.15	11.62	11.49	9.08	12.25	14.28	10.18
		Std. Dev.	18.57	19.25	23.64	23.05	22.96	30.06	24.92	27.99	17.28
Grocery - Super Market	GROC	Mean	62.82	63.29	65.69	54.05	49.95	56.66	70.69	58.79	54.52
		Std. Dev.	71.94	84.30	82.32	64.47	67.60	117.19	93.74	70.28	76.60
Grocery-Family	GROCF	Mean	6.71	6.54	6.87	7.04	7.63	7.24	8.01	7.21	7.89
		Std. Dev.	5.86	6.29	6.11	6.29	7.05	6.06	7.79	5.61	7.61
Gym	GYM	Mean	5.15	3.70	5.08	18.24	14.04	15.35	16.82	13.63	12.66
		Std. Dev.	4.12	2.83	17.80	46.90	37.86	39.53	44.59	36.62	33.49

Business Type (BT)	BT Code	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Hotel - Bed & Breakfast	HTLBB	Mean	51.94	51.54	22.30	16.96	18.61	18.90	19.27	23.22	
		Std. Dev.	59.75	78.06	28.52	18.92	17.55	20.01	19.17	29.15	24.72
Hotel - Luxury	HTLLX	Mean	489.34	497.70	328.12	267.82	262.25	219.28	261.06	203.50	166.97
		Std. Dev.	505.51	564.63	417.13	374.71	328.90	305.13	356.94	231.31	175.18
Hotel - Standard	HTLST	Mean	126.31	139.40	40.13	33.18	34.80	32.50	36.20	35.88	32.31
		Std. Dev.	68.17	77.71	45.80	42.56	39.19	38.07	39.81	42.72	41.27
Laundromat	LANDY	Mean	248.84	314.67	278.16	247.91	223.75	198.05	213.03	192.43	139.01
		Std. Dev.	433.20	505.94	677.96	563.89	560.24	501.35	595.57	532.26	354.69
Medical	MEDIC	Mean	9.69	11.69	11.94	10.34	11.77	10.57	8.95	8.86	8.45
		Std. Dev.	11.47	19.45	38.60	20.86	26.12	26.88	16.49	15.60	16.76
Meeting Hall	METHL	Mean	35.05	35.10	31.48	31.31	29.24	30.11	32.63	28.30	27.73
		Std. Dev.	53.78	52.95	54.87	55.31	54.11	58.30	60.76	53.92	53.32
Motel	MOTEL	Mean	125.74	125.14	95.32	92.08	85.90	72.02	65.85	59.41	66.11
		Std. Dev.	87.85	101.00	82.80	76.68	75.28	66.59	50.93	44.80	50.34
Nursing/Convalescent Home	NRSHM	Mean	45.42	46.48	38.11	35.71	33.62	31.57	43.12	38.40	37.85
		Std. Dev.	49.30	49.40	46.24	47.02	45.41	34.57	55.54	46.77	45.92
Nursery - Plant	NUSRY	Mean	13.48	10.89	12.10	11.90	9.39	16.40	22.84	18.47	15.71
		Std. Dev.	9.93	8.10	9.12	11.31	8.49	16.40	24.18	24.13	22.90
Open space - drought/drip	ODRGH	Mean	10.42	8.00	8.97	11.29	10.20	9.12	10.36	13.75	11.84
		Std. Dev.	36.69	36.65	23.30	31.63	27.33	24.96	25.97	41.74	30.46
Office - general	OFFCE	Mean	13.04	12.28	10.53	9.58	9.45	8.02	7.53	7.14	6.74
		Std. Dev.	37.72	35.58	33.84	25.76	30.37	26.58	21.44	23.18	19.91
Open space - non-turf	ONTRF	Mean	28.14	29.93	24.14	22.69	21.41	21.51	23.98	21.55	20.34
		Std. Dev.	63.17	69.03	50.70	50.21	48.75	58.07	54.69	50.35	48.43
Open space - turf	OTURF	Mean	127.77	110.85	108.61	111.61	87.53	79.48	100.37	99.79	89.83
		Std. Dev.	658.52	535.61	560.92	554.26	472.00	418.78	508.77	560.17	510.85
Pizza - take out/delivery	PIZZA	Mean	8.08	9.09	8.00	28.31	8.89	11.59	10.23	7.65	9.27
		Std. Dev.	2.21	10.13	3.63	56.42	9.31	24.70	17.14	2.91	5.07
Swimming Pool	POOL	Mean	16.45	16.13	13.62	16.02	17.96	20.05	21.43	26.85	21.92
		Std. Dev.	7.02	16.36	8.93	7.05	7.48	12.31	13.25	20.39	18.19
Public restroom	RESRM	Mean	44.72	38.98	15.65	15.20	10.93	8.19	9.39	12.36	9.39
		Std. Dev.	148.97	170.57	64.78	41.16	36.30	13.54	16.38	28.99	20.59
Retail - general	RETAL	Mean	9.33	9.50	7.98	6.98	7.84	5.87	5.17	4.93	4.63
		Std. Dev.	28.59	29.84	26.74	24.21	27.41	21.11	21.31	21.53	21.88
Restaurant - 24-hour	RST24	Mean					162.40	135.66	148.12	122.48	
		Std. Dev.						21.32	18.21	28.17	13.69

