TECHNICAL MEMORANDUM

Date:	March 27, 2014	**Project No.:**	013-1500-035
To:	Jacque Klug	**Company:**	Washington State Department of Ecology
From:	Carl Einberger, LHg., Chris Pitre, LHg, David Banton, LHg		
cc:	Margo Gillaspy Skagit County Public Works		
RE:	**SKAGIT COUNTY EXEMPT WELL METERING PROGRAM – 2012-2013**		

1.0 INTRODUCTION

This Technical Memorandum presents the results of voluntary exempt well metering conducted in the Skagit Basin. The data collection and analysis discussed in this memorandum was conducted by Golder Associates, Inc. (Golder) under contract to the Washington State Department of Ecology (Ecology) for 2013. Previous work for the 2012 study was conducted under contract to the Skagit County Public Works Department (County), and was jointly funded by the County, Ecology, and the City of Anacortes. The County also conducted several activities in support of this study, as detailed in this memorandum. In addition, the Skagit County Public Utility District (Skagit PUD) provided support with equipment for retrieving the on-site data downloads from the meters.

The primary objectives of the metering study were to:

- Identify a network of volunteer exempt well users for installation of meters and collect monitoring data on water use over the period of two years.
- Create and populate a database for managing information collected from the metering program.
- Statistically analyze attributes of metered properties in comparison to other parcels in the Fisher-Carpenter and Upper Nookachamps (also referred to as the Main Stem Nookachamps sub-basins.
- Estimate indoor versus (vs.) outdoor use, where feasible based on the metering records.
- Evaluate use of the metering data to support future water management decisions affecting the Carpenter-Fisher and Upper Nookachamps sub-basins.

1.1 Background

In 2001, Ecology established an instream flow rule (WAC 173-503) for the Skagit River to maintain minimum instream flows to protect salmon and other natural resources. The instream flow rule was amended in 2006 to establish reservations of groundwater by sub-basins for specific out-of-stream uses not subject to instream flows, including agricultural irrigation; domestic, municipal, commercial, and industrial use; and stock watering.

Golder Associates Inc.
18300 NE Union Hill Road, Suite 200
Redmond, WA 98052 USA
Tel: (425) 883-0777 Fax: (425) 882-5498 www.golder.com

The Carpenter-Fisher sub-basin of the lower Skagit River basin was closed to further withdrawals in June 2011, because residential growth and associated new exempt wells exceeded the limits of the reservation amount. The Upper Nookachamps sub-basin was also close to reaching the limitations on new exempt wells associated with the reservation. This study targeted these two sub-basins for the metering program given their reservation status.

On October 3, 2013, the Washington Supreme Court overturned the 2006 Skagit Instream Rule Amendments following a legal challenge regarding the amended rule's validity brought by the Swinomish Tribe. Through an agreement between Ecology and the Swinomish Tribe, use of exempt wells already approved through the amended rule and the now invalid groundwater reservations will not become interruptible. As part of the agreement, Ecology has agreed to develop mitigation alternatives for these exempt wells. Although the measurements of exempt well use obtained through this study are no longer relevant for the now defunct water reservations, the metering data can potentially be used to support determination of necessary mitigation requirements for exempt wells, as discussed in Section 6 of this report.

1.2 Volunteer Metering Network

In fall 2010, the County conducted a survey in the Carpenter-Fisher and Upper Nookachamps sub-basins to select volunteer candidates for a well metering study. This work was conducted with support from Golder in developing the survey and Ecology in implementing the survey. As part of the solicitation for metering volunteers, the County agreed to maintain the confidentiality of volunteers. Eighteen volunteers participated in this study.

In 2011, Badger Recordall M-25 meters were installed by a private contractor (Wolfe Mechanical) on 18 exempt wells interspersed within the sub-basins. The meters were set to measure hourly use data throughout the study. The volunteer residences range from mobile homes to large multi-family households, with lot sizes ranging from 0.25 acre to more than 5.5 acres. Of the total 77 acres monitored, 39.5 acres are described as "cleared" and the remaining 37.5 are described as "wooded/brush". In keeping with the County's confidentiality agreement with volunteers, no specific mention of parcel numbers for the volunteers is used in this memorandum, and the individual homes are referred to as Properties 1 through 18.

Metering data for all of 2012 and 2013 are presented in this memorandum. The data collected by the meters were downloaded through onsite visits conducted on a periodic basis by Golder. The Skagit PUD provided data retrieval instrumentation (Radix handheld computer) for Golder's use during the study. The Skagit PUD also conducted bi-monthly remote measurements of the meters during the study.

2.0 METERING DATA MANAGEMENT

An Access database was prepared by Golder to allow compiled data to be queried and analyzed. In addition to hourly data on water use obtained from the meters, data on metered and non-metered parcel characteristics within the Carpenter-Fisher and Upper Nookachamps sub-basins were incorporated into the database from the County's Geographic Information System (GIS) parcel database.

County personnel prepared a filtered subset of the County's parcel database limiting the data to parcels with the following attributes for incorporation into the metering study database:

- Parcels within the Carpenter-Fisher and Upper Nookachamps sub-basins; and
- Parcels outside of the City of Mount Vernon and Skagit County Sewer District No. 2. These parcels are assumed to be on septic systems.

The metering study database allows sorting based on various attributes of the parcels available from the County's GIS database, including several key parameters that may influence water use:

- Land Use
- Building Value
- Land Area
- Improved Land Value
- Unimproved Land Value
- Living Area
- Number of Full Baths
- Number of Master Baths
- Number of Half Baths
- Number of Bedrooms
- Basin (Carpenter-Fisher or Upper Nookachamps)
- Undeveloped Area

Metering results and analysis supported by use of the metering study database are presented in the following sections of this memorandum.

3.0 METERING RESULTS

Metering results from the 18 monitored properties have been evaluated for the following for 2012, 2013, and the combined data from the 2012-2013 period:

- Average annual daily use
- Average annual indoor daily use (estimated)
- Average annual outdoor daily use (estimated)
- Weekly average of daily use

- Weekly average of daily use during the peak period of outdoor use

Comparisons have also been made between 2012 and 2013 period to identify properties with significant difference in use between the two years.

A graphical summary of the mean monthly average of daily groundwater use for all properties combined is presented in Figure 1 for the 2012-2013 period. Additional summaries of the mean weekly average of daily groundwater use for all properties combined (Figure 2) and mean daily groundwater use for all metered properties combined (Figure 3) have also been developed from the metering data. Figures A-1 through A-18 (Appendix A) present the monthly average of daily groundwater use for all metered properties. Figures B-1 through B-18 (Appendix B) show the weekly average of daily groundwater use for all metered properties. Figures C-1 through C-18 (Appendix C) present the daily groundwater use for the properties.

3.1 2012 Metering Results

Table 1 presents a summary of 2012 metering data for the 18 monitored properties. Average annual daily use was calculated directly from the metering data, and ranged from 56 to 456 gallons per day (gal/day), with an average for all of the properties of 175 gal/day (Table 1).

Average indoor use was determined by averaging water use for the year, excluding observed peaks in water use during the period from May through October, assumed to be the typical period of significant outdoor water use. Some exceptions outside of this period have been noted, particularly around holiday periods, but these were considered indoor use peaks. In some cases, these peaks may be associated with water use for outdoor projects such as pressure washing, but given the uncertainty in use these are not included with outdoor use.

Average annual outdoor use was then determined by subtracting the average annual indoor use from the average annual total use, if a pattern of outdoor use was observed. For seven of the properties in 2012, it did not appear that there was significant outdoor use, and it was not possible to determine indoor vs. outdoor use. It also was not possible to distinguish indoor vs. outdoor use at Property 4, due to seasonal occupancy, although the high water use at this property suggests that irrigation was occurring.

The estimated average annual indoor daily use ranged from 36 to 268 gal/day, with an average of 135 gal/day (Table 1) for the 17 properties where it was estimated. Average annual outdoor daily use ranged from 4 to 117 gal/day with an average of 39 gal/day for the 10 properties where it was estimated. This does not account for likely outdoor use at Property 4.

The highest peak water use based on weekly averages use occurred at Property 4, where 3,015 gal/day of average use were observed during the week ending September 8 (Table 1). The lowest peak use was observed at Property 15, where 217 gal/day of average use were measured during the week ending

August 18. Peak use at several properties occurred well outside of the irrigation season; For example, at Property 1, a peak weekly use of 375 gal/day of average use was observed during the week ending January 21, and at Property 18 a peak use of 1,111 gal/day of average use was observed during the week ending November 17.

Figures 1 through 3 illustrate the increase in water use during the outdoor watering season. The maximum mean weekly average of daily groundwater use for all properties combined is 467 gal/day on August 18 (Figure 2), and the maximum mean daily average for all properties is 745 gal/day, also on August 18 (Figure 3).

3.2 2013 Metering Results

Table 1 presents a summary of 2013 metering data for the 18 monitored properties. Average annual daily use was calculated directly from the metering data, and ranged from 80 to 989 gal/day, with an average for all of the properties of 199 gal/day (Table 1).

Similar to the 2012 analysis, average indoor use was determined by averaging water use for the year excluding observed peaks in water use during the period from May through October, assumed to be the typical range of significant outdoor water use. For seven of the properties in 2013, it did not appear that there was significant outdoor use, and it was not possible to determine indoor vs. outdoor use. This was consistent with the findings in 2012. It also was not possible to distinguish indoor vs. outdoor use at Property 4, due to seasonal occupancy, although as in 2012 the high water use at this property suggests that irrigation was occurring. Although indoor vs. outdoor use was distinguished at Property 2 in 2012, this was not possible in 2013 due to a period of missing metering data that overlapped with the irrigation season.

The estimated average annual indoor daily use in 2013 ranged from 80 to 311 gal/day, with an average of 126 gal/day (Table 1) for the 17 properties where it was estimated. Average annual outdoor daily use ranged from seven to 138 gal/day with an average of 73 gal/day for the 9 properties where it was estimated.

Peak daily water use (based on weekly averages) for 2013 at each property is also noted in Table 1. The highest peak water use based on weekly averages occurred at Property 4, where 7,578 gal/day of average use were observed during the week ending August 24. The lowest peak use was observed at Property 8, where 127 gal/day of average use were measured during the week ending January 19th.

As for 2012, Figures 1 through 3 illustrate the increase in water use during the outdoor watering season. The maximum mean weekly average of daily groundwater use for all properties combined in 2013 is 666 gal/day on August 24 (Figure 2), and the maximum mean daily average for all properties is 1,152 gal/day, on August 18 (Figure 3).

3.3 Combined 2012 to 2013 Metering Results

Table 1 presents a summary of combined 2012-2013 metering data for the 18 monitored properties. Average annual daily use was calculated directly from the metering data, and ranged from 68 to 723 gal/day, with an average for all of the properties of 188 gal/day (Table 1).

The combined 2012-2013 data average indoor use was determined by averaging water use for the year excluding observed peaks in water use during the period from May through October, combining the indoor quantities discussed above for the individual years 2012-2013. As previously noted some exceptional peaks outside of this period have been noted, particularly around holiday periods, but these were considered indoor use peaks. For seven of the properties, it did not appear that there was significant outdoor use, and it was not possible to determine indoor vs. outdoor use. Again, it was not possible to distinguish indoor vs. outdoor use at Property 4, due to seasonal occupancy, although the high water use at this property suggests that irrigation was occurring.

The estimated average annual indoor daily use ranged from 41 to 289 gal/day, with an average of 131 gal/day for the 17 properties where it was estimated (Table 1). Average annual outdoor daily use ranged from 6 to 112 gal/day with an average of 56 gal/day for the 10 properties were it was estimated.

3.4 Individual Property Summaries

A summary of key responses to the volunteer survey conducted prior to metering and metering observations for each property follows. Plots of water use for each property are presented in Appendices A, B, and C of daily water used based on monthly, weekly and daily averages, respectively. Metering observations are for the combined years of 2012 and 2013.

Property No. 1

- Survey Responses:
  - Permanent residence, 1 occupant
  - Conservation fixtures in place
  - No lawn watering
- Metering observations:
  - Annual average daily use = 68 gal/day
  - Indoor vs. outdoor use was not delineated
  - Peak daily use based on a weekly average = 353 gal/day (week ending January 19, 2013)
  - Maximum daily use = 1,237 gal/day (October 18, 2013)

Property No. 2

- Survey responses:
  - Permanent residence, 2 occupants

- Metering observations:
  - A gap in metering data due to meter failure occurred between January 21 and November 22, 2013
  - Annual average daily use = 281 gal/day
  - Average annual indoor daily use (estimated) = 229 gal/day
  - Average annual outdoor daily use (estimated) = 104 gal/day
  - Peak daily use based on a weekly average = 1,163 gal/day (week ending August 25, 2012)
  - Maximum daily use = 1,335 gal/day (August 8, 2012)

Property No. 3

- Survey Responses:
  - Permanent residence, 2 occupants
  - Lawn/garden watering
  - Stock watering
  - Rain Barrels (200 gallon tank)
- Metering observations:
  - Annual average daily use = 105 gal/day
  - Average annual indoor daily use (estimated) = 76 gal/day
  - Average annual outdoor daily use (estimated) = 29 gal/day
  - Peak daily use based on a weekly average = 465 gal/day (week ending March 12, 2012)
  - Maximum daily use = 1,086 gal/day (March 28, 2012)

Property No. 4

- Survey Responses:
  - Permanent residence, 3 occupants
  - Lawn/garden watering
  - Also use a spring with associated water right for lawn and garden watering
- Metering observations:
  - Annual average daily use = 723 gal/day
  - Indoor vs. outdoor use was not delineated
  - Peak daily use based on a weekly average = 7,578 gal/day (week ending August 24, 2013)
  - Maximum daily use = 12,661 gal/day (August 19, 2013)

Property No. 5

- Survey Responses:
  - Permanent residence, 3 occupants
  - Conservation fixtures in place

- Lawn/garden watering (garden irrigation system)
- Rain Barrels

- Metering observations:
  - Annual average daily use = 184 gal/day
  - Average annual indoor daily use (estimated) = 113 gal/day
  - Average annual outdoor daily use (estimated) = 71 gal/day
  - Peak daily use based on a weekly average = 887 gal/day (week ending July 13, 2013)
  - Maximum daily use = 2,116 gal/day (August 15, 2012)

Property No. 6

- Survey Responses:
  - No survey information available
- Metering observations:
  - Annual average daily use = 118 gal/day
  - Indoor vs. outdoor use was not delineated
  - Peak daily use based on a weekly average = 602 gal/day (week ending March 23, 2013)
  - Maximum daily use = 3,160 gal/day (March 10, 2013)

Property No. 7

- Survey Responses:
  - Permanent residence, 4 occupants
  - Conservation fixtures in place
  - Lawn watering
- Metering observations:
  - Annual average daily use = 164 gal/day
  - Indoor vs. outdoor use was not delineated
  - Peak daily use based on a weekly average = 351 gal/day (week ending August 3, 2013)
  - Maximum daily use = 968 gal/day (July 30, 2013)

Property No. 8

- Survey Responses:
  - Permanent residence, 2 occupants
  - Conservation fixtures in place
  - Lawn watering
  - Rain Barrels
- Metering observations:
  - Annual average daily use = 121 gal/day

- Indoor vs. outdoor use was not delineated
- Peak daily use based on a weekly average = 244 gal/day (week ending January 28, 2012)
- Maximum daily use = 337 gal/day (January 22, 2012)

Property No. 9

- Survey Responses:
  - Permanent residence, 3 occupants
  - Conservation fixtures in place
  - Lawn watering
- Metering observations:
  - Annual average daily use = 138 gal/day
  - Indoor vs. outdoor use was not delineated
  - Peak daily use based on a weekly average = 257 gal/day (week ending June 16, 2012)
  - Maximum daily use = 367 gal/day (June 28, 2013)

Property No. 10

- Survey Responses:
  - Permanent residence, 2 occupants
  - Conservation fixtures in place
  - Lawn watering
  - Stock watering
- Metering observations:
  - Annual average daily use = 177 gal/day
  - Indoor vs. outdoor use was not delineated
  - Peak daily use based on a weekly average = 277 gal/day (week ending August 11, 2012)
  - Maximum daily use = 735 gal/day (June 19, 2013)

Property No. 11

- Survey Responses:
  - Permanent residence, 2 occupants
  - Conservation fixtures in place
  - Lawn watering (irrigation system)
  - Stock watering
- Metering observations:
  - Annual average daily use = 166 gal/day
  - Average annual indoor daily use (estimated) = 54 gal/day
  - Average annual outdoor daily use (estimated) = 112 gal/day

- Peak daily use based on a weekly average = 652 gal/day (week ending August 11, 2012)
- Maximum daily use = 1,622 gal/day (May 26, 2013)

Property No. 12

- Survey Responses:
  - Permanent residence, 2 occupants
  - Lawn watering
- Metering observations:
  - Annual average daily use = 181 gal/day
  - Indoor vs. outdoor use was not delineated
  - Peak daily use based on a weekly average = 292 gal/day (week ending July 14, 2012)
  - Maximum daily use = 562 gal/day (October 19, 2012)

Property No. 13

- Survey Responses:
  - No survey information available
- Metering observations:
  - Annual average daily use = 102 gal/day
  - Average annual indoor daily use (estimated) = 52 gal/day
  - Average annual outdoor daily use (estimated) = 50 gal/day
  - Peak daily use based on a weekly average = 438 gal/day (week ending August 18, 2012)
  - Maximum daily use = 872 gal/day (August 12, 2012)

Property No. 14

- Survey Responses:
  - Seasonal residence (8 months), 2 occupants
  - Conservation fixtures in place
  - Lawn watering
  - Rain Barrels
- Metering observations:
  - Annual average daily use = 149 gal/day
  - Average annual indoor daily use (estimated) = 41 gal/day
  - Average annual outdoor daily use (estimated) = 108 gal/day
  - Peak daily use based on a weekly average = 571 gal/day (week ending September 8, 2012)
  - Maximum daily use = 1,899 gal/day (June 11, 2013)

Property No. 15

- Survey Responses:
  - Permanent residence, 1 occupant
  - Conservation fixtures in place
  - No lawn watering
  - Limited garden watering (flower baskets)
- Metering observations:
  - Annual average daily use = 82 gal/day
  - Average annual indoor daily use (estimated) = 72 gal/day
  - Average annual outdoor daily use (estimated) = 10 gal/day
  - Peak daily use based on a weekly average = 217 gal/day (week ending August 18, 2012)
  - Maximum daily use = 566 gal/day (August 17, 2012)

Property No. 16

- Survey Responses:
  - Permanent residence, 2 occupants
  - Lawn watering
- Metering observations:
  - Annual average daily use = 164 gal/day
  - Average annual indoor daily use (estimated) = 130 gal/day
  - Average annual outdoor daily use (estimated) = 34 gal/day
  - Peak daily use based on a weekly average = 413 gal/day (week ending July 28, 2012)
  - Maximum daily use = 1,046 gal/day (July 26, 2012)

Property No. 17

- Survey Responses:
  - Permanent residence, 2 occupants
  - Conservation fixtures in place
  - Lawn watering
  - Rain barrels
- Metering observations:
  - Annual average daily use = 108 gal/day
  - Average annual indoor daily use (estimated) = 101 gal/day
  - Average annual outdoor daily use (estimated) = 6 gal/day
  - Peak daily use based on a weekly average = 434 gal/day (week ending July 27, 2013)
  - Maximum daily use = 1,006 gal/day (July 25, 2013)

Property No. 18

- Survey Responses:
  - Permanent residence, 2 occupants
  - Lawn watering
- Metering observations:
  - Annual average daily use = 329 gal/day
  - Average annual indoor daily use (estimated) = 289 gal/day
  - Average annual outdoor daily use (estimated) = 40 gal/day
  - Peak daily use based on a weekly average = 1,111 gal/day (week ending November 17, 2012)
  - Maximum daily use = 2,689 gal/day (December 7, 2013)

4.0 PRECIPITATION DATA

Figure 4 is a plot of the cumulative precipitation for May through October (the expected range of significant outdoor water use) from 1994 through 2013 (1996 data was unavailable) in the Skagit River basin. The precipitation data were obtained from the Washington State University (WSU) Agriculture Weather Network program (AgWeatherNet). The weather station is located in Skagit County near Mt. Vernon, Washington.

In the 2012 irrigation season, the WSU Mt. Vernon station received average precipitation relative to the period of record until late June, when a short period of higher than average rainfall occurred until early July (Figure 4). At that time a very dry period occurred, with little rainfall from early July through mid-October (one of the longest dry spells in the last 16 years). From July 24 through October 11, only 0.15 inches of rainfall were recorded. This suggests that for properties where significant outdoor water use occurred, this period should represent a relatively high level of total use compared to a typical year.

In the 2013 irrigation season, the WSU Mt. Vernon station received less than average precipitation until a brief period in mid to late June when approximately an inch of rain occurred. This was followed by an unusually dry July where no rainfall occurred, and a relatively dry period until the end of August. Throughout this period, cumulative precipitation for the year remained below normal. At the end of August, precipitation increased markedly, and by the end of September, cumulative precipitation was above average for the 1994 to 2013 period. This suggests that for properties where significant outdoor water use occurred the period through the end of August should represent a relatively high level of total use compared to a typical year.

Review of Figure 2 illustrates that daily groundwater use (based on a weekly average) for all properties shows expected increases during the irrigation season in both 2012 and 2013 that generally follow the dry and wet periods noted above. Water use associated with outdoor watering was less in July 2012 than in July 2013, which is consistent with a wetter July in 2012 vs. 2013 (Figure 4). Water use in mid to late

September was greater in 2012 than in 2013, which is consistent with the pattern of greater precipitation during this period in 2013, relative to 2012.

5.0 STATISTICAL ANALYSIS OF REPRESENTATIVENESS OF RESULTS

A statistical analysis was completed to evaluate the representativeness of the 18 metered properties relative to other parcels in the Carpenter-Fisher and Upper Nookachamps sub-basins.

There are many statistical techniques to estimate the properties of a larger population from a smaller sample drawn from that population. This implicitly requires that the smaller sample be statistically representative of the larger population. Because this study relied upon volunteers, it was necessary to determine if the volunteered parcels were representative of the water usage expected for the parcels in Carpenter-Fisher and Upper Nookachamps sub-basins that were part of the monitoring network.

There are many factors that potentially relate to water usage: the number of bathrooms, the improved and unimproved land value, the type of structure (mobile home, rural single family dwelling, etc.), the age of the dwelling, the building value, the total acreage, living area, and the number of bedrooms, among others. These variables were available for both the metered and unmetered parcels. To the extent that these factors in the metered properties are similar to the unmetered parcels, they are potentially representative of the unmetered parcel water usage.

Representativeness was quantified by measuring the similarity in several aspects of the parcels that potentially impact water usage. Parcel parameters considered included:

- Neighborhood
- Land Use
- Year Built
- Building Value
- Land Area
- Improved Land Value
- Unimproved Land Value
- Living Area
- Number of Full Baths
- Number of Master Baths
- Number of Half Baths
- Number of Bedrooms
- Basin (Carpenter-Fisher or Upper Nookachamps)
- Assigned Land Use Class
- Undeveloped Area

A K-Nearest Neighbor (KNN) cluster analysis was used to assess whether the monitored properties were representative of the residential parcels that were not part of the monitoring network. The KNN method can incorporate continuous, ordinal, and categorical data types, and thus all of the measured data could be assessed to determine the similarity between the unmonitored and monitored parcels. There were 18 monitored parcels and 1,155 unmonitored parcels within the Carpenter-Fisher and Upper Nookachamps sub-basins. The KNN procedure was carried out using SPSS, a commercial statistics software system (www.spss.com). The similarity was quantified by using a distance metric based on the Z-scores (i.e. the number of standard deviations an observation is above or below the mean) of the continuous data, and a normalization of the categorical data, such that the differences for each variable carried approximately the same weight. The locations in variable space were calculated for each metered and unmetered parcel based on these normalized variables.

Figure 5 shows the locations of the monitored and unmonitored residential parcels in terms of what was determined through the analysis to be the most important variables: building value, land use, and construction year. Monitored parcels were designated as “Focal Data” in order to make it easier to visually assess the representativeness of the monitored properties.

It is clear from visual examination of this chart that the red points (monitored parcels) are well dispersed throughout the blue points (unmonitored parcels), and red points are present in all major clusters. Figure 6 shows some additional views of the data in terms of other variables:

- Land Use
- Building Value
- Improved Land Value
- Year Built
- Land Area
- Unimproved Land Value

The red symbols either bracket or are well-dispersed throughout the blue symbols, which indicates that the characteristics of the monitored parcels are similar to or bracket the unmonitored parcels. Overall, the KNN analyses indicate that the monitored properties are representative of the unmonitored parcels, with perhaps only a few (approximately 10 to 20) exceptions within the unmonitored parcels.

As part of the KNN cluster analysis, the percentages of unmonitored parcels that were most similar to a specific monitored property were determined:

Property No.	% Similar
1	2.35%
2	3.79%
3	2.89%
4	8.76%
5	0.45%
6	6.14%
7	1.08%
8	6.41%
9	4.88%
10	11.56%
11	5.69%
12	2.80%
13	1.08%
14	4.97%
15	3.97%
16	1.36%
17	20.23%
18	11.56%

For example, 20.23% of the unmonitored parcels were most similar to Property 17. The evenness in the percent similarity in all but three parcels shows that the monitored sample is broadly representative of the unmonitored data, although Properties 10, 17, and 18 are the most similar to the unmonitored parcels. It is of note that none of these properties appear to have significant outdoor water use associated with them.

6.0 EVALUATION OF MANAGEMENT ALTERNATIVES

Limited data on specific exempt well metering data are available in Washington State. Ecology is considering several approaches for water management in the Skagit Basin, including water rights acquisition, extension of purveyor service, storage options, and mitigation using enhanced recharge.

Since the 2013 Supreme Court decision eliminated the previous reservations of water for exempt wells, it is increasingly important to understand the potential impacts of exempt wells. Key components of this include:

- Quantifying how much water is actually being used.
- Understanding indoor vs. outdoor use, as the consumptive use differs in each situation.
- Evaluating the effects on using average water use estimates for higher seasonal uses.

This metering study can potentially support determination of mitigation needs for exempt wells, evaluation of the effects on water use of any limitations on outdoor water use that may be considered, and encouraging water conservation by providing residents data on the range of water use observed.

6.1 Mitigation Needs

Based on the 2012 and 2013 data sets obtained through this study, average annual daily groundwater use for the 18 monitored properties was 187 gal/day, based on the metering data. For properties where it was possible to estimate indoor and outdoor quantities, average annual indoor use was estimated to be 131 gal/day, and average annual outdoor use was estimated to be 56 gal/day. Not all of this use is consumptive, with consumptive use varying significantly between indoor and outdoor uses. All of the properties of concern for exempt well use in this study are assumed to be on septic systems based on the review on County parcel data.

In the Dungeness Basin, Ecology typically assumes that 10% of indoor use is consumptive for properties on septic systems, and 90% of outdoor use is consumptive, with the rest of the water returning to the subsurface and the watershed via return flows (WAC 173-518-085). Based on the consumptive use estimates developed for the Dungeness Basin and the water use collected for 2012 and 2013, the average consumptive use for the Carpenter-Fisher and Upper Nookachamps sub-basins on an average annual basis is estimated to be:

- Indoor Use: 131 gal/day x 0.10 = 13.1 gal/day
- Outdoor Use: 56 gal/day x 0.90 = 50.4 gal/day
- Total Consumptive Use: 63.5 gal/day (approximately 34% of the overall average annual daily use of 187 gal/day for the 18 properties)

Seasonal consumptive use will vary from these amounts because of increases during the irrigation season.

The average annual outdoor use can be applied over the irrigation season only to get a better estimate of average consumptive use during this period. Assuming the irrigation season extends from May through the end of September (5 months), the average consumptive outdoor use distributed over this period is 125.3 gal/day. Based on this, the total irrigation season (May through September) consumptive use can be estimated as:

- Irrigation Season Indoor Use: 13.1 gal/day
- Irrigation Season Outdoor Use: 121.0 gal/day
- Total Irrigation Season Consumptive Use: 134.1 gal/day

These calculations do not include Property 4, where outdoor use was not distinguished because of seasonal occupancy. While these estimates provide a basis for estimating mitigation quantities based on actual metering results, other considerations for mitigation include:

- Lag times associated with the distance to surface waters of concern, the depth of well completions, and the specific hydrogeological conditions associated with the specific exempt well locations.
- Contingencies to allow for variations and outliers in actual water use among individual properties, such as those observed at Property 4.

6.2 Effects of Average Use Estimates of Higher Water Users

Several properties involved in this study exhibited substantially more water use than others. In particular, Property 4 had very high annual average daily water use (723 gal/day). Relatively high annual average daily water use was also observed at Properties 2 and 18 (281 and 329 gal/day respectively). In order to get an indication of overall annual water use, the average annual daily use for all other properties with these properties excluded was calculated (Table 1):

- Average annual daily water use for all properties = 187 gal/day
- Average annual daily water use excluding Property 4 = 155 gal/day (17% reduction)
- Average annual daily water use excluding Properties 2, 4, and 18 = 147 gal/day (79% reduction)

Note that for Properties 2 and 18, there is significant estimated indoor use (229 and 289 gal/day) in addition to outdoor use relative to other properties. At Property 4, where outdoor use was not able to be distinguished, it is still expected that a significant portion of water use must be for irrigation, given the large quantities used.

The data presented in this study indicate that there is a range in water use for the exempt well users that participated in this study. At 15 of the 18 properties, overall average annual water use was in a relatively small range, varying from 68 to 184 gal/day (Table 1). The three outlier properties discussed above all had average annual water use above 280 gal/day. This study can support efforts to educate the public that there is wide variability in both indoor and outdoor water use for exempt wells, and that conservation can have a positive effect on mitigation requirements and associated costs.

7.0 SUMMARY AND CONCLUSIONS

Eighteen properties with exempt wells in the Carpenter-Fisher and Upper Nookachamps sub-basins of the Skagit River watershed were monitored for groundwater use during 2012 and 2013. The properties were identified through solicitation of volunteers and equipped with flow meters. A database for managing information collected from the metering program was developed and supported the data analysis presented in this memorandum. Estimates of indoor vs. outdoor use were developed, where feasible based on the metering records. A statistical analysis of the data using KNN cluster analysis

methods was conducted to determine the representative of the monitored properties relative to unmonitored parcels. Key conclusions from the study include:

- Average annual daily use during 2012 and 2013 ranged from 68 to 723 gal/day, with an average for all of the properties of 187 gal/day.
  - Average annual daily use during 2012 ranged from 56 to 456 gal/day, with an average for all of the properties of 175 gal/day.
  - Average annual daily use during 2013 ranged from 80 to 989 gal/day, with an average for all of the properties of 199 gal/day.
- Eleven of the properties showed seasonal increases in water use that are likely associated with outdoor water use. For ten of the properties, indoor vs. outdoor use was able to be estimated. For Property 4, it was not possible to distinguish indoor vs. outdoor use, due to seasonal occupancy, although the high seasonal water use at this property clearly suggests that irrigation use was occurring.
- The estimated average annual indoor daily use for the combined years of 2012 and 2013 ranged from 41 to 289 gal/day, with an average of 131 gal/day for the 17 properties where it was estimated. Average annual outdoor daily use ranged from 6 to 112 gal/day with an average of 56 gal/day for the 10 properties were it was estimated. Assuming all of this outdoor use occurs during the five month irrigation season from May through September, then average outdoor daily use during the irrigation season ranges from approximately 14 to 268 gal/day, with an average of 134 gal/day for the 10 properties.
  - The estimated average annual indoor daily use for 2012 ranged from 36 to 268 gal/day, with an average of 135 gal/day for the 17 properties where it was estimated. Average annual outdoor daily use ranged from four to 117 gal/day with an average of 39 gal/day for the 10 properties where it was estimated.
  - The estimated average annual indoor daily use for 2013 ranged from 80 to 311 gal/day, with an average of 126 gal/day for the 17 properties where it was estimated. Average annual outdoor daily use ranged from seven to 138 gal/day with an average of 73 gal/day for the 9 properties where it was estimated.
- The highest peak water use based on weekly averages from 2012 to 2013 occurred at Property 4, where 7,578 gal/day of average use were observed during the week ending August 13, 2013. The lowest peak use was observed at Property 8, where 127 gal/day of average use were measured during the week ending January 19, 2013.
- Precipitation during the expected outdoor watering season of May through October was evaluated and compared to other years.
  - In comparison to the available record from 1994 through 2013, precipitation in the 2012 irrigation season at the WSU Mt Vernon station was average relative to the period of record until later June, when a short period of higher than average rainfall occurred until early July. From that point on, a significant dry spell occurred from early July through mid-October, suggesting that for properties where significant outdoor water use occurred this period should represent a relatively high level of total use compared to a typical year.
  - In comparison to the available record from 1994 through 2013, precipitation in the 2013 irrigation season was generally less than average until a brief period in mid to late June when approximately an inch of rain occurred. This was followed by an unusually dry July where no rainfall occurred, and a relatively dry period until the end of August. Throughout this period, cumulative precipitation for the year remained below normal. At the end of August, precipitation picked up markedly, and by the end of September, cumulative precipitation was above average for the 1994 to 2013 period. This suggests that for properties where significant outdoor water use

occurred the period through the end of August should represent a relatively high level of total use compared to a typical year.

- Daily groundwater use (based a weekly average) for all properties shows expected increases during the irrigation season in both 2012 and 2013 that generally follow the dry and wet periods noted above. For example, water use associated with outdoor watering was less in July 2012 than in July 2013, which is consistent with a wetter July in 2012 vs. 2013. Water use in mid to late September was greater in 2012 than in 2013, which is consistent with the pattern of greater precipitation during this period in 2013, relative to 2012.

