WRC
WATER RESOURCES COMMISSIONER
Jim Nash

OAKLAND COUNTY
WATER RESOURCES COMMISSIONER

RESIDENTIAL EQUIVALENT UNIT STUDY
FINAL REPORT

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1.0 - Introduction

Purpose

The Oakland County Water Resources Commissioner's Office (WRC) has a published document titled "Oakland County Drain Commissioner - Schedule of Unit Assignment Factors" dated July 1, 1998. This document is utilized by the WRC and many of the communities within the County for determination of water and sewer use factors for different development types. The document uses a Single Family Residential property as the baseline for all comparisons by assigning a unit factor of 1.0 to this use. The document outlines many different non-residential development types and assigns a Residential Equivalent Unit (REU) factor relative to Single Family Residential use for each of these developments.

In order to update the Schedule of Unit Assignment Factors document, the WRC commissioned Johnson & Anderson, Inc. (J&A) to evaluate actual billing data for actual water consumption throughout the County for the purpose of quantifying a modern usage based REU quantification and to update the business classes and REU unit factors outlined in the current Schedule of Unit Assignment Factors.

The calculation of a new REU factor based on actual domestic usage will assist the WRC in improving the accuracy of an updated Schedule of Unit Assignment Factors in the future to more accurately predict projected non-residential REU quantities.

A number of factors governed the WRC's decision to update the current Schedule: 1) the current Schedule of Unit Assignment Factors has not been updated since 1998; 2) recent disputes have been filed with various entities over sewer connection fees and rates; 3) residential water usage is declining; and 4) high-efficiency appliances and fixtures are becoming increasingly popular, thus reducing overall water usage in the region.

The Study was comprised of two (2) phases:

Phase 1
Evaluating data to define the consumption characteristics of the baseline Single Family Residential use, commonly referred to as a Residential Equivalent Unit (REU).

Phase 2
Evaluating data and making recommendations for updates to the 1998 Schedule of Unit Assignment Factors document for various usages within Oakland County.

Trends in Water Consumption

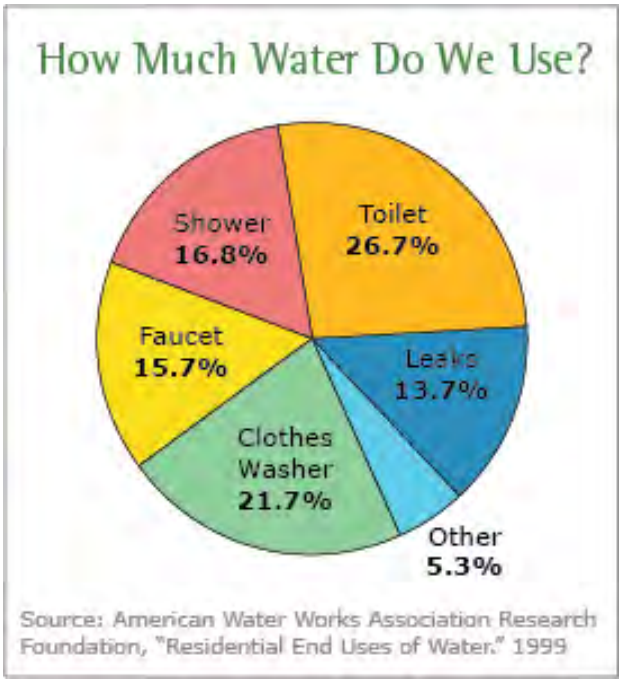
In recent years, water consumption has been on a downward trend due to improved water efficiency and water conservation practices. Updating the value of an REU based on actual consumption data will provide a realistic estimation of current water use in these communities.

Improved Water Efficiency

High-efficiency appliances have become increasingly popular over the past few years as people try to reduce their water bills and be more environmentally conscious.

Appliance and fixture manufacturers are producing more water-efficient products than ever before. Appliances such as high efficiency dishwashers and washing machines which use less water to operate are more common now than in years past. Low flow toilets, faucets and shower heads are also being installed in homes as many residents aim to reduce their water consumption.

Looking at the pie chart below from the American Water Works Association (AWWA) Research Foundation, toilets and washing machines combined account for nearly half of the water used in a home.



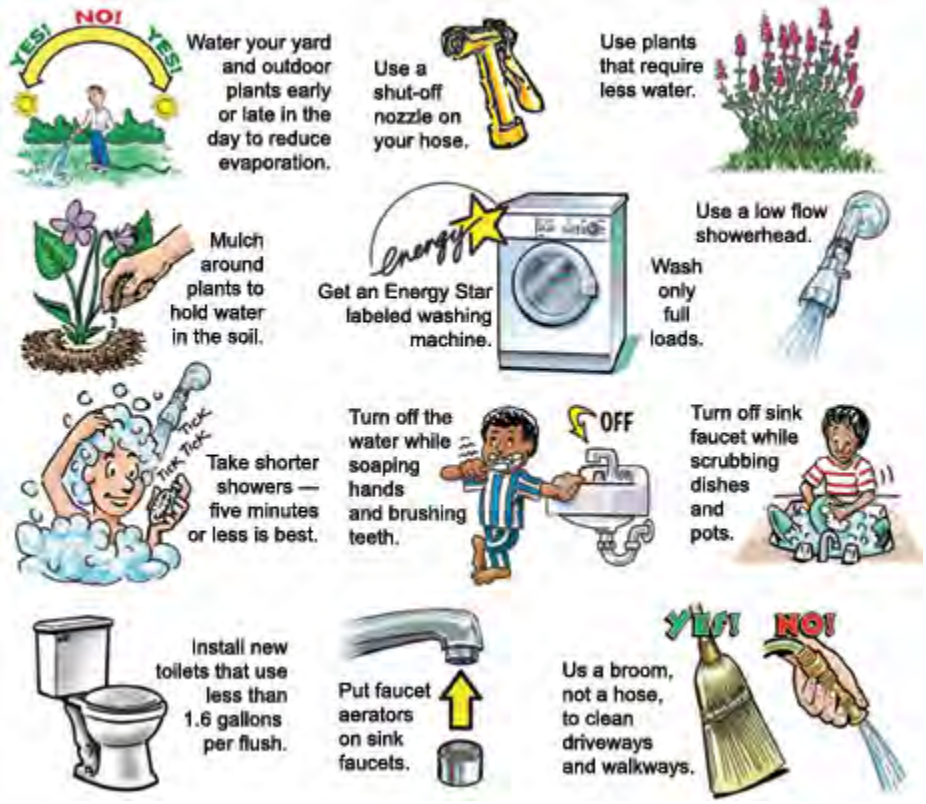
Since high-efficiency models of both of these appliances have become overwhelmingly popular in the last few years, it is easy to understand the impact they have had water consumption.

Water Conservation

Public education programs and other media have also encouraged water conservation techniques. Evidence of this can be seen as municipalities across the country have introduced rebate programs and ordinances that promote water conservation.

Source: http://www.fortlauderdale.gov/news/2011/toilet_rebates.htm

Although Oakland County does not have a rebate program, efforts have been increased to inform residents of ways they can reduce the amount of water they use on a daily basis. Oakland County and its communities regularly inform residents of ways to conserve water on their websites, newspapers, flyers, and bulletins. Some of these strategies include: installing rain gardens, sweeping rather than hosing paved surfaces, installing automatic shut-off hose nozzles, and fixing leaks and runny toilets.



Source: www.watersavingstips.org/tips.html

Demographic Influence on Water Usage

Studies by agencies such as AWWA and USEPA have proven that water consumption trends are also responsive to demographic characteristics such as household income, value of household and persons per household. Oakland County covers a broad range of demographics, which vary per community as well as within each community.

Because certain demographics can influence water consumption, a standardized REU value may or may not be representative of each community. In many cases, factors such as average number of persons per household, household income and household value show a correlation to water consumption. For this reason, REU values and demographic information for each community were compared to draw conclusions about the accuracy of using a single REU value to represent all communities. Refer to Section 2.3 for further analysis of demographics.

2.0 – Phase I

Previous WRC rate studies were reviewed for methodology and scope. The Phase I study evaluated water usage data for eleven (11) communities in the Oakland County billing system: Bingham Farms, Bloomfield Hills, Commerce Township, Farmington Hills, Highland Township, Keego Harbor, Lyon Township, Oakland Township, Orchard Lake, Oxford Township, and Royal Oak Township.

Water meter billing data provided by the WRC from these 11 communities was organized, filtered, and analyzed. The data was then cross referenced with SEMCOG demographic data for each community to determine key demographics that could have an impact on water consumption. Billing information for the November through March time frame was utilized to determine a baseline flow rate that does not include irrigation consumption. Despite the fact that previous WRC rate studies were conducted utilizing the annual water usage data, it was decided for this current study to eliminate irrigation consumption. The benefits of analyzing winter quarter data only include:

- Eliminating skewed water usage data during wet or dry years,
- Eliminating large variations in water usage data from residential and commercial properties that irrigate aggressively versus those properties that don't irrigate at all, thus reducing potential outliers, and
- Reducing the impacts from inflow and infiltration.

Data was analyzed for years 2010, 2011, 2012, and 2013 in order to yield the most pertinent results and detect possible trends over time. Usage data from 5/8-inch and 1-inch residential water meters were used to best represent the single family residential accounts in the communities. Industry wastewater and water usage guidelines were reviewed and compared to actual community and weighted average usages.

SEMCOG and billing data were used to calculate an actual weighted billing based usage per household per day representative of the communities' population percentage of the whole study population. The Phase I report summarized the findings of the investigation, and presented the results in a way that demonstrates how different demographics impact the water and sewer use for a Single Family Residence. The analysis indicates that as people per household, average household value, and average household income increase, so too does water usage. The calculated weighted usage per household per day was then utilized to provide the basis for an updated baseline REU recommendation.

The original data set was statistically reduced to eliminate 5% of high end outliers and 5% of low end outliers resulting in the remaining 90% consumption being utilized in the analysis as well as 80% of the used water being returned to the wastewater system and 15% of the usage being returned to the wastewater system as infiltration and inflow.

The current WRC Schedule of Unit Assignment Factors assumed usage for a single family residential sewer customer is 15,370 cubic feet per year, assuming:

- 3.5 people per household, and
- each person using 90 gallons of wastewater per day,
- for a total household usage of 315 gallons of wastewater per day per household.

Quantifying a Modern REU Value

The existing WRC REU value of 15,370 cubic feet per year, derived theoretically without the use of actual consumption data, was calculated using the assumption of 3.5 people per household with each person using 90 gallons of water per day. As part of the Phase I study, both the number of people per household and their resulting water use per day based on actual winter month billing usage were evaluated. Analysis has demonstrated, for instance, that the number of people per household has dropped significantly according to recent SEMCOG data with the average number of people per household in Oakland County dropping to 2.46 in 2010 and 2.44 in 2013.

Table 2.01 - People per household by community (SEMCOG)

COMMUNITY	2010	2013	Percent Change (2010-2013)
BINGHAM FARMS	2.11	2.05	-2.8%
BLOOMFIELD HILLS	2.44	2.43	-0.4%
COMMERCE TOWNSHIP	2.71	2.67	-1.5%
FARMINGTON HILLS	2.36	2.34	-0.8%
HIGHLAND TOWNSHIP	2.69	2.65	-1.5%
KEEGO HARBOR	2.3	2.31	0.4%
LYON TOWNSHIP	2.78	2.76	-0.7%
OAKLAND TOWNSHIP	2.9	2.87	-1.0%
ORCHARD LAKE	2.78	2.73	-1.8%
OXFORD TOWNSHIP	2.8	2.79	-0.4%
ROYAL OAK TOWNSHIP	2.36	2.44	3.4%
OAKLAND COUNTY	**2.46**	**2.44**	**-2.0%**

The Phase I study also verified direct correlations between: 1) increase in water rates and decrease in water consumption; 2) increase in people per household and increase in water consumption; 3) increase in home value and increase in water use; and 4) increase in household income and increase in water use.

For comparison sake, the following published water use recommendations from various sources are provided.

1. The Great Lakes – Upper Mississippi River Board (GLUMRB) (aka 10 States Standards) indicates in the 2004 Recommended Standards for Wastewater Facilities that they recommend sizing facilities based on an average per capita flow of **100 gallons per day**. This number does include flow due to normal infiltration into a system built with modern construction techniques.
2. The United States Geological Society (USGS) published a 2005 report on domestic water use. The total domestic per capita use in Michigan was **80 gallons per day**, the U.S. average was **98 gallons per day**. (These numbers include indoor and outdoor use).

3. Haestad Methods Computer Applications in Hydraulic Engineering fifth edition indicates studies have shown that, on average, a resident of middle class housing generates **74 gallons per day** in wastewater.
4. A 1999 report by Aquacraft, Inc. Water Engineering and Management, sponsored and published by the AWWA Research Foundation indicates that the average per capita indoor water use was **69.3 gallons per day** for the study area.
5. Innovyze - Comprehensive Sewer Collection Systems Analysis Handbook for Engineers and Planners 2004 indicates a typical wastewater load of **75 gallons per day** per person in single-family dwellings.