Business Type	Code	2001	2002	2003	2004	2005	2006	2007	2008	2009	
Restaurant – with bar	RSTBR	Mean	246.38	129.91	91.19	87.53	79.87	74.41	75.13	67.06	59.31
		Std. Dev.	925.42	279.19	121.12	100.11	88.92	83.21	89.63	67.43	61.97
Restaurant – fast food	RSTFF	Mean	35.99	38.39	39.41	34.35	27.93	27.36	23.55	21.26	23.03
		Std. Dev.	30.09	35.49	35.61	30.20	22.88	23.94	21.44	19.91	20.35
Restaurant – full service	RSTFS	Mean	69.83	68.54	56.18	60.66	61.55	52.52	53.18	50.57	42.95
		Std. Dev.	92.17	92.19	85.82	88.24	93.54	73.38	83.02	89.77	61.60
School	SCHL	Mean	93.25	94.73	62.21	36.65	30.21	25.33	30.12	30.59	26.51
		Std. Dev.	137.48	138.41	147.02	102.54	88.02	72.85	97.07	102.02	80.62
Self Storage	SLFST	Mean		9.37	4.44	3.96	2.13	2.04	2.29	2.33	1.30
		Std. Dev.		10.17	4.54	9.08	2.23	2.22	2.42	2.81	2.36
Spa	SPA	Mean	6.42	7.06	6.96	5.25	7.70	7.97	7.20	6.84	6.78
		Std. Dev.	1.24	2.24	1.37	2.92	4.59	3.91	3.31	4.75	5.09
Theater	THETR	Mean	6.33	6.33	6.17	5.00	9.68	8.00	5.17	8.00	9.37
		Std. Dev.	3.39	2.87	2.33	3.14	6.94	2.76	3.33	4.31	3.96
Veterinary	VET	Mean	7.13	8.24	6.25	5.57	6.91	7.30	7.56	7.24	7.20
		Std. Dev.	5.43	11.09	4.77	4.11	6.59	6.48	5.87	5.64	5.04
Wine tasting room	WINE	Mean	2.39	1.25	1.08	1.25	0.88	0.68	0.79	0.85	1.37
		Std. Dev.	3.24	1.22	0.88	0.85	0.74	0.48	0.48	0.83	1.20
Warehouse	WRHSE	Mean	5.60	4.63	3.45	3.15	2.62	3.11	2.52	2.45	2.26
		Std. Dev.	11.41	10.22	6.68	6.67	3.80	6.83	3.98	4.04	3.82

Table 3 examines Non-Residential Water Use standardized by the measurements units. Note that the mean use per unit for any business type cannot be derived by dividing the mean water use of that business type by the mean number of measurement units. This is due to a well known statistical property that the expected value of the product of two random variables does not in general equal the product of the expectation value of the first random variable times the expectation of the second random variable. This is because there can be a relationship between the two variables. To illustrate, many large landscapes are professionally managed and can have a lower use per irrigated area. The correlation between mean use and mean units would also be required to correctly infer the mean use per unit. Table 3 does not provide any direct measure of the dispersion of the distribution of mean use per unit across customers.