- The KNN cluster analysis indicated that the monitored parcels are representative of the parcels within the Carpenter-Fisher and Upper Nookachamps sub-basins that were not part of the monitoring program.
- The percentages of unmonitored parcels that were most similar to a specific monitored property were also evaluated. The evenness in the percent similarity in all but three parcels shows that the monitored sample is broadly representative of the unmonitored data. Properties 10, 17, and 18 are the most similar to the unmonitored parcels.
- Based on the metering data obtained in this study, the estimated average consumptive use on an annual average basis is:
  - Indoor Use: 13.1 gal/day
  - Outdoor Use: 50.4 gal/day
  - Total Consumptive Use: 63.5 gal/day (approximately 34% of the overall average annual daily use of 187 gal/day for the 18 properties)
- Seasonal consumptive use will vary from these amounts because of increases during the irrigation. The total irrigation season (May through September) consumptive use was estimated as:
  - Irrigation Season Indoor Use: 13.1 gal/day
  - Irrigation Season Outdoor Use: 121.0 gal/day
  - Total Irrigation Season Consumptive Use: 134.1 gal/day
- The estimates of consumptive use can provide a basis for estimating mitigation quantities based on actual metering results, but other factors must be considered, include:
  - Lag times associated with the distance to surface waters of concern, the depth of well completions, and the specific hydrogeological conditions associated with the specific exempt well locations.
  - Contingencies to allow for variations and outliers in actual water use among individual properties, such as those observed at Property 4.
- Several properties involved in this study exhibited substantially more water use than others. Water use estimates were made with these properties excluded to illustrate the effects of unusually high water users:
  - Average annual daily water use for all properties = 187 gal/day
  - Average annual daily water use excluding Property 4 = 155 gal/day
  - Average annual daily water use excluding Properties 2, 4, and 18 = 147 gal/day.
- At 15 of the properties, overall average annual water use was in a relatively small range, varying from 68 to 184 gal/day. Three properties (Properties 2, 4, and 18) had water use above 280 gal/day.

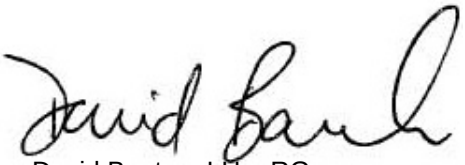
- This study can support efforts to educate the public that there is wide variability in both indoor and outdoor water use for exempt wells, and that conservation can have a positive effect on mitigation requirements and associated costs.

GOLDER ASSOCIATES INC.

Derek Holom, LHg
Project Hydrogeologist

Carl Einberger, LG, LEG, LHg
Project Environmental Scientist

Chris Pitre, LHg
Associate, Hydrogeologist



David Banton, LHg, RG
Principal, Hydrogeologist

DIH/CME/CVP/DB/ks

List of Tables

List of Figures

List of Appendices

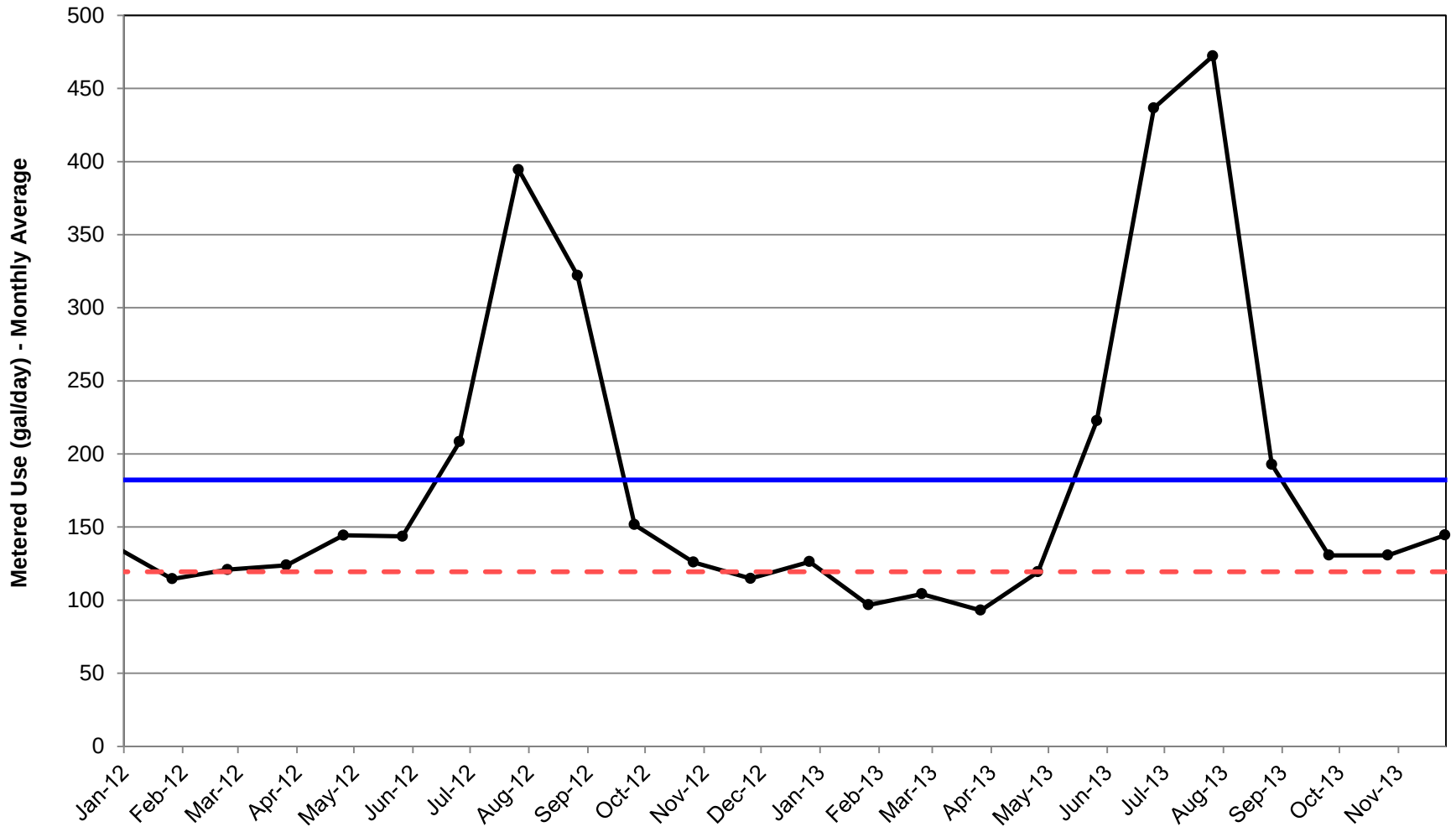
TABLE

Table 1: Summary of Exempt Well Metering Data

	Combined 2012-2013			2012			2013			Peak Daily Use (Weekly Average) 2012 vs. 2013			
Property No.	**Average Annual Daily Use (gal/day)**	**Average Annual Indoor Daily Use (estimated) (gal/day)**	**Average Annual Outdoor Daily Use (estimated) (gal/day)**	**Annual Average Daily Use (gal/day)**	**Average Annual Indoor Daily Use (estimated) (gal/day)**	**Average Annual Outdoor Daily Use (estimated) (gal/day)**	**Annual Average Daily Use (gal/day)**	**Average Annual Indoor Daily Use (estimated) (gal/day)**	**Average Annual Outdoor Daily Use (estimated) (gal/day)**	**2012 Peak Use gal/day/wk**	**Week Ending (2012)**	**2013 Peak Use gal/day/wk**	**Week Ending (2012)**
1	68	68	Not Estimated	56	56	Not Estimated	80	80	Not Estimated	375	21-Jan-12	383	19-Jan-13
2	281	229	104	328	223	104	235	235	Not Estimated	1,163	25-Aug-12	257	30-Nov-13
3	105	76	29	95	81	15	114	71	43	465	31-Mar-12	345	06-Jul-13
4	723	Not Estimated	Not Estimated	456	Not Estimated	Not Estimated	989	Not Estimated	Not Estimated	3,015	08-Sep-12	7,578	24-Aug-13
5	184	113	71	163	96	67	206	130	75	614	18-Aug-12	887	06-Jul-13
6	118	118	Not Estimated	105	105	Not Estimated	132	132	Not Estimated	549	29-Sep-12	602	23-Mar-13
7	164	164	Not Estimated	172	172	Not Estimated	157	157	Not Estimated	322	17-Mar-12	351	03-Aug-13
8	121	121	Not Estimated	147	147	Not Estimated	95	95	Not Estimated	244	28-Jan-12	127	19-Jan-13
9	138	138	Not Estimated	145	145	Not Estimated	131	131	Not Estimated	257	16-Jun-12	249	29-Jun-13
10	177	177	Not Estimated	183	183	Not Estimated	171	171	Not Estimated	277	11-Aug-12	275	22-Jun-13
11	166	54	112	194	108	86	138	0	138	652	08-Sep-12	576	08-Jun-13
12	181	181	Not Estimated	187	187	Not Estimated	174	174	Not Estimated	292	14-Jul-12	244	10-Aug-13
13	102	52	50	106	56	50	99	49	50	438	18-Aug-12	325	08-Jun-13
14	149	41	108	153	36	117	145	46	98	571	08-Sep-12	549	15-Jun-13
15	82	72	10	88	74	13	77	70	7	217	18-Aug-12	141	06-Jul-13
16	164	130	34	164	129	35	163	131	32	413	28-Jul-12	339	06-Jul-13
17	108	101	6	104	100	4	111	103	8	268	11-Aug-12	434	27-Jul-13
18	329	289	40	297	268	29	360	311	50	1,111	17-Nov-12	761	24-Aug-13
All Properties	187	131	56	175	135	39	199	126	73				
Excluding Property 4	155												
Excluding Properties 2, 4, and 18	147												

Notes:
For Property 4, indoor versus outdoor use were not estimated because water use typically did not occur outside of the irrigation season.
For Property 2, metering data were missing during the 2013 irrigation season, and indoor versus outdoor use were not estimated.

FIGURES



LEGEND

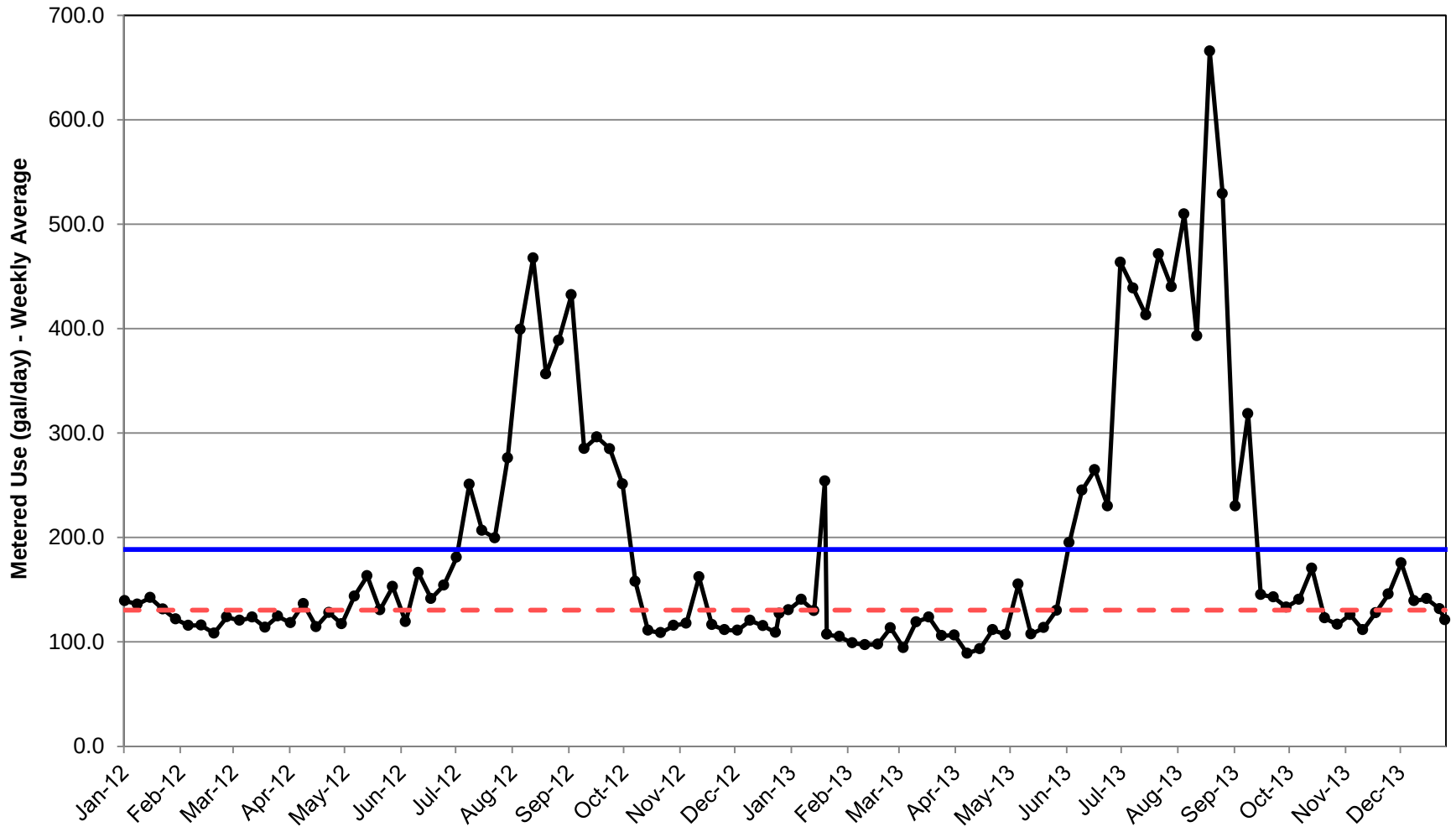
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **1**

MEAN DAILY GROUNDWATER USE (MONTHLY AVERAGE) FOR ALL METERED PROPERTIES

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

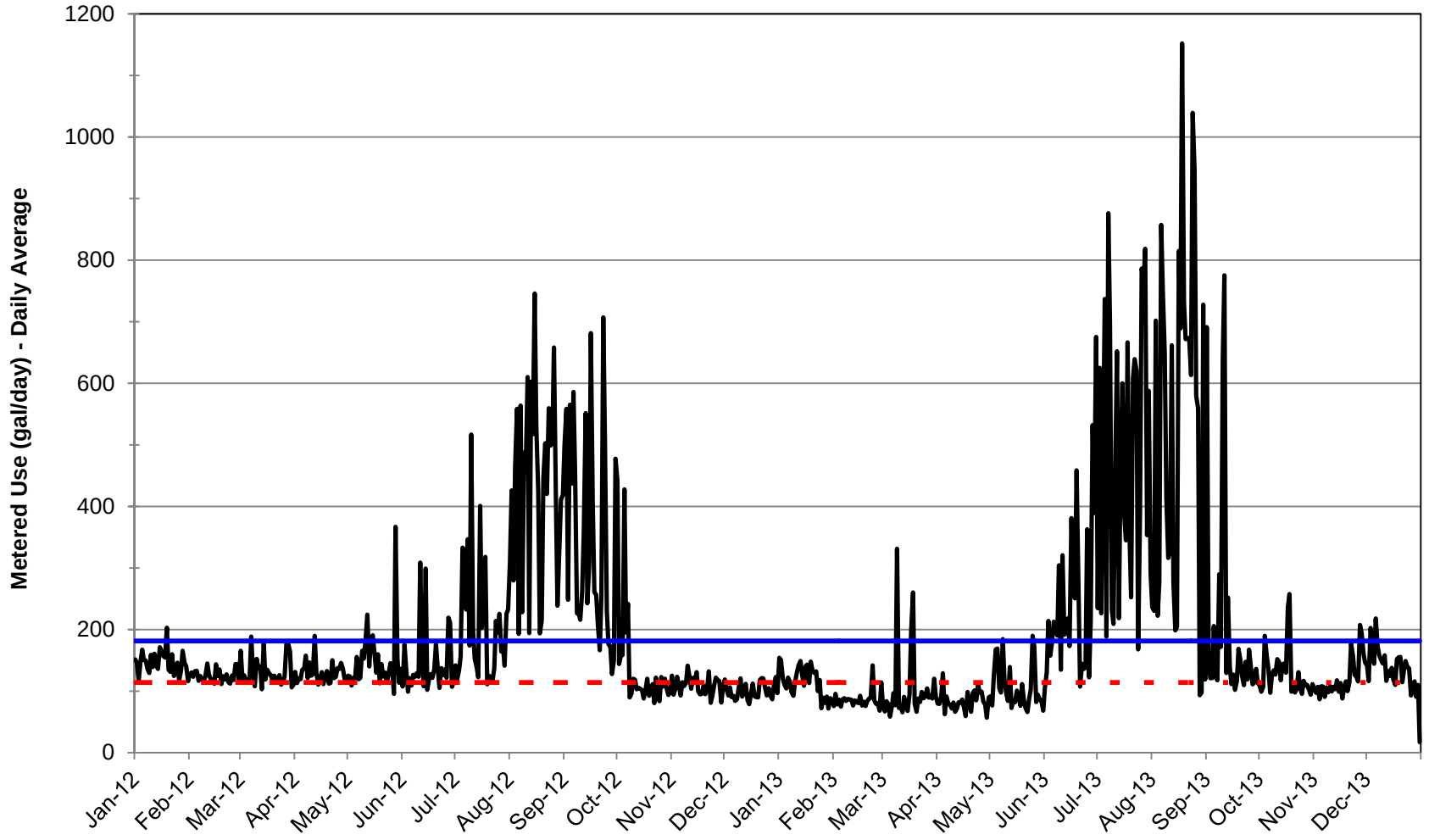
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **2**

MEAN DAILY GROUNDWATER USE (WEEKLY AVERAGE) FOR ALL METERED PROPERTIES

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

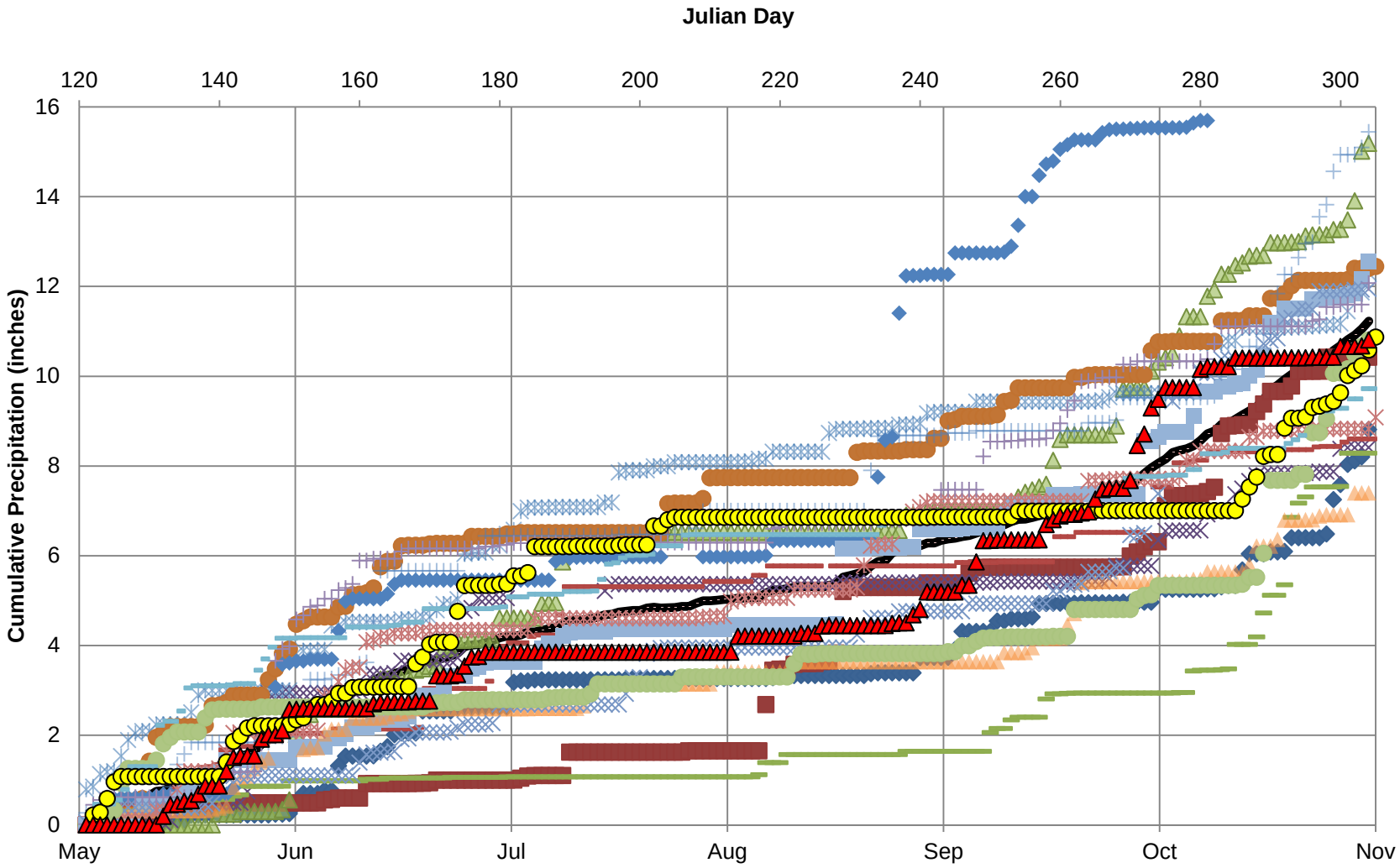
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **3**

MEAN AVERAGE DAILY GROUNDWATER USE FOR ALL METERED PROPERTIES

SC/Well Pilot Metering Program/WA

013-1500.035



Data provided courtesy of Washington State University AgWeatherNet. Data are copyright of Washington State University.

Golder Associates

LEGEND

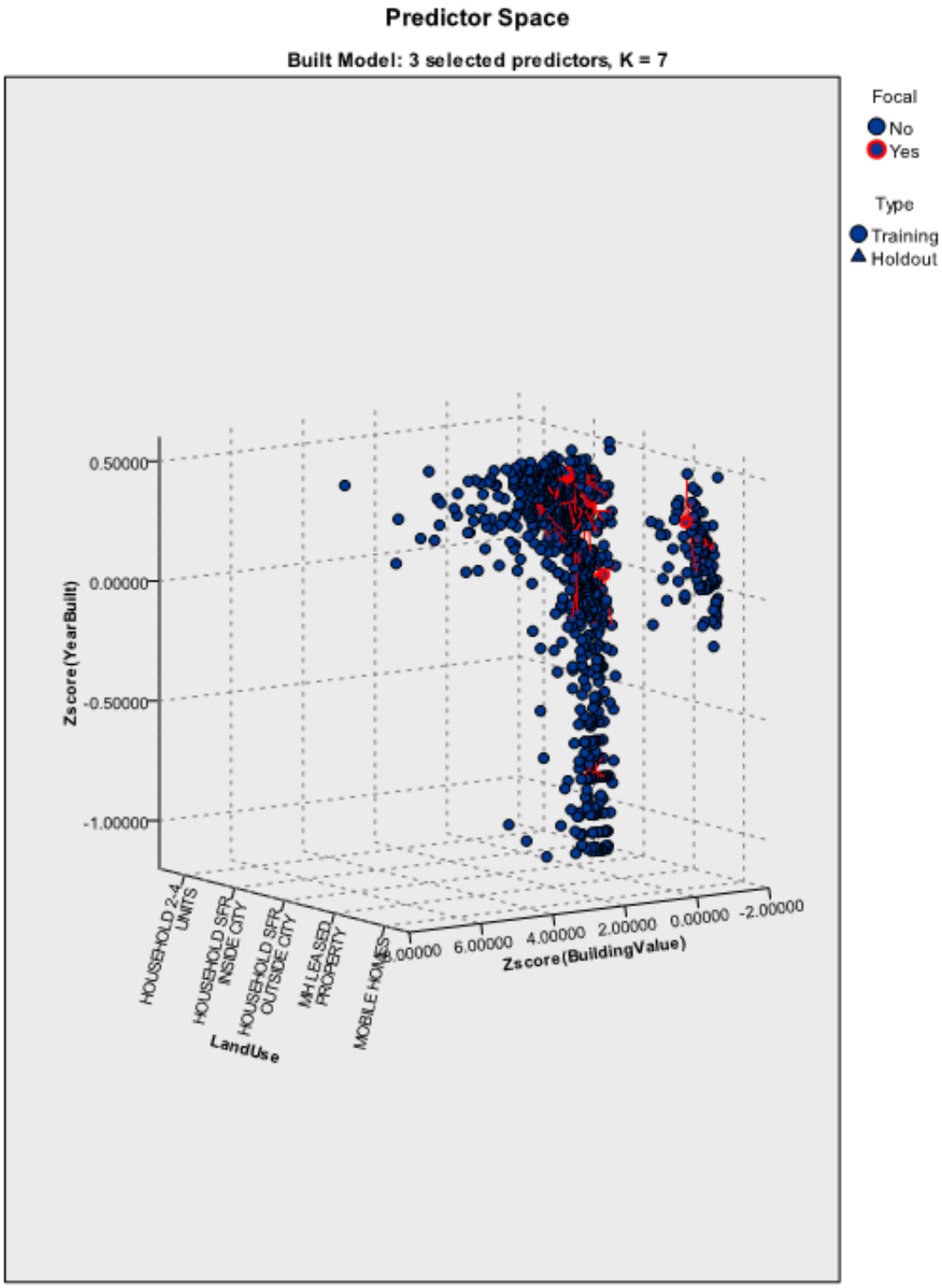
1994	1995	1997	1998
1999	2000	2001	2002
2003	2004	2005	2006
2007	2008	2009	2010
2011	2012	2013	Average

FIGURE **4**

PRECIPITATION AT WSU WEATHER STATION MT VERNON, WA

SC/Well Pilot Metering Program/WA

013-1500.035



NOTES

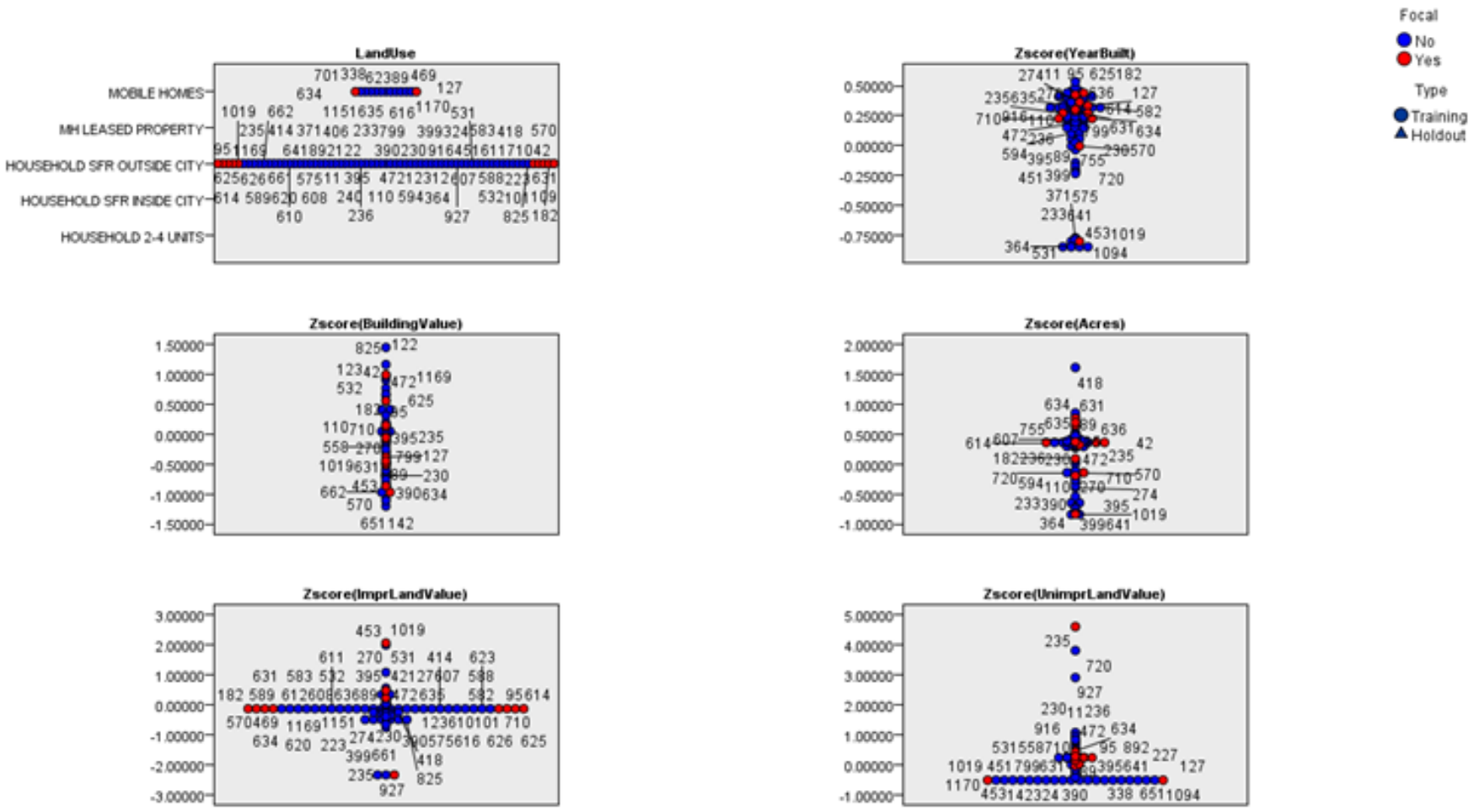
This Chart is a lower-dimensional projection of the predictor space, which contains a total of ten predictors.

Red Symbols are the monitored parcels that constitute the focal data, while the blue symbols represent unmonitored parcels.

FIGURE **5**

K-NEAREST NEIGHBOR (KNN) RESULTS

SC/WELL PILOT METERING PROGRAM/WA



NOTES

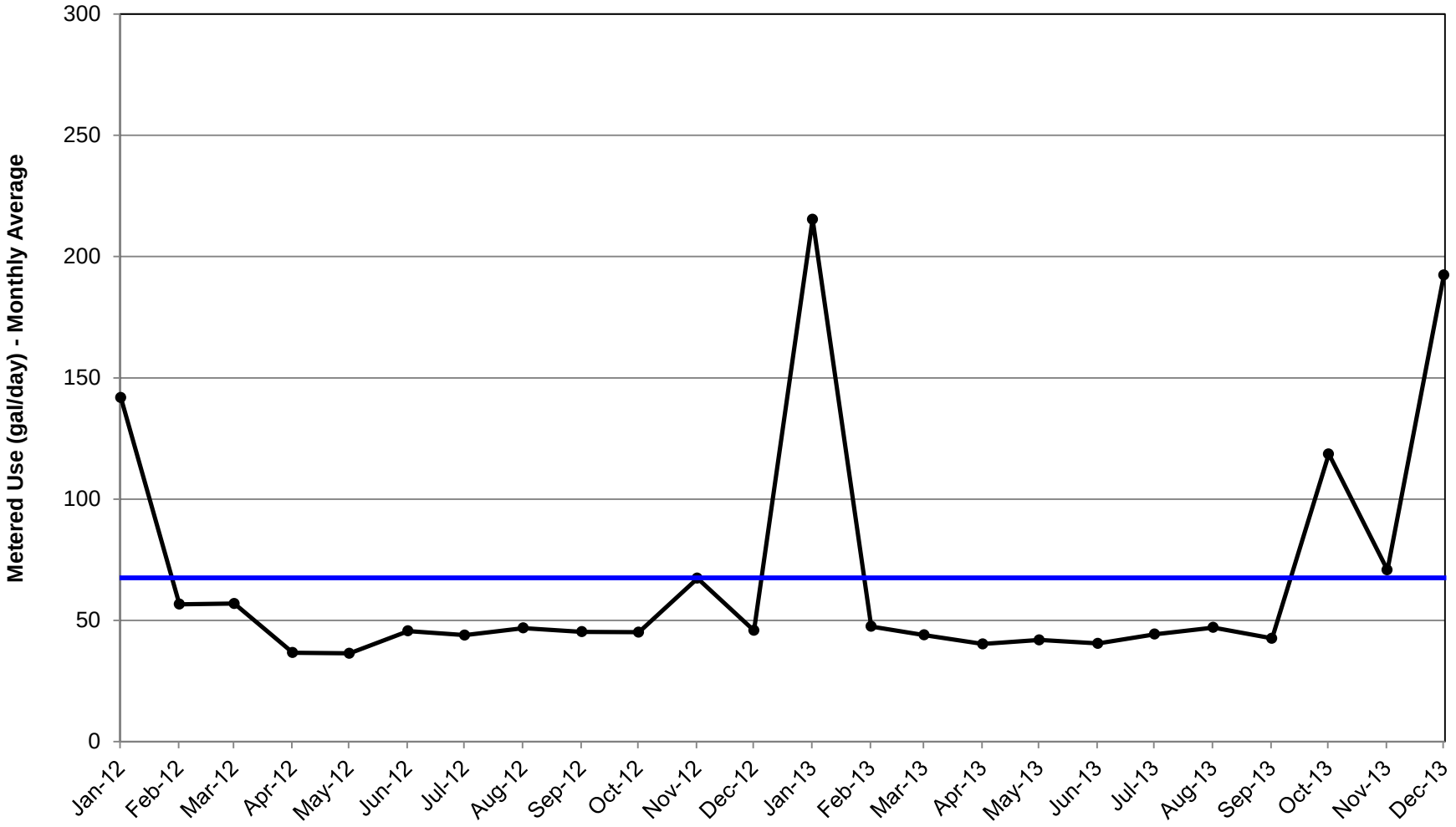
Charts depict the similarity between the monitored and unmonitored parcels in terms of other variables used in the analysis. Numbers represent internal parcel IDs.

FIGURE **6**

K-NEAREST NEIGHBOR (KNN) PEERS CHARTS

SC/WELL PILOT METERING PROGRAM/WA

APPENDIX A
MONTHLY WATER USE FIGURES



Note: Indoor vs. outdoor use not determined.

