

TECHNICAL MEMORANDUM

TO: Keri Martinez, Carlsbad Municipal Water District

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DATE: September 8, 2025

RE: Seasonal Population Variance Analysis Technical Memorandum

The "Making Conservation a California Way of Life" regulation, as a result of 2018's Assembly Bill 1668 / Senate Bill 606, introduces an Annual Water Use Report that is due to the California Department of Water Resources (DWR) by January 1 every year. This report requires information on an urban water supplier's actual water use for the prior reporting year, their calculated urban water use objective (UWUO), and any variances that may modify (increase) their UWUO. Final rules established by the State Water Resources Control Board (SWRCB) requires that agencies requesting variances submit "information quantifying and substantiating each request" to the SWRCB by October 1.

In preparation of the next report due January 1, 2026, Carlsbad Municipal Water District (CMWD) hired Woodard & Curran to quantify a volume for the Significant Fluctuations in Seasonal Populations variance, which will be referred to in this Technical Memorandum (TM) as "Seasonal Population Variance". Woodard & Curran followed the methodology established by the DWR and required by the SWRCB in the final regulations, titled *Methods for Estimating Seasonal Populations with Water and Energy Data* (2022), published by University of California Davis Center for Water-Energy Efficiency.

This TM describes the analysis performed (Section 1) and the results (Section 2). The variance volume for CMWD is approximately 46 MG which meets the minimum requirements to be considered for a variance (must be at least 1% of the residential indoor portion of the UWUO without variances).

1. ANALYSIS

1.1 DATA

This analysis was conducted with two datasets: (1) Advanced Metering Infrastructure (AMI) hourly water consumption and (2) water billing customer classification, as described below.

(1) AMI Hourly Water Consumption Data:

- Prepared by CMWD Information Technology (IT) staff
- Consists of hourly water consumption data from May 1, 2023 to May 31, 2025.

- The data export comes from a differential database (e.g. consumption has been pre-calculated from raw meter readings and screened to remove the impacts of some typical AMI data errors) provided by CMWD's AMI vendor, Itron
- The data export was generated for property categories of Single-Family, Single with Fire¹, Multiple, and Duplex as shown in Table 1

Table 1: AMI Premises Category

Category	Count
Single-Family	22,488
Single With Fire ¹	1,611
Multiple	903
Duplex	491
Sum	25,493

- Relevant data fields:
 - ChannelID: Unique ID assigned by CMWD's Information Technology staff when compiling the AMI consumption dataset; used as a primary key (unique identifier) for analysis.
 - Account_no: Unique ID assigned to each property; a lookup was provided to relate each ChannelID to an Account_no for purpose of address analysis described further below.
 - ReadingDateTime: Date/time of hourly observations
 - ReadingValue: Quantity of water used within the hour in units of hundred cubic feet (CCF)

Water Billing Customer Classification:

- Prepared by Woodard & Curran based on information from the NorthStar customer billing database:
 - Account_no: (described above)
 - Service Address: physical location to which water is delivered. Service Address was already split into separate fields for Street Number and Street Name and noted to be generally very consistently formatted (e.g. street suffix for "Boulevard" was consistently abbreviated to "BL").
 - Billing Address: mailing address to which the bill is delivered and/or the account is registered. The street number and street name for Billing Address are stored in one combined field and were noted to have less standardization in street suffixes than Service Address. Due to the nature of mailing addresses (as opposed to property/service

¹ Assumed to be single-family residences with combined fire protection service

addresses), there is also more variation in formatting,, e.g. with various unit numbers and other suffixes.

- The steps below describe the overall process used to classify each account:
 - Total accounts: 25,493
 - Compared Service and Premise addresses for each account
 - Woodard & Curran decomposed Billing Address into separate fields for street number and street name, and attempted to standardize the street suffix (e.g. Replace "DRIVE" with the more commonly used "DR" in the Service Addresses).
 - Further, PO Boxes were flagged if the following phrases were present in the Billing Address: "PO B", "P O B", "P.O. B", "BOX", "PSC", or "PMB").
 - Using the criteria in Table 2: Water Billing Customer Classification Criteria, classified each account:
 - Permanent Homeowner: 23,582
 - Potential Rental Property: 1,911

Table 2: Water Billing Customer Classification Criteria

Billing address matches premise address?	Is PO box?	Zip Code of billing address	Count of Billing Address use across all premises	Then Classify As
Yes	No	Not evaluated	Not evaluated	Permanent Homeowner
No	Yes	Matches zip code of premise	Not evaluated	Permanent Homeowner
No	Yes	Does not match zip code of premise	Not evaluated	Potential Rental Property
No	No	Not evaluated	>1	Potential Rental Property
No	No	Not evaluated	1	Permanent Homeowner