**Table 3: Number of Customers, Mean Use, Measure Units, and Mean Use per Unit by Business Type Code 2001-2007**

Business Type	Measure	Customers	Mean Use (ccf/month)	Mean Measurement Units	Mean Use per Unit (ccf/month)
Auto Repair	Square-footage	30	6.36268	6375.7	0.000719
Auto Sales	Lot size (sq.ft.)	7	25.17874	48162.86	0.000403
Bakery	Square-footage	11	13.1737	2548.545	0.004609
Bank	Square-footage	18	4.91999	4902.167	0.00062
Bar	seats	3	16.39019	38.66667	0.337797
Beauty Shop	stations	46	5.74767	13.43478	0.907793
Child Care	Per child	3	21.37009	66.33333	0.355089
Church	Square-footage	20	11.40189	10718.15	0.001215
Convenience Store	Square-footage	5	8.293641	2320	0.002933
Deli/Sandwich Shop	Square-footage	18	9.218712	1243.889	0.008184
Dental Office	Square-footage	9	5.945703	1880.444	0.003333
Dorm	rooms	3	18.15895	23.33333	0.49537
Dry Cleaners	Square-footage	8	24.89167	2615	0.009407
Fish Market	Square-footage	8	16.07599	17750.5	0.000977
Gas Station	pumps	10	14.12797	5.8	1.43361
Grocery - Super Market	Square-footage	14	59.2631	15751	0.003272
Grocery-Family	Square-footage	2	7.207281	4400	0.001331
Gym	Square-footage	13	15.45871	10053.85	0.000746
Hotel - Bed & Breakfast	rooms	24	24.05786	8.416667	2.667197
Hotel - Luxury	rooms	12	276.4509	288.1667	1.61104
Hotel - Standard	rooms	21	39.74463	100.8571	2.351392
Laundromat	machines	21	162.5437	27.42857	5.802469
Medical	Square-footage	58	9.250372	8457.276	0.000901
Meeting Hall	Square-footage	13	27.50149	11774.92	0.001834
Motel	rooms	13	69.14348	38.30769	1.933431
Nursing/Convalescent Home	rooms	21	39.62089	17.19048	2.038529
Nursery - Plant	Square-footage	5	21.76817	57782.4	0.000378
Open space - drought/drip	acres	82	13.66131	1.197805	22.3807
Office - general	Square - footage	228	7.667042	8110.592	0.00073
Open space - non-turf	acres	159	22.82046	1.099057	26.78182
Open space - turf	acres	72	94.37164	4.004306	46.11918
Pizza - take out/delivery	Square-footage	3	10.34267	2738.667	0.006733
Swimming Pool	Surface area	2	18.27954	740	0.031767
Public restroom	Per toilet	27	16.78672	5.740741	1.404167
Retail - general	Square-footage	223	5.268265	5232.816	0.000663
Restaurant - 24-hour	seats	1	135.91	120	1.132583
Restaurant - with bar	seats	26	86.76832	145.9231	0.417419
Restaurant - fast food	seats	26	24.21441	88.11538	0.325071
Restaurant - full service	seats	63	52.93366	109.5238	0.434065
School	rooms	49	29.54959	29025.29	0.000809
Self Storage	Square-footage	2	2.734236	81083.5	4.55E-05
Spa	fixtures	4	8.157802	7.75	1.448429
Theater	seats	1	6.92	499	0.013868
Veterinary	Square-footage	7	7.132926	2758.714	0.002884
Wine tasting room	Square-footage	2	1.138889	3750	0.000285
Warehouse	Square-footage	65	3.154317	7529.662	0.00033

Table 4 goes beyond the mean use per unit provided in the previous table to give the 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, and 90<sup>th</sup> percentiles of the entire distribution of mean customer use per unit. Thus, a mean use per unit is derived from each customer—no within customer variation is contained in Table 4. Note too that the mean customer use per unit of Table 3 is usually greater than the 50th percentile, also known as the median. This is due to the skew in the distribution of mean customer use per unit. For purposes of targeting conservation programs the top 10 percent (defined by use per unit equal to or greater than the 90<sup>th</sup> percentile) is a common metric used to identify high water use.