LEGEND

Total Water Use (Metered)

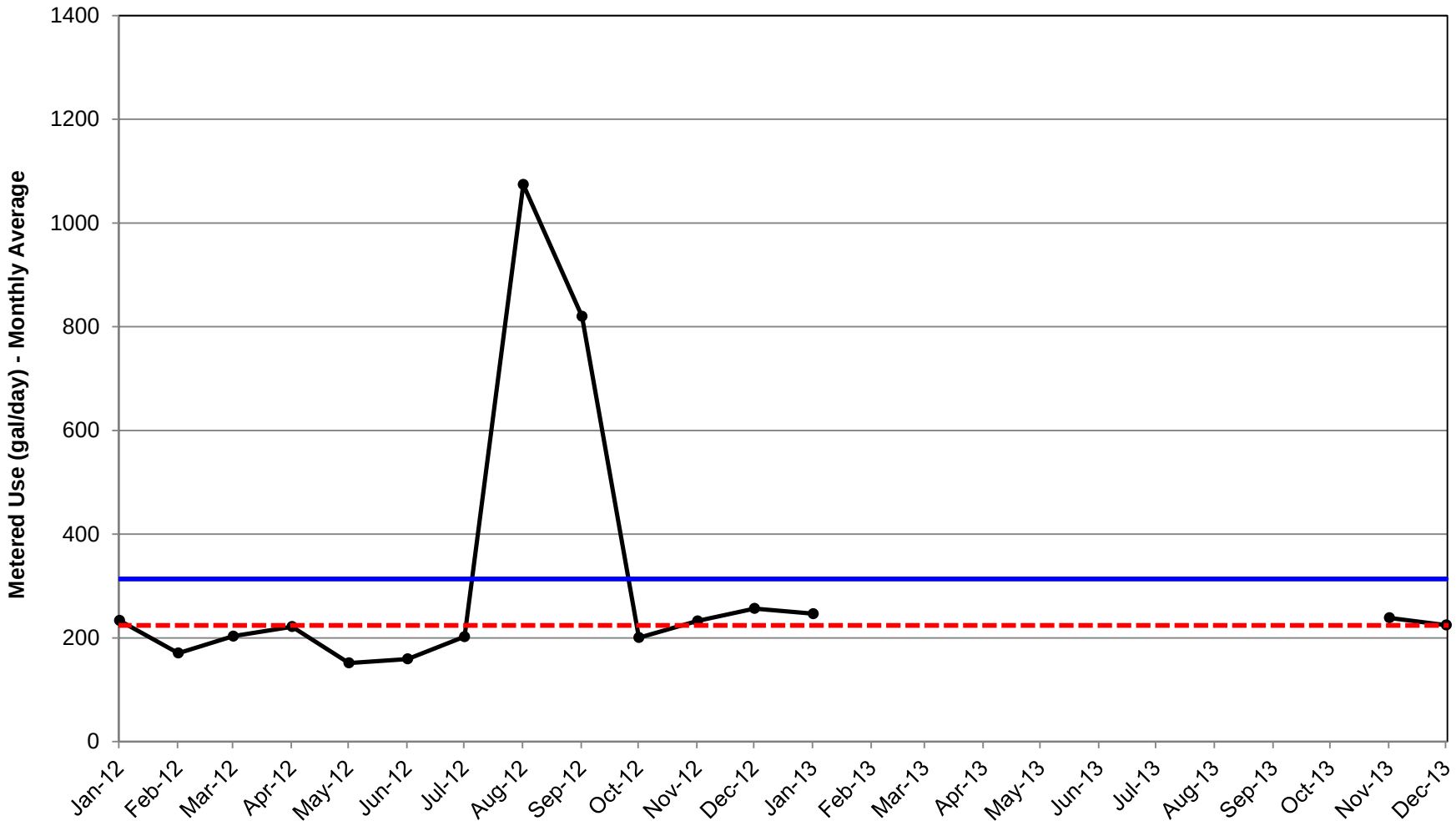
Average Annual Use

FIGURE **A-1**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 1

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Data are unavailable from January 21 to November 22, 2013 due to meter failure.

LEGEND

- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

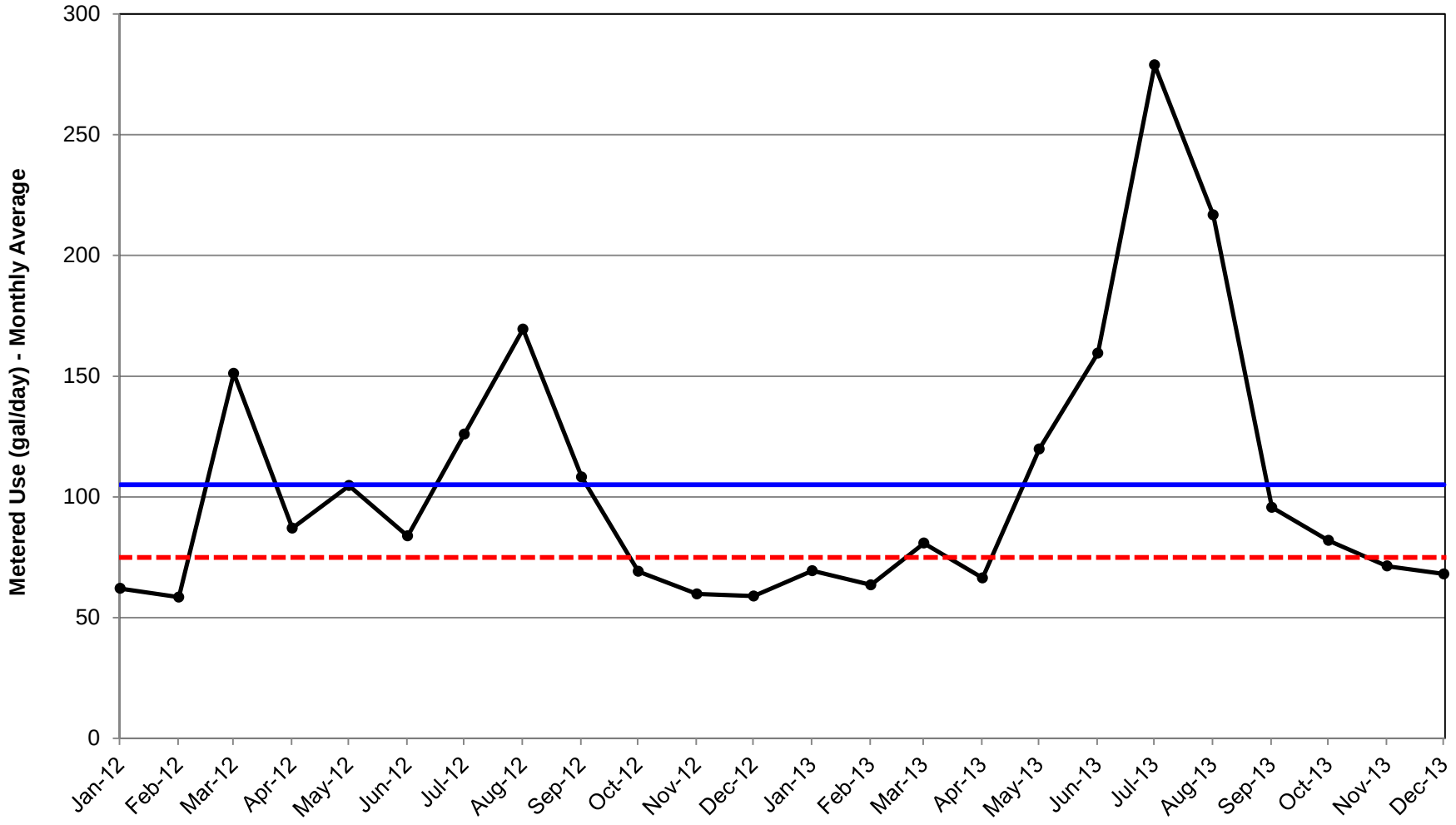
Golder Associates

FIGURE **A-2**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 2

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

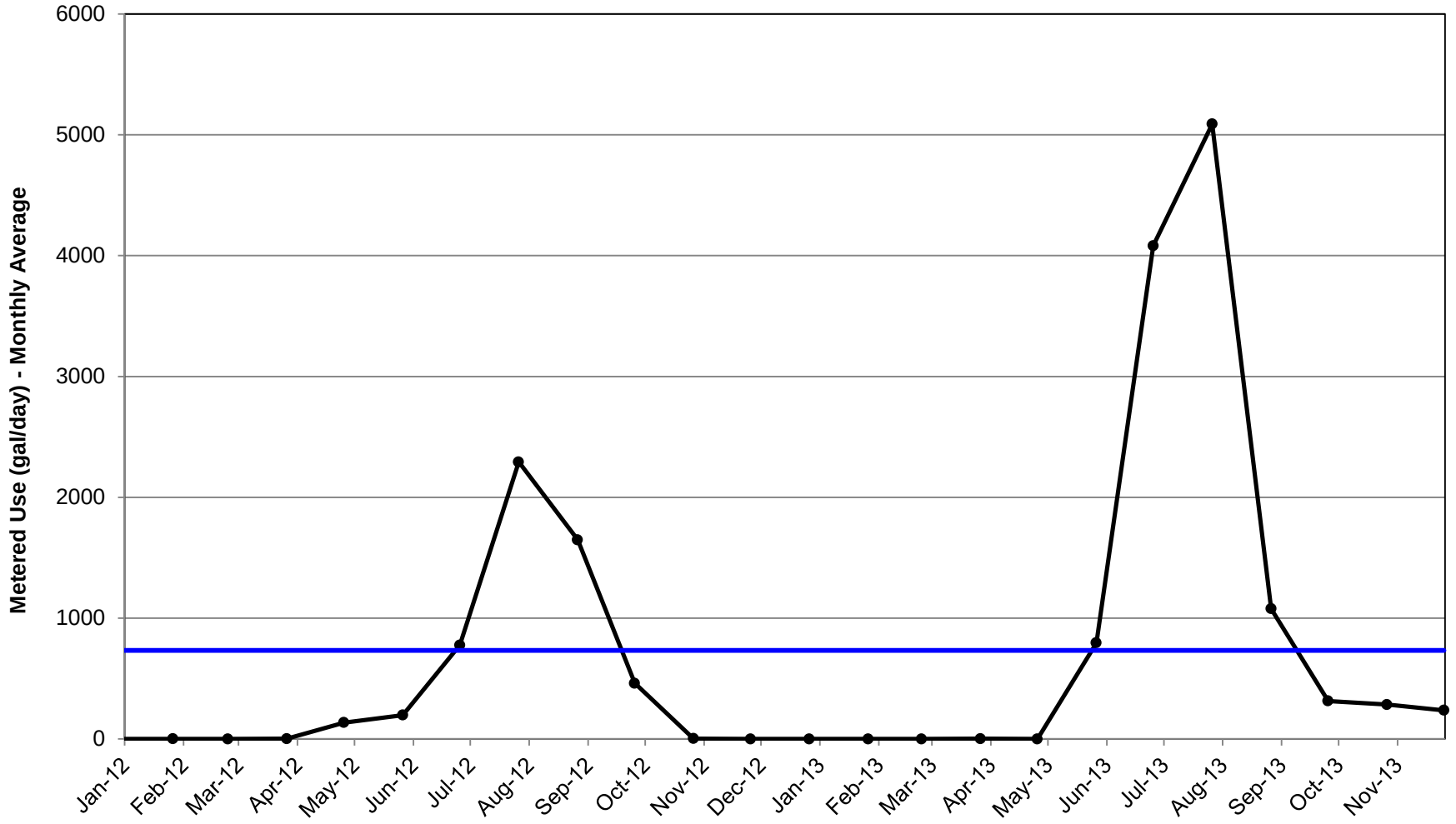
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-3**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 3

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

.

LEGEND

Total Water Use (Metered)

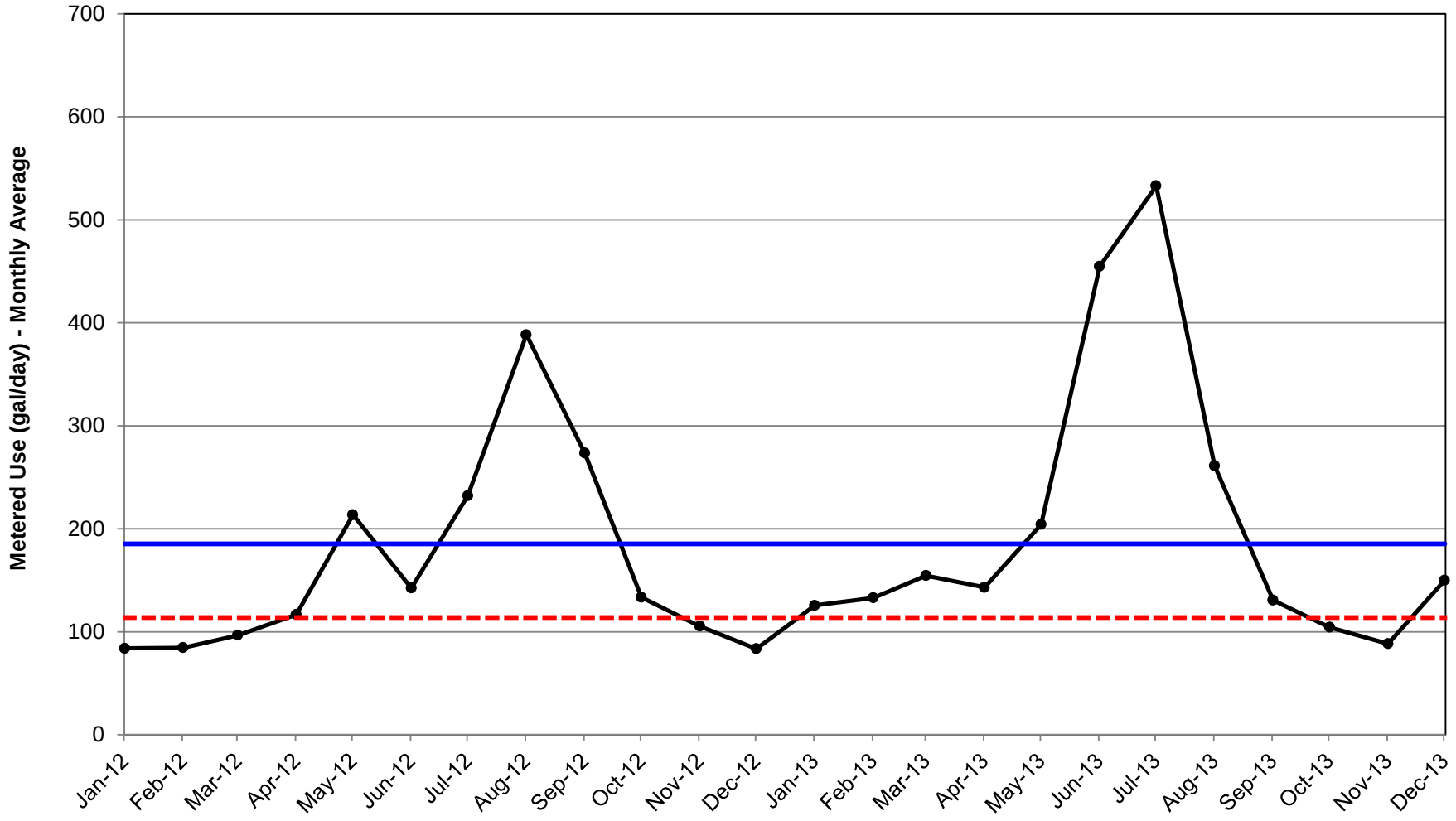
Average Annual Use

FIGURE **A-4**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 4

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

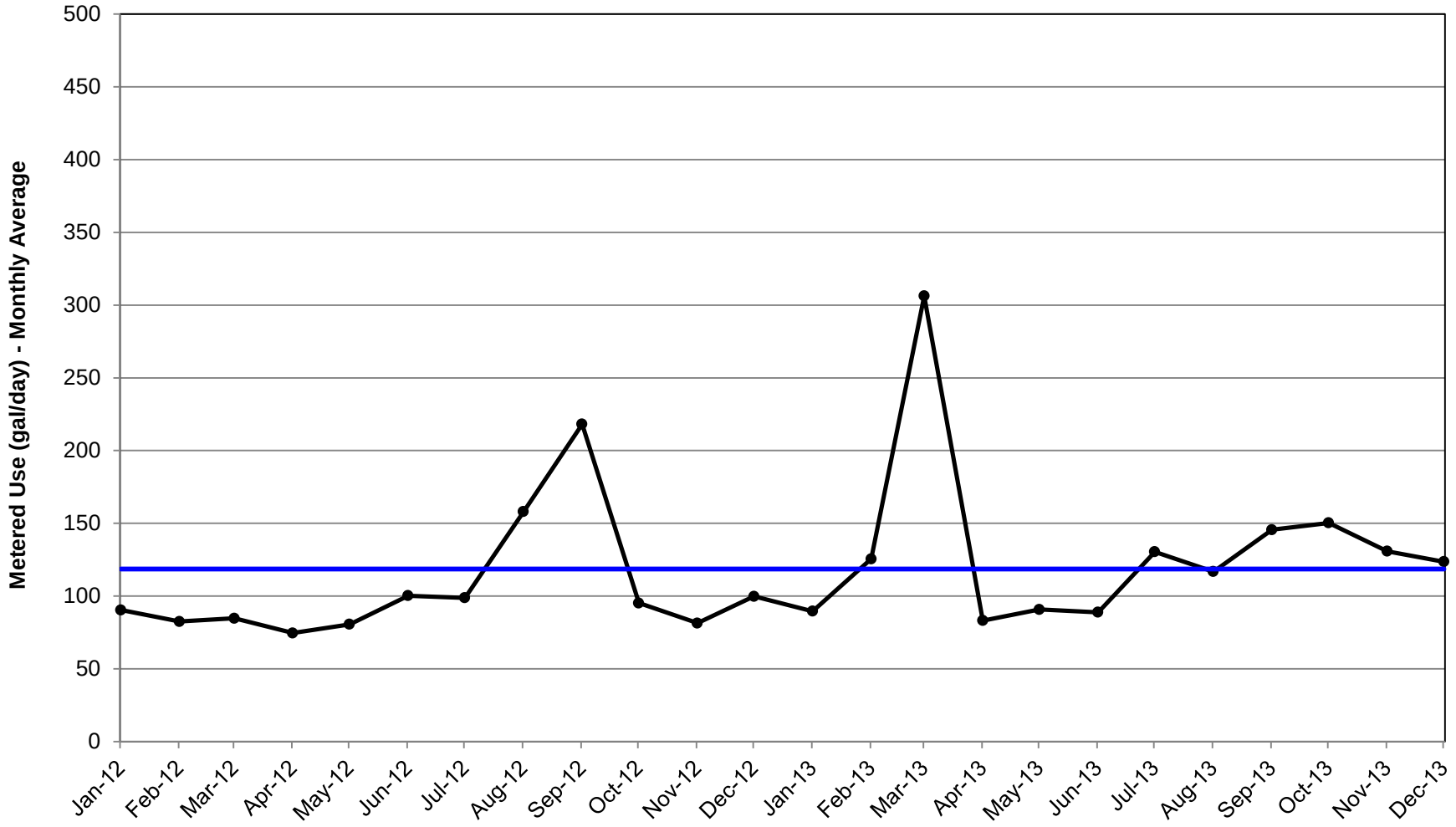
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-5**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 5

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

Total Water Use (Metered)

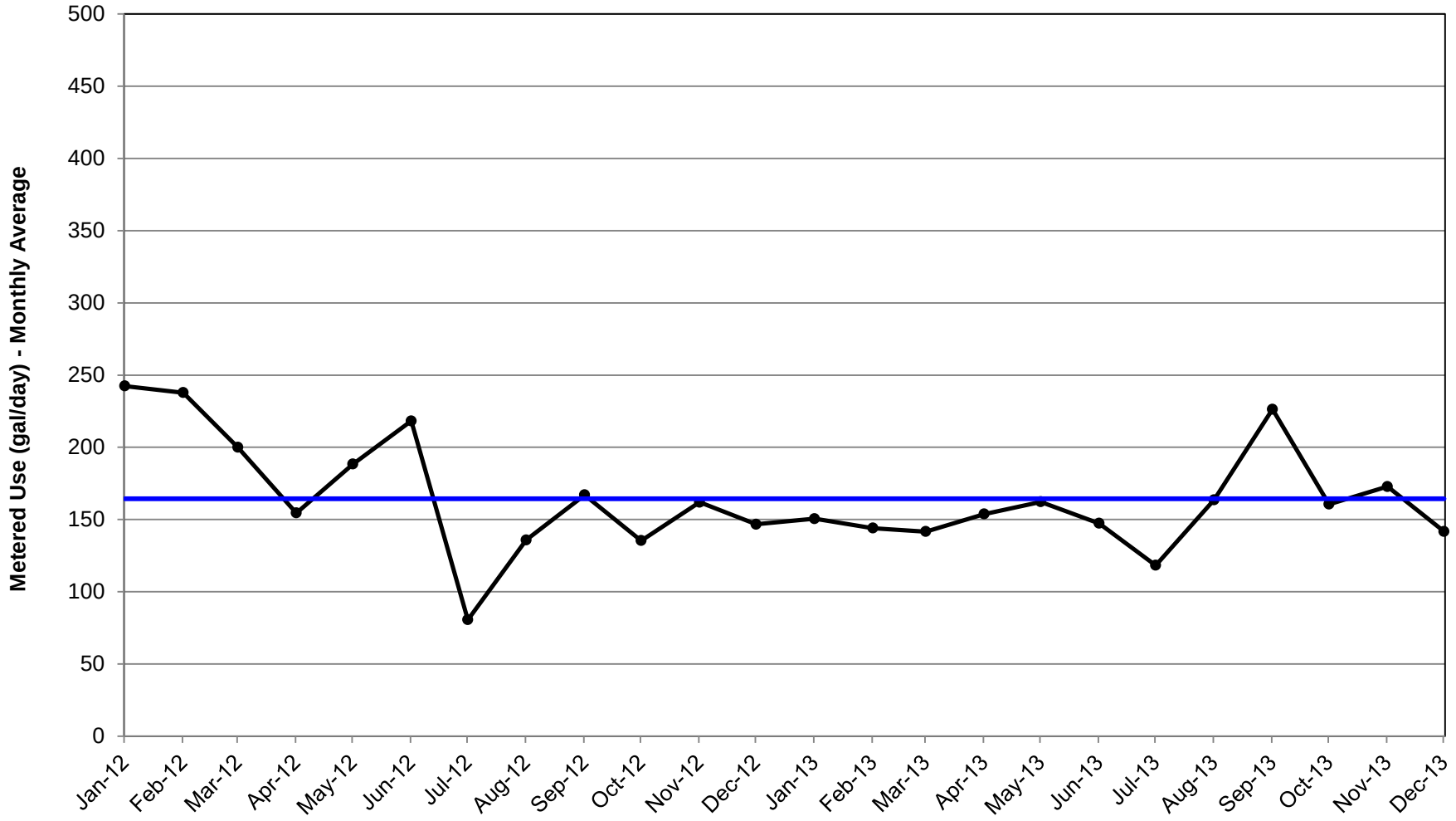
Average Annual Use

FIGURE **A-6**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 6

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

LEGEND

Total Water Use (Metered)

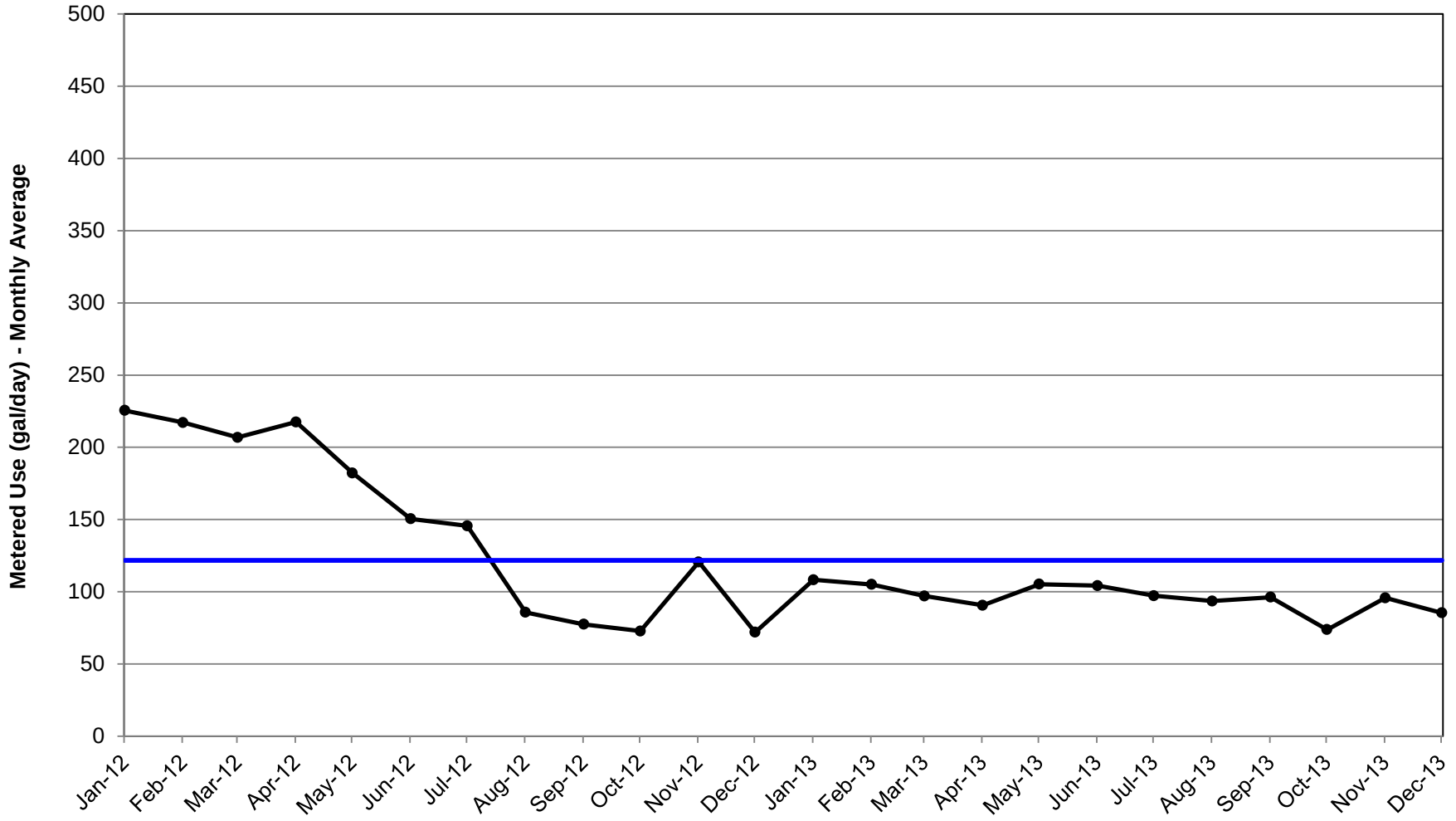
Average Annual Use

FIGURE **A-7**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 7

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

LEGEND

Total Water Use (Metered)

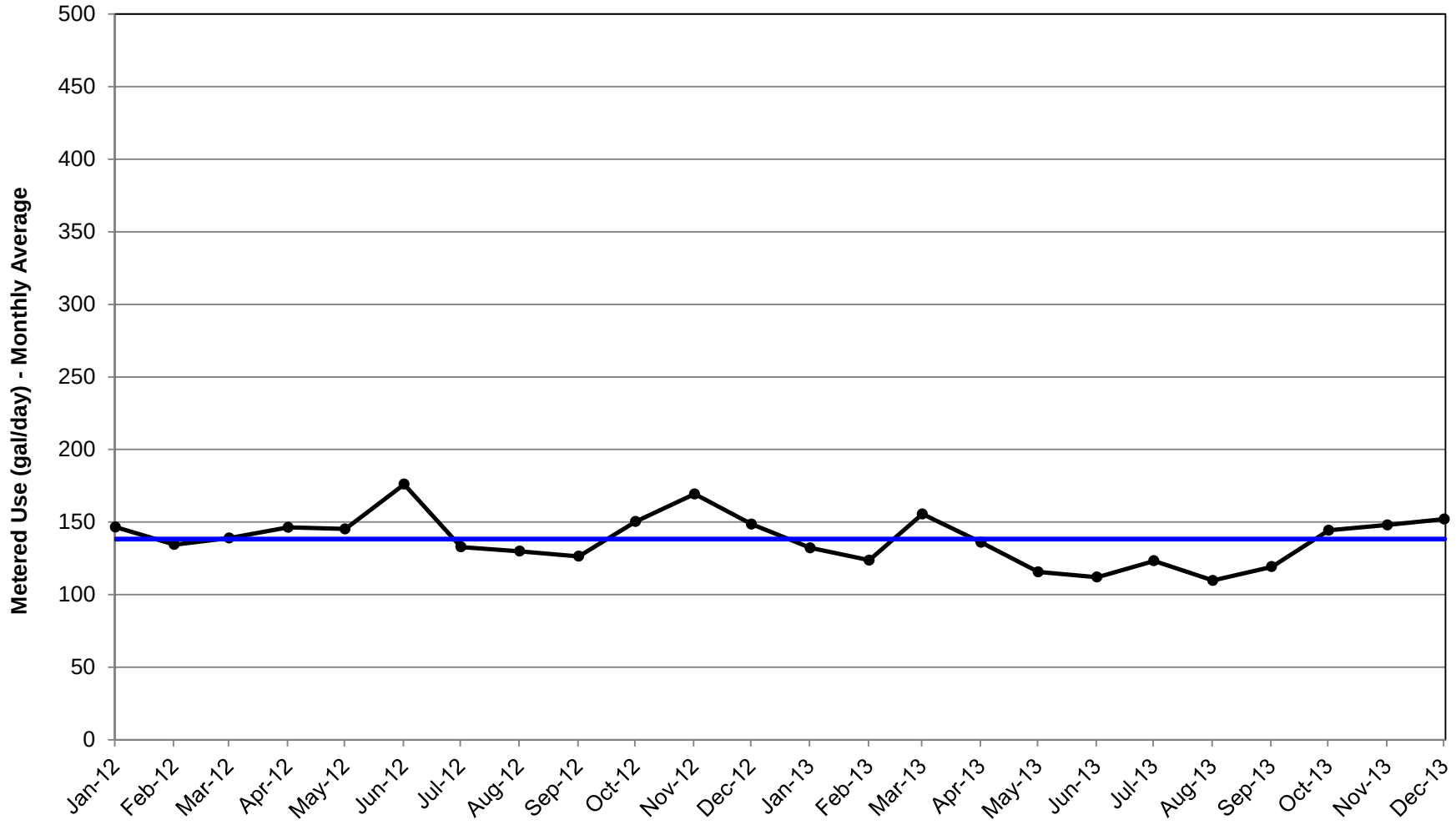
Average Annual Use

FIGURE **A-8**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 8

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

LEGEND

Total Water Use (Metered)