Several of these sources report consumption in terms of wastewater rather than water usage. In order to compare these values to the recommended water usage for each community, conversions were made assuming 80% of water is returned to the system as wastewater. 80% is a widely accepted industry standard for this water to wastewater relationship. Please refer to Appendix VII for the conversions of sewer usage to water usage.

Table 2.02 - Published recommended water use values.

Source:	Recommended Water Usage
USGS (Michigan Average)	80 gal/person/day
USGS (U.S. Average)	98 gal/person/day
Aquacraft, Inc.	69.3 gal/person/day
Oakland County	90 gal/person/day

Table 2.03 - Published recommended sewer use values.

Source:	Recommended Sewer Usage	Water Usage Converted from Sewer Usage
GLUMRB	100 gal/person/day	125 gal/person/day
Haestad Methods	74 gal/person/day	93 gal/person/day
Innovyze	75.0 gal/person/day	94 gal/person/day

2.1 - Data Analysis Process

A complete set of all residential water meter readings were provided by the Oakland County Water Resources Commissioner (WRC) for eleven communities over a four year span, 2010 through 2013. The data set was statistically reduced in order to analyze only the data from typical single-family residential units during the winter months for each community. From the resulting data, a baseline quarterly water consumption value was calculated and displayed for each community, as well as for all of the communities combined. This value can be converted to accurately represent the water usage of one residential equivalent unit, REU. The following data analysis process was utilized for each community in the study.

Community Demographics

Relevant demographic information was obtained from SEMCOG and used to develop profiles for each community.

Table 2.10 - Sample Community - SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	1,111	1,086	-2.3%
Occupied Units	527	531	0.8%
People per Household	2.11	2.05	-2.8%
Median Housing Value	$391,900	N/A	N/A
Median Household Income	$130,625	N/A	N/A
Avg. Water Consumption (Units)	23.08	21.73	-5.8%

The information represented in these tables is used to identify correlations between demographic trends and water consumption.

Water Meter Sizes

The water meter billing data provided includes all residential accounts within each of the 11 communities. From this data set, only 5/8-inch and 1-inch meters were analyzed because they represent the bulk of typical residential installations. Initially, the data for 5/8-inch meters and 1-inch meters were analyzed separately. Then, the two sets of data were combined and analyzed together.

The distribution of the two meter sizes is displayed as shown Table 2.11 for each community along with the average water usage for both sizes separately and combined.

Table. 2.11 - Sample Community - Water Meter Size Distribution

Community	People/ Household	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
SAMPLE	2.05	206	12%	88%

Base Data

Only meter readings from February, March and April were used in order to determine baseline water consumption during the winter months. Eliminating data from "non-winter" months removes those which include landscape irrigation and other seasonal water use, which would increase the average quarterly residential water consumption, which is not representative of baseline consumption. Meter readings of zero (0) were also removed from the data set to prevent inactive accounts from reducing the average quarterly consumption.

Histogram graphs were created using consumption in intervals of 10 units, where 1 unit equals 100 cubic feet. Consumption was plotted versus the number of account readings within each interval. First, data was plotted separately for 5/8-inch and 1-inch meters, shown in **Figure 2.12** and **Figure 2.13**. A third graph, **Figure 2.14,** was then generated using both 5/8-inch and 1-inch meter data combined. For initial analysis, separate bars were created for each of the four years, which are displayed simultaneously on each graph. Note that one "unit" on these graphs represents 100 cubic feet of water, as commonly used by communities for billing purposes.

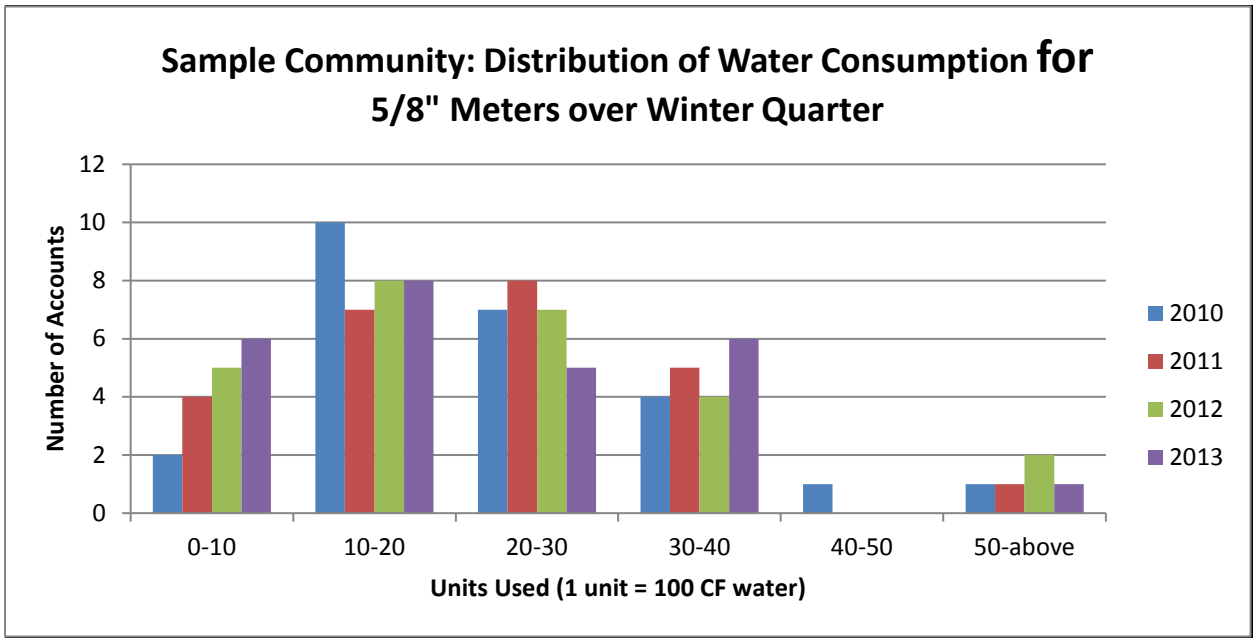


Figure 2.12 - 5/8" Meter Data from 2010 to 2013 Winter Months

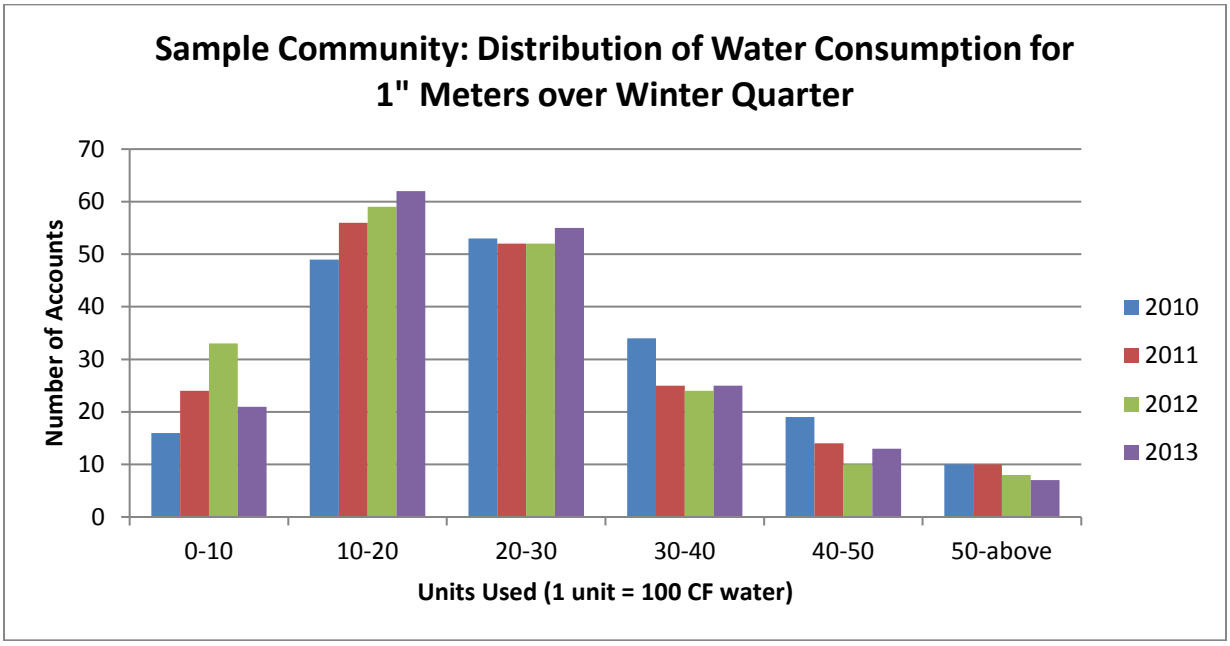


Figure 2.13 - 1" Meter Data from 2010 to 2013 Winter Months

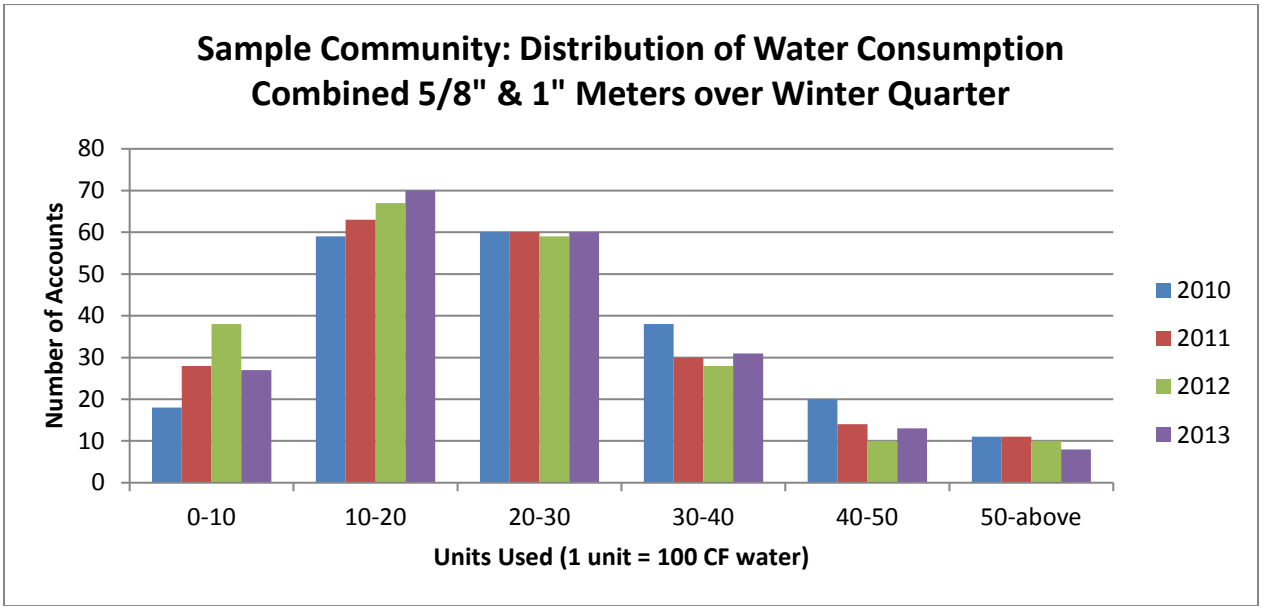


Figure 2.14 - Combined 1" & 5/8" Meter Data from 2010 to 2013 Winter Months

The distribution of data for each of the four years follows the same general pattern for all three graphs, a "positively-skewed unimodal histogram." This means that there is one peak, creating a bell-shape, and that the graphs tail off to the right.

Four-Year Averages

Since the same general consumption distribution can be observed from year to year, the number of accounts within each consumption interval were averaged over the four years. The four-year averages were then displayed separately using intervals of 500 cubic feet (5 units) to increase resolution. These three graphs are shown below.