1.2 METHODOLOGY

The number of seasonally occupied units were estimated using guidelines in the UC Davis publication: *Methods for Estimating Seasonal Populations with Water and Energy Data* (2022). A script was developed using open-source R software to support a repeatable analysis process. The analysis steps are described in bullets below, with accompanying explanatory text:

Preparing the AMI data:

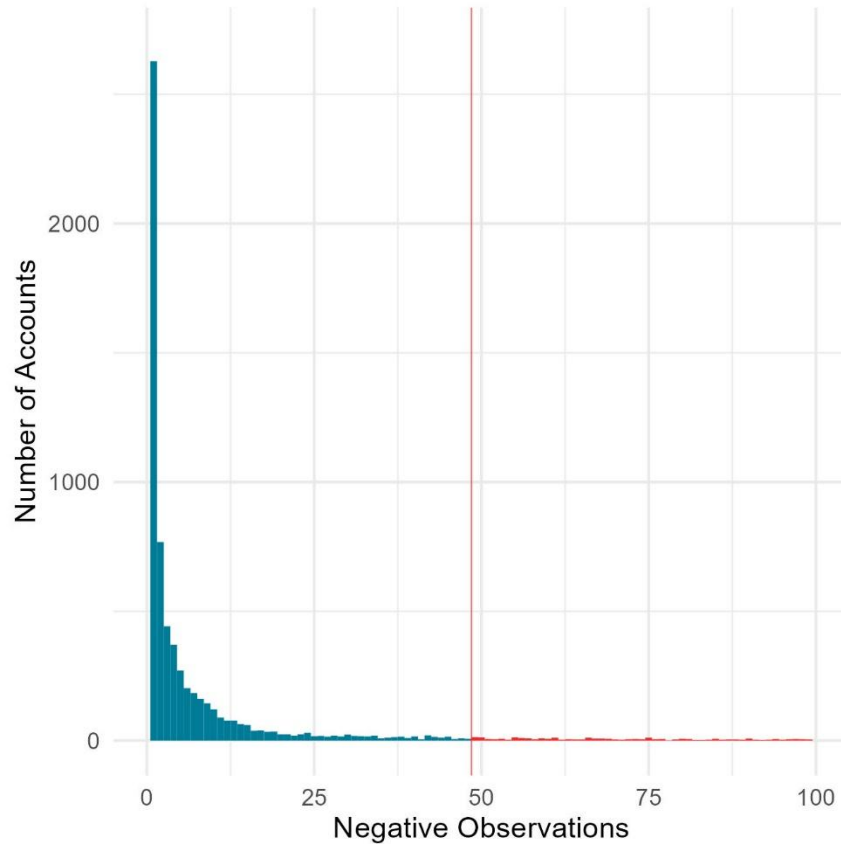
- Iterate over each month of AMI data and combine into a complete timeseries for all accounts.
 - a. Expected: 465,604,152 hourly observations (25,493 accounts * 761 days * 24 hrs/day), actual: 399,784,656 hourly observations.
 - i. 14% less observations than expected. This is due to new accounts, discontinued accounts, and meter downtime.
- Convert CCF values to Cubic Feet (CF), by multiplying "ReadingValue" by 100.

Handling negative numbers:

Although the AMI dataset was prescreened, some negative values were still observed and assumed to be recorded in error. Highly frequent and consistent negative values are assumed to indicate an improperly installed meter. Less frequent negative values are expected in AMI data due to more minor AMI equipment or data transmission issues. During the analysis period, 2,628 meters recorded only one negative value each (see Figure 1). Meters which had up to 48 total hours negative (not necessarily consecutive) were reset to 0 CF so the account could remain in the analysis. Meters with greater than 48 negative observations were removed from the analysis on the assumption that there could be an issue with the meter. As shown in Figure 1, all accounts to the right of the red line were removed from the analysis. In total, 6,259 accounts were corrected (i.e., negative readings reset to 0), and 1,090 accounts were removed. The UC Davis methodology does not provide guidance on handling of negative consumption.

- Count observations where "ReadingValue" is negative.
- For accounts with up to 48 total negative hourly observations, replace negative values with 0 CF. Filter out accounts with greater than 48 negative observations.