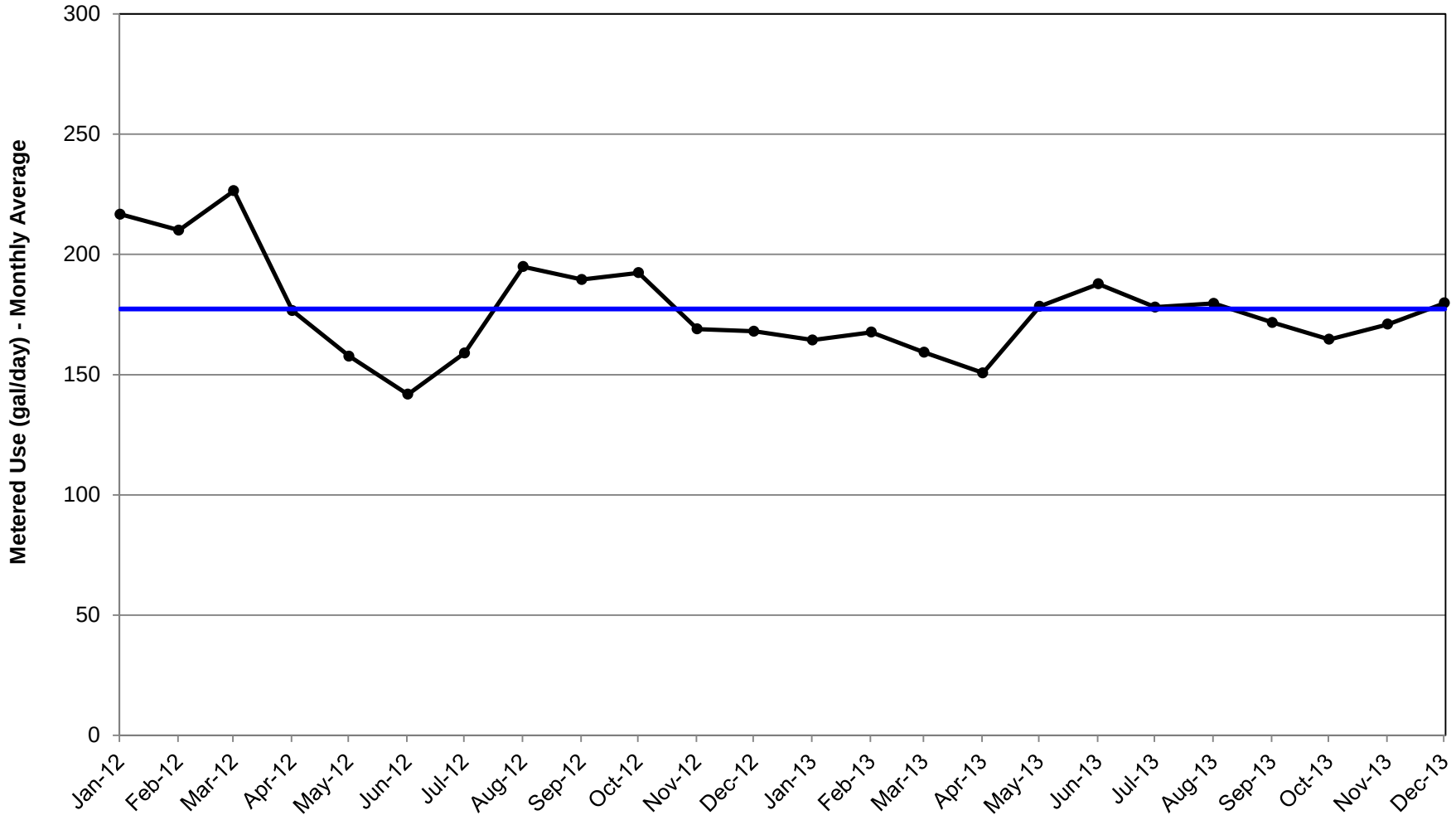
Average Annual Use

FIGURE **A-9**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 9

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

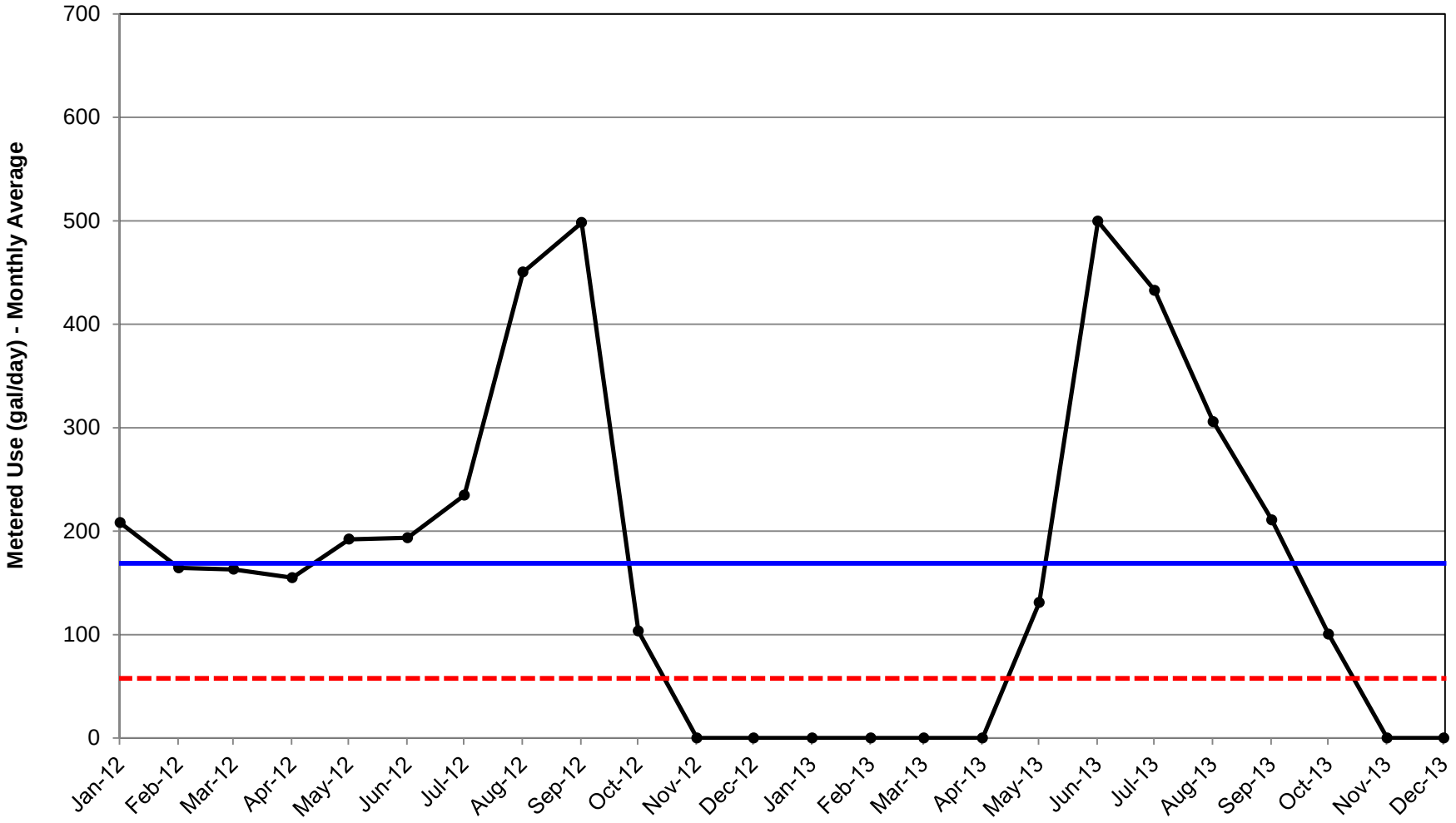
Average Annual Use

FIGURE **A-10**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 10

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

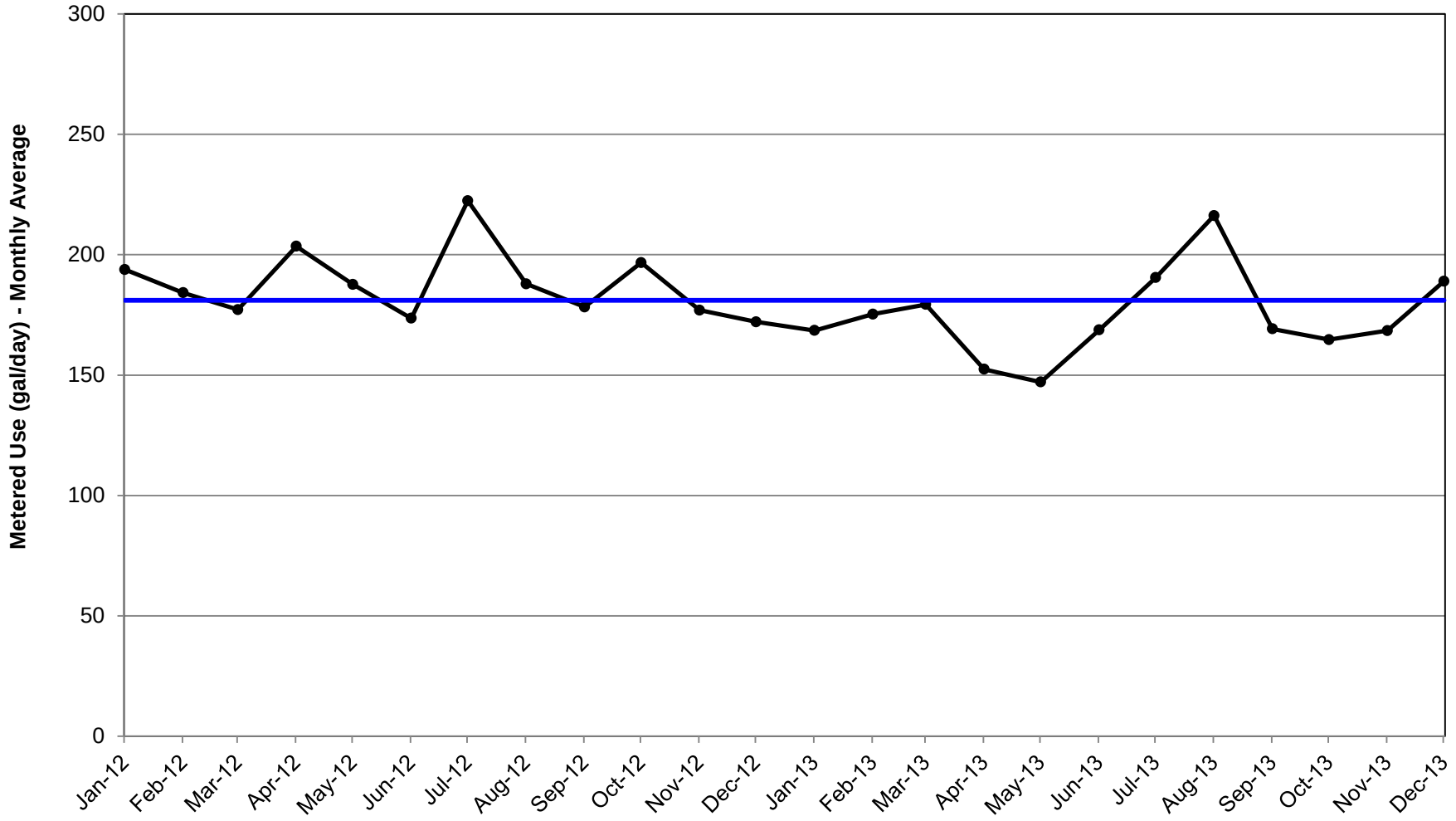
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-11**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 11

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

LEGEND

Total Water Use (Metered)

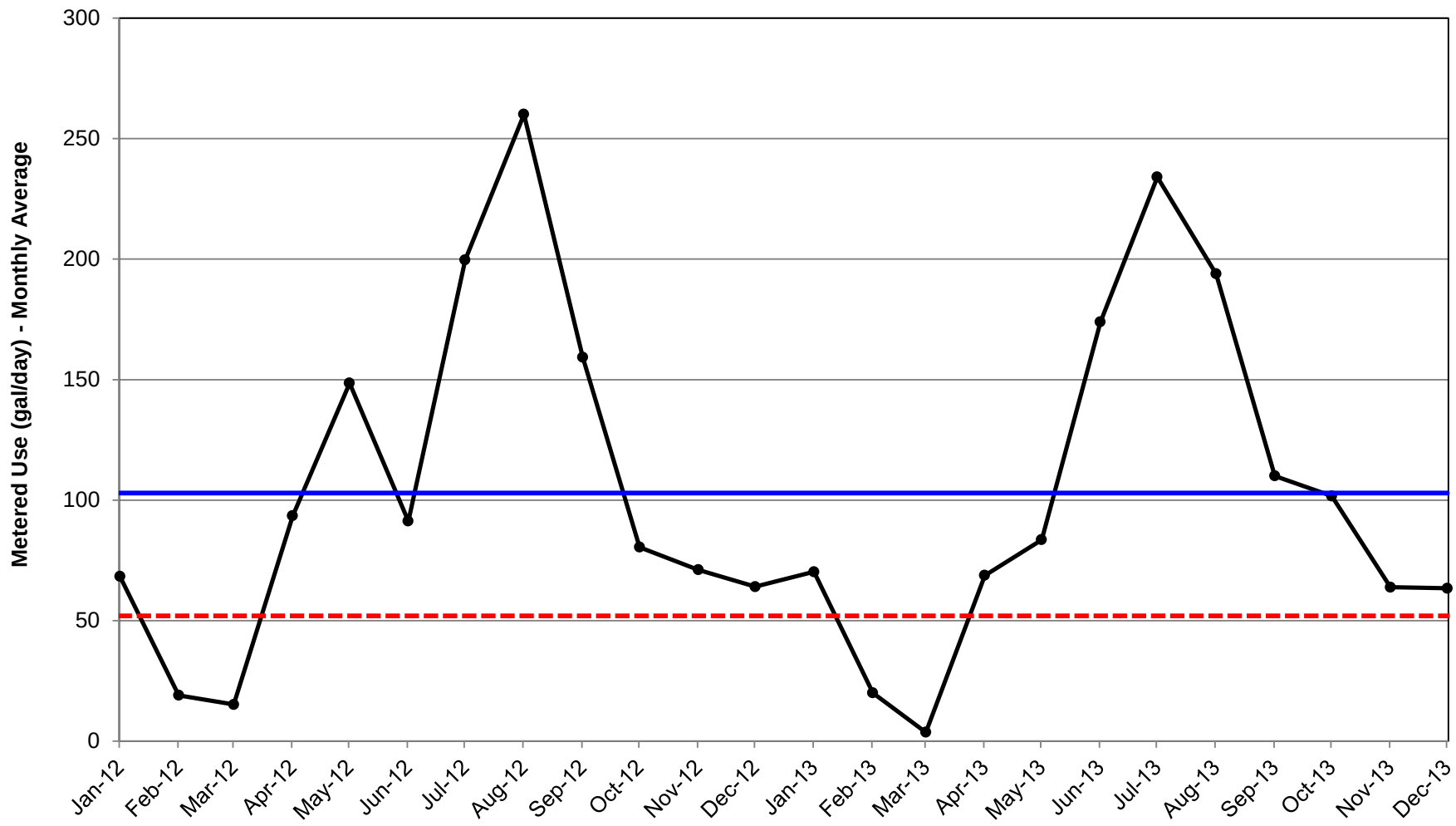
Average Annual Use

FIGURE **A-12**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 12

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

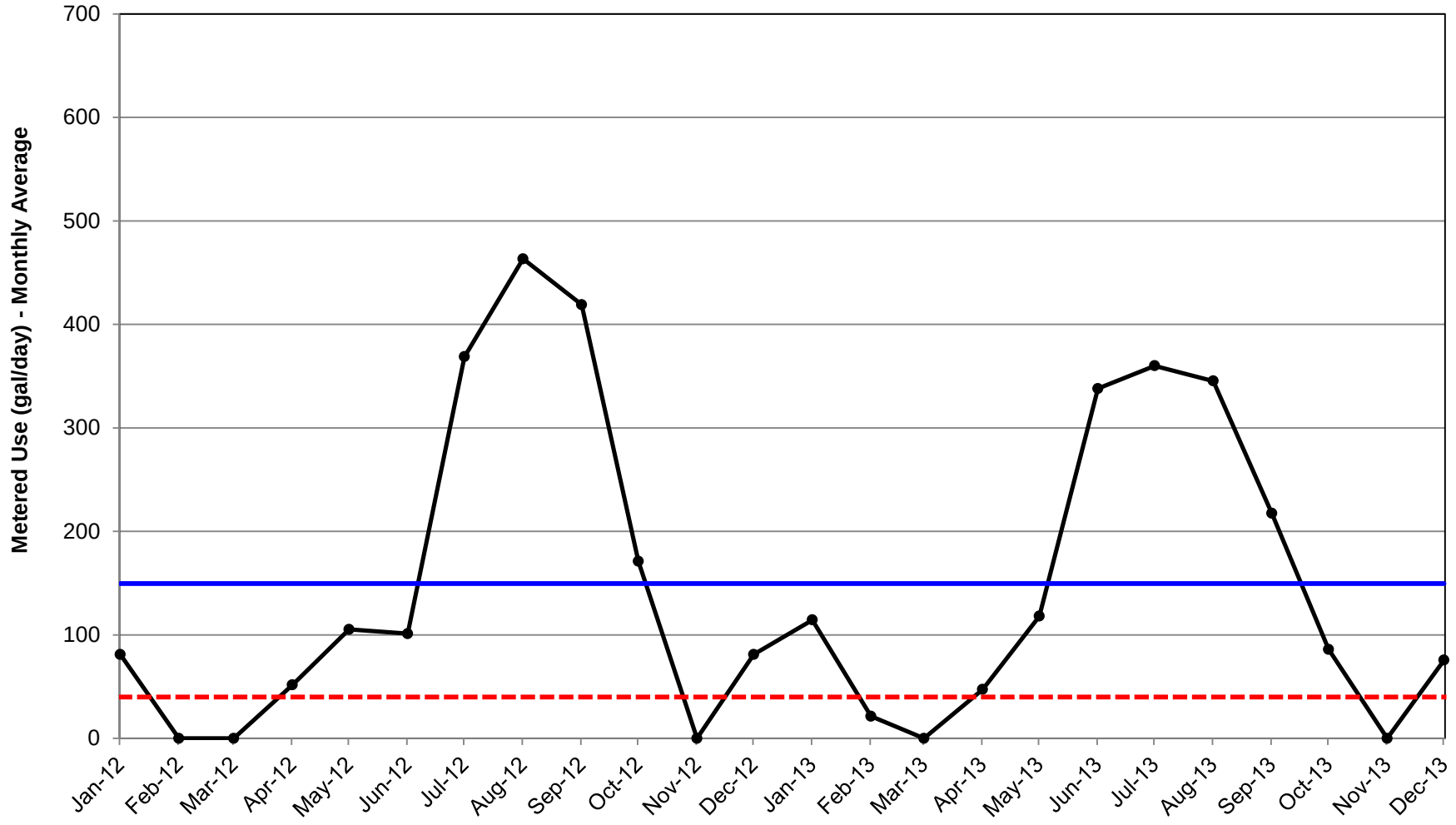
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-13**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 13

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

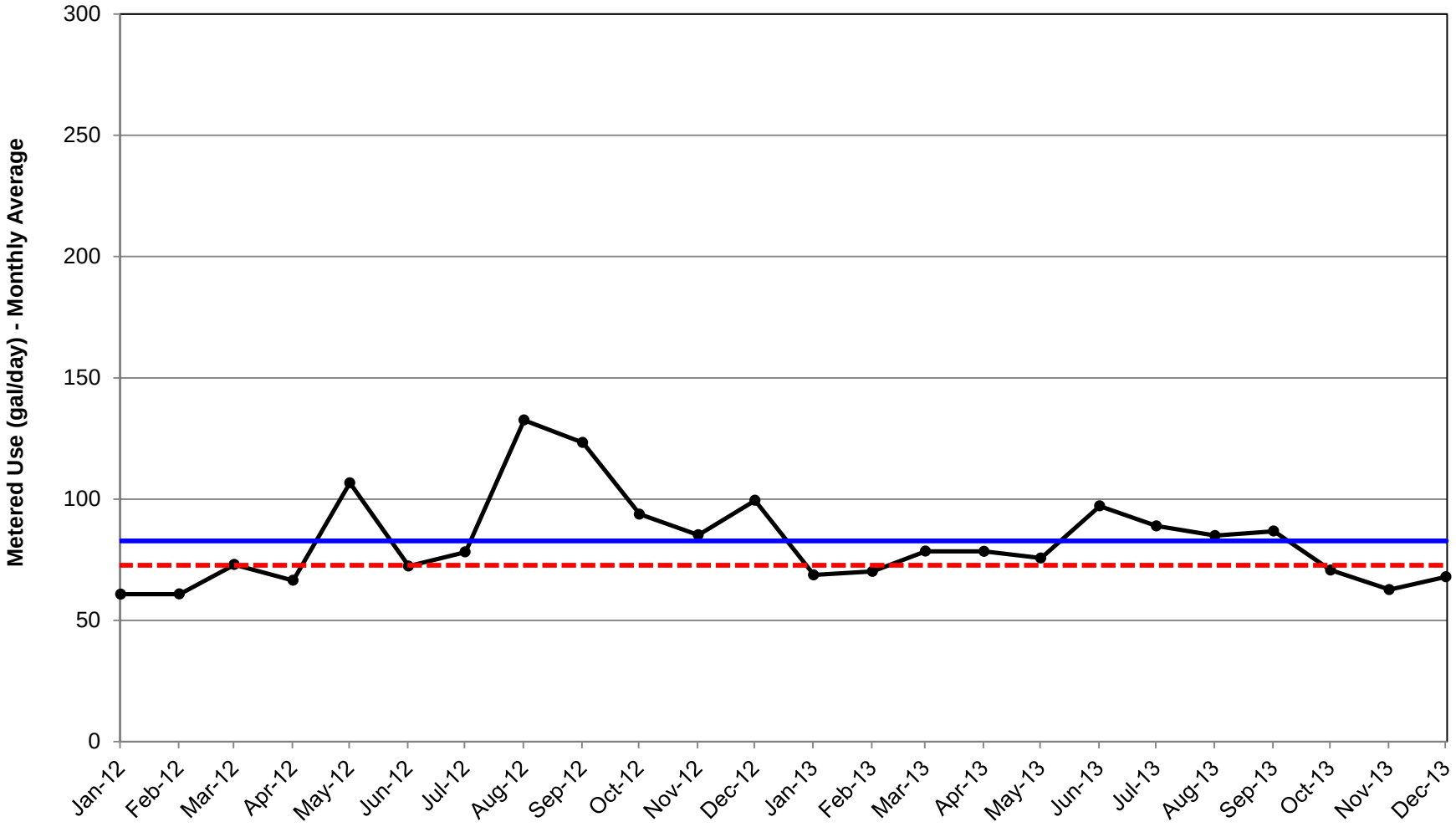
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-14**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 14

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

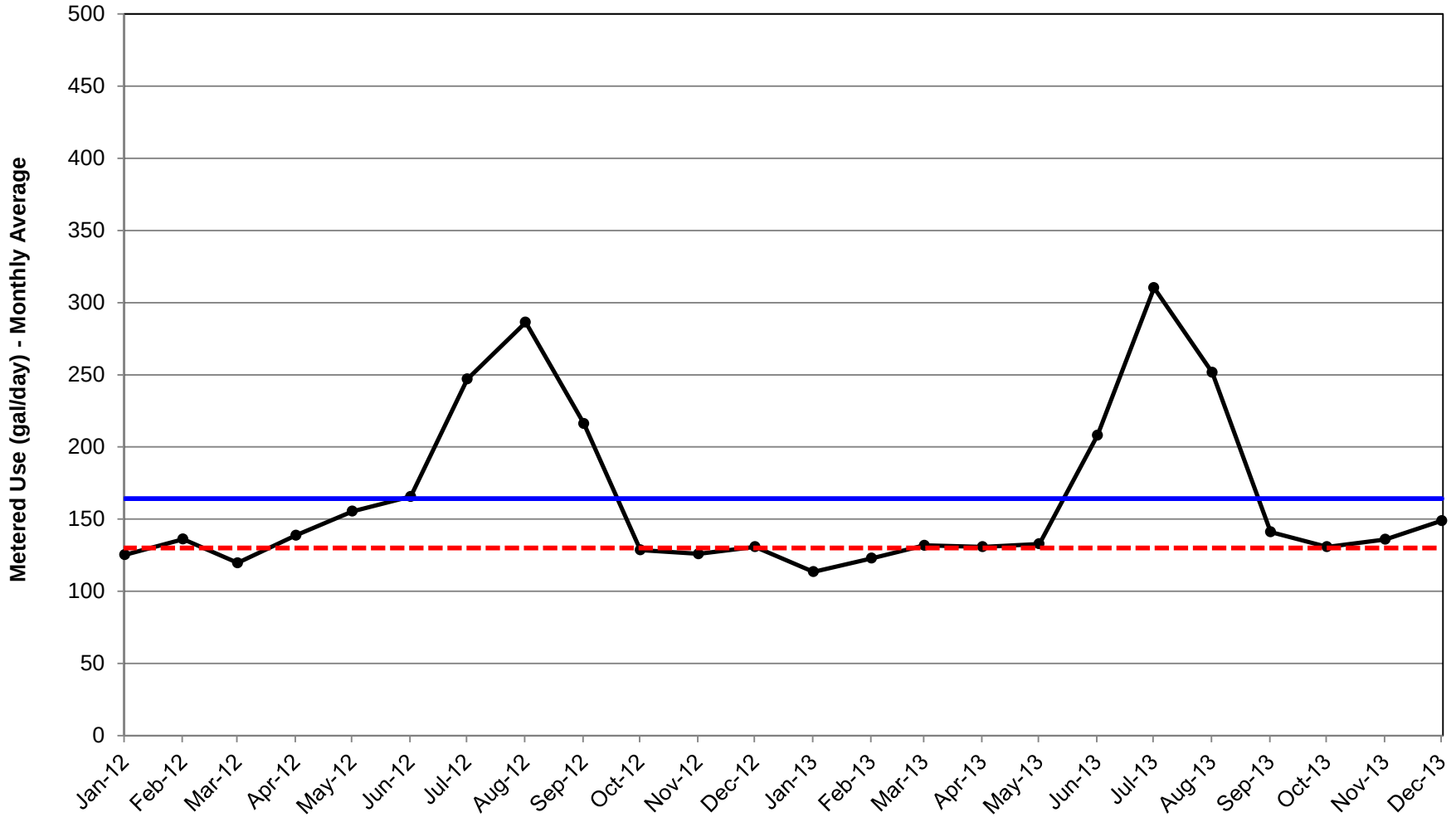
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-15**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 15

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

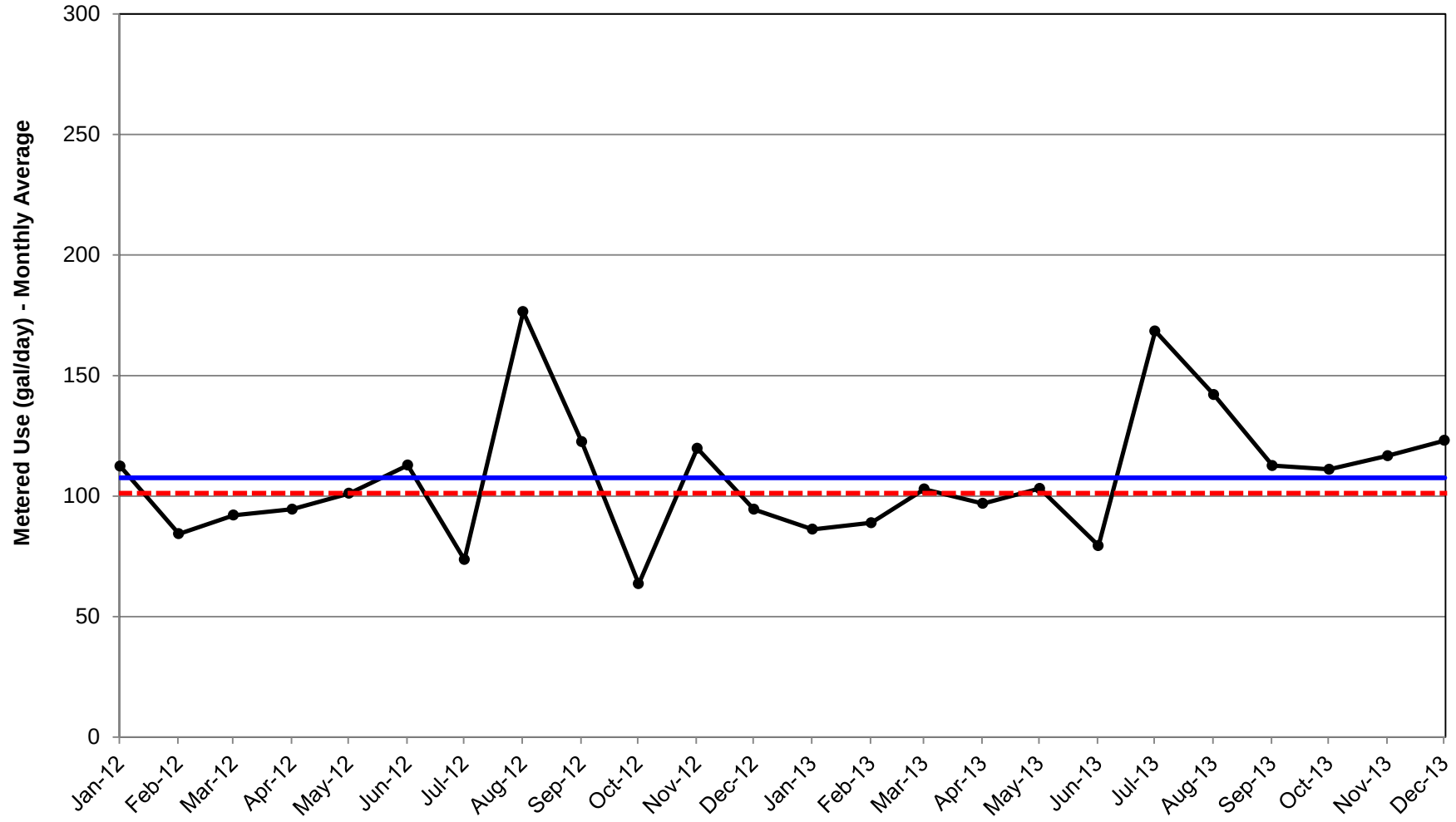
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-16**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 16

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

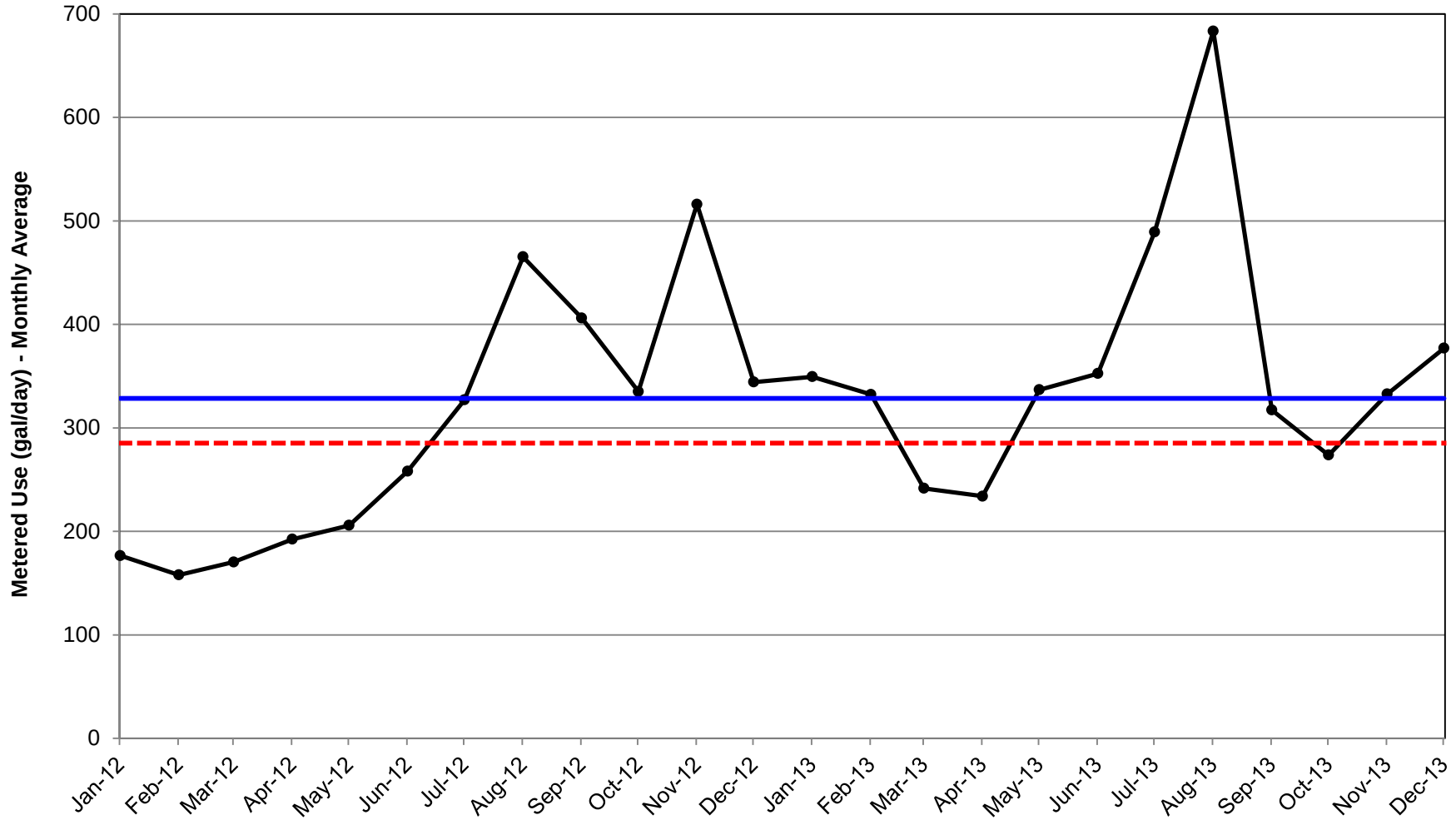
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **A-17**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 17

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

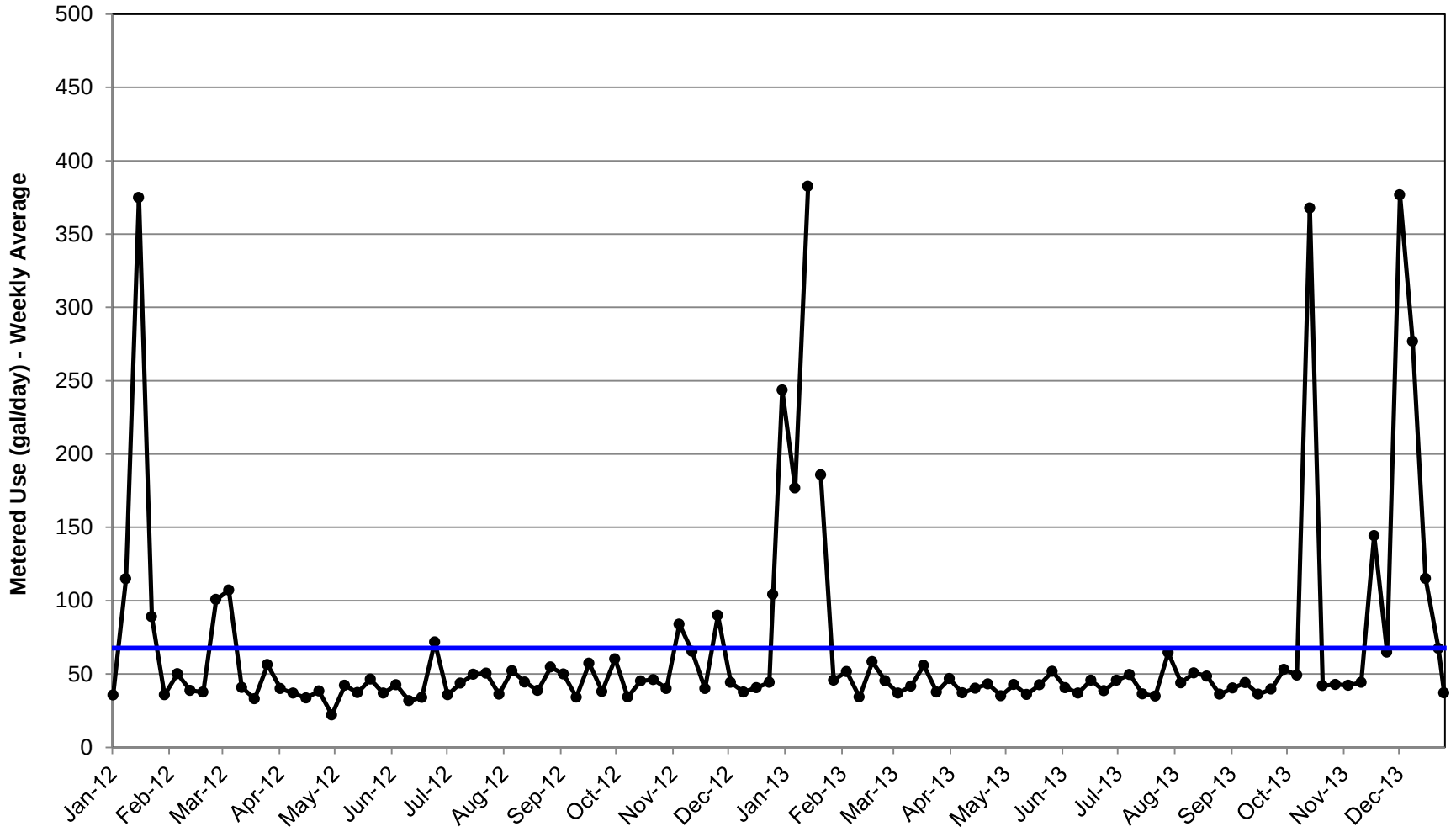
FIGURE **A-18**

DAILY GROUNDWATER USE (MONTHLY AVERAGE)
PROPERTY NO. 18

SC/Well Pilot Metering Program/WA

013-1500.035

APPENDIX B
WEEKLY WATER USE FIGURES



Note: Indoor vs. outdoor use not determined.