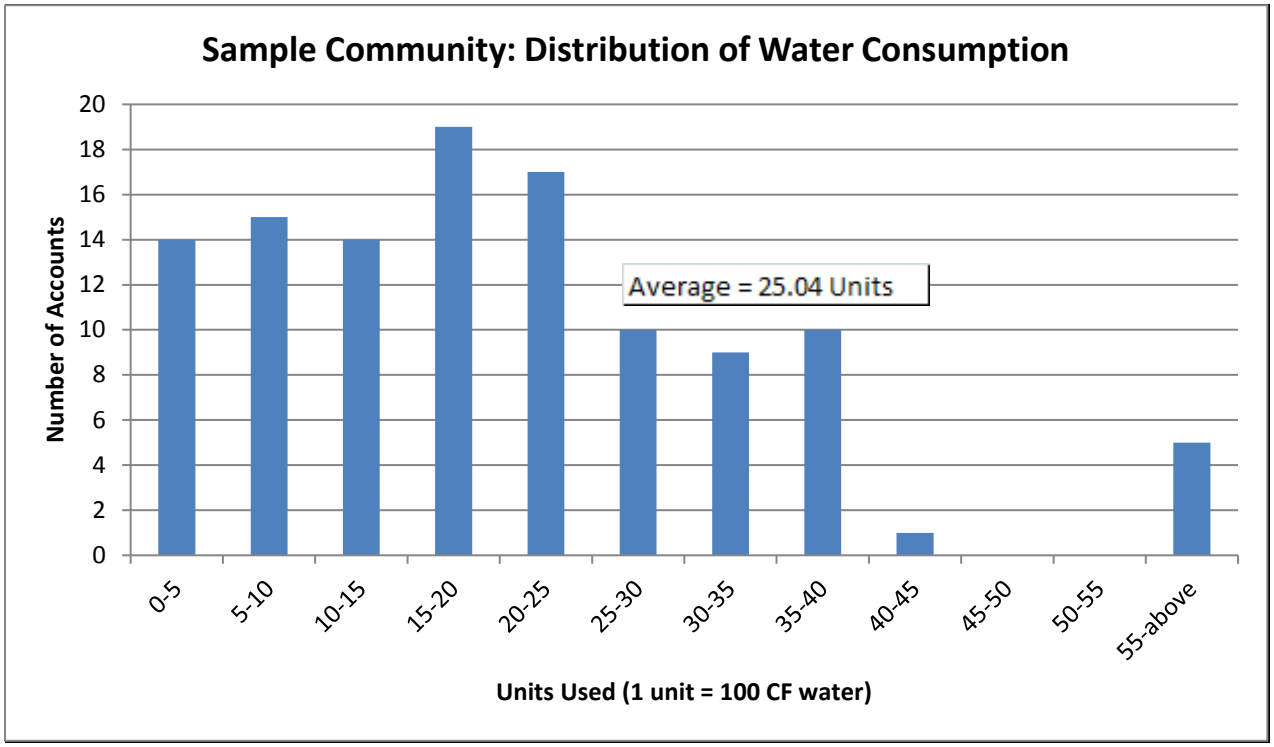


Figure 2.15 - 5/8" Meter Data Averaged from 2010 to 2013 Winter Months

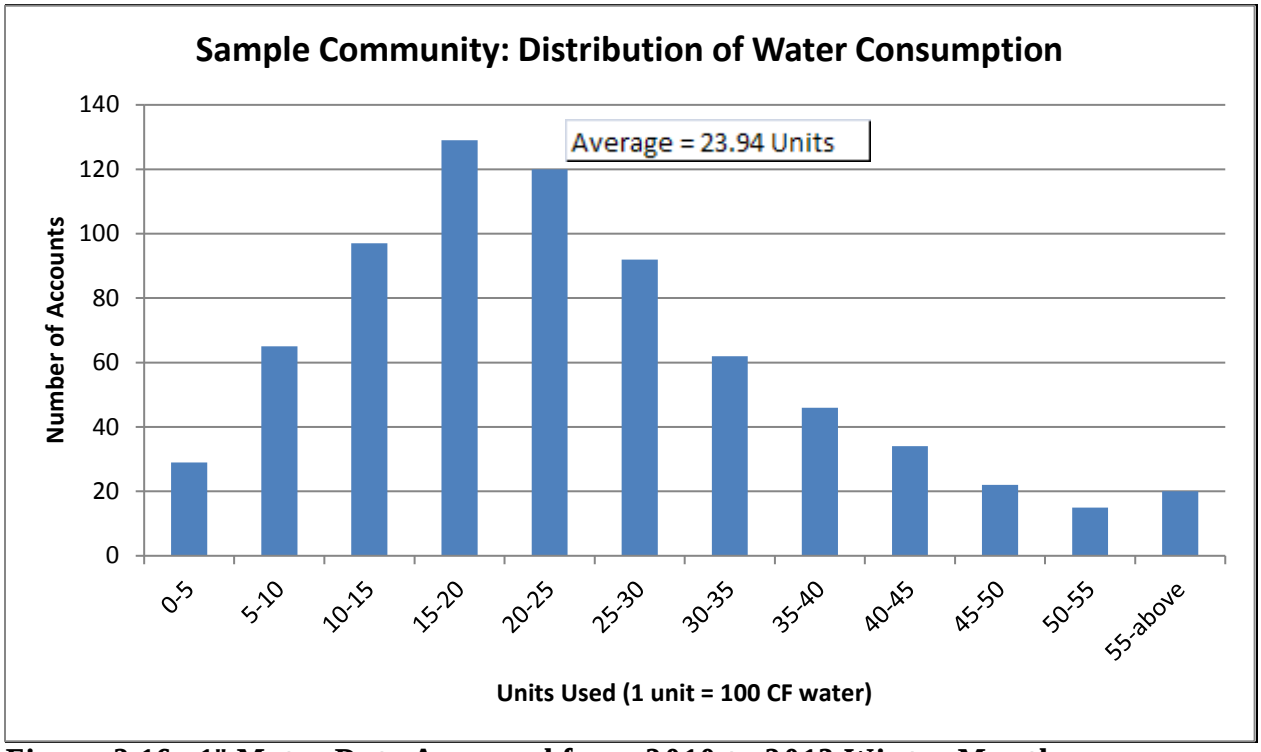


Figure 2.16 - 1" Meter Data Averaged from 2010 to 2013 Winter Months

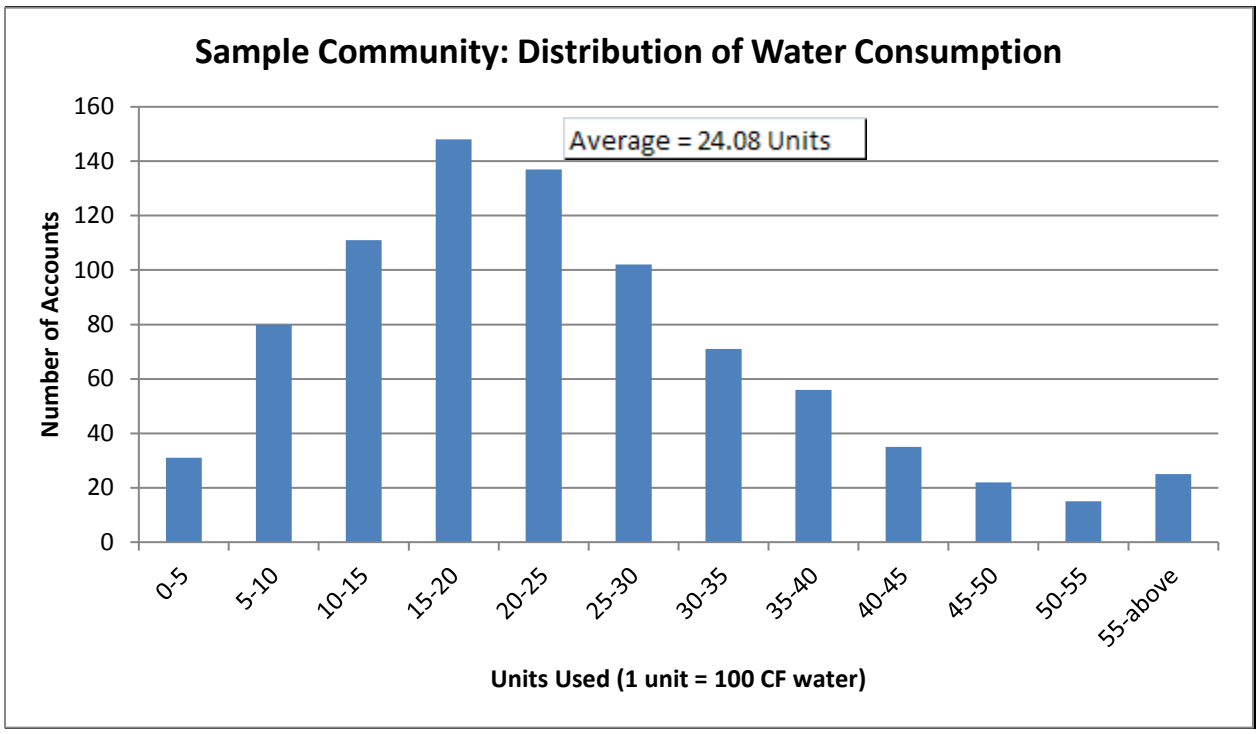


Figure 2.17 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Months

Outliers on the high end of a positively skewed unimodal distribution tend to pull the mean, or average, to the right of the median value. This effect is observed for all eleven

communities. In order to reduce the influence of accounts that do not follow the characteristics of typical households, a portion of the data was removed from the set as explained below.

Statistically Reduced Data

Several accounts with extremely high water consumption were discovered to be improperly coded as residential and others simply use much more water than typical households. On the other hand, accounts with extremely low consumption are also uncharacteristic of the typical household. Therefore, the data set was reduced in order to eliminate such accounts and provide data that is more representative of a typical single-family residence.

Statistical publications, such as *Applied Statistics - Second Edition* by Devore and Farnum, commonly use 90%, 95% and 99% levels of confidence for data analysis. This means there is a 90%, 95% or 99% chance, respectively, that a sample from an undefined population will fall within the confidence interval. Due to the relatively large statistical variance, or dispersion of data, 90% was chosen for this analysis.

Following this method, the lowest 5% and highest 5% of water consumption data were eliminated. This leaves the middle 90% of the data to be analyzed. Using the middle 90% means that 45% of the data is taken from both sides of the median value.

Across the 11 communities, there are a significant number of accounts with 5/8-inch and 1-inch meters. In order to most accurately represent actual consumption, a combination of the data from both meter sizes was used for analysis. **Figure 2.18** on the following page represents the distribution of the middle 90% of water meter data provided for a combination of both meter sizes.

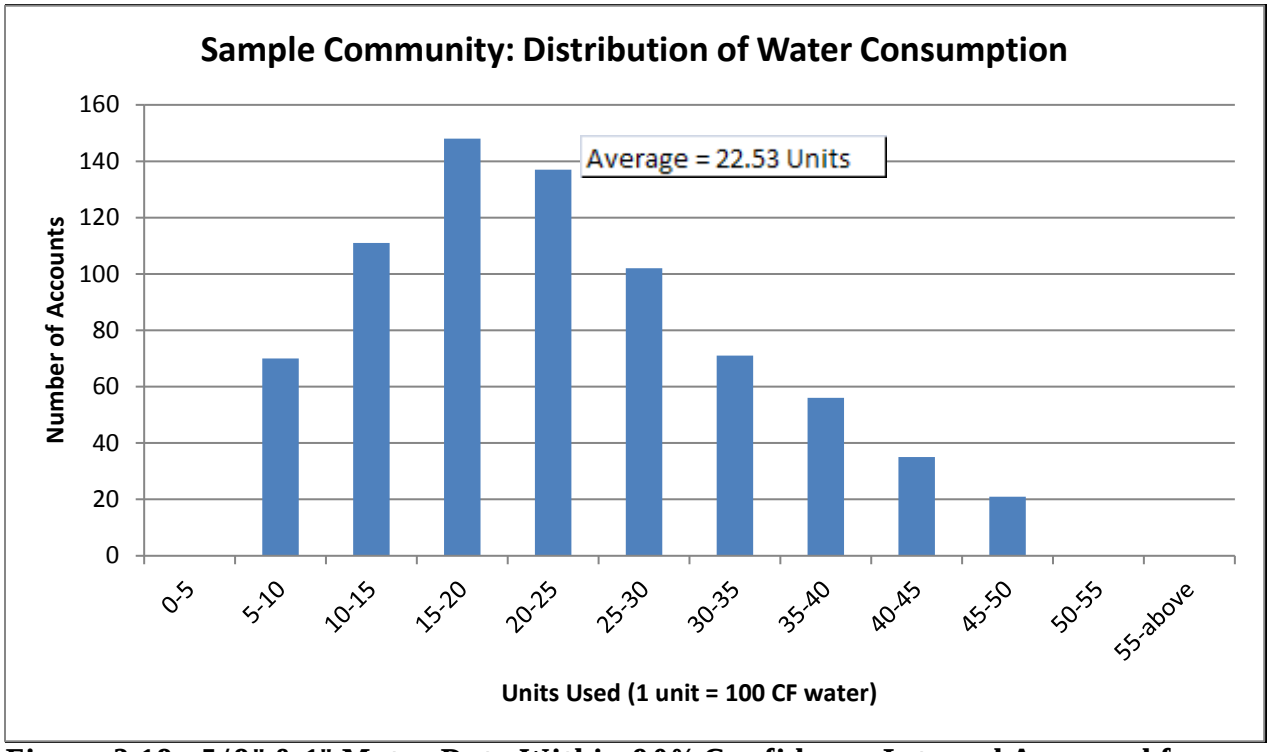


Figure 2.18 - 5/8" & 1" Meter Data Within 90% Confidence Interval Averaged from 2010 to 2013 Winter Months

From this reduced set of four-year averages from winter quarters, an average consumption was calculated for each community in units per quarter (Units/Qtr). Units were then converted to cubic feet per day and then gallons per day.