**Table 4: Distribution of Mean Customer Use per Unit, 2001-2007: 10<sup>th</sup>, 25<sup>th</sup>, 50<sup>th</sup>, 75<sup>th</sup>, 90<sup>th</sup> Percentiles**

Business Code	Type	10 <sup>th</sup> Percentile Use per Unit (ccf/month)	25 <sup>th</sup> Percentile Use per Unit (ccf/month)	Median (50 <sup>th</sup> Percentile) Use per Unit	75 <sup>th</sup> Percentile Use per Unit (ccf/month)	90 <sup>th</sup> Percentile Use per Unit (ccf/month)
AUTO1		0.000286	0.000402	0.000719	0.00114	0.001739
AUTO2		7.47E-05	0.000154	0.000403	0.000568	0.000794
BAKE		0.001129	0.001412	0.004609	0.008224	0.015551
BANK		0	0.000377	0.00062	0.001631	0.002681
BAR		0.237127	0.237127	0.337797	0.713287	0.713287
BEAUT		0.426339	0.586364	0.907793	1.490203	2.367284
CHILD		0.17845	0.17845	0.355089	0.689864	0.689864
CHRCH		0.000373	0.000537	0.001215	0.001791	0.003348
CONVS		0.001622	0.002227	0.002933	0.005302	0.005526
DELI		0.002041	0.003608	0.008184	0.010519	0.011378
DENTL		6.05E-05	0.00187	0.003333	0.00412	0.007196
DORM		0.455947	0.455947	0.49537	1.933704	1.933704
DRYCL		0.000839	0.006198	0.009407	0.011525	0.017537
FISH		0.000618	0.00077	0.000977	0.003064	0.004913
GAS		0.064815	0.166667	1.43361	2.003037	3.329817
GROC		0.000655	0.001774	0.003272	0.004724	0.008304
GROCF		0.000487	0.000487	0.001331	0.002175	0.002175
GYM		0.000494	0.00072	0.000746	0.001378	0.001827
HTLBB		0.522825	1.39657	2.667197	4.477022	5.702217
HTLLX		0.185428	0.730134	1.61104	2.459241	2.847334
HTLST		0.717546	1.509259	2.351392	2.584774	3.603292
LANDY		1.884058	3.348716	5.802469	6.417875	9.844898
MEDIC		0.000178	0.000329	0.000901	0.001817	0.003098
METHL		0.00083	0.00128	0.001834	0.002401	0.013086
MOTEL		0.699006	1.378985	1.933431	3.104126	3.780432
NRSHM		0.692644	1.092052	2.038529	2.821875	3.567181
NUSRY		4.95E-05	0.000373	0.000378	0.000437	0.000945
ODRGH		0	5.242165	22.3807	72.33987	151.0185
OFFCE		2.46E-05	0.000333	0.00073	0.00149	0.003244
ONTRF		0.148935	5.072464	26.78182	66.26542	120.1415
OTURF		0.637456	9.039238	46.11918	87.06117	120.0434
PIZZA		0.000961	0.000961	0.006733	0.008999	0.008999
POOL		0.01166	0.01166	0.031767	0.051873	0.051873
RESRM		0.240909	0.574383	1.404167	3.088889	5.302741
RETAL		0.000145	0.000391	0.000663	0.001452	0.002361
RST24		1.132583	1.132583	1.132583	1.132583	1.132583
RSTBR		0.268349	0.347723	0.417419	0.668279	0.993686
RSTFF		0.004762	0.178889	0.325071	0.772012	0.894864
RSTFS		0.129571	0.214091	0.434065	0.615719	0.814583
SCHL		0.000365	0.00059	0.000809	0.001122	0.001718
SLFST		1.24E-07	1.24E-07	4.55E-05	9.09E-05	9.09E-05
SPA		0.472727	0.541563	1.448429	2.705729	3.125
THETR		0.013868	0.013868	0.013868	0.013868	0.013868
VET		0.001139	0.001438	0.002884	0.006147	0.006296
WINE		0.000253	0.000253	0.000285	0.000316	0.000316
WRHSE		5.13E-05	0.000148	0.00033	0.000898	0.002068



Table 5 provides additional information on the distribution of mean customer use per unit from 2001-2007—in addition to the mean of the distribution, the standard deviation (a measure of dispersion), the coefficient of variation (ratio of the mean to standard deviation), and comparisons to the existing California American and MPWMD Non-Residential Water Use Factors. The standard deviation can give the reader an idea of the spread between customers. The coefficient of variation standardizes the standard deviation by the mean, so the business types with the largest relative dispersion have a larger coefficient of variation. The standard error of the estimated mean is a measure of uncertainty attached to the estimated mean use per unit. The standard error of the estimated mean can be used when incorporating reliability into any variable defined using the estimated mean—such as an allocation factor. The 90th percentile is included as an index of high water use per unit for that business type code. Last, the overall mean water use per unit is compared to the MPWMD and California American Non-Residential Water Use Factors.