LEGEND

Total Water Use (Metered)

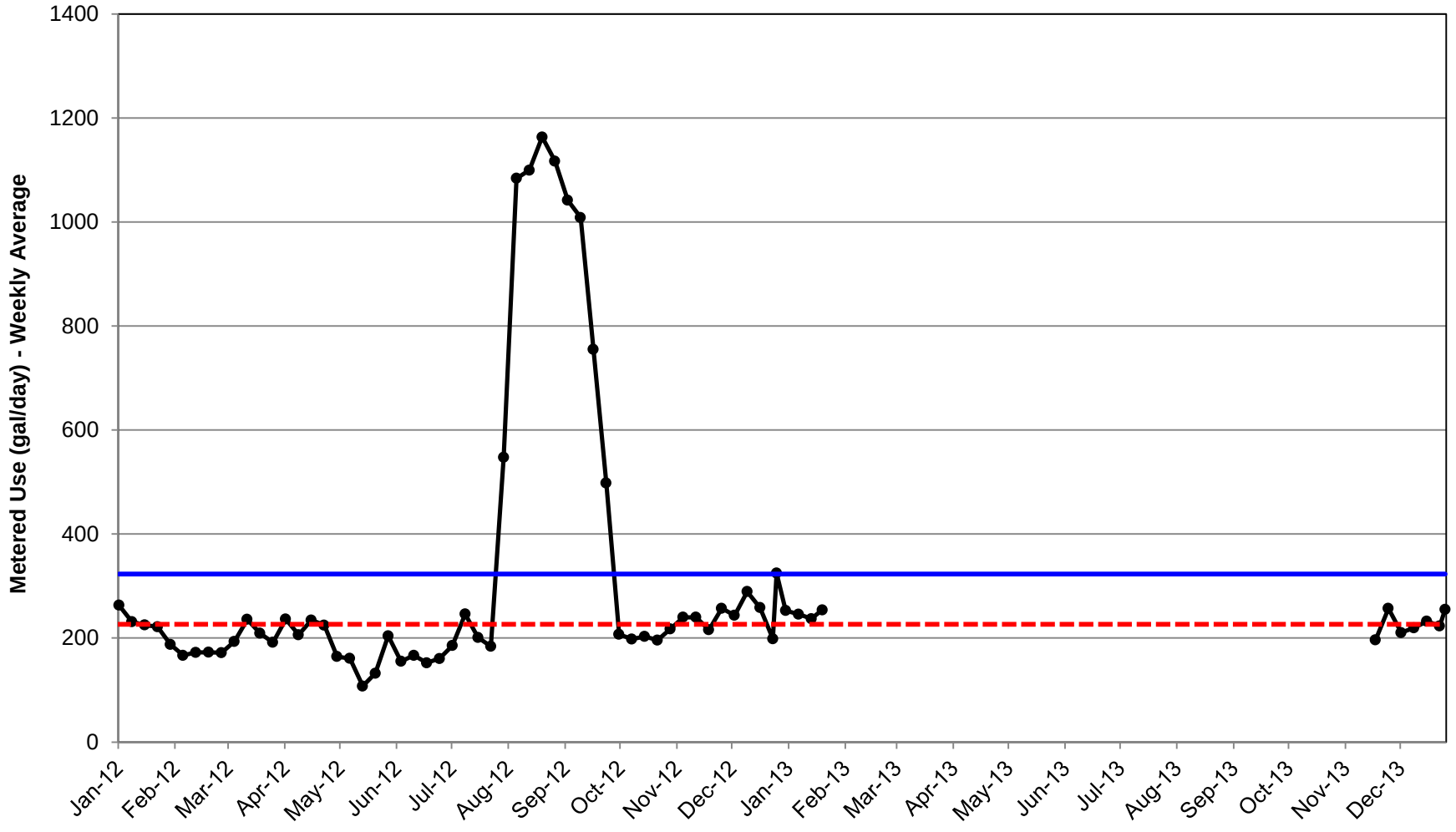
Average Annual Use

FIGURE **B-1**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 1

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Data are unavailable from January 21 to November 22, 2013 due to meter failure.

Golder Associates

LEGEND

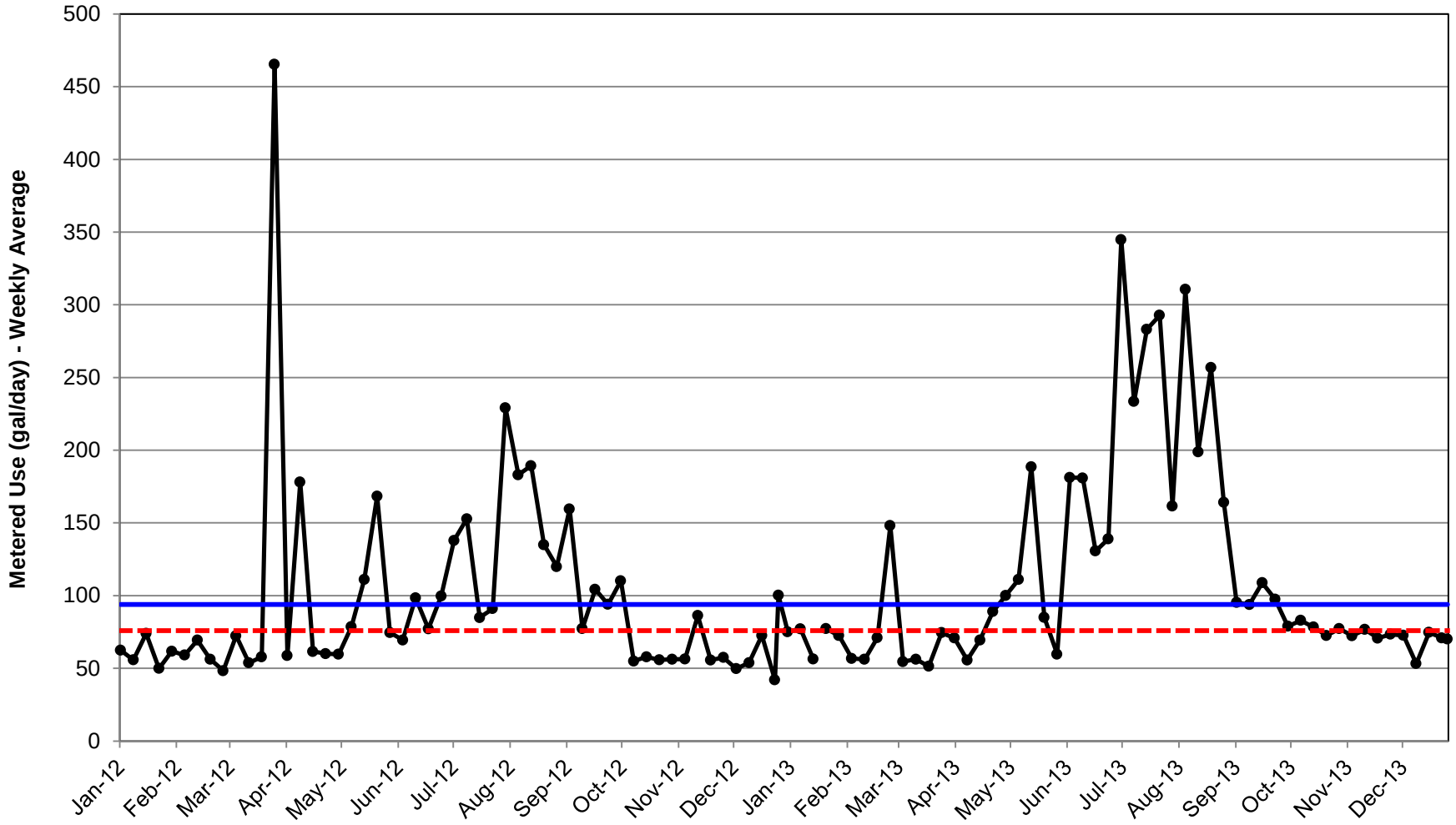
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-2**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 2

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

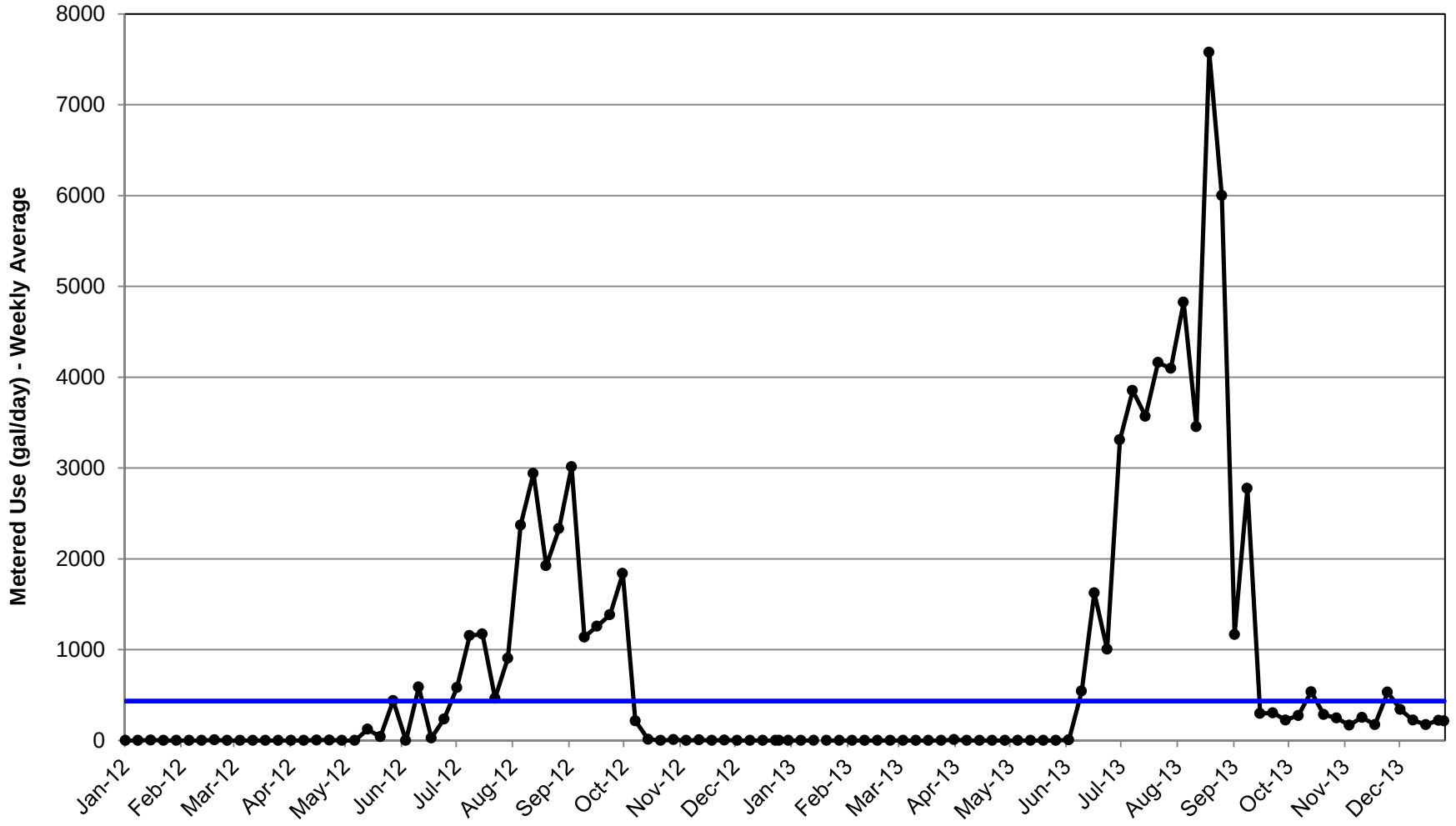
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-3**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 3

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

.

LEGEND

Total Water Use (Metered)

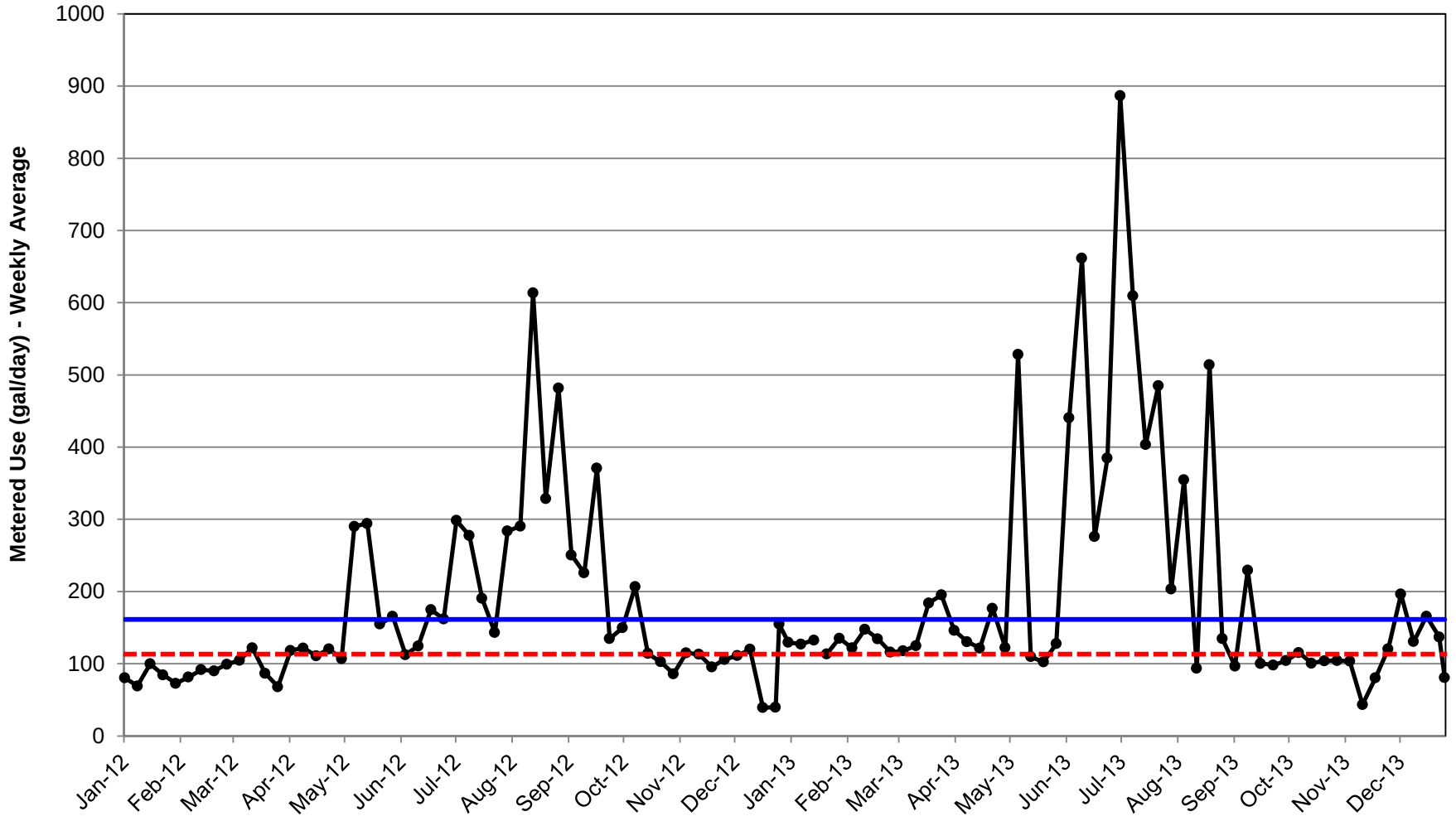
Average Annual Use

FIGURE **B-4**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 4

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

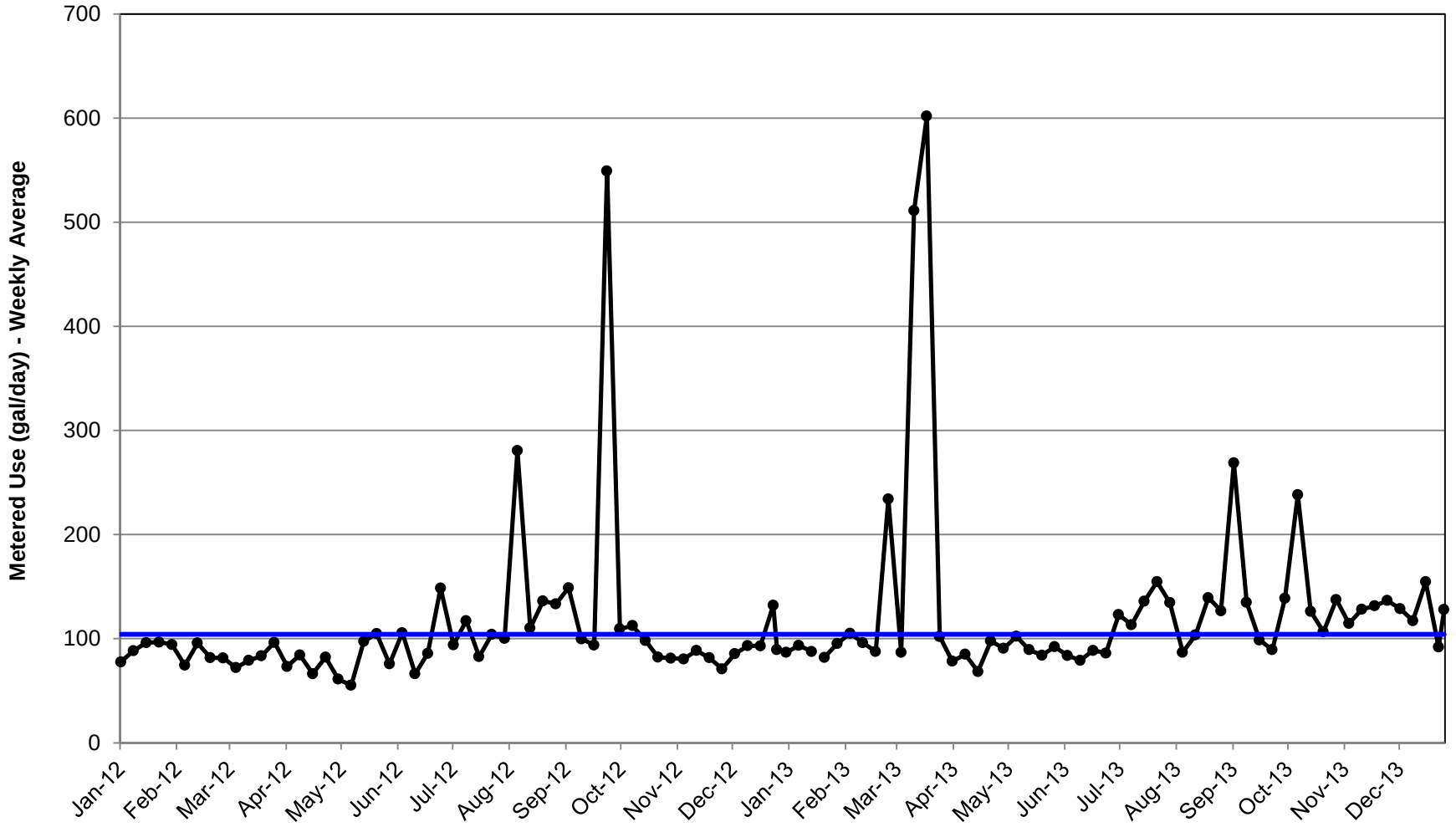
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-5**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 5

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

.

LEGEND

Total Water Use (Metered)

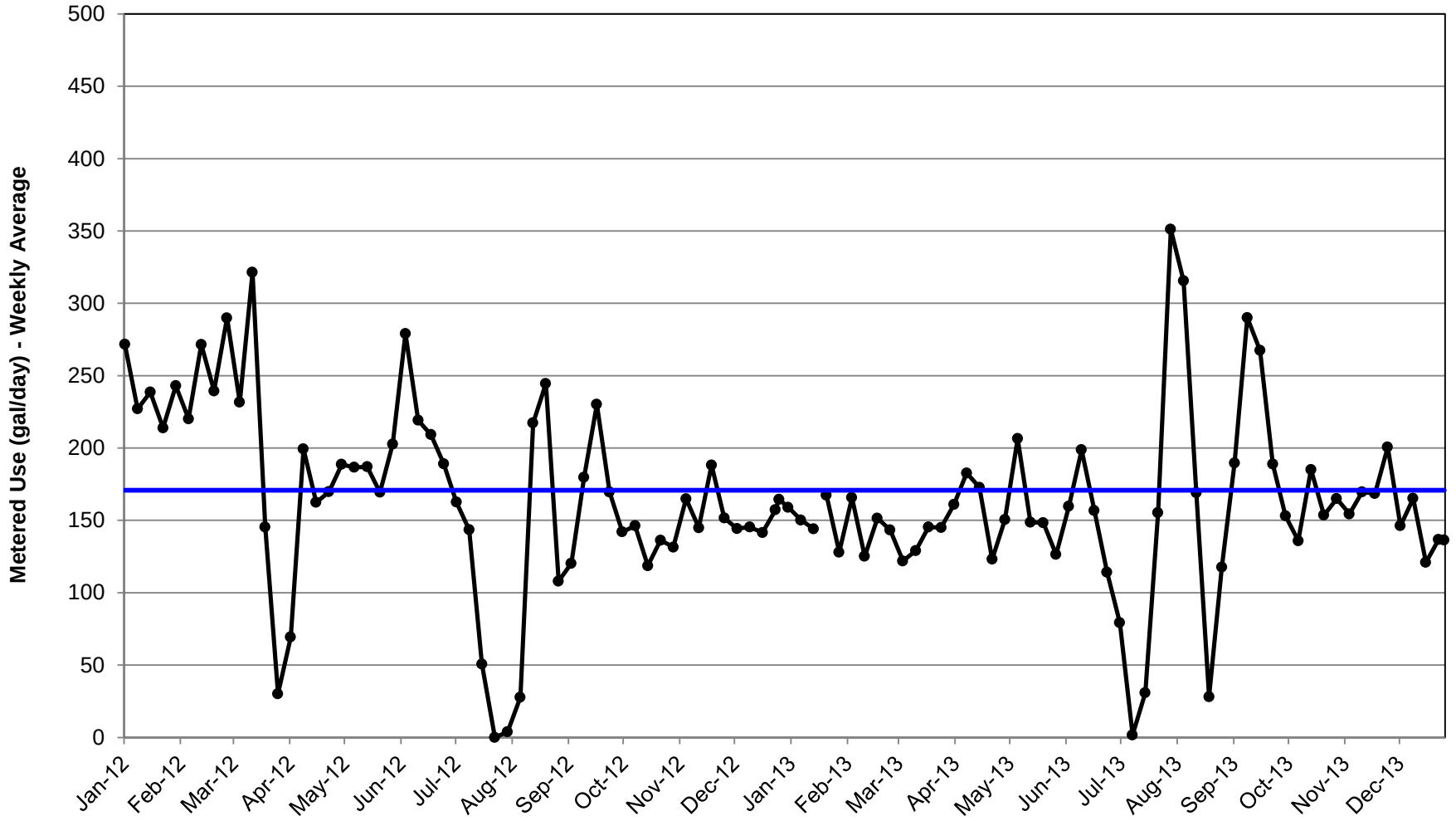
Average Annual Use

FIGURE **B-6**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 6

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined. No data available after September 22, 2012

Golder Associates

LEGEND

Total Water Use (Metered)

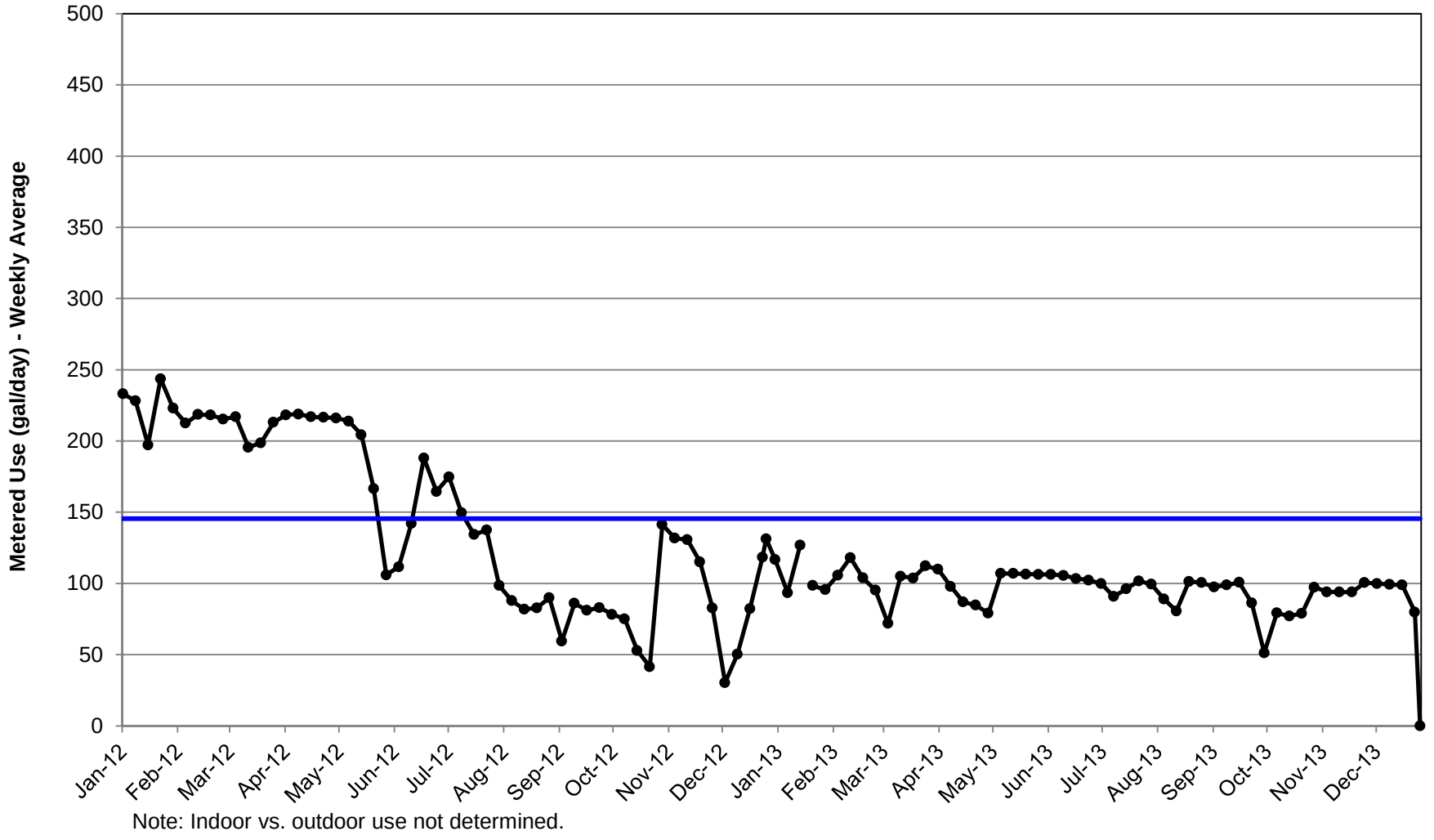
Average Annual Use

FIGURE **B-7**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 7

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

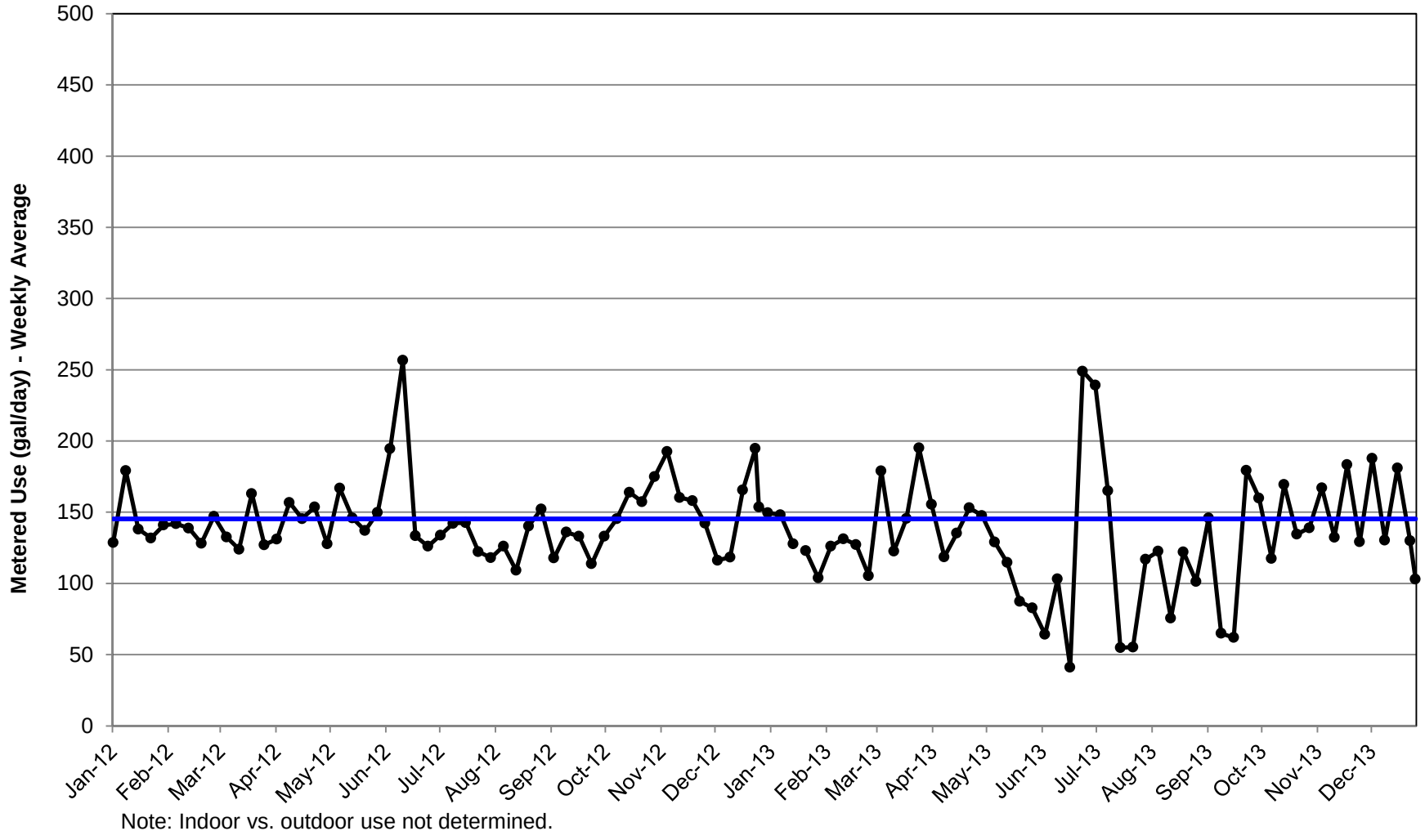
Average Annual Use

FIGURE **B-8**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 8

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

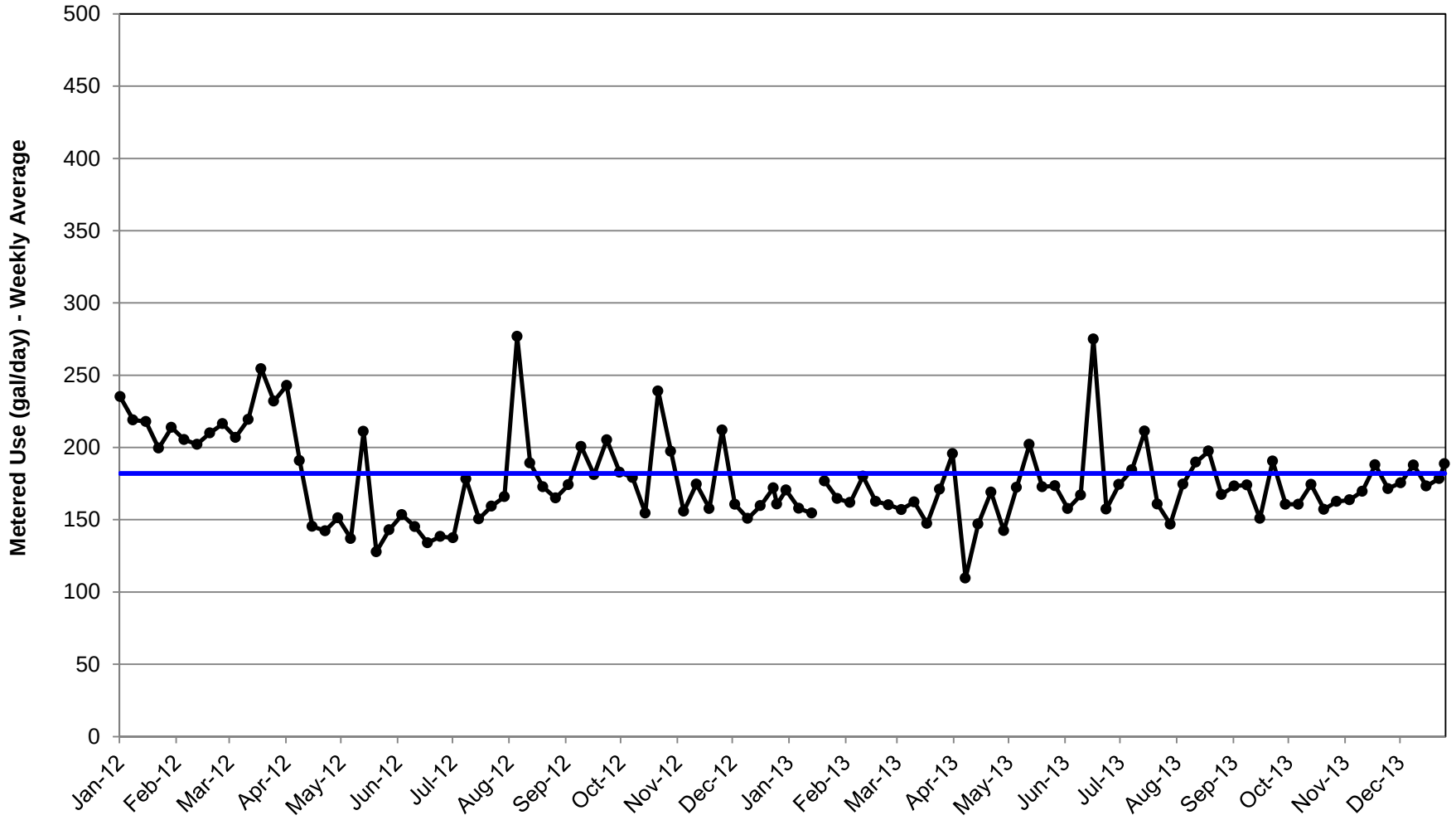
Average Annual Use

FIGURE **B-9**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 9

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

LEGEND

Total Water Use (Metered)