Dividing the average usage in gallons per day by the average number of people per household from SEMCOG, the average usage per capita per day was calculated for each community. The table below summarizes the analysis for each community.

Table 2.19 - Sample Community Analysis Summary

People/ Household	Residential Accounts	4-Year Avg. Winter Use (units/quarter)	Avg. from Statistically Reduced Data (units/quarter)	Gal/day/ household	Gal/person/ day
2.05	206	24.08	22.53	187.2	91.3

Calculated water use for 1 REU in Sample Community: **187.2 gal/day**

2.2 - Individual Community Usage Analysis

Individual Community Reports

Bingham Farms

Bingham Farms represents a relatively small portion of the single-family residential water meter data with only 206 accounts. The following demographic information was gathered from SEMCOG for Bingham Farms, to outline some of the characteristics related to water consumption.

Table A.01 - Bingham Farms SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	1,111	1,086	-2.3%
Occupied Units	527	531	0.8%
People per Household	2.11	2.05	-2.8%
Median Housing Value	$391,900	N/A	N/A
Median Household Income	$130,625	N/A	N/A

From the 206 5/8-inch and 1-inch meter accounts, 12% are 5/8-inch meters represent and 88% are 1-inch meters as the table below suggests.

Table. A.02 - Bingham Farms Water Meter Size Distribution

Community	People/ Household	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
BINGHAM FARMS	2.05	206	12%	88%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

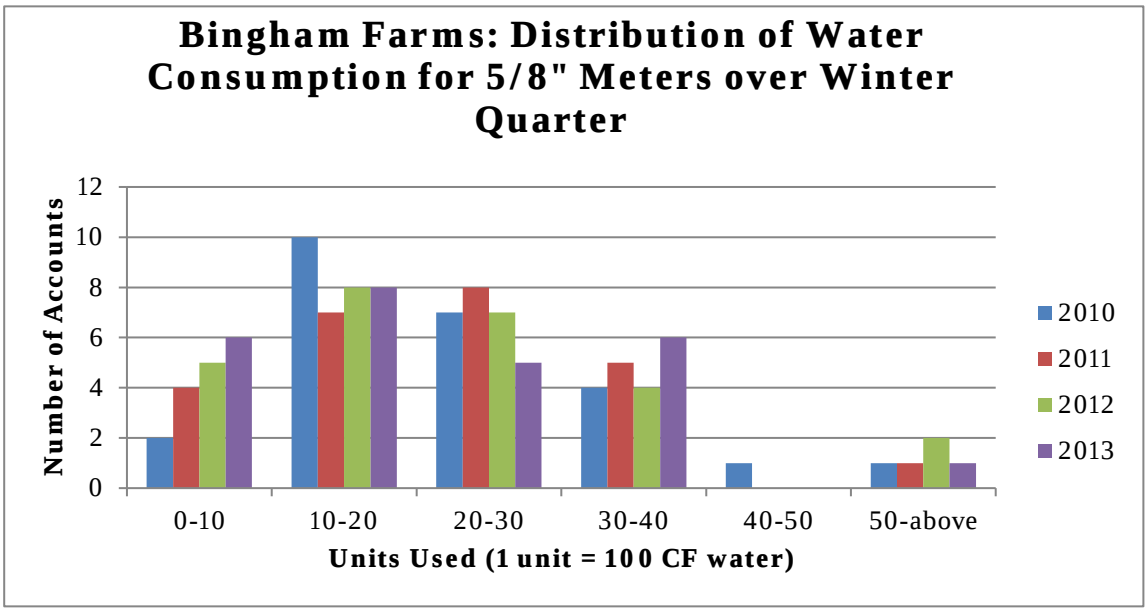


Figure A.01 - 5/8" Meter Data from 2010 t0 2013 Winter Quarters (25 of 206 Accounts)

The 5/8" meter graph above was created from a small data set, whereas the 1" meter graph below is from a much larger data set since the majority of residential meters in Bingham Farms are 1". Notice that both graphs create very similar bell-shaped distribution patterns.

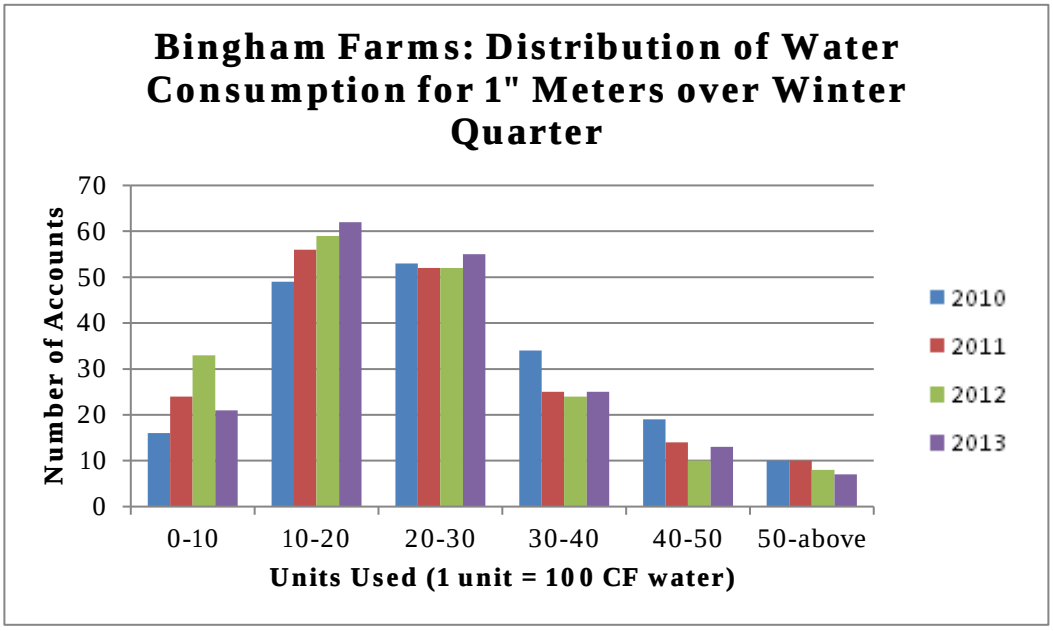


Figure A.02 - 1" Meter Data from 2010 to 2013 Winter Quarters (181 of 206 Accounts)

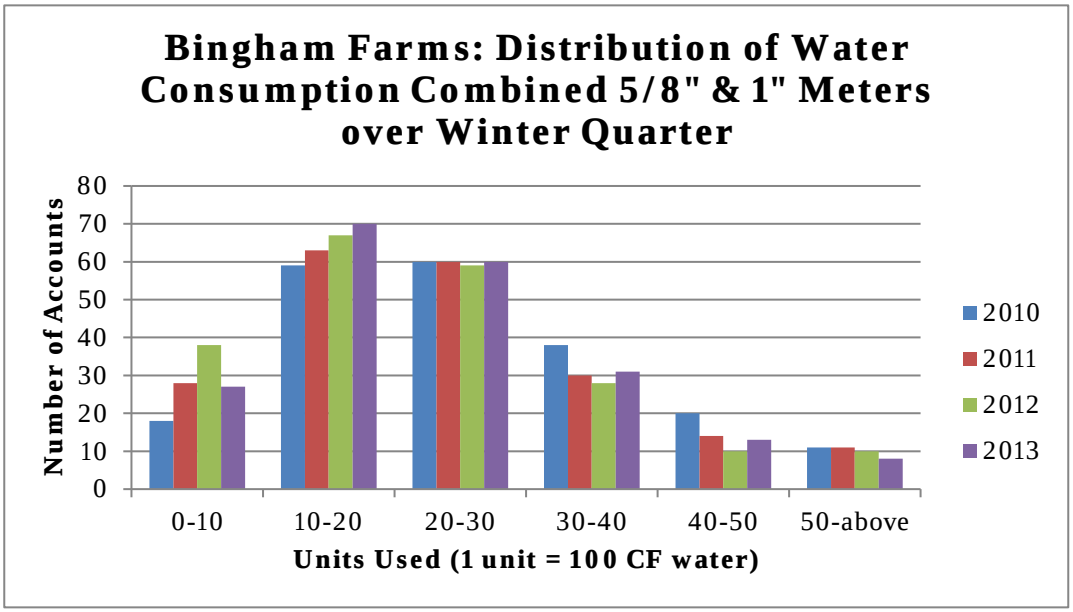


Figure A.03 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (206 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 24.08 units or 2,408 cubic feet per quarter.

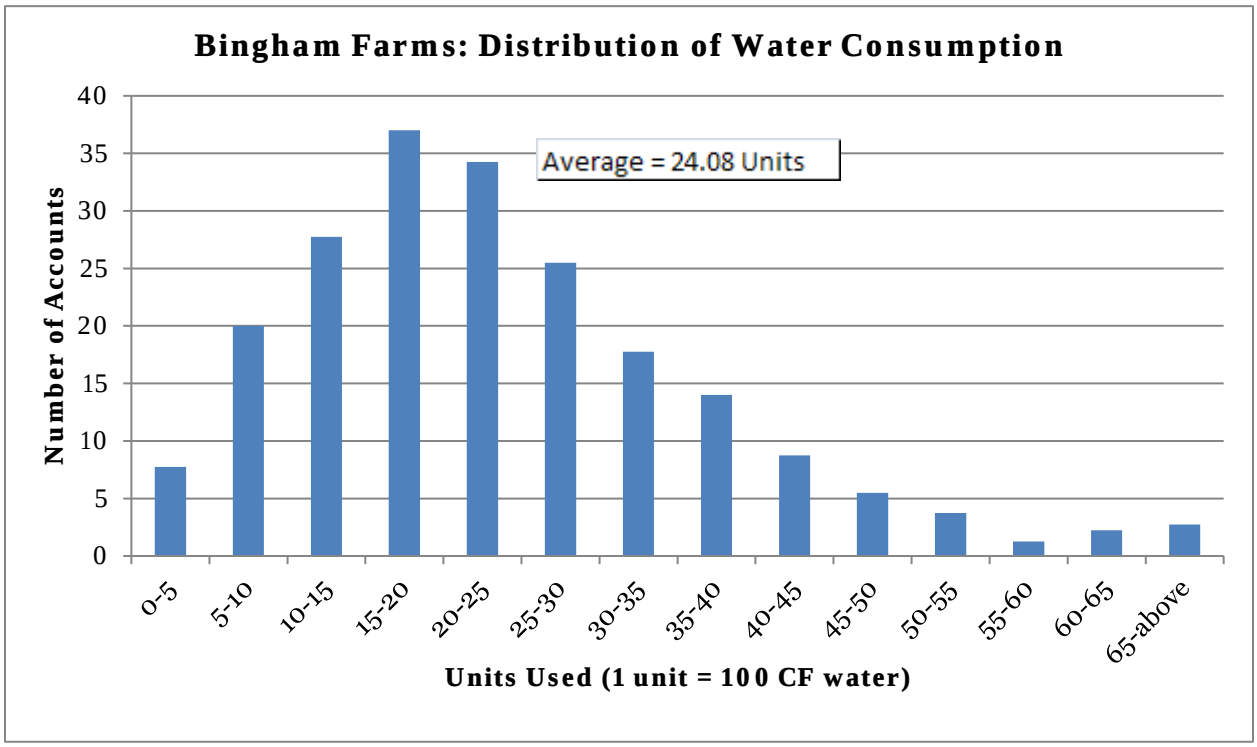


Figure A.04 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 22.53 units (2,253 cubic feet) as shown below.