Figure 1: Summary of Negative ReadingValue Observations



Preparing the timeseries:

As mentioned in data preparation, there were 14% less observations than expected. To correct this, missing observations were added so later calculation steps could proceed smoothly.

- Generate a sequence with the first and last "ReadingDateTime" for each account. Complete the timeseries by filling all missing expected observations with zeros. Hours that were filled with a zero due to missing data were flagged with a separate "missing data" indicator that was taken into consideration in the later steps of calculating occupancy.
- Add a Day column of year-dates to make distinct 'days' for May 2023 to May 2025.
- From "ReadingDateTime", calculate a Weekend column to indicate which dates are Saturdays or Sundays (e.g. distinguishing workdays and weekdays for later summary calculations).

Detect irrigation:

Irrigation is identified by looking for repeating values of usage on a weekly basis. This was done using a rolling-window calculation over "ReadingValue", comparing hourly values from exactly one week previous

and one week ahead of the current value. This is assumed to capture scheduled irrigation controlled by an automatic irrigation system that wouldn't necessarily be influenced by household occupancy.

- Flag rows where both criteria are met:
 - Usage is greater than 6 CF (threshold suggested by UC Davis; note that the guide suggests further refinements are appropriate in areas of low-water-use irrigation).
 - Current "ReadingValue" is within $\pm 10\%$ of the value in the same hour for one week prior and one week ahead.
- ReadingValues that were not flagged as Irrigation were passed to a new column: "ReadingValueIrrAdj" ("irrigation adjusted consumption"). In other words, any hour flagged as irrigation was assumed to be entirely dedicated to irrigation.

Detect "leak-only" days:

"Leak-only" days are identified by constant hourly water usage of small quantities across discrete days. Each day is evaluated and flagged as a "leak-only" day if every hour has consumption between 0.03 CF and 1 CF (UC Davis, 2022). If a day is flagged as a "leak-only" day, then it is excluded from the later occupancy calculations. This is meant to screen out the potential impact of leaks in unoccupied homes being counted as occupied.

- Flag each hourly observation where the following is true:
 - $0.03 \text{ CF} < \text{"ReadingValue"} < 1 \text{ CF}$
- Aggregate the dataset from hourly to daily timesteps. Calculate the sum of "ReadingValueIrrAdj".
- Count the number of hours meeting the leak threshold per day. If the count is 24, then the day is flagged as a "leak-only" day.

Calculate Daily Occupancy:

Occupancy is recorded on a daily timestep where water usage, excluding irrigation, is greater than 1 CF, and the day is not a "leak-only" day.

- Flag a day as "occupied" where total "ReadingValueIrrAdj" $\geq 1 \text{ CF}$ AND "Leak-only day" = False.

Calculate average occupancy:

Average occupancy rates for each site are calculated using the daily "Occupancy" field. To be consistent with UC Davis's publication, this value is calculated separately for overall, weekend, and weekday occupancies. Federal Holidays are ignored from the datasets for purpose of calculating the averages (Table 5 in Appendix A). Finally, any day that was flagged with 24 values of "missing data" is excluded from the denominator (e.g. in one year period, a site that had 180 days flagged as occupied and 20 days flagged as "missing data" would have an overall occupancy of $180/(365-20) = 52\%$).

- Calculate "overall_occupancy" by taking the average of all "Occupancy" days.
- Calculate "average_weekend_occupancy" by taking the average of all days flagged as a Saturday or Sunday.
- Calculate "average_weekday_occupancy" by taking the average of all days that are not flagged as a weekend.

Join with water billing customer classification:

The processed AMI data was joined with the water billing customer classification dataset by Account_no. The classification was either "Permanent Homeowner" or "Potential Rental Property" (see explanation in Table 2).

- Join the water billing customer classification dataset with the AMI data by "Account_no".

Perform final classification:

For each account, a "FinalClassification" was assigned based on the criteria in Table 3. Accounts that did not meet any of the first three criteria were determined to be seasonally occupied.