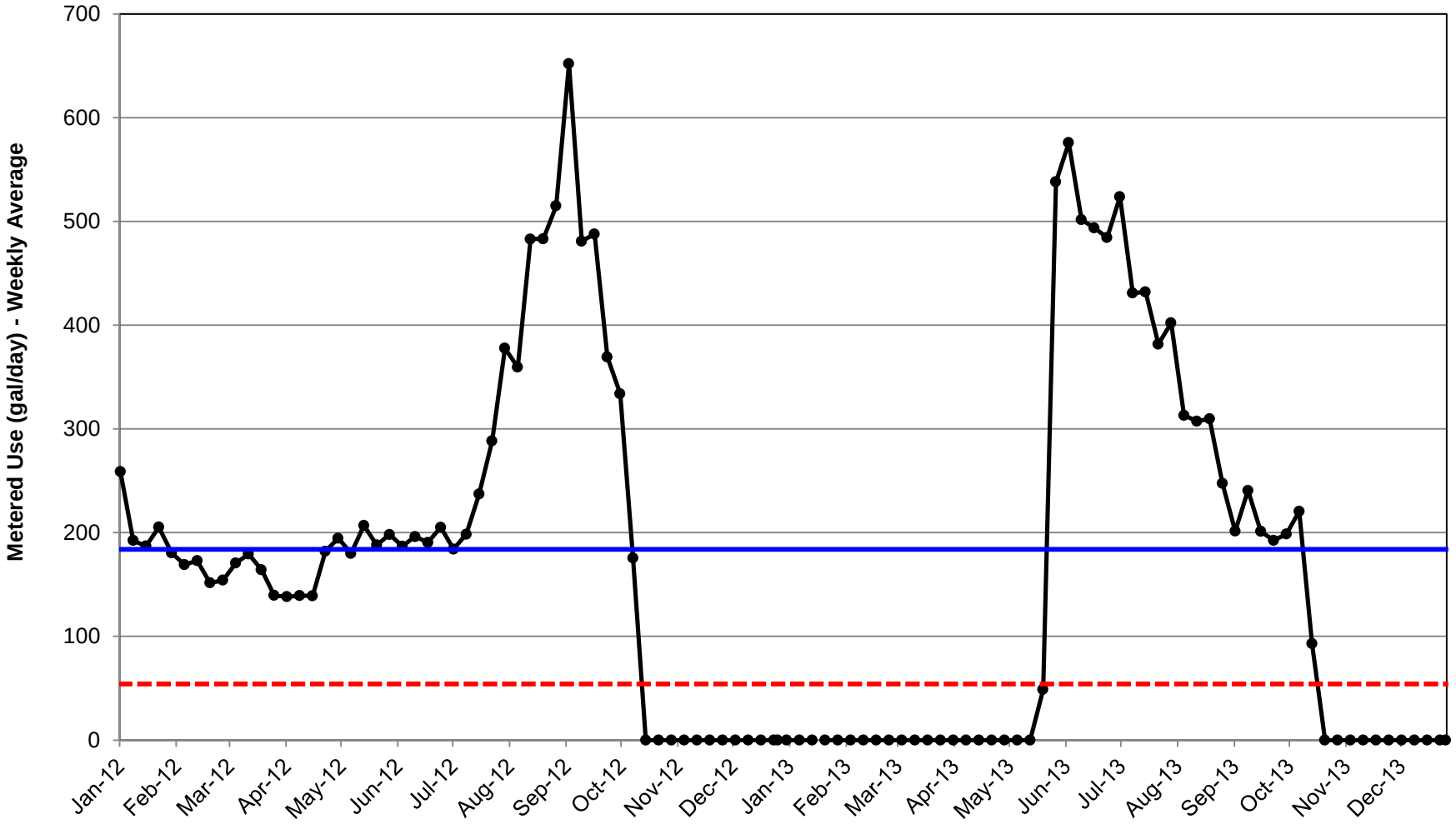
Average Annual Use

FIGURE **B-10**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 10

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

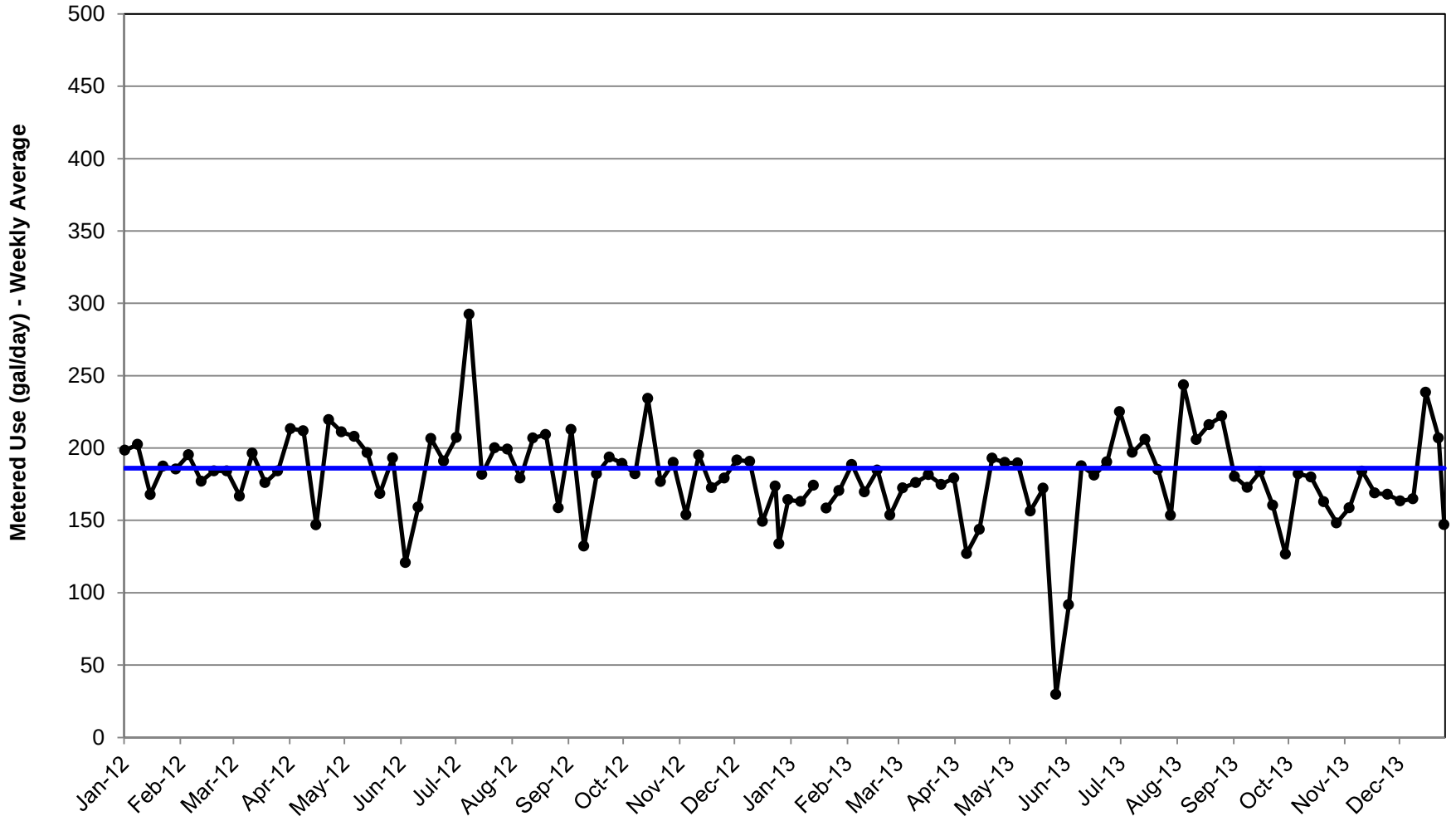
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-11**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 11

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

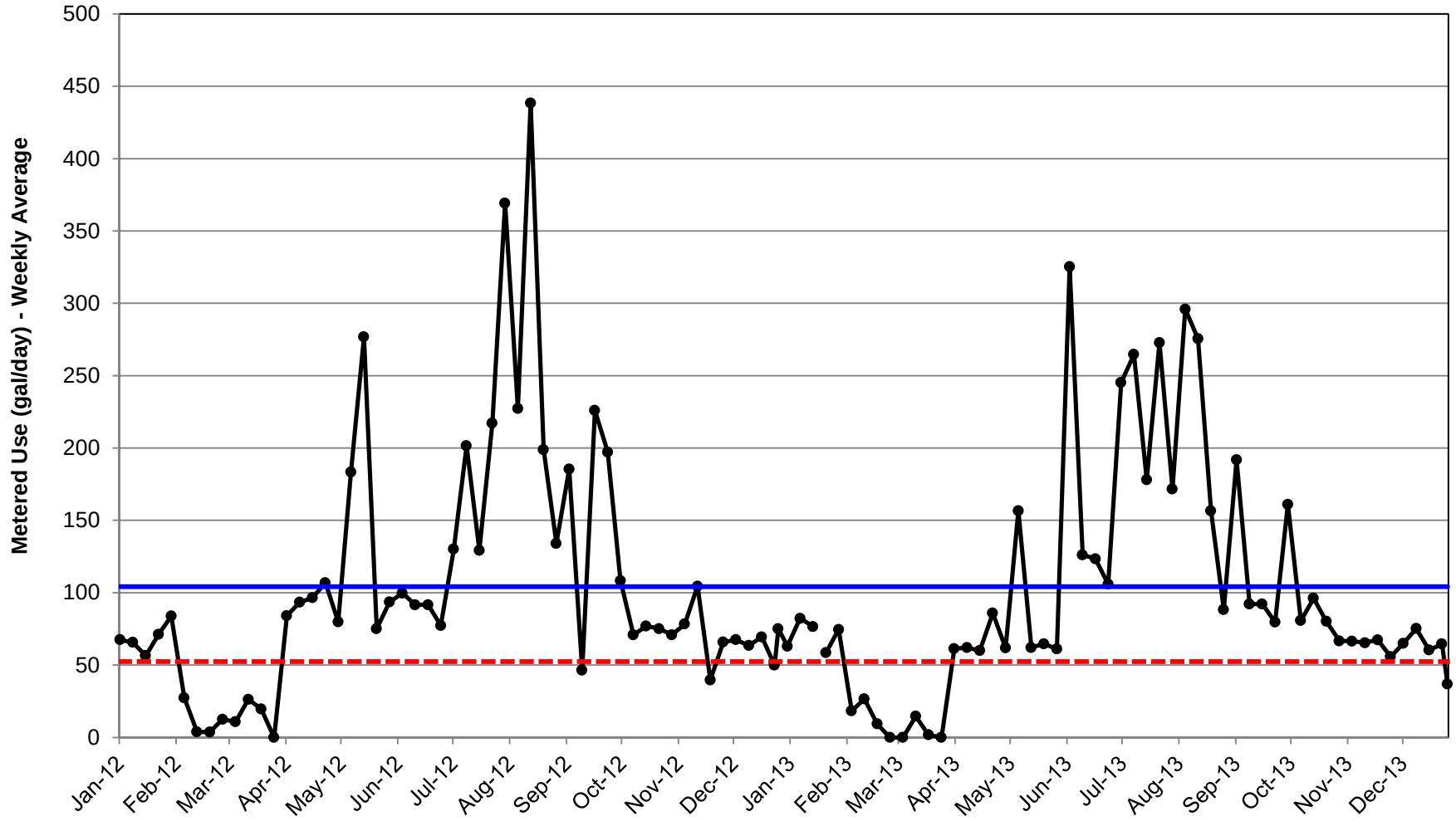
Average Annual Use

FIGURE **B-12**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 12

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

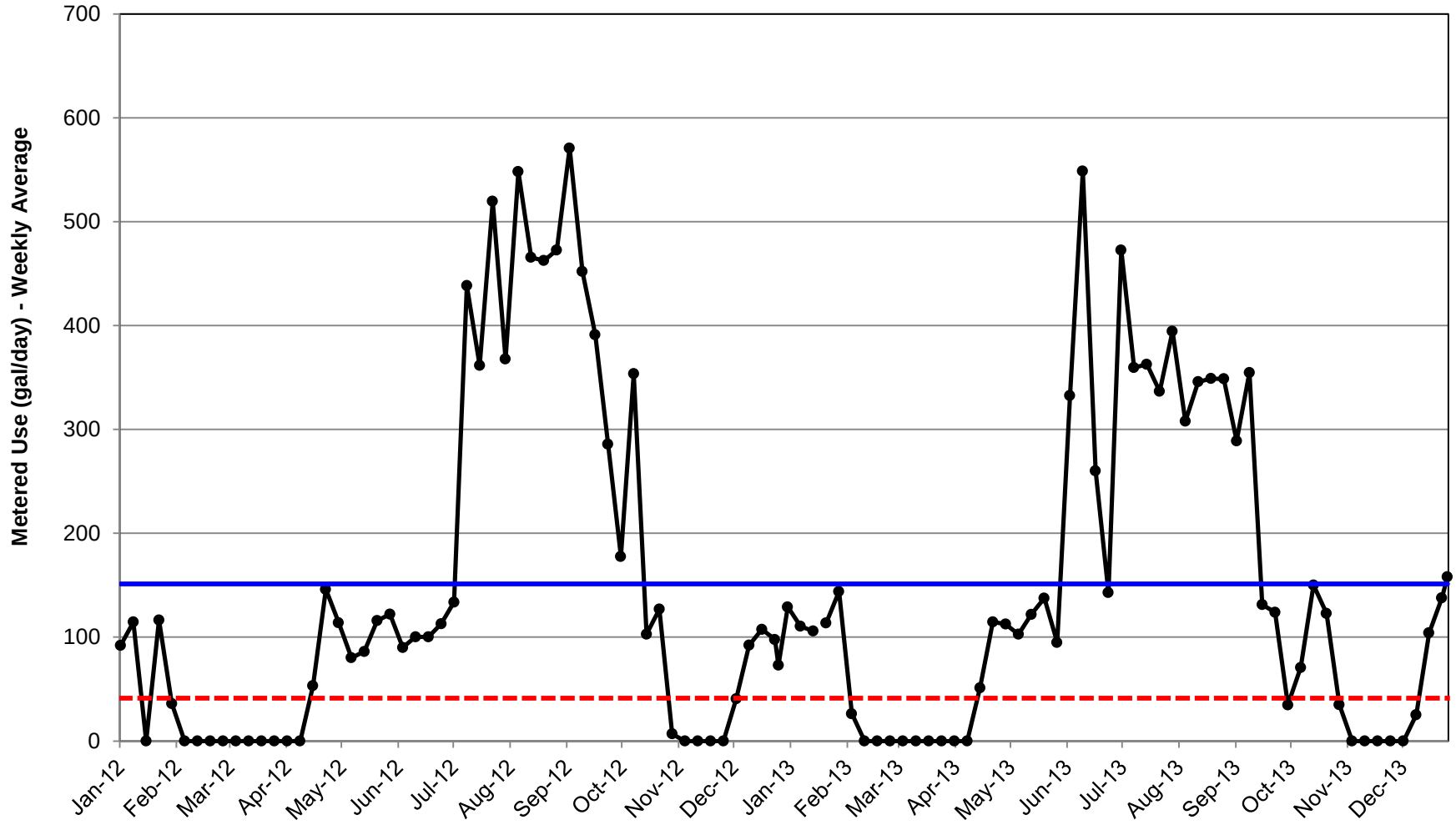
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-13**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 13

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

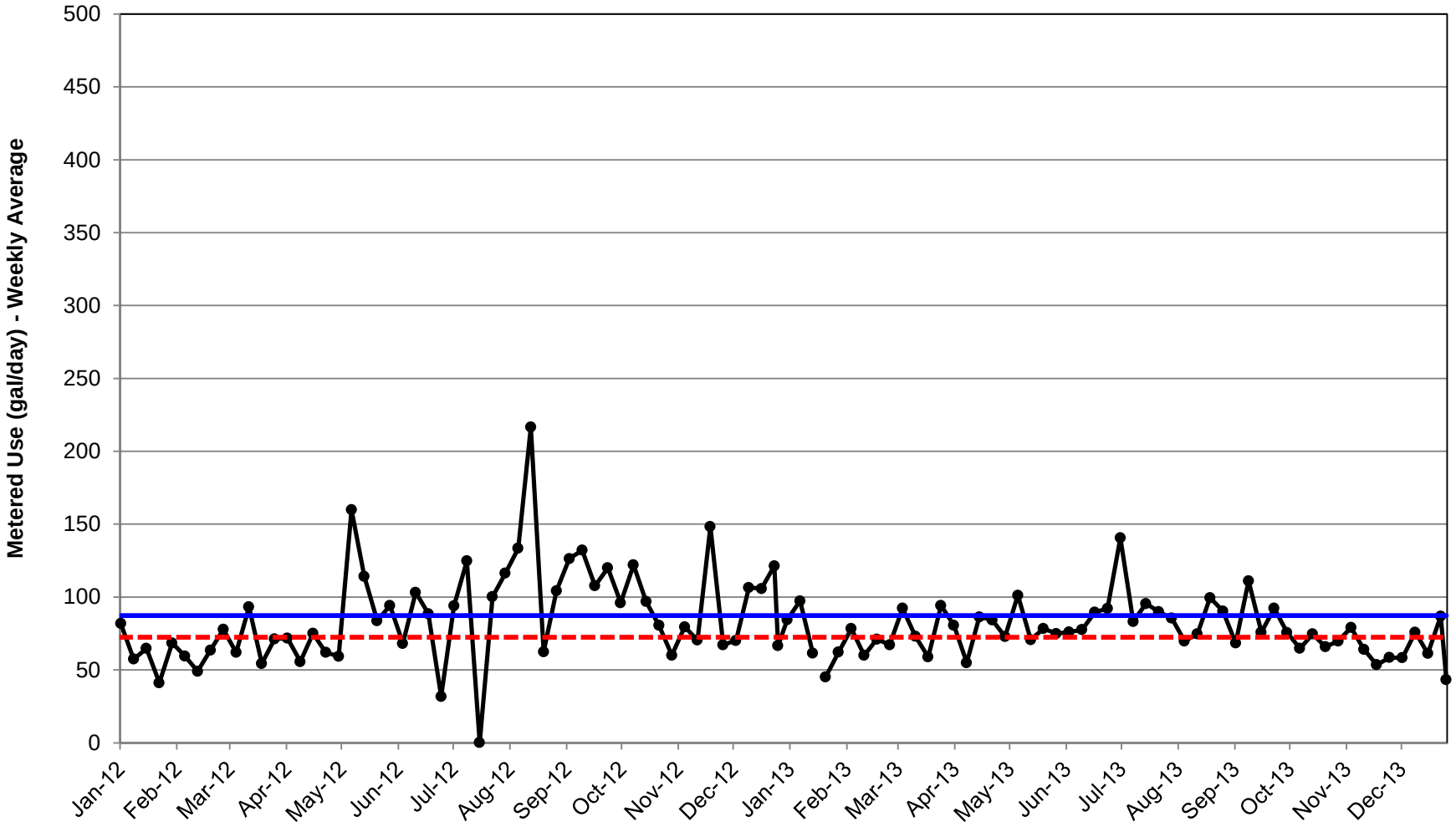
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-14**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 14

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

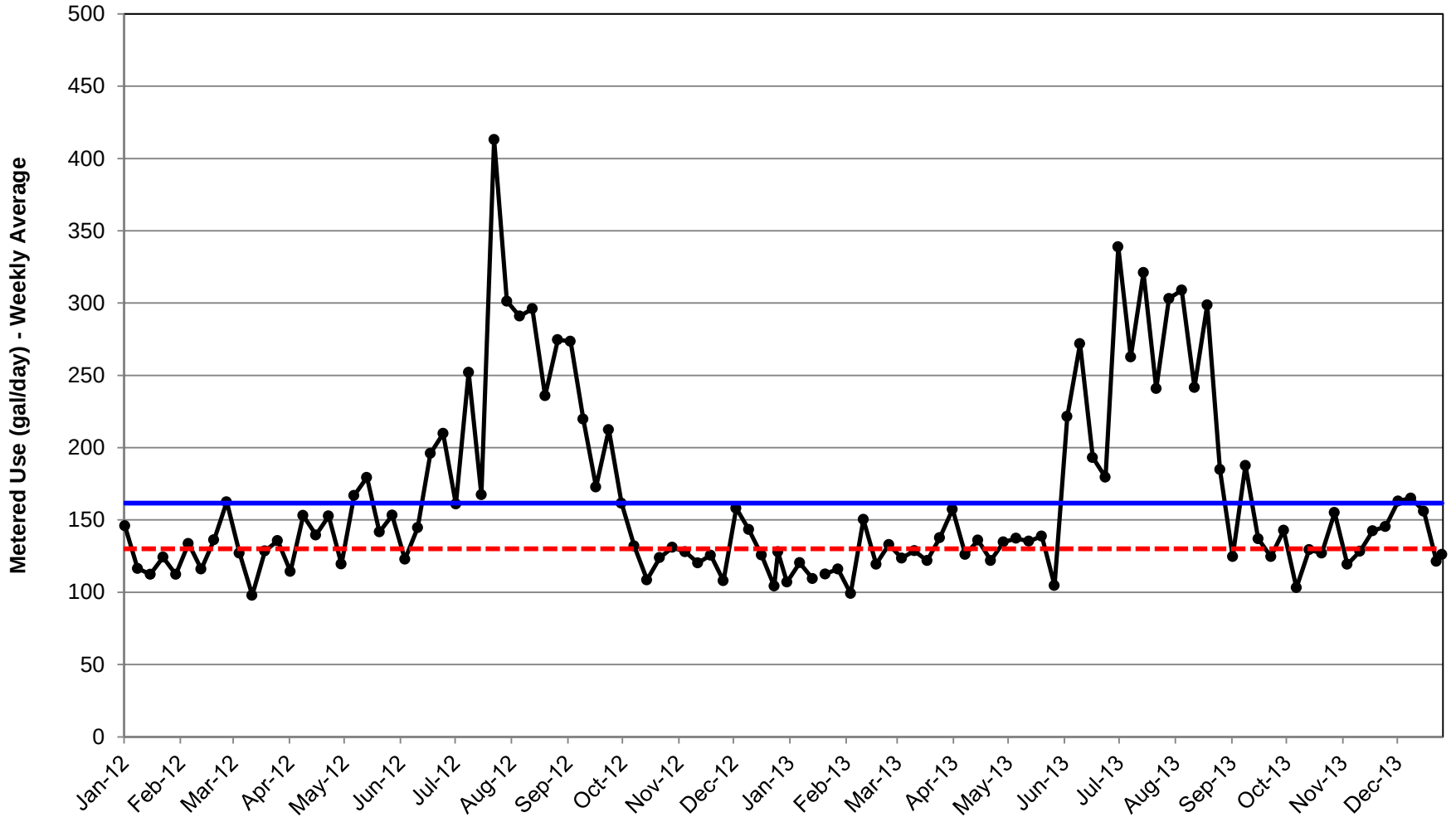
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-15**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 15

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

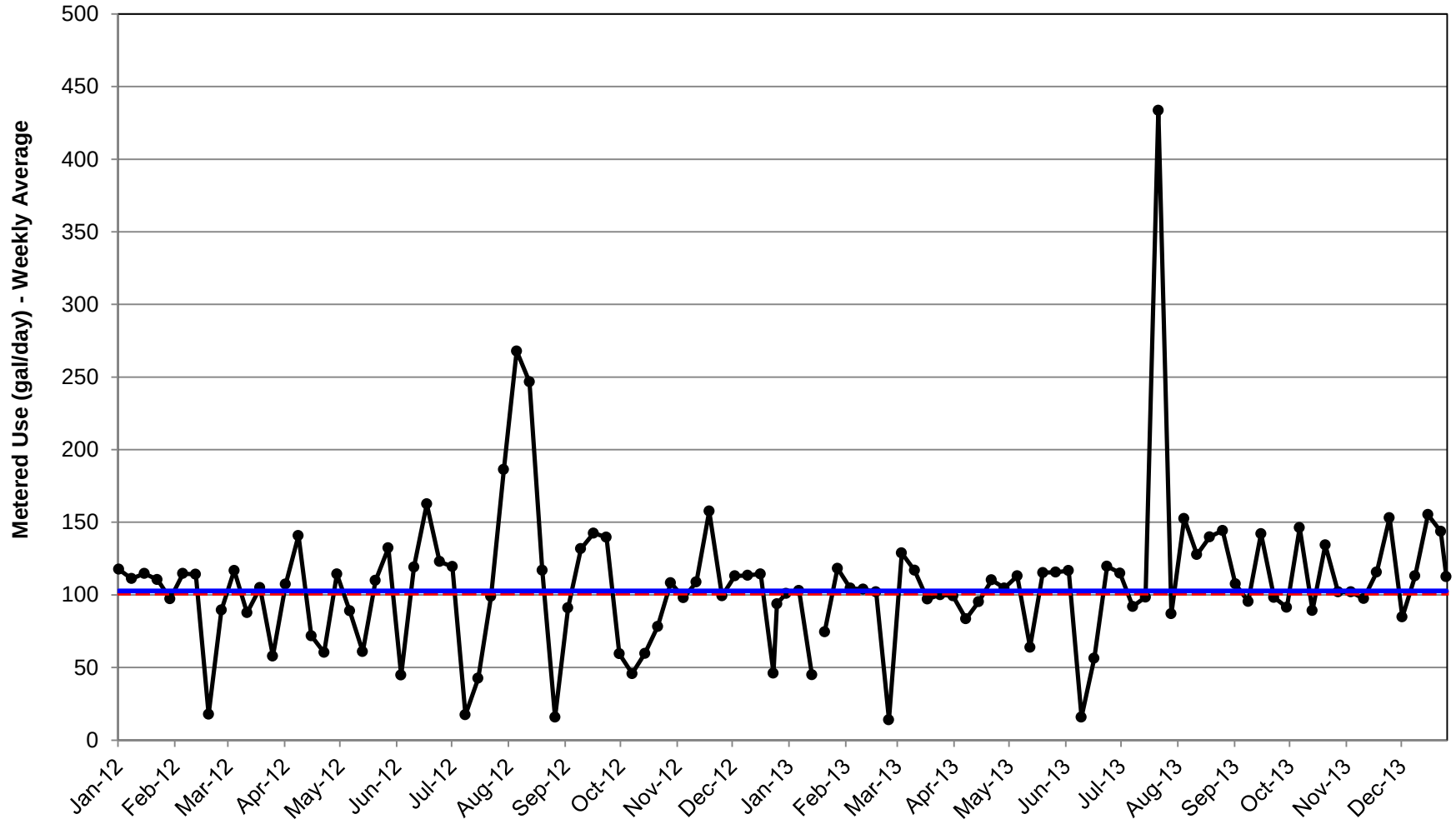
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-16**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 16

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

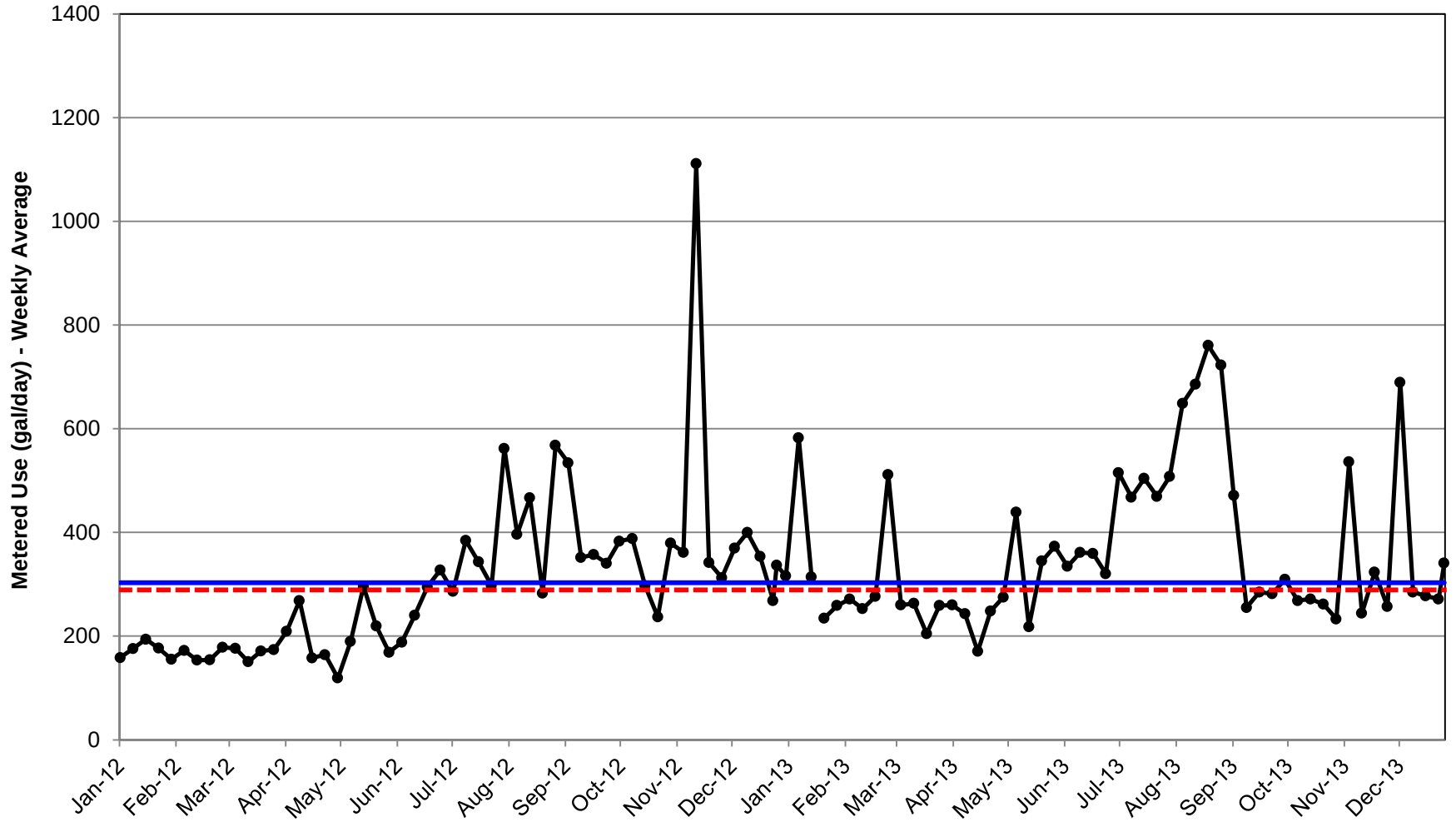
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **B-17**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 17