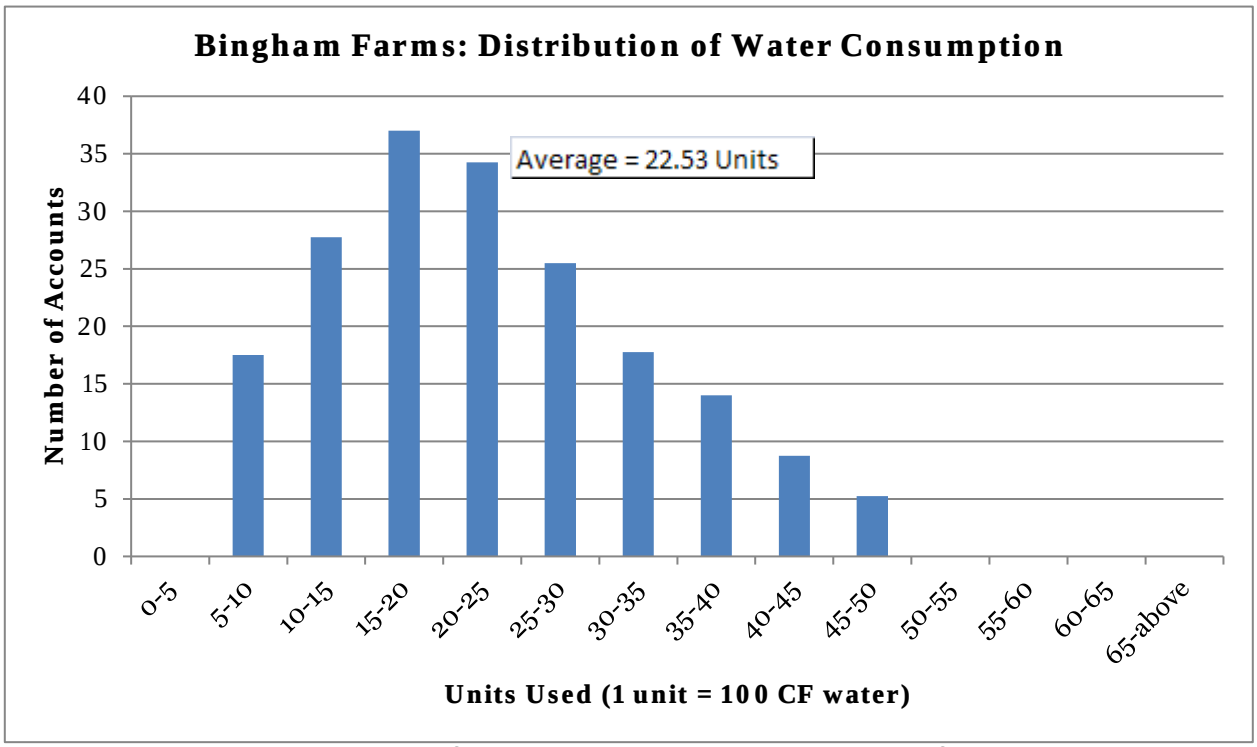


Figure A.05 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Bingham Farms. Converting the value in units/quarter to gallons/day, the recommended REU for Bingham Farms is 187.2 gallons per day per household, or 91.3 gallons per person per day, as shown in the following table.

Table A.06 - Bingham Farms Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person /day
2.05	206	24.08	22.53	187.2	91.3

Calculated water use for 1 REU in Bingham Farms: **187.2 gal/day** with 10% of high and low end account usage analyzed

Bloomfield Hills

There are 803 single-family residential water service accounts on record in Bloomfield Hills. The demographic information on the following table was gathered from SEMCOG in order to outline a few of the community characteristics that may impact water consumption.

Table. B.01 - Bloomfield Hills SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	3,869	4,045	4.5%
Occupied Units	1,489	1,565	5.1%
People per Household	2.44	2.43	-0.4%
Median Housing Value	$715,300	N/A	N/A
Median Household Income	$133,370	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 19% and 1-inch meters represent 81% of the data as indicated in the table below.

Table. B.02 - Bloomfield Hills Water Meter Size Distribution

Community	People/ Household	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
BLOOMFIELD HILLS	2.43	803	19%	81%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

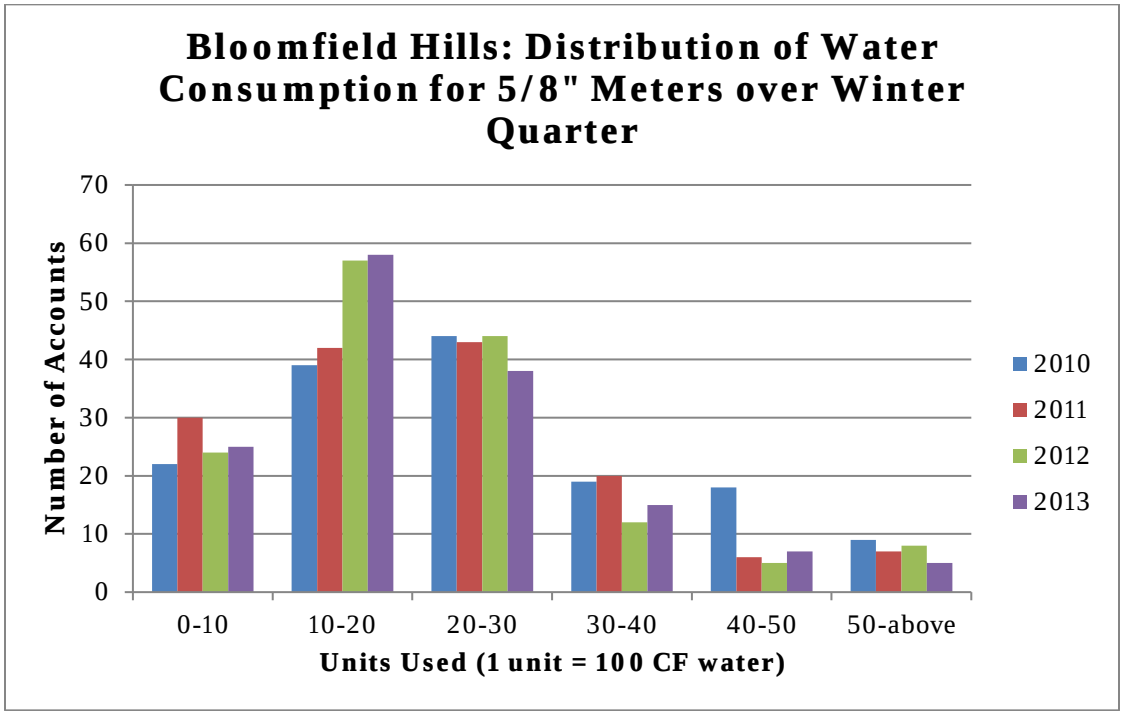


Figure B.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (153 of 803 Accounts)

The 5/8" meter graph above was created from a small data set, whereas the 1" meter graph below is from a much larger data set since the majority of residential meters in Bloomfield Hills are 1". Notice that both graphs create similar distribution patterns.

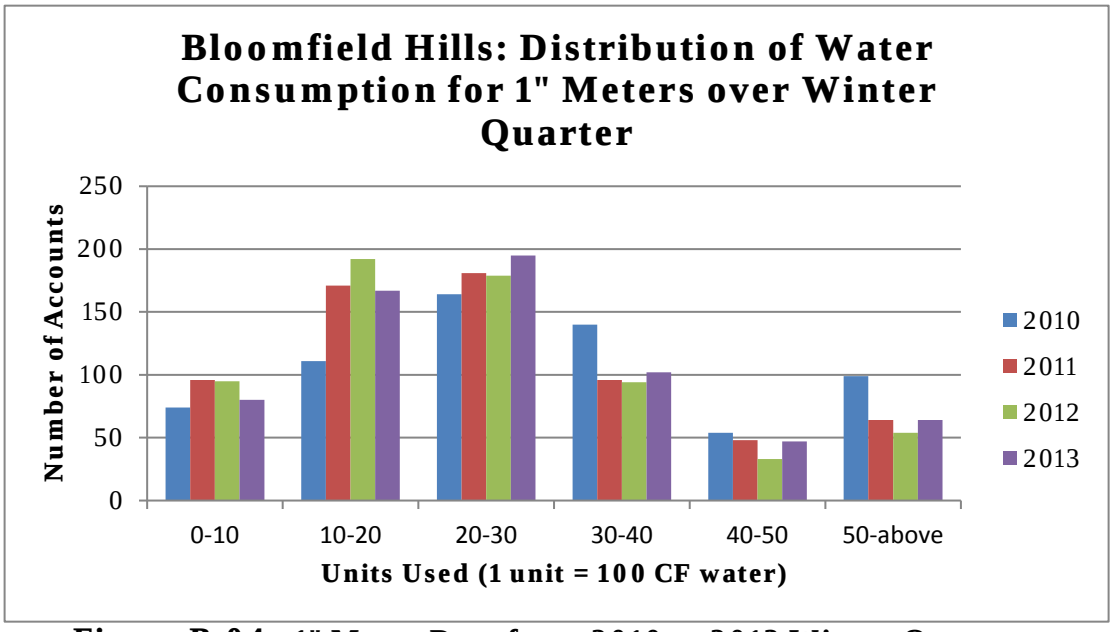


Figure B.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (650 of 803 Accounts)

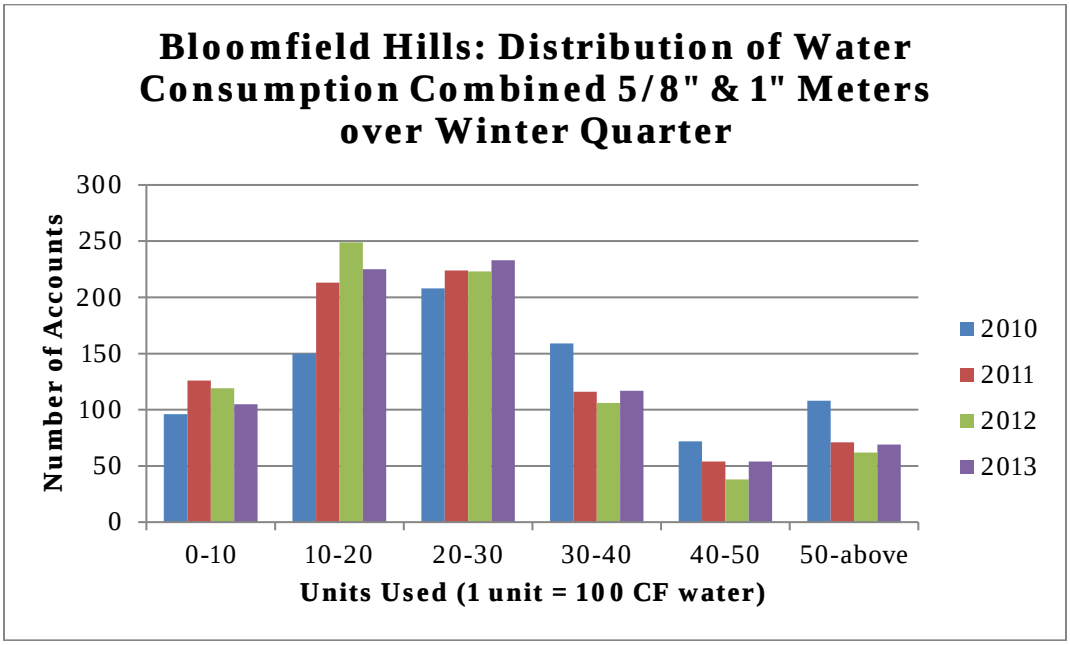


Figure B.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (803 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 27.5 units or 2,750 cubic feet per quarter.

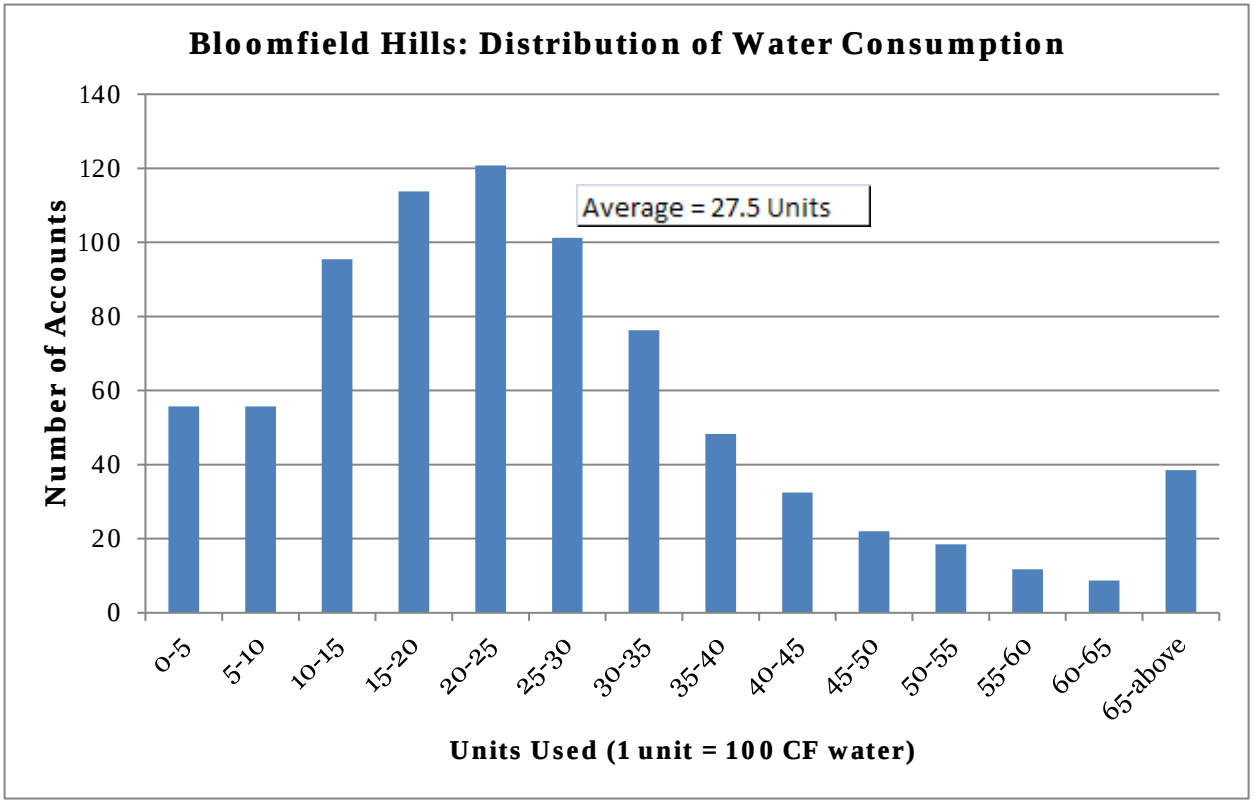


Figure B.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 24.5 units (2,450 cubic feet) as shown below.