Readers are cautioned to be careful interpreting results since only 11 business type categories (in bold) have a sample size that was greater than or equal to a sample size of 30 customer accounts. Given the insufficient sample sizes, the regression modeling could not be attempted on all business type categories. The only inference derived from the regression models is that a small negative trend, reflecting ongoing efficiency improvements, was detectable in many business type categories. (Results of these fixed-effect regression models are provided separately in Attachment B.)

**Table 5: Distribution of Use per Unit 2001-2007 Compared to Existing Cal-Am and MPWMD Allocation Factors**

Business Type	Measure	N	Mean Use per Unit (ccf/mo.)	Std. Dev. Use per Unit (ccf/mo.)	Coef. of Variation (Std.Dev./Mean)	Std. Error of Mean (SD/ $\sqrt{N}$ )	90th Percentile Use per Unit	MPWMD Allocation Factor (AF/yr)	MPWMD Allocation Factor (Ccf/mo)	Cal-Am Allocation Factor (AF/yr)	Cal-Am Allocation Factor (Ccf/mo)	Is 2001-2007 Trimmed Mean within MPWMD Factor?	Is 2001-2007 Trimmed Mean within Cal-Am Factor?
Auto Repair	Square-footage	30	0.000981	0.00095	0.97	0.00021	0.00174	0.00007	0.002541	0.00006	0.002175	Within	Within
Auto Sales	Lot size (sq.ft.)	7	0.000406	0.00024	0.60	0.00015	0.00079	0.00007	0.002541	0.00002	0.000725	Within	Within
Bakery	Square-footage	11	0.005907	0.00553	0.94	0.00239	0.01555	0.00007	0.00726	0.00029	0.010525	Within	Within
Bank	Square-footage	18	0.001002	0.00094	0.94	0.00029	0.00268	0.00007	0.002541	0.0001	0.003633	Within	Within
Bar	seats	3	0.429404	0.25095	0.58	0.34280	0.71329	0.02	0.726	0.023	0.8349	Within	Within
Beauty Shop	stations	46	1.142022	0.80721	0.71	0.13960	2.36728	0.0567	2.05821	0.0567	2.058208	Within	Within
Child Care	Per child	3	0.407801	0.25975	0.64	0.35482	0.68986	0.0072	0.26136	0.0072	0.261358	Mean>Factor	Mean>Factor
Church	Square-footage	20	0.00151	0.00148	0.98	0.00043	0.00335	0.00007	0.002541	0.0001	0.003633	Within	Within
Convenience Store	Square-footage	5	0.003522	0.00179	0.51	0.00145	0.00553	0.0002	0.00726	0.00016	0.005808	Within	Within
Deli/Sandwich Shop	Square-footage	18	0.007378	0.00374	0.51	0.00115	0.01138	0.0002	0.00726	0.00024	0.008708	Mean>Factor	Within
Dental Office	Square-footage	9	0.003261	0.00239	0.73	0.00120	0.00720	0.00007	0.002541	0.00026	0.009442	Mean>Factor	Within
Dorm	rooms	3	0.961674	0.84203	0.88	1.15024	1.93370	0.04	1.452	0.04	1.452	Within	Within
Dry Cleaners	Square-footage	8	0.00908	0.00518	0.57	0.00283	0.01754	0.0002	0.00726	0.00038	0.013792	Mean>Factor	Within
Fish Market	Square-footage	8	0.001894	0.00162	0.86	0.00089	0.00491	0.00007	0.002541	0.0009	0.032667	Within	Within
Gas Station	pumps	10	1.389792	1.34078	0.96	0.62008	3.32982	0.0913	3.31419	0.0913	3.314192	Within	Within
Grocery - Super Market	Square-footage	14	0.004194	0.00388	0.93	0.00142	0.00830	0.0002	0.00726	0.00016	0.005808	Within	Within
Grocery-Family	Square-footage	2	0.001331	0.00119	0.90	0.00288	0.00218	0.00007	0.002541	0.00009	0.003267	Within	Within
Gym	Square-footage	13	0.000999	0.00051	0.51	0.00020	0.00183	0.00007	0.002541	0.00008	0.0029	Within	Within
Hotel - Bed & Breakfast	rooms	24	2.853508	1.99698	0.70	0.51218	5.70222	0.1	3.63	0.1123	4.076492	Within	Within
Hotel - Luxury	rooms	12	1.589179	1.06189	0.67	0.43095	2.84733	0.03	1.089	0.2046	7.426983	Mean>Factor	Within
Hotel - Standard	rooms	21	2.063956	1.13469	0.55	0.31673	3.60329	0.1	3.63	0.0844	3.063717	Within	Within
Laundromat	machines	21	5.551946	3.09706	0.56	0.86448	9.84490	0.2	7.26	0.2	7.26	Within	Within
Medical	Square-footage	58	0.001326	0.00142	1.07	0.00022	0.00310	0.00007	0.002541	0.00015	0.005442	Within	Within
Meeting Hall	Square-footage	13	0.00408	0.00527	1.29	0.00202	0.01309	0.00053	0.019239	0.00053	0.019242	Within	Within
Motel	rooms	13	2.145916	1.13733	0.53	0.43650	3.78043	0.1	3.63	0.0993	3.604592	Within	Within
Nursing/Convalescent Home	rooms	21	2.126036	1.31366	0.62	0.36668	3.56718	0.12	4.356	0.23	8.349	Within	Within
Nursery - Plant	Square-footage	5	0.000436	0.00032	0.74	0.00026	0.00094	0.00009	0.003267	0.00009	0.003267	Within	Within
Open space - drought/drip	acres	82	84.33094	195.81160	2.32	24.3082	151.0185	MAWA	0.00007	0.9	32.67	Mean>Factor	Within
Office - general	Square - footage	228	0.001209	0.00141	1.17	0.00010	0.00324	0.00007	0.002541	0.0001	0.003633	Within	Within
Open space - non-turf	acres	159	53.42863	94.10464	1.76	8.10582	120.14150	MAWA	0.002541	1.8	65.34	Within	Within