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

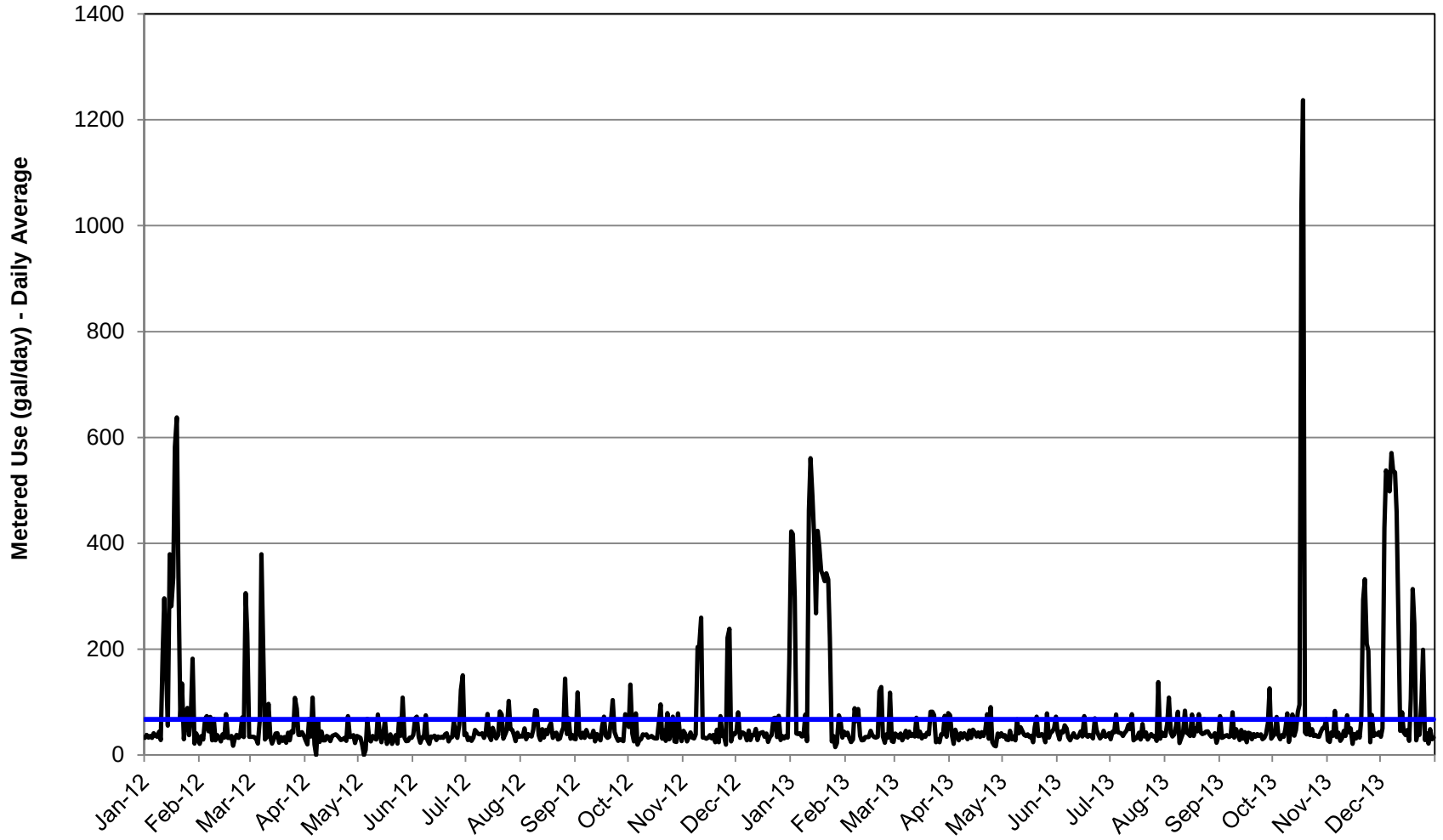
FIGURE **B-18**

DAILY GROUNDWATER USE (WEEKLY AVERAGE)
PROPERTY NO. 18

SC/Well Pilot Metering Program/WA

013-1500.035

APPENDIX C
DAILY WATER USE FIGURES



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

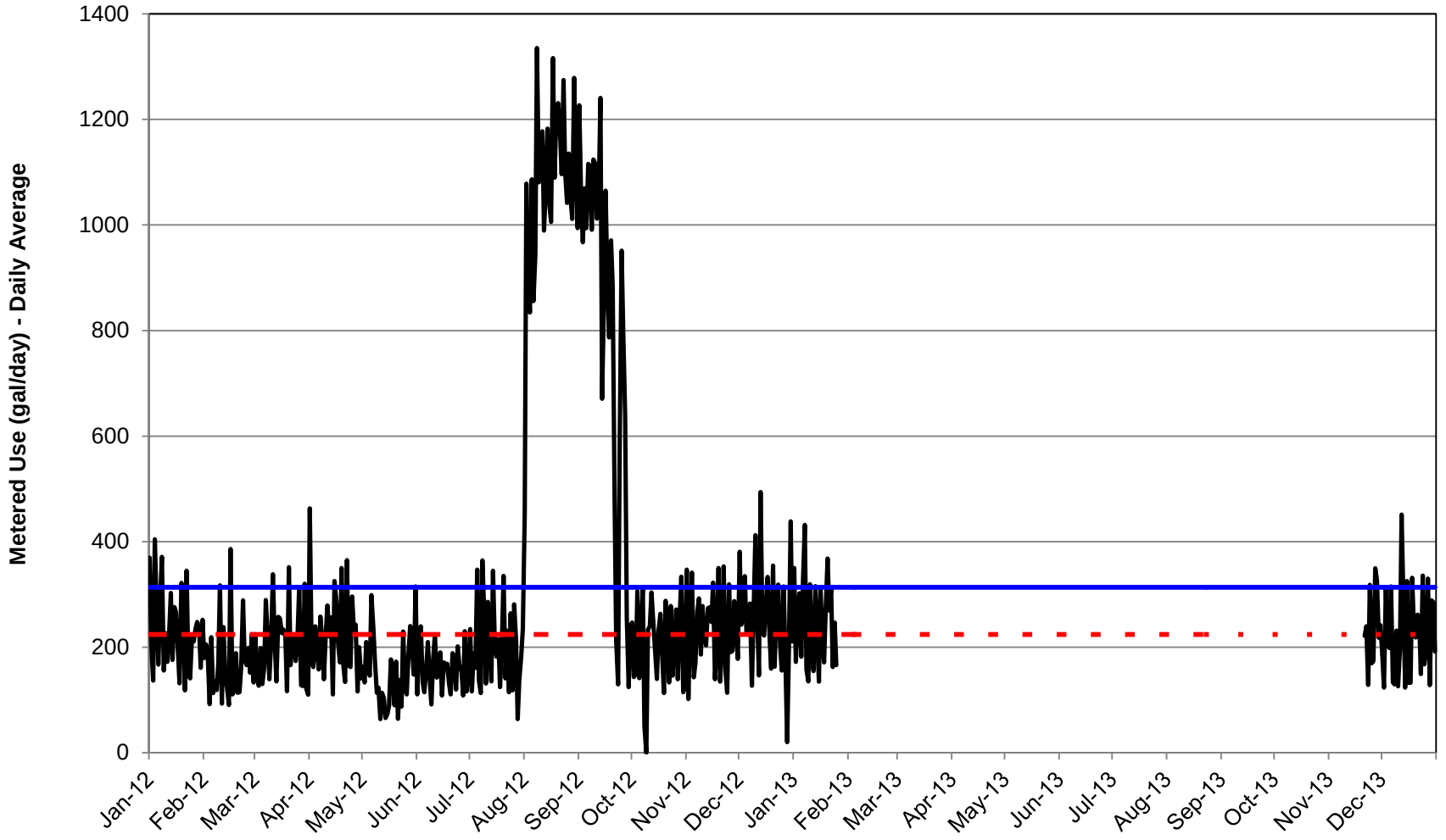
Average Annual Use

FIGURE **C-1**

DAILY GROUNDWATER USE
PROPERTY NO. 1

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Data are unavailable from January 21 to November 22, 2013 due to meter failure.

Golder Associates

LEGEND

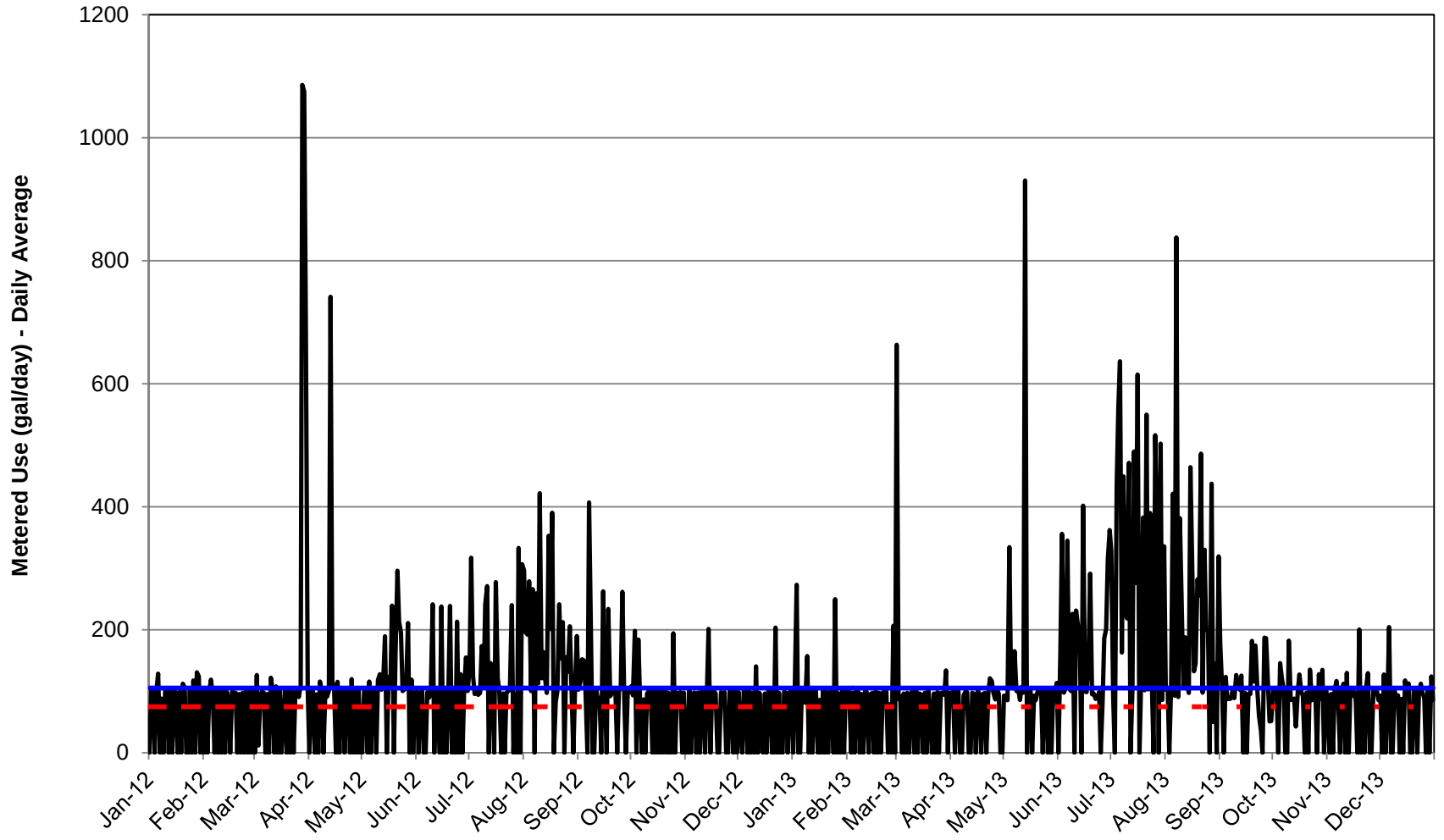
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-2**

DAILY GROUNDWATER USE
PROPERTY NO. 2

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

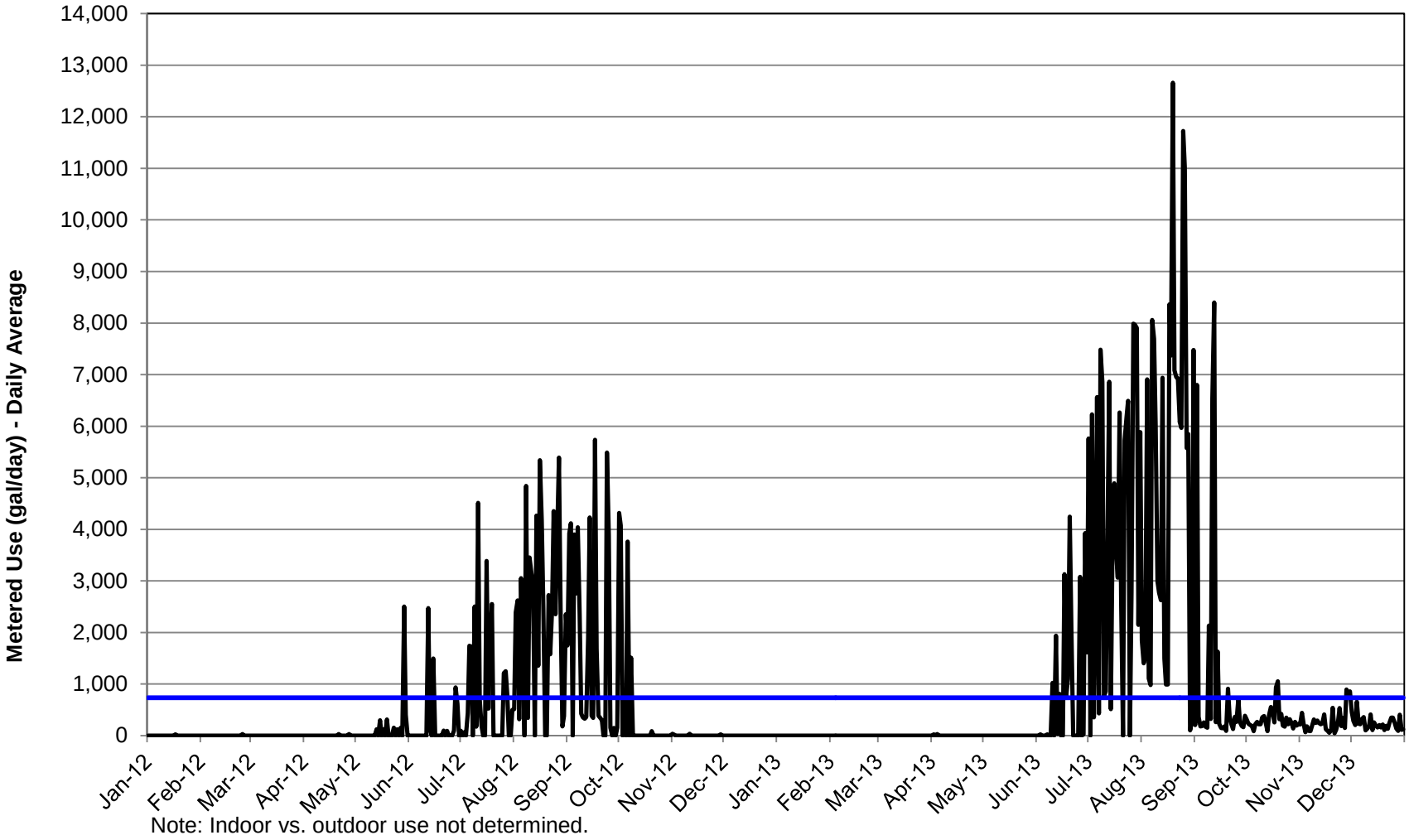
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-3**

DAILY GROUNDWATER USE
PROPERTY NO. 3

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

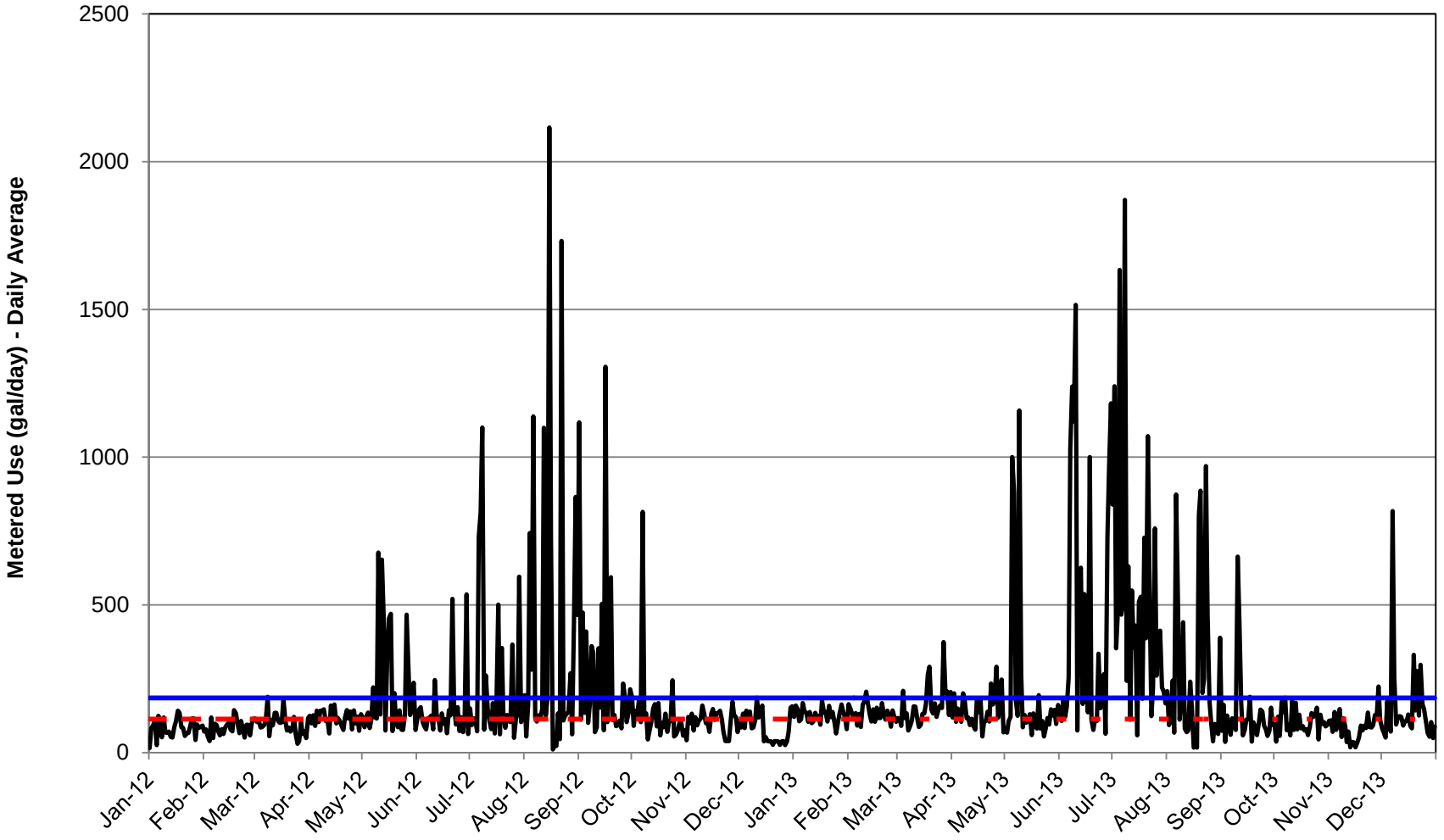
Average Annual Use

FIGURE **C-4**

DAILY GROUNDWATER USE
PROPERTY NO. 4

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

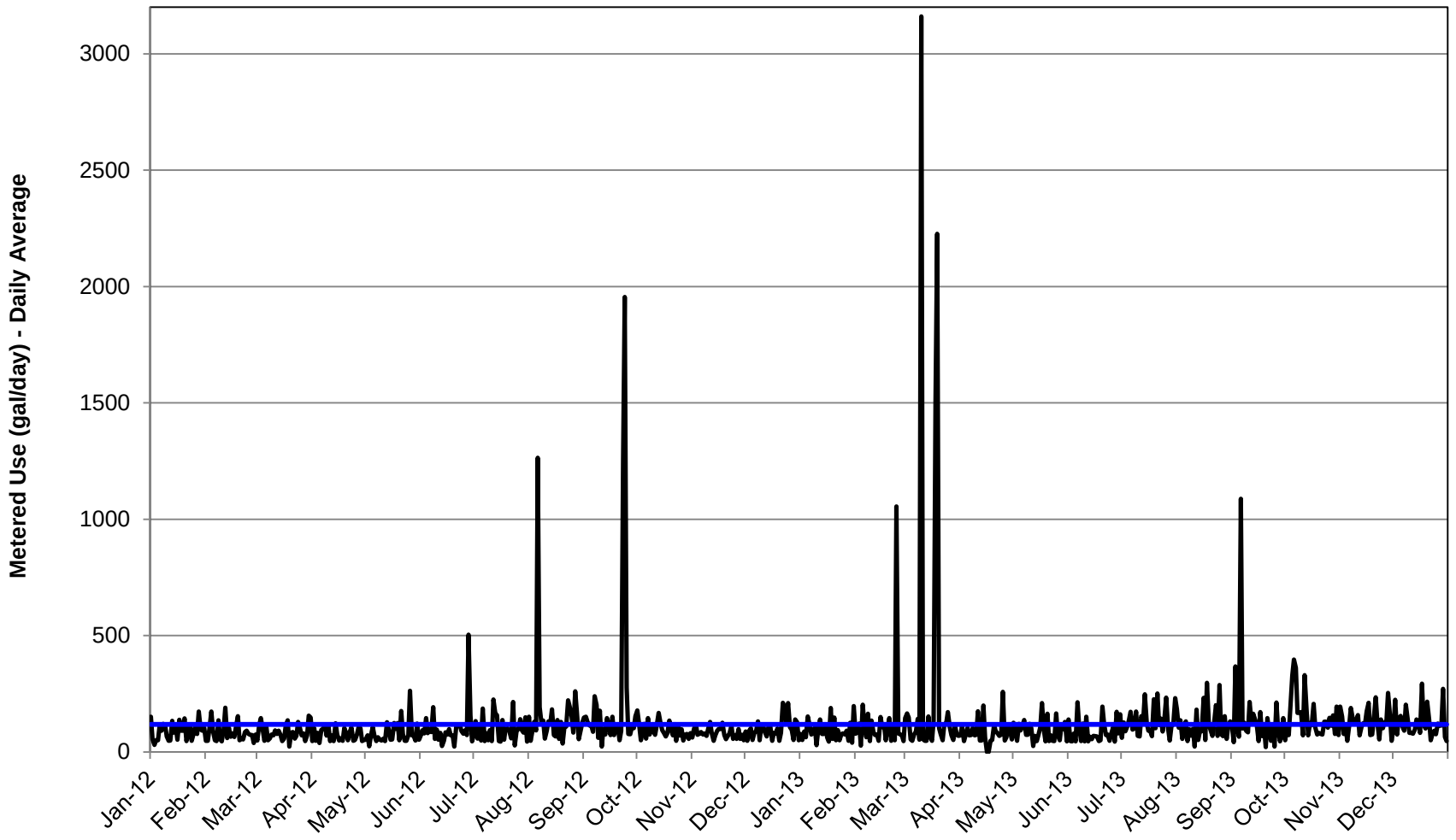
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-5**