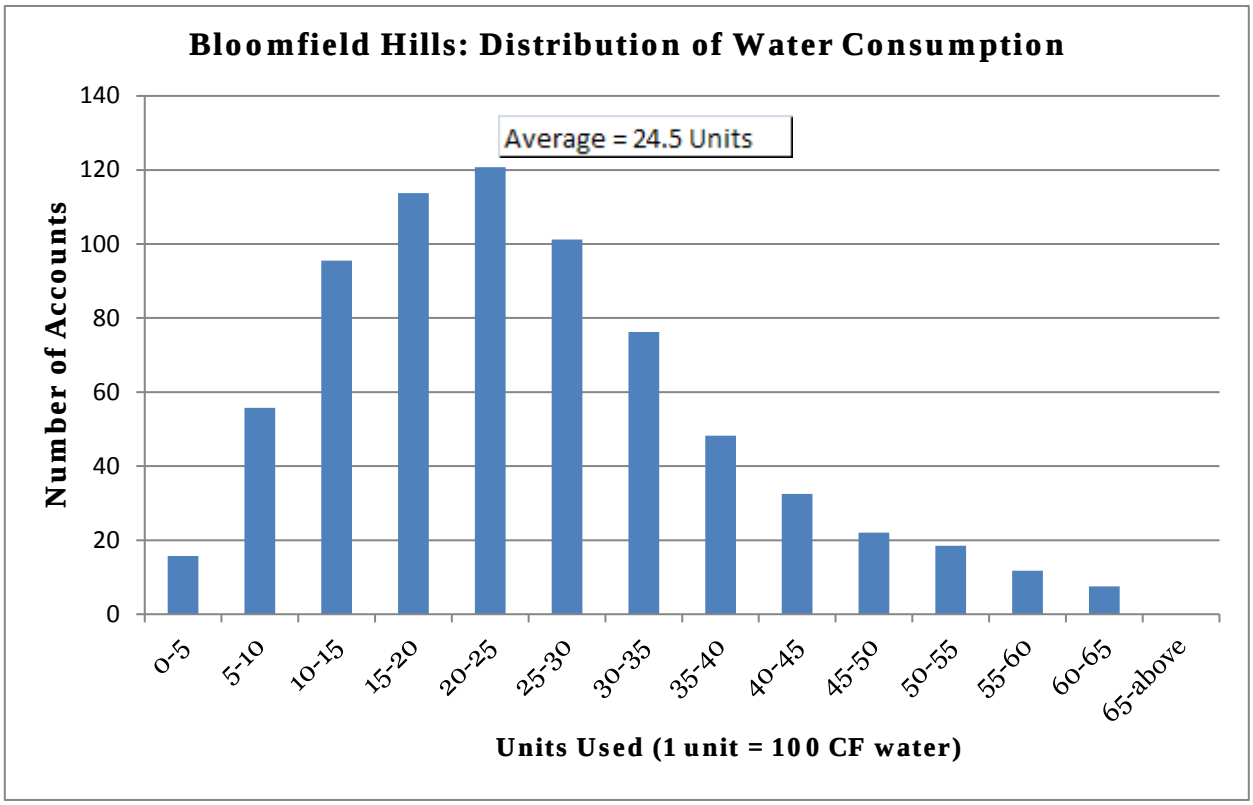


Figure B.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Bloomfield Hills. Converting the value in units/quarter to gallons/day, the recommended REU for Bloomfield Hills is 203.6 gallons per day per household, or 83.8 gallons per person per day, as shown in the following table.

Table B.08 - Bloomfield Hills Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.43	803	27.50	24.5	203.6	83.8

Calculated water use for 1 REU in Bloomfield Hills: **203.6 gal/day** with 10% of high and low end account usage analyzed

Commerce Township

Commerce Township represents a large portion of the single-family residential water meter data with a total of 4,912 accounts. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table. C.01 - Commerce Township SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	35,874	36,570	1.9%
Occupied Units	13,220	13,674	3.4%
People per Household	2.71	2.67	-1.5%
Median Housing Value	$229,300	N/A	N/A
Median Household Income	$82,691	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 29% and 1-inch meters represent 71% of the data as indicated in the table below.

Table. C.02 - Commerce Township Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
COMMERCE TOWNSHIP	2.67	4,912	29%	71%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

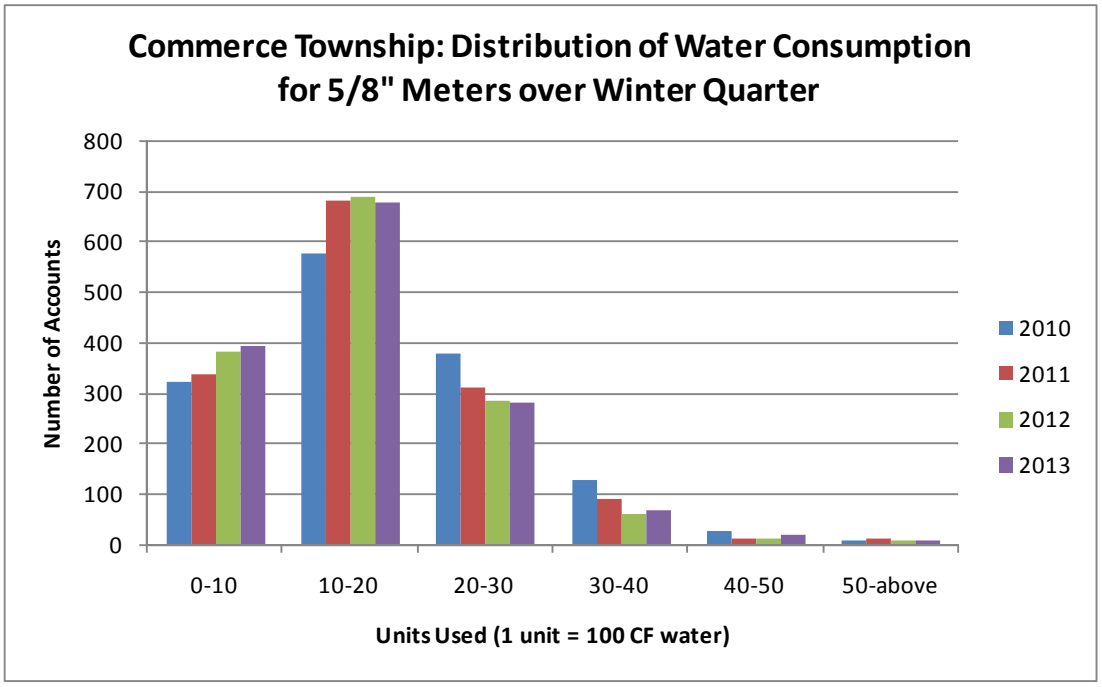


Figure C.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (1,424 of 4,912 Accounts)

The 5/8" meter graph above was created from a small data set, whereas the 1" meter graph below is from a much larger data set since the majority of residential meters in Commerce Township are 1". Notice that both graphs create very similar bell-shaped distribution patterns.

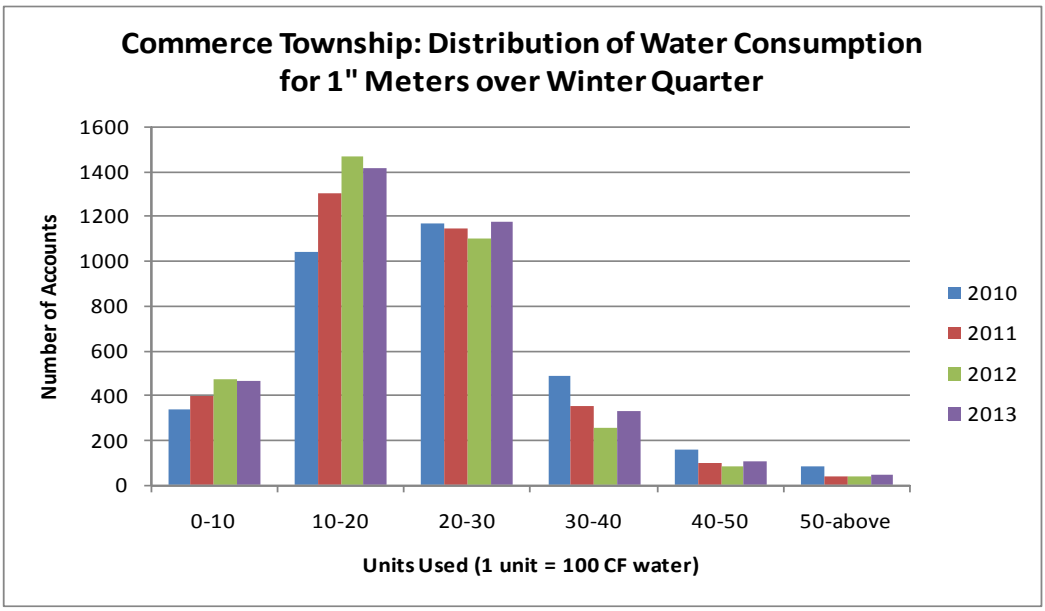


Figure C.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (3,488 of 4,912 Accounts)

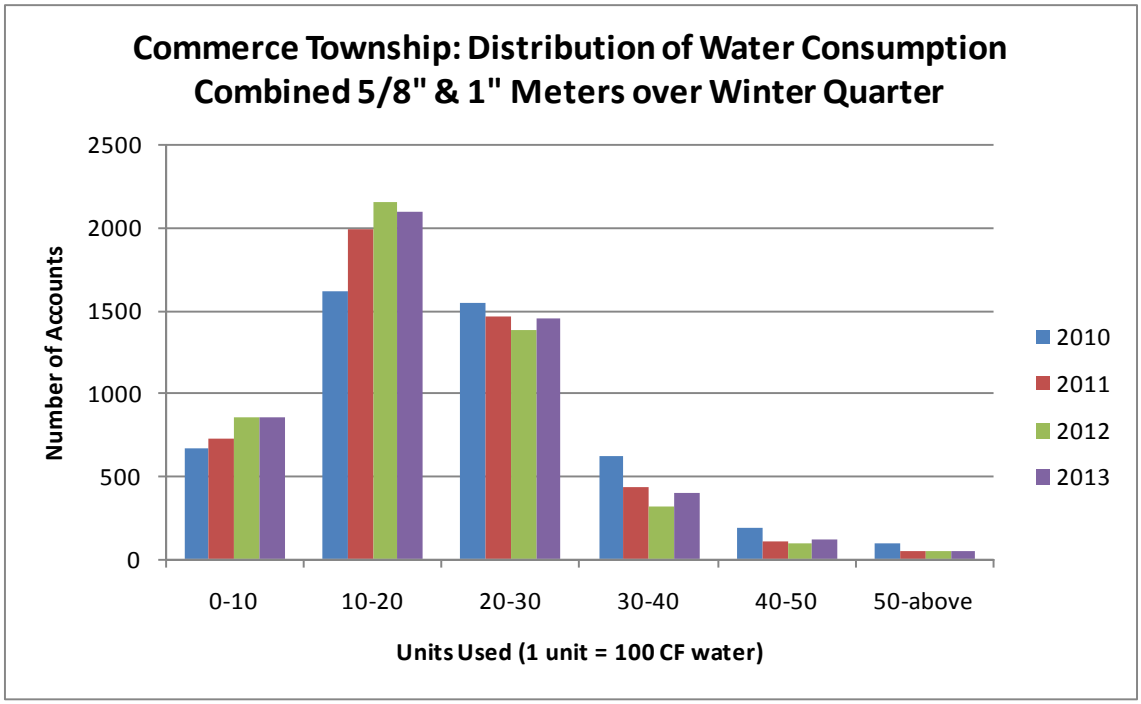


Figure C.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (4,912 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph on the following page displays this distribution with an average consumption value of 19.26 units or 1,926 cubic feet per quarter.