Open space - turf	acres	72	68.39855	107.77060	1.58	14.3976	120.04340	MAWA	2.1	76.23	Within
Pizza - take out/delivery	Square-footage	3	0.005564	0.00414	0.74	0.00566	0.00900	0.00007	0.00014	0.005083	Mean>Factor
Swimming Pool	Surface area	2	0.031767	0.02844	0.90	0.06865	0.05187	0.0002	0.00022	0.007983	Mean>Factor
Public restroom	Per toilet	27	2.12713	1.83200	0.86	0.43659	5.30274	0.02	0.02	0.726	Mean>Factor
<b>Retail - general</b>	Square-footage	223	0.001081	0.00114	1.05	0.00008	0.00236	0.058	0.064	2.3232	Within
Restaurant - 24-hour	seats	1	1.132583		0.00		1.13258	0.00007	0.00004	0.00145	Mean>Factor
Restaurant - with bar	seats	26	0.552288	0.37333	0.68	0.09108	0.99369	0.038	0.0412	1.495558	Within
Restaurant - fast food	seats	26	0.416086	0.32554	0.78	0.07942	0.89486	0.02	0.019	0.6897	Within
<b>Restaurant - full service</b>	seats	63	0.451079	0.28598	0.63	0.04122	0.81458	0.038	0.034	1.2342	Within
School	rooms	49	0.000987	0.00081	0.82	0.00014	0.00172	0.02	0.0173	0.627992	Within
Self Storage	Square-footage	2	4.55E-05	0.00006	1.41	0.00015	0.00009	0.0008	0.00001	0.000367	Within
Spa	fixtures	4	1.623646	1.29675	0.80	1.29675	3.12500	0.05	0.05	1.815	Within
Theater	seats	1	0.013868		0.00		0.01387	0.0012	0.0012	0.043538	Within
Veterinary	Square-footage	7	0.003256	0.00215	0.66	0.00131	0.00630	0.00007	0.00023	0.00835	Mean>Factor
Wine tasting room	Square-footage	2	0.000285	0.00004	0.16	0.00011	0.00032	0.0002	0.00021	0.007625	Within
<b>Warehouse</b>	Square-footage	65	0.00075	0.00117	1.56	0.00017	0.00207	0.00007	0.00005	0.001817	Within