DAILY GROUNDWATER USE
PROPERTY NO. 5

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

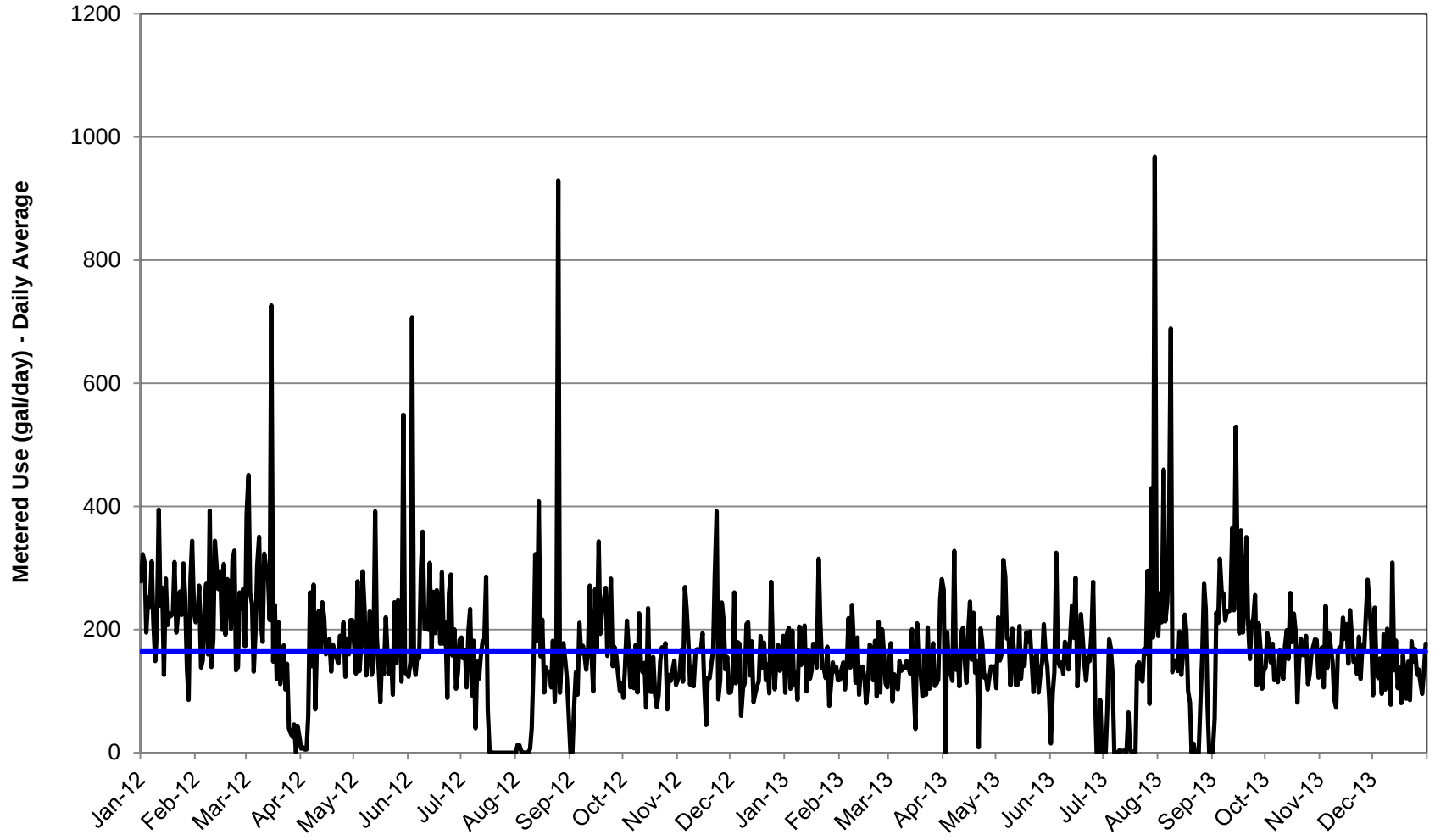
Average Annual Use

FIGURE **C-6**

DAILY GROUNDWATER USE
PROPERTY NO. 6

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

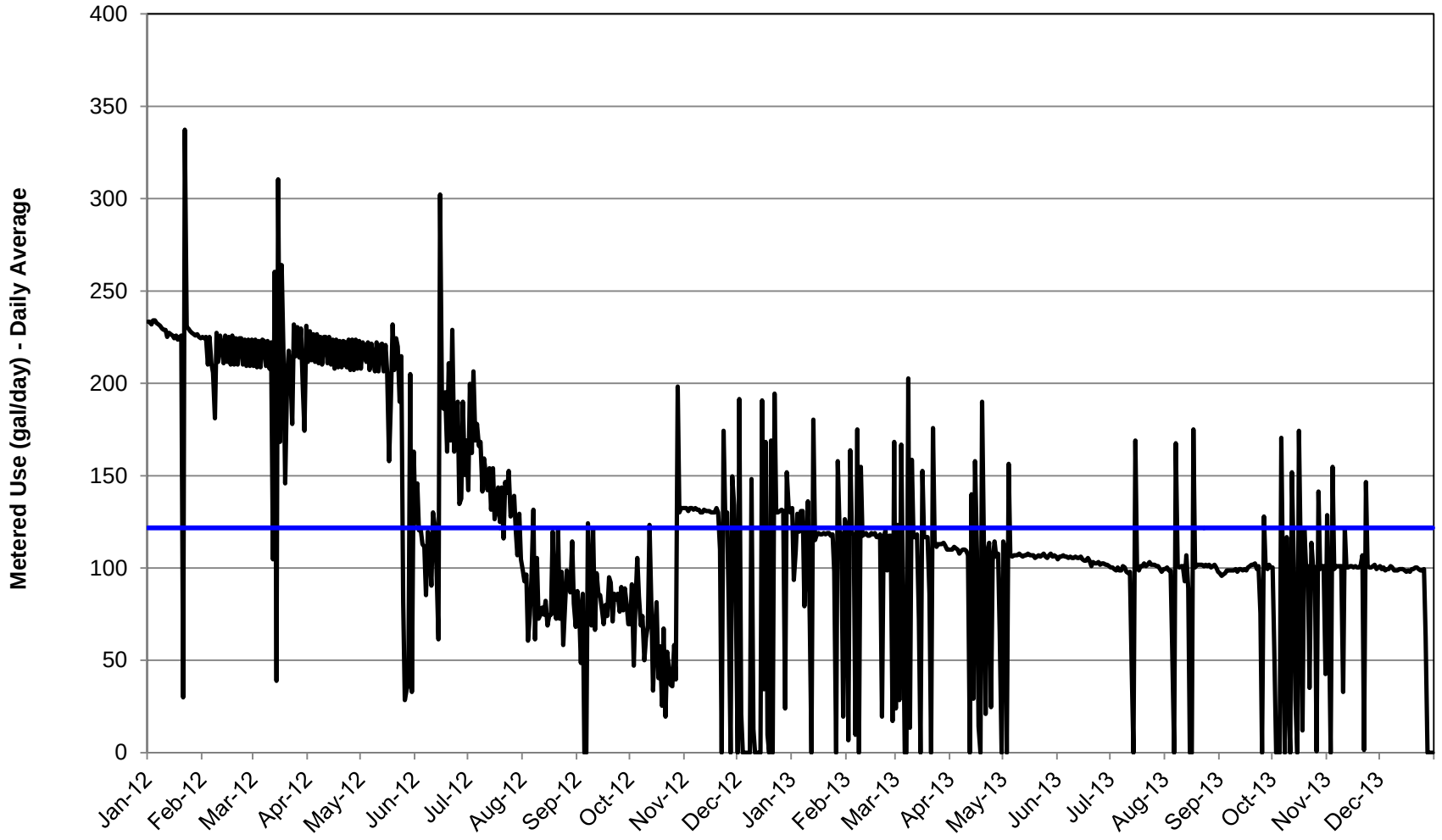
Average Annual Use

FIGURE **C-7**

DAILY GROUNDWATER USE
PROPERTY NO. 7

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

LEGEND

Series1 Series2

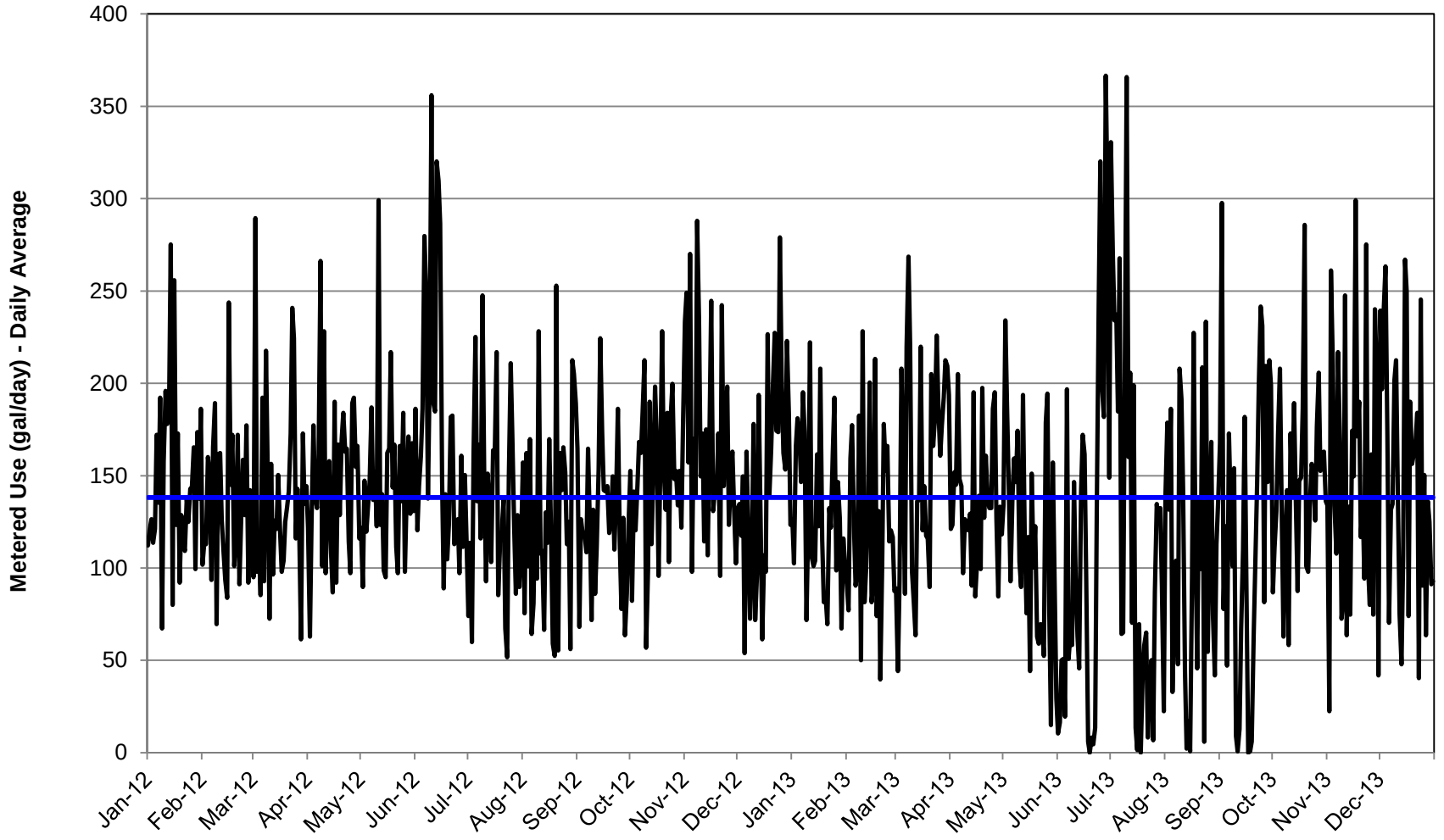
Golder Associates

FIGURE **C-8**

DAILY GROUNDWATER USE
PROPERTY NO. 8

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

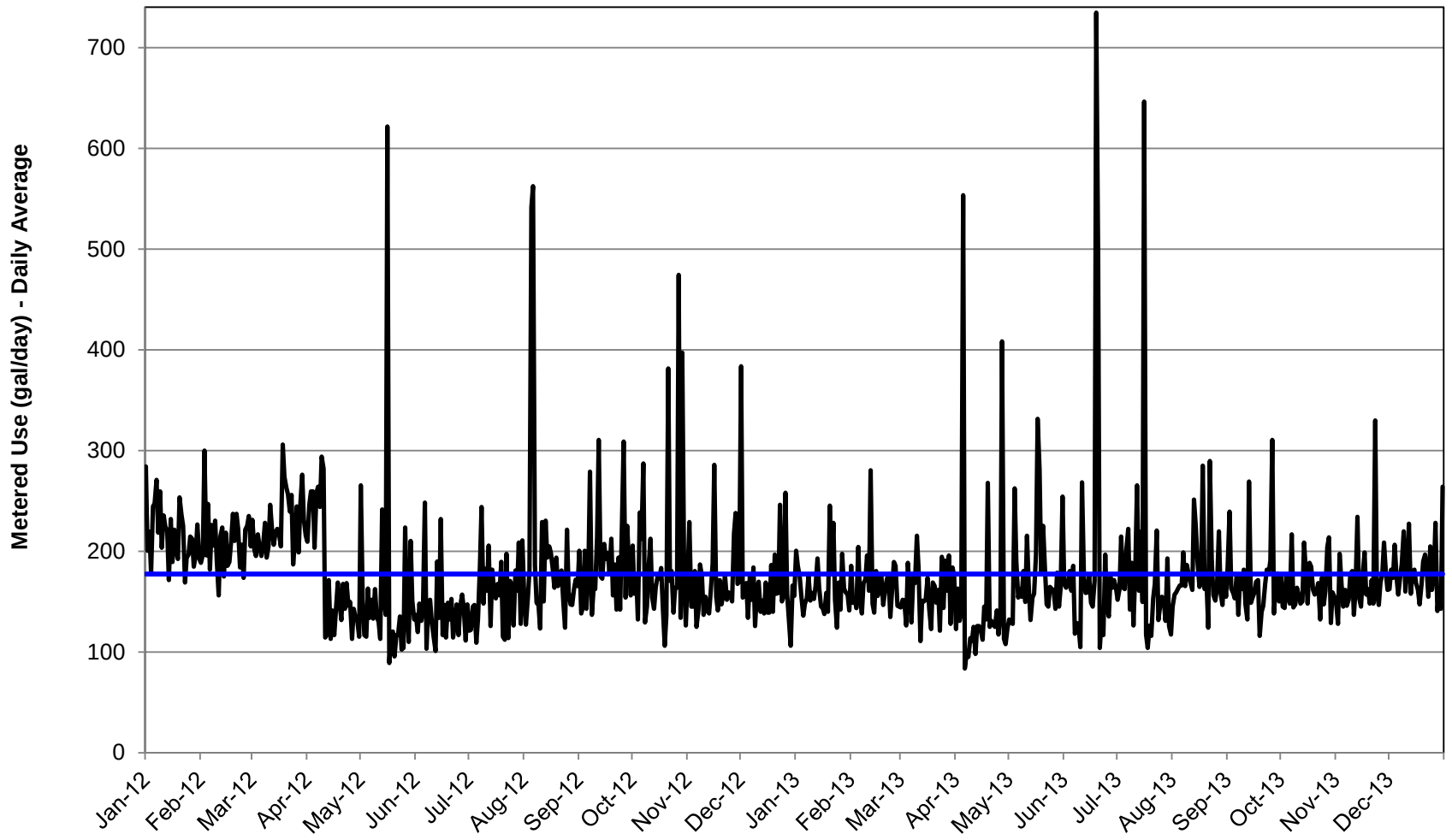
Average Annual Use

FIGURE **C-9**

DAILY GROUNDWATER USE
PROPERTY NO. 9

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

LEGEND

Series1 Series2

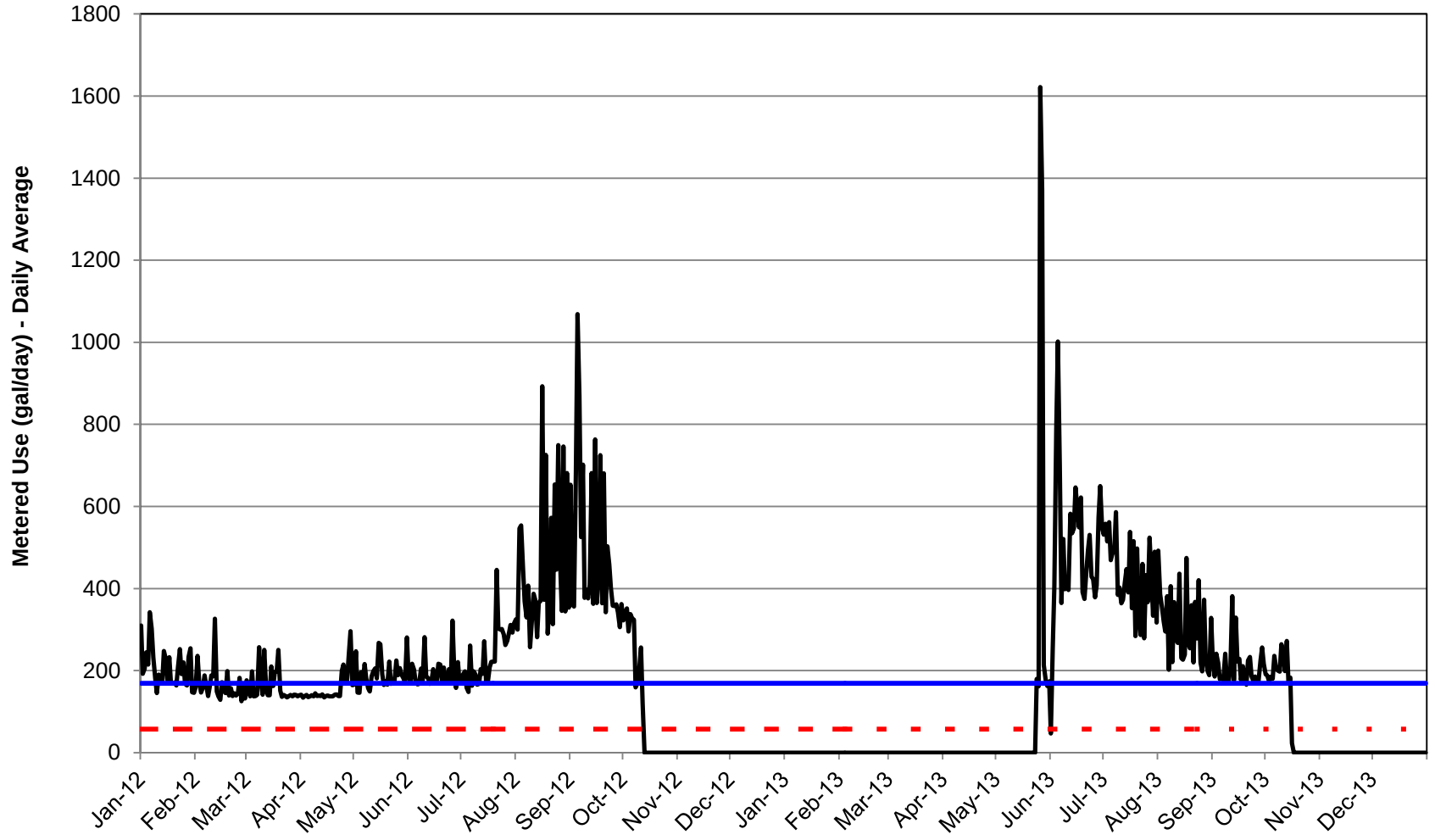
Golder Associates

FIGURE **C-10**

DAILY GROUNDWATER USE
PROPERTY NO. 10

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

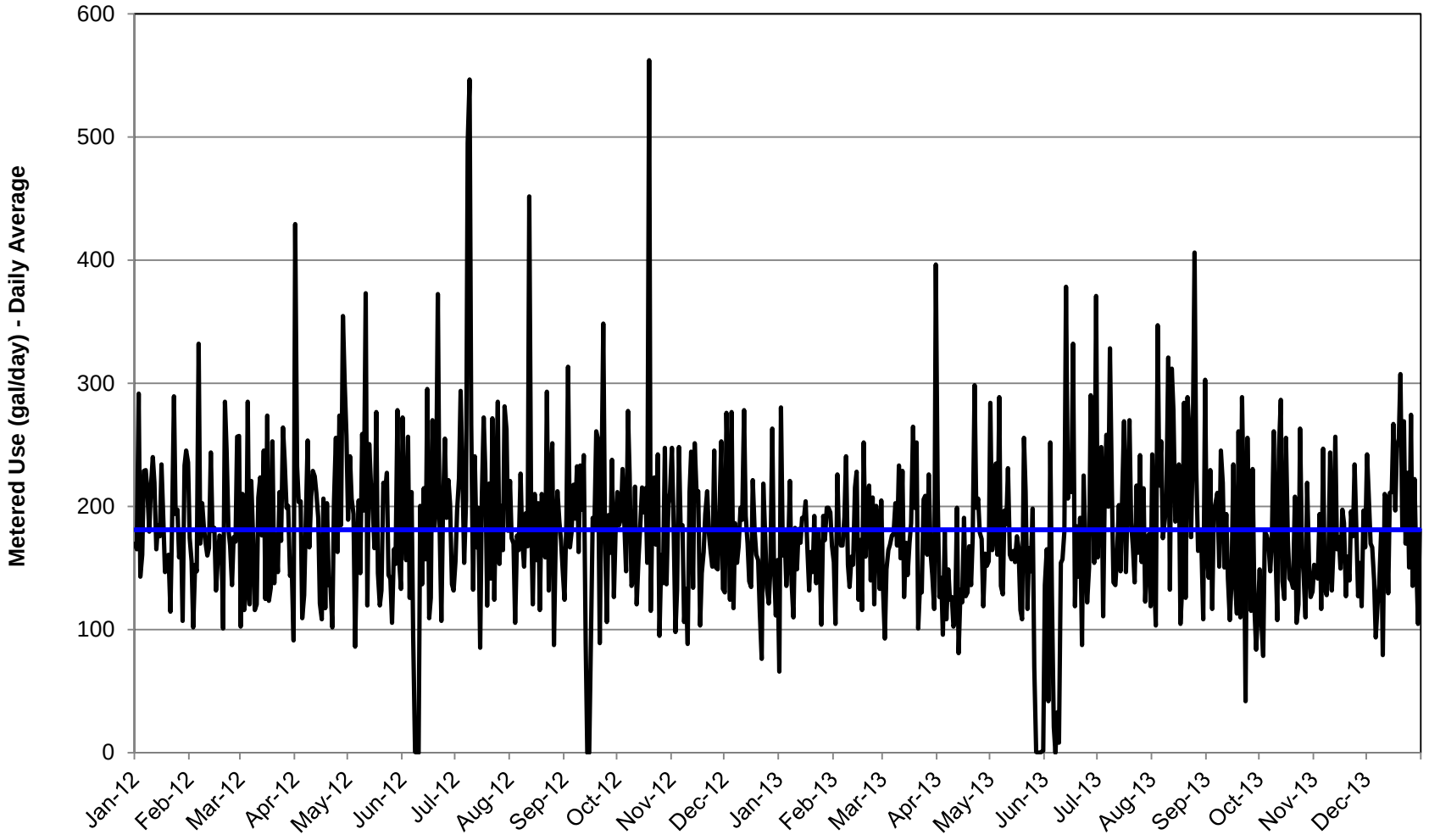
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-11**

DAILY GROUNDWATER USE
PROPERTY NO. 11

SC/Well Pilot Metering Program/WA

013-1500.035



Note: Indoor vs. outdoor use not determined.

Golder Associates

LEGEND

Total Water Use (Metered)

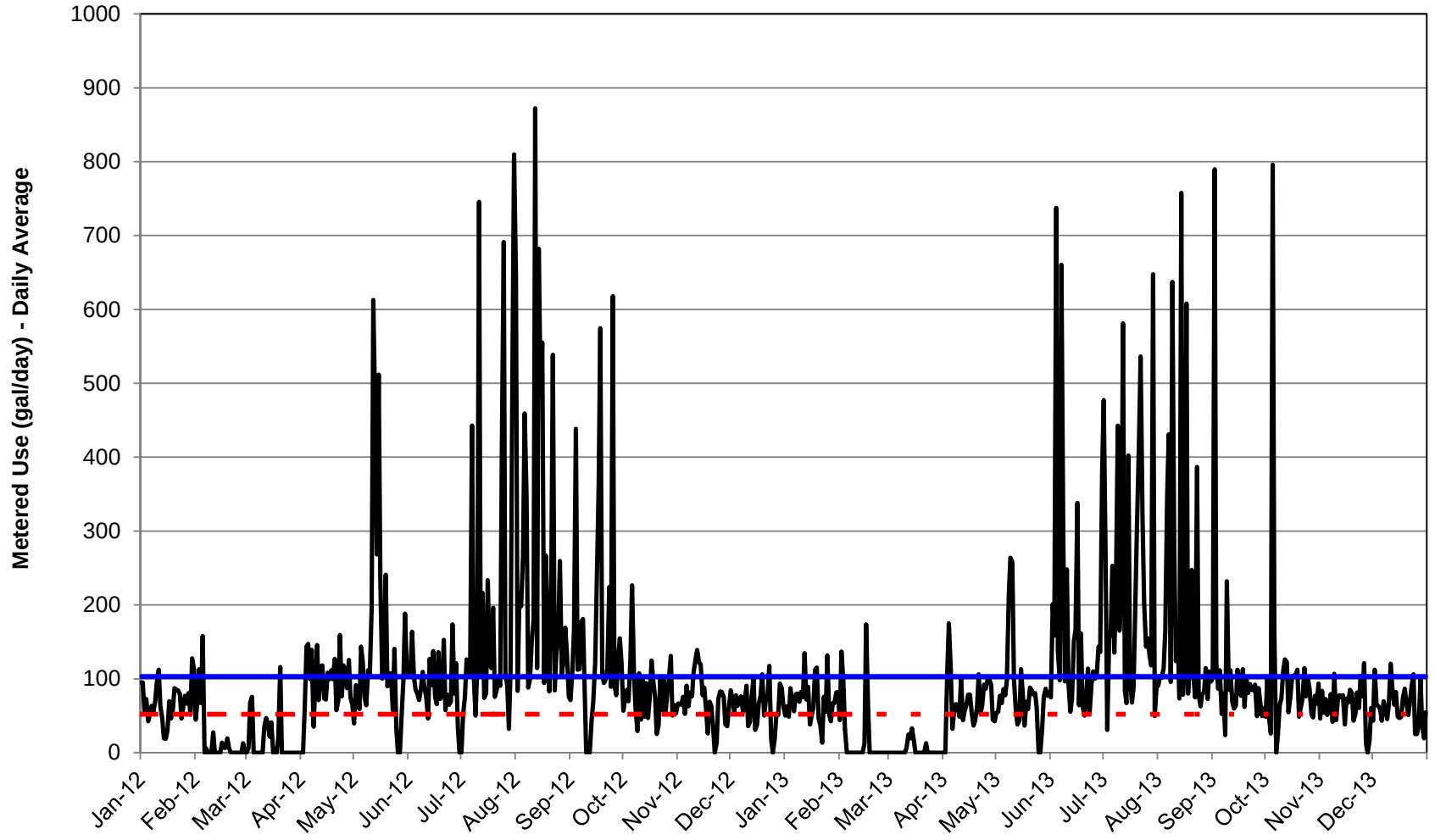
Average Annual Use

FIGURE **C-12**

DAILY GROUNDWATER USE
PROPERTY NO. 12

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

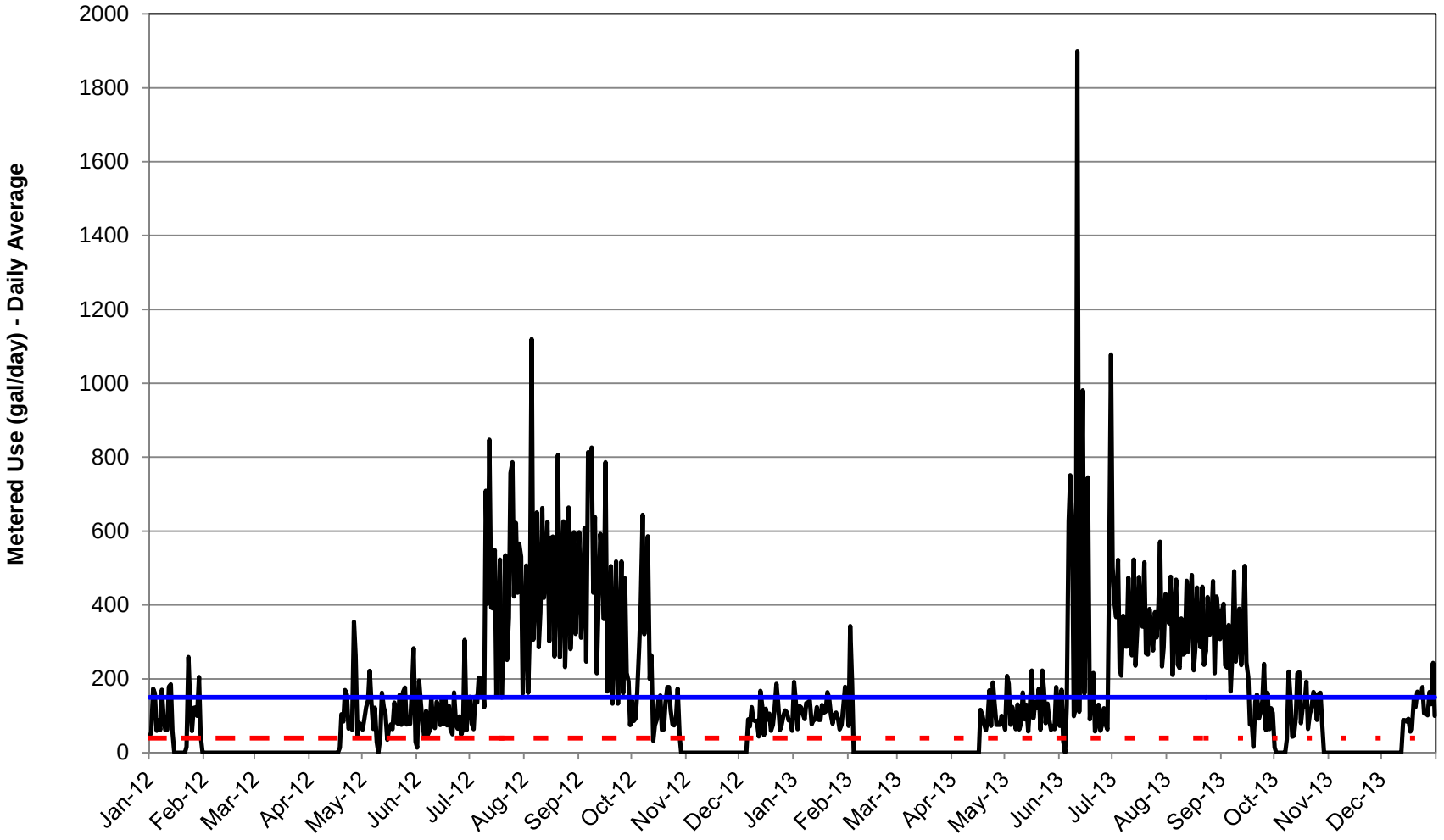
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-13**

DAILY GROUNDWATER USE
PROPERTY NO. 13

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

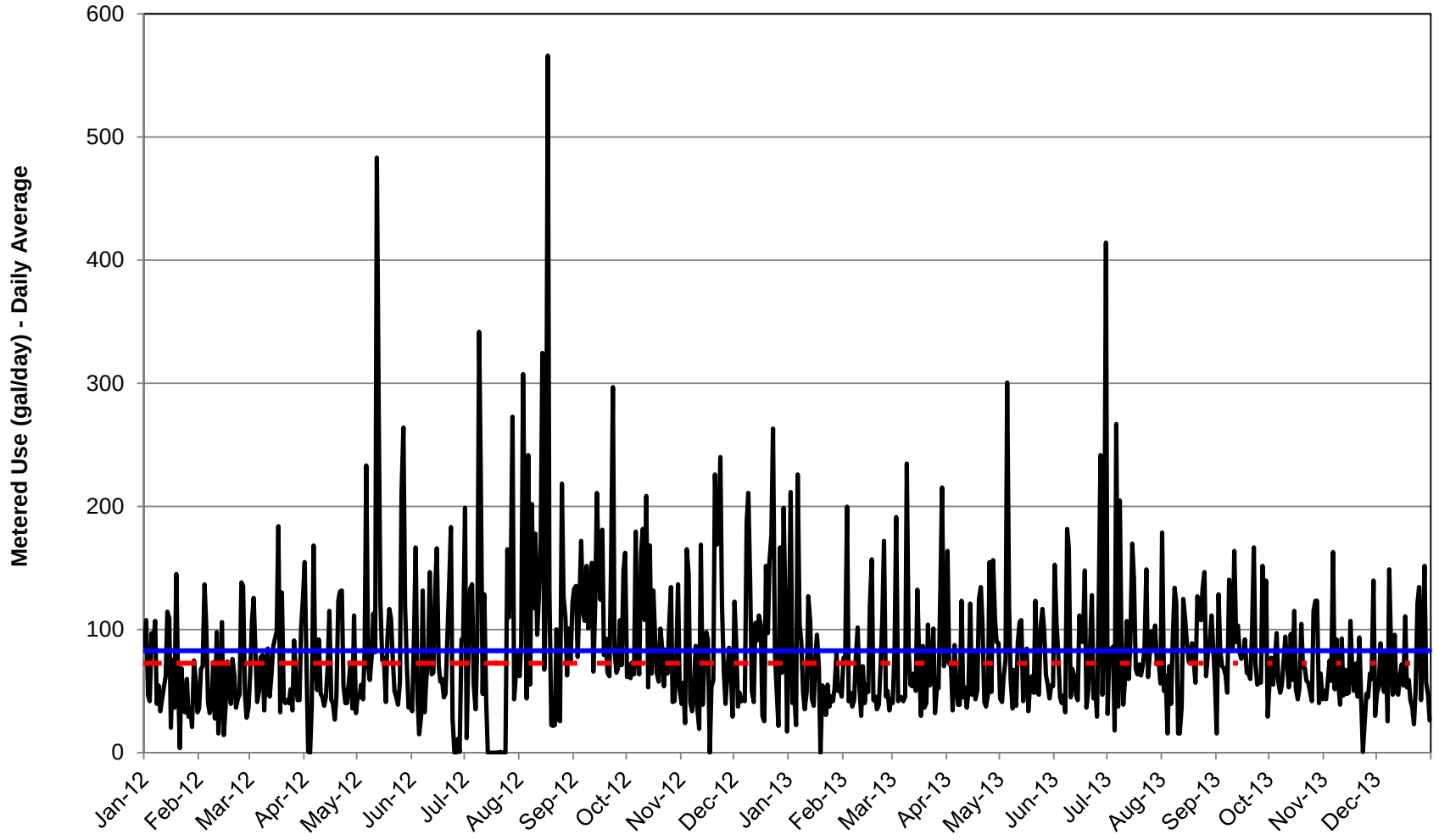
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-14**

DAILY GROUNDWATER USE
PROPERTY NO. 14

SC/Well Pilot Metering Program/WA

013-1500.035



Golder Associates

LEGEND

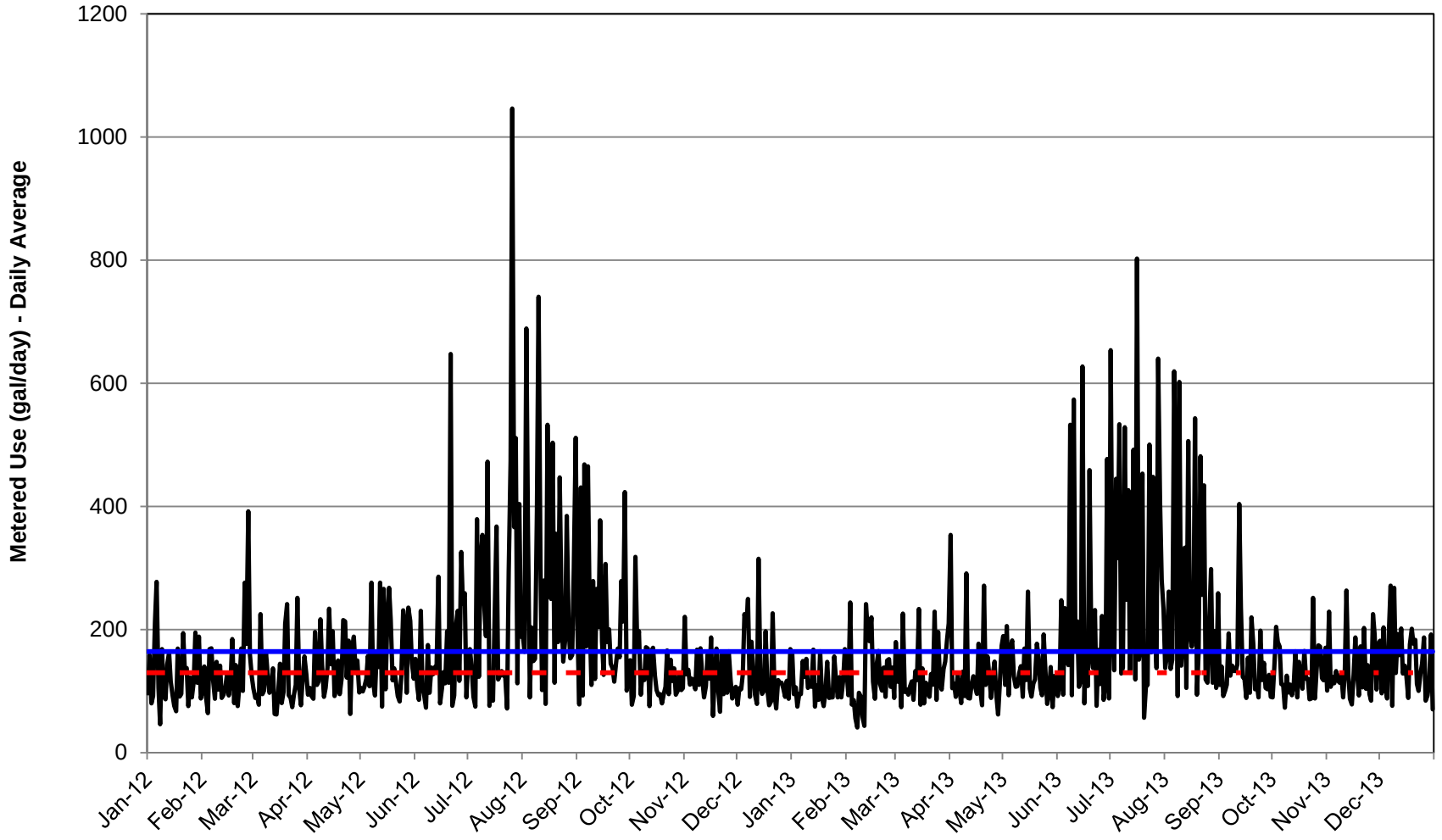
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-15**

DAILY GROUNDWATER USE
PROPERTY NO. 15

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

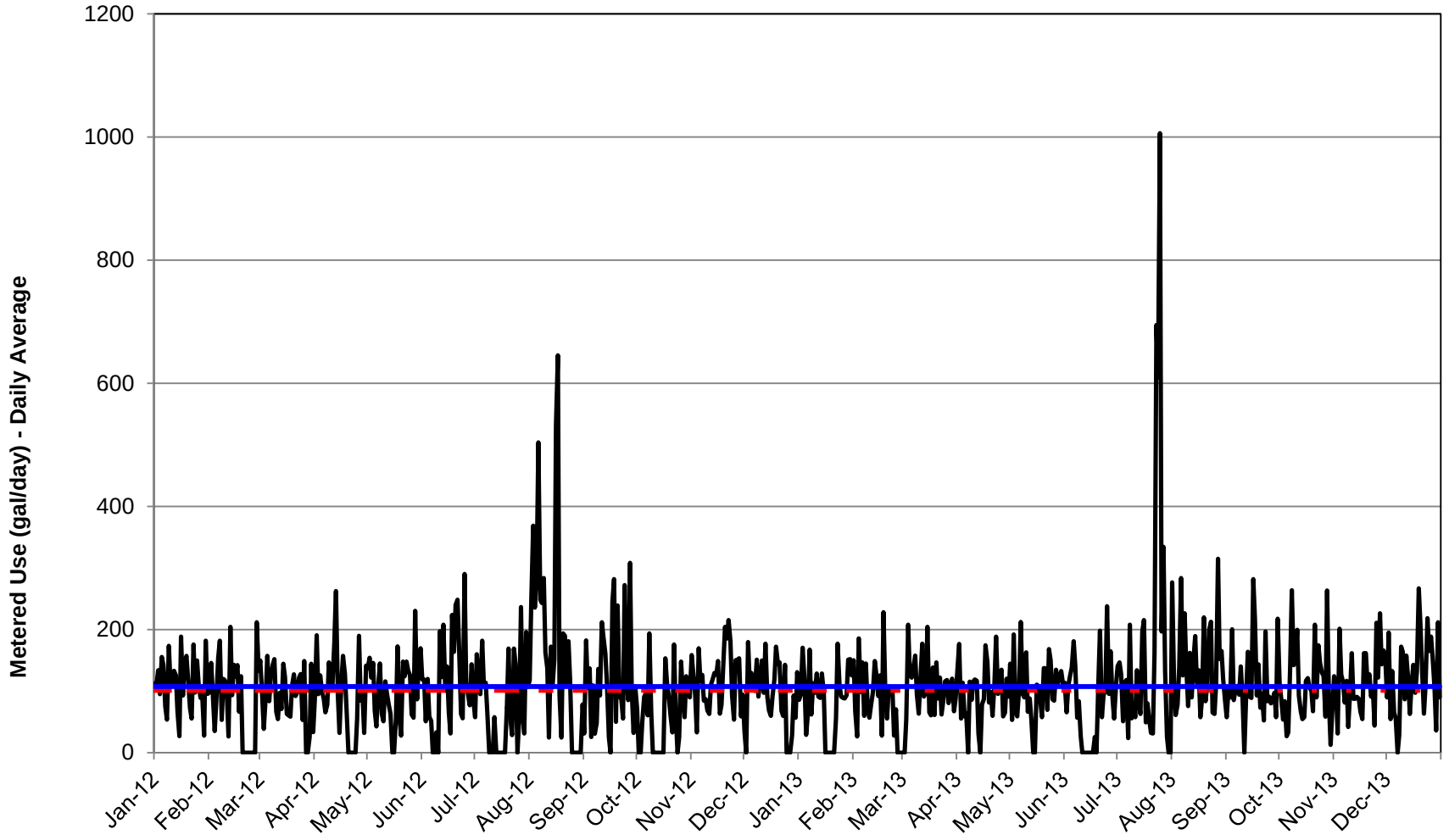
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-16**

DAILY GROUNDWATER USE
PROPERTY NO. 16

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

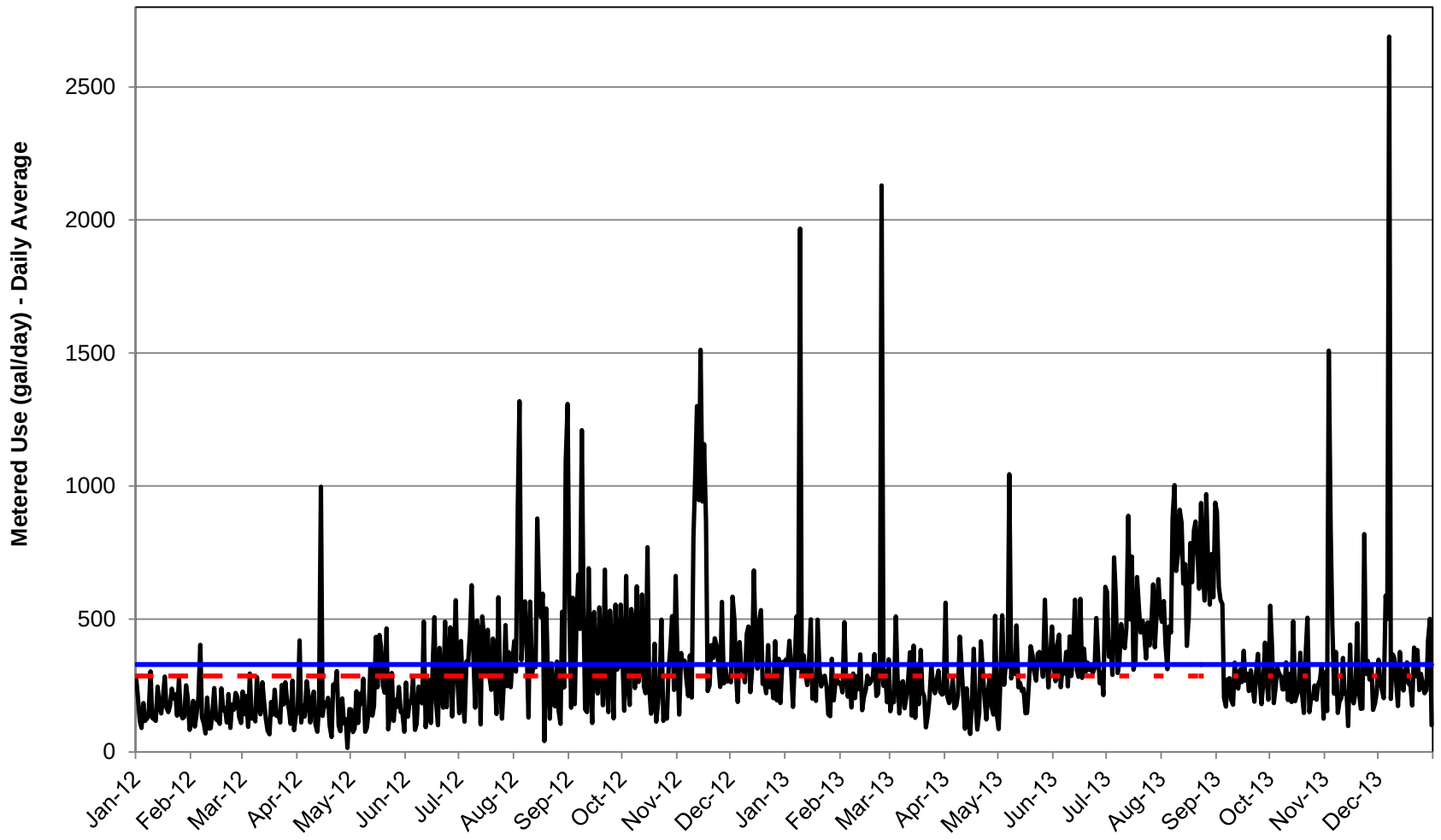
- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-17**

DAILY GROUNDWATER USE
PROPERTY NO. 17

SC/Well Pilot Metering Program/WA

013-1500.035



LEGEND

- Total Water Use (Metered)
- Average Indoor Use (Estimated)
- Average Annual Use

FIGURE **C-18**

DAILY GROUNDWATER USE
PROPERTY NO. 18

SC/Well Pilot Metering Program/WA

013-1500.035