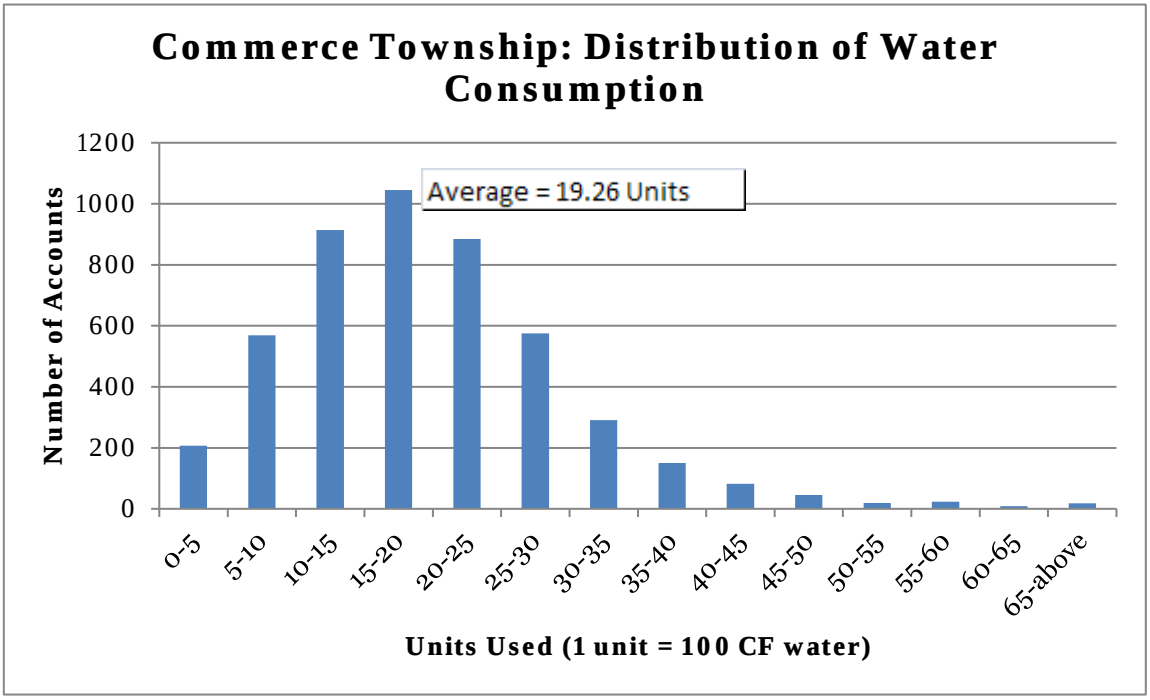


Figure C.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 18.49 units (1,849 cubic feet) as shown below.

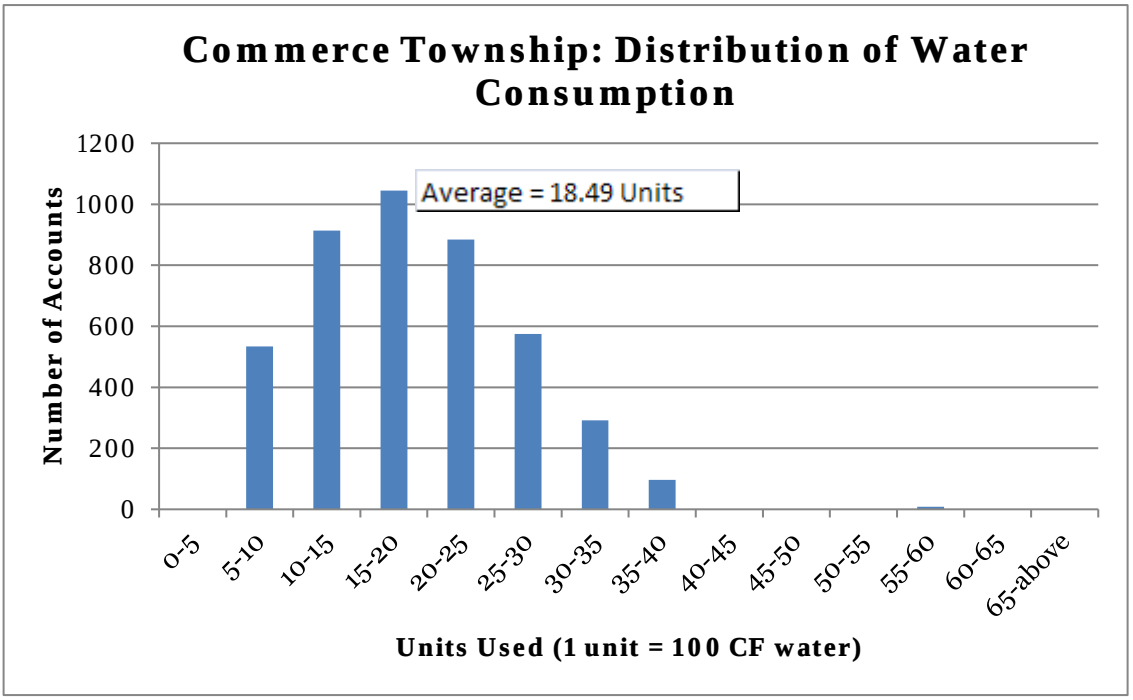


Figure C.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Commerce Township. Converting the value in units/quarter to gallons/day, the recommended REU for Commerce Township is 153.7 gallons per day per household, or 57.6 gallons per person per day, as shown in the following table.

Table C.08 - Commerce Township Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.67	4,912	19.26	18.49	153.7	57.6

Calculated water use for 1 REU in Commerce Township: **153.7 gal/day** with 10% of high and low end account usage analyzed

Farmington Hills

Farmington Hills represents the largest portion of data used in this study with a total of 19,329 single-family residential water service accounts. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table D.01 - Farmington Hills SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	79,740	81,171	1.8%
Occupied Units	33,559	34,411	2.5%
People per Household	2.36	2.34	-0.8%
Median Housing Value	$238,300	N/A	N/A
Median Household Income	$67,803	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 64% and 1-inch meters represent 36% of the data as indicated in the table below.

Table D.02 - Farmington Hills Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
FARMINGTON HILLS	2.34	19,329	64%	36%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

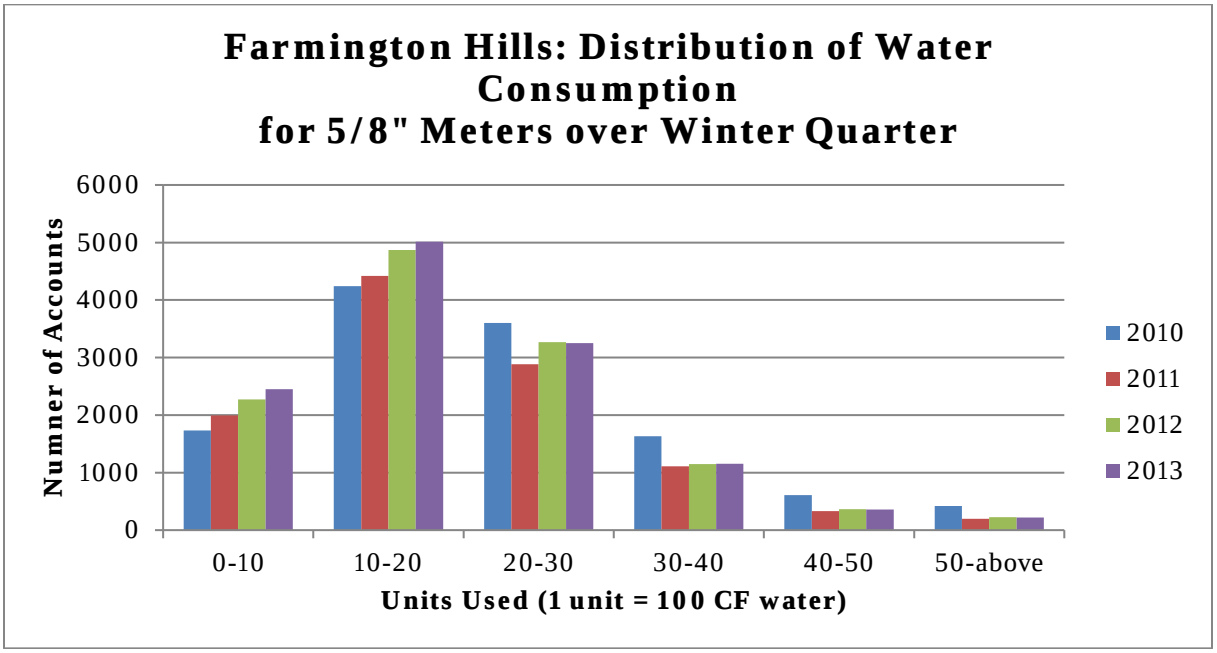


Figure D.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (12,371 of 19,329 Accounts)

The 5/8" meter data in the graph above accounts for slightly more than half of the total data set for Farmington Hills, whereas the 1" meter graph below is representative of slightly less than half of the data set. Notice that both graphs create very similar bell-shaped distribution patterns.

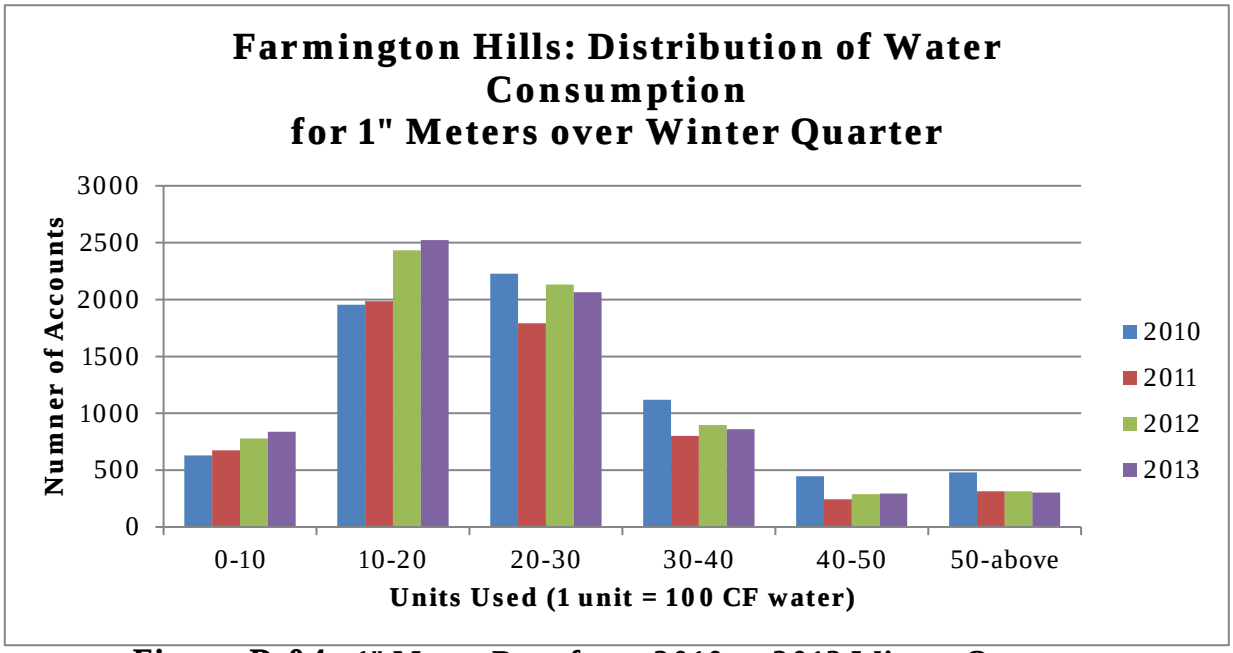


Figure D.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (6,958 of 19,329 Accounts)

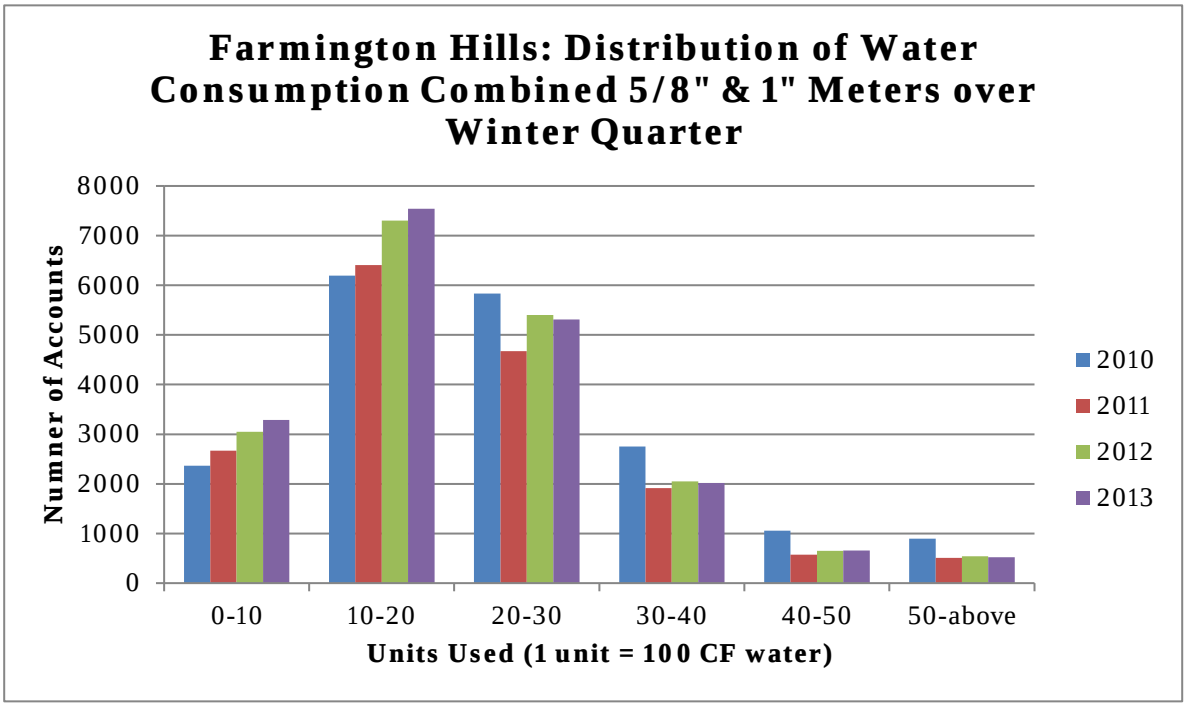


Figure D.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (19,329 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 21.76 units or 2,176 cubic feet per quarter.