Table 3: AMI Final Classification

Water Billing Customer Classification	Overall Occupancy	Weekend vs Workday Occupancy	Final Classification
Permanent Homeowner	>50%	$[\text{Workday}] \geq ([\text{Weekend}] - 2.25\%)$	Permanent Homeowner
Potential Rental Property	>75%	$[\text{Workday}] \geq ([\text{Weekend}] - 2.25\%)$	Permanent Renter
(Either)	<1%	Not evaluated	Vacant
Remaining accounts -->			Seasonally Occupied

The "Weekend versus Workday Occupancy" criterion varies from UC Davis's original protocol of "[Workday] \geq [Weekend]". Instead, this analysis includes workday values that were up to 2.25% lower than weekend occupancy. Before implementing the change, seasonal occupancy was much higher, accounting for more than 36% of all residential accounts. Per UC Davis guidelines, this adjustment helped to calibrate the classification to better fit the most recently available 2023 American Community Survey 5-Year estimates for number of units for "seasonal, recreational, or occupational use" which was $1,866 \pm 396$ for the City of Carlsbad (U.S. Census Bureau, Table B25004).

2. RESULTS

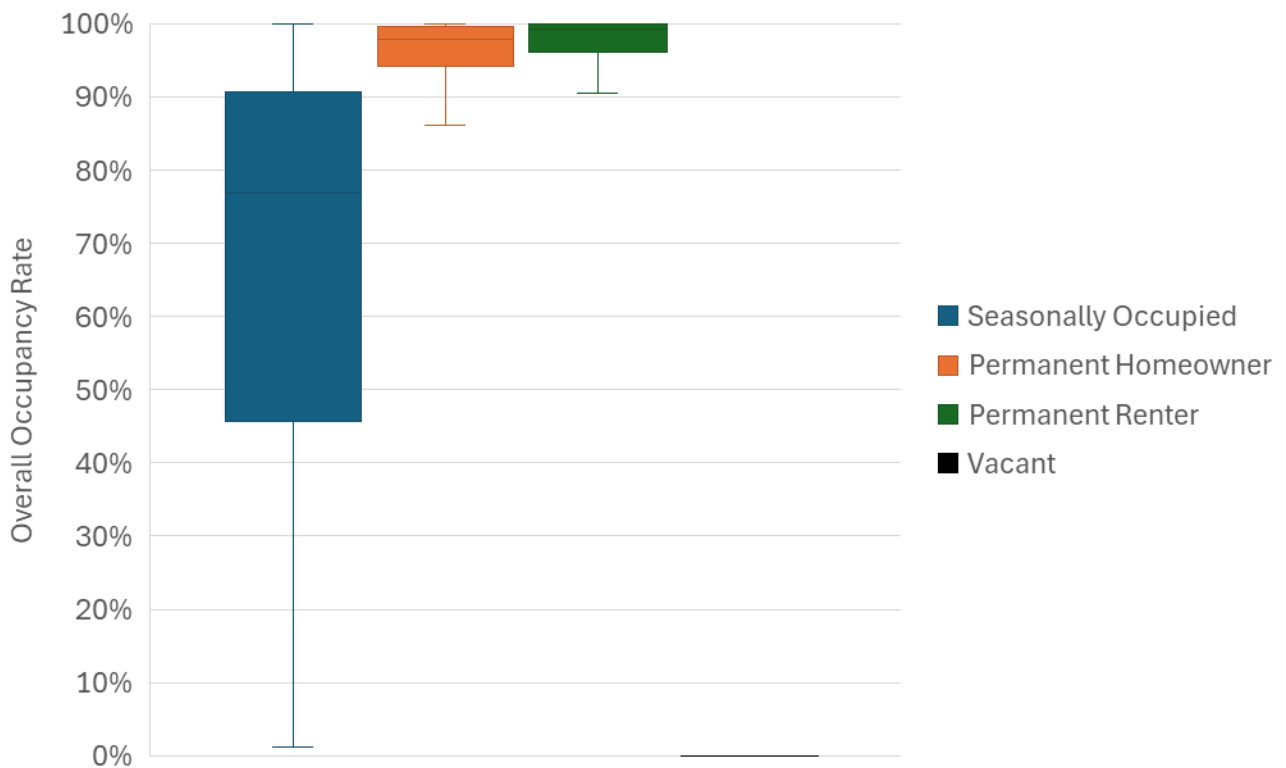
2.1 OCCUPANCY

Table 4 shows the final classification results. Figure 2 uses a set of box plots to demonstrate the distribution of occupancy across the different final classifications.

Table 4: Results of Final Classification

Final Classification	Count	Percent of Total
Permanent Homeowner	20,633	85%
Permanent Renter	1,495	6%
Seasonally Occupied	2,215	9%
Vacant	60	0.2%
Grand Total	24,403	100%

Figure 2: Average Overall Occupancy by Classification



2.2 SEASONAL POPULATION VARIANCE

The Seasonal Population Variance (volume) is calculated following the methods and formulas provided in the SWRCB's final regulation. First, the Occupancy Rate for seasonally occupied units must be calculated (see Equation 1 and accompanying calculated values from the analysis). Separate equations are defined depending on whether or not AMI data is being used; only the AMI version is presented below.