## Findings and Recommendations

### **Data**

1. **Customer Data**—The number of measurement units per customer account does not exist for about 38 percent of the active non-residential accounts (1,744 [=1616CONV+128NOALL] out of 4,613 unique active non-residential accounts in the provided factor data.)
2. **Integrated Data needed for Integrated Planning**—MPMWD does not currently have a method for matching its data to California American consumption data. Good Water Use Efficiency Programs are built on an understanding of individual customer water demand. Integrated planning requires integrated data.

### **Non-Residential Water Use Factors**

1. **MPMWD Water Use Factors**—Demand Load. Current MPMWD planning uses three groups of water use for assignment of future capacity requirements. These assignments are generous for some business types and potentially insufficient for others. The analysis of historical consumption suggests where each may be the case. The use of these Water Use Factors for water rationing is subject to the same caveats for their use in a water rate structure, as enumerated next.
2. **Cal-Am Water Use Factors**—Implement-ability as a Water Budget in a Tiered Rate. It is difficult to see how a non-residential rate structure can be implemented on the existing definitions of Nonresidential Water Use Factors:
  - a. The number of measurement units is missing for almost 38 percent of the active non-residential accounts.
  - b. The reliability of existing measurement units is unknown.
  - c. The use of a single measure to standardize constitutes an extremely crude form of a water budget. This estimated water budget can be expected to be an inaccurate definition of efficient water use for most customers.
  - d. The combination of inaccurate water budget and steep rate tiers will magnify the economic impact of erroneous definitions of water budgets. Customers will rightfully perceive the situation as illogical, unfair, and economically unjust.

It is my professional opinion that the existing definitions of Non-Residential Water Use Factors are not appropriate for use in a rate structure. The heterogeneous nature of

commercial, industrial, and institutional water use is well known and precludes simple characterization through use of a single cross-sectional variable. I recommend that any block definition for use in a steep rate structure have a defensible and understandable basis as a water budget.

3. **Implementation Plan for Improving the Definition of Allocation Factors.** Improving the data used in the definition of Water Use Factors is critical. Implementing data improvements should proceed sequentially:
  - a. Cross checking the number of measurement units of the 66 accounts in Attachment A whose mean use was more than three times the allotment.
  - b. Measuring the number of measurement units for business missing this information is an important first step. This would include the accounts for whom this information is missing (business type codes "CONV" and "NOALL", approximately 38 percent of active unique accounts).
  - c. Cross checking the number of measurement units of the top tenth percentile by business type. Customers using more water than 90 percent of their similarly classified business are candidates for water efficiency improvements, water audits, or reclassification if misclassified.
  - d. Collecting additional information on Hotels and Restaurants would assist in better defining an accurate water budget. Draft templates for collecting this information are provided in Attachment C.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that this is crucial for ensuring the integrity of the financial statements and for providing a clear audit trail. The text notes that any discrepancies or errors in the records can lead to significant complications during an audit and may result in the disallowance of certain expenses.

2. The second part of the document outlines the specific requirements for record-keeping. It states that all receipts, invoices, and other supporting documents must be retained for a minimum of three years. Furthermore, it is required that these records be organized in a systematic and accessible manner, such as by date or by category, to facilitate the audit process. The document also mentions that digital records are acceptable, provided they are secure and can be easily accessed and verified.

3. The third part of the document addresses the issue of documentation for travel expenses. It specifies that travel costs must be supported by receipts for transportation, lodging, and meals. Additionally, it requires that a log be maintained detailing the purpose of the travel, the dates, and the individuals involved. This documentation is essential for proving that the travel is a necessary business expense and not a personal one.

4. The final part of the document provides guidance on the handling of miscellaneous expenses. It advises that these expenses should be tracked and documented just as rigorously as the other categories. The text suggests that a separate log or ledger be used to record these smaller, more frequent transactions, with supporting receipts being kept for each entry. This ensures that no expense is overlooked and that all claims are properly substantiated.