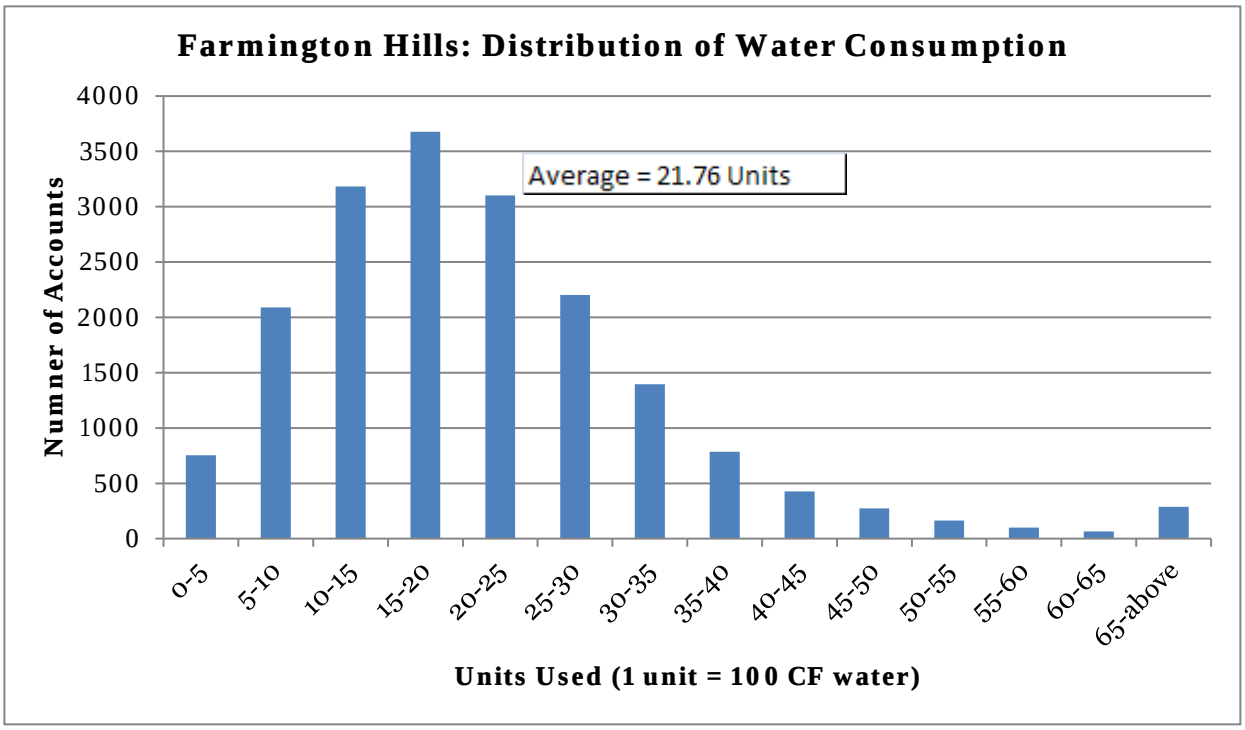


Figure D.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 19.97 units (1,997 cubic feet) as shown below.

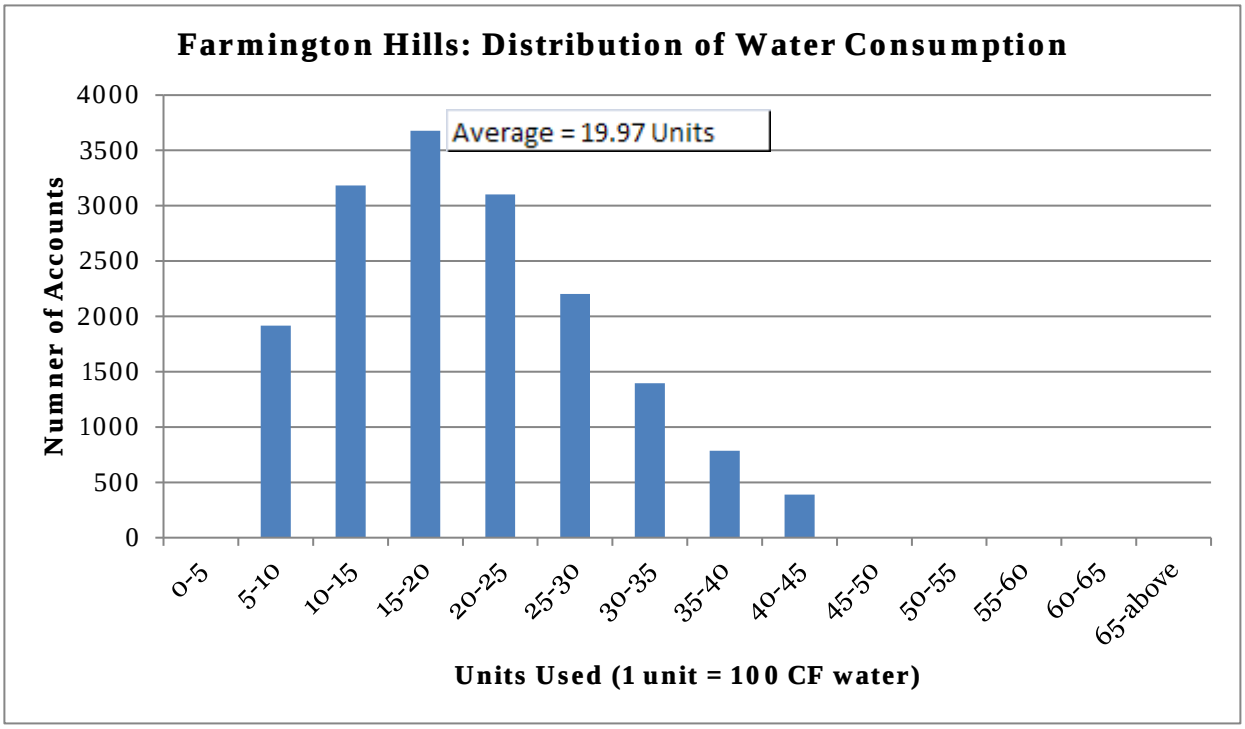


Figure D.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Farmington Hills. Converting the value in units/quarter to gallons/day, the recommended REU for Farmington Hills is 166 gallons per day per household, or 70.9 gallons per person per day, as shown in the following table.

Table D.08 - Farmington Hills Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.34	19204	21.67	19.97	166.0	70.9

Calculated water use for 1 REU in Farmington Hills: **166.0 gal/day** with 10% of high and low end account usage analyzed

Highland Township

Highland Township represents a smaller portion of the single-family residential water meter data with 996 accounts. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table E.01 - Highland Township SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	19,202	19,114	-0.5%
Occupied Units	7,125	7,217	1.3%
People per Household	2.69	2.65	-1.5%
Median Housing Value	$212,900	N/A	N/A
Median Household Income	$68,227	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 22% and 1-inch meters represent 78% of the data as indicated in the table below.

Table E.02 - Highland Township Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
HIGHLAND TOWNSHIP	2.65	996	22%	78%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

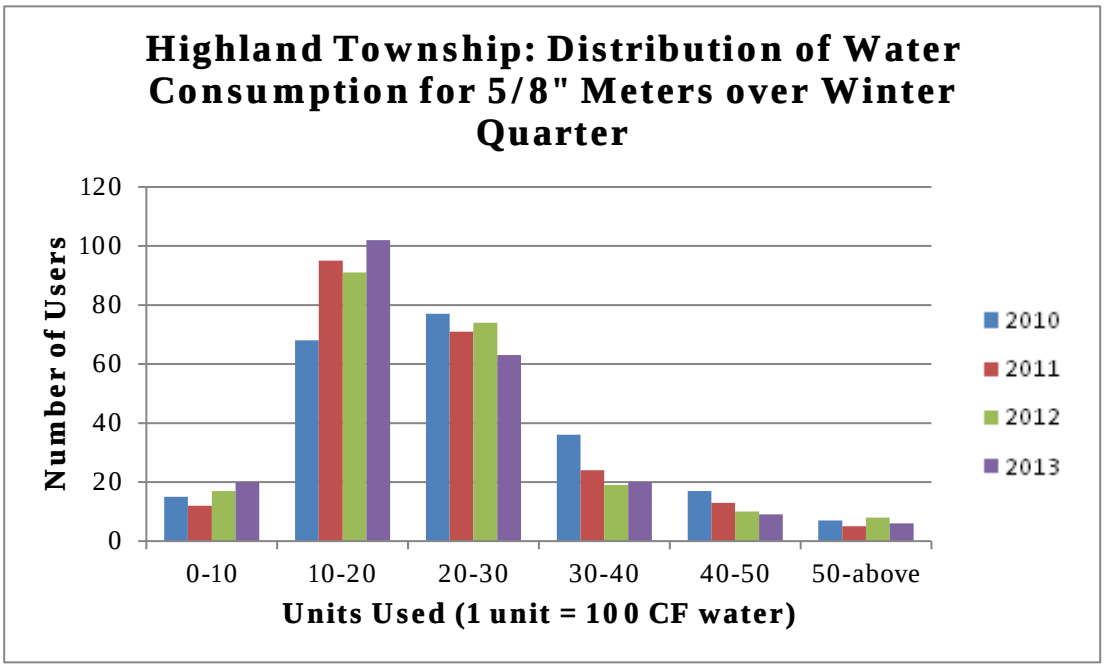


Figure E.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (219 of 996 Accounts)

The 5/8" meter graph above was created from a small data set, whereas the 1" meter graph below is from a much larger data set since the majority of residential meters in Highland Township are 1". Notice that both graphs create very similar bell-shaped distribution patterns.

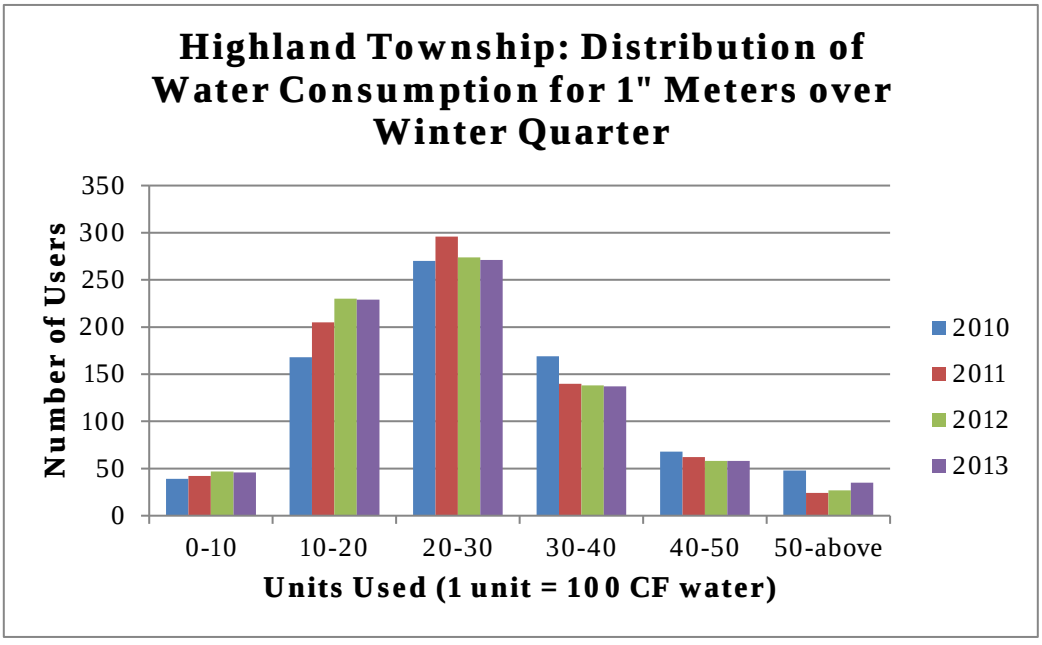


Figure E.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (777 of 996 Accounts)