Equation 1: Occupancy Rate if Using AMI Data

$$R_o = \frac{W_{SO} * P}{W_{PO}} * \frac{S_{days}}{N_{DU}}^1$$

Where:

R_o = Occupancy Rate

W_{SO} = Water use by seasonal homes

P = Residential Service Area Population

W_{PO} = Water use by permanent homes

S_{days} = Average days of seasonal occupation

N_{DU} = Number of dwelling units associated with seasonal occupancy¹

76,550,792	Water Use for Seasonally Occupied Homes (gal) ^{2,3}
95,158	Population of Permanent Residents (Safe Drinking Water Information System (SDWIS) for FY 24-25)
1,981,299,250	Water Use for All Units with Permanent Residents (gal) ⁴
245	Average Number of Days per year with Occupancy (Seasonally Occupied Units)
2,215	Number of Identified Units with Seasonal Population
406.67	Occupancy Rate (person-days/household)

¹ Per 9/5/2025 email from SWRCB, "There was an error in the formula with the unit conversion on this method of the seasonal pop variance." In an updated version 1.2 of their variance request Excel workbook, SWRCB added the additional step of dividing by number of seasonal units in order to correct the unit conversion mistake in the regulation.

² Note that one outlier of very high water use more than 50 times larger than any other site was excluded from this sum; this was noted to be a multi-family complex with numerous dwelling units

³ The sum of water use by seasonally occupied homes was divided by 2.1 years to adjust for the May 2023 – May 2025 time period used in the analysis which results in an average annual value

⁴ The sum of water use by permanent residents was divided by 2.1 years to adjust for the May 2023 – May 2025 time period used in the analysis which results in an average annual value

Second, the Occupancy Rate is multiplied by the Number of Identified Units with Seasonal Population and the Indoor Residential Water Use Standard (which is 55 gallons per capita per day [gpcd] through 1/1/2025 and 47 gpcd from 1/1/2025 through 1/1/2030, thus a mid-point of 51 gpcd was used for the purposes of this calculation) to calculate the Variance Efficient Water Use Volume (see Equation 2 and accompanying calculated values from the analysis).

Equation 2: Variance Efficient Water Use Volume

$$V_{SP} = N_{DU} * R_o * S_{indoor}$$

Where:

V_{SP} = Variance for water use associated with seasonal populations

N_{DU} = Number of dwelling units associated with seasonal occupancy

R_o = Occupancy Rate

S_{indoor} = Residential indoor use standard for the given time period

2,215	Number of Identified Units with Seasonal Population
406.67	Occupancy Rate (person-days per year)
51	Indoor Residential Water Use Standard (gpcd)
45,938,962	Variance Efficient Water Use Volume (gallons)

Per DWR and SWRCB guidance, when using hourly water consumption (the “Detailed Method”) to calculate the variance, the Variance Efficient Water Use Volume must be equal to or greater than 1% of the volume of the indoor residential UWUO (without any variances included). The indoor UWUO (without variances) is 95,158 people (SDWIS FY 24-25) multiplied by 55 gpcd for half of the year and 47 gpcd for half of the year, or an average of 51 gpcd, which results in 1,771,366,170 gallons. The Variance Efficient Water Use Volume is 2.6% of the UWUO (without variances) and thus meets the 1% threshold for consideration.

APPENDIX – A

Table 5: List of Holidays Excluded from Analysis Calculations

Holiday	Calendar Date
Memorial Day	5/29/2023
Juneteenth	6/19/2023
Independence Day	7/4/2023
Labor Day	9/4/2023
Columbus Day	10/9/2023
Veterans Day	11/11/2023
Thanksgiving Day	11/23/2023
Christmas Day	12/25/2023
New Year's Day	1/1/2024
Martin Luther King Jr. Day	1/15/2024
Presidents' Day	2/19/2024
Memorial Day	5/27/2024
Juneteenth	6/19/2024
Independence Day	7/4/2024
Labor Day	9/2/2024
Columbus Day	10/14/2024
Veterans Day	11/11/2024
Thanksgiving Day	11/28/2024
Christmas Day	12/25/2024
New Year's Day	1/1/2025
Martin Luther King Jr. Day	1/20/2025
Presidents' Day	2/17/2025
Memorial Day	5/26/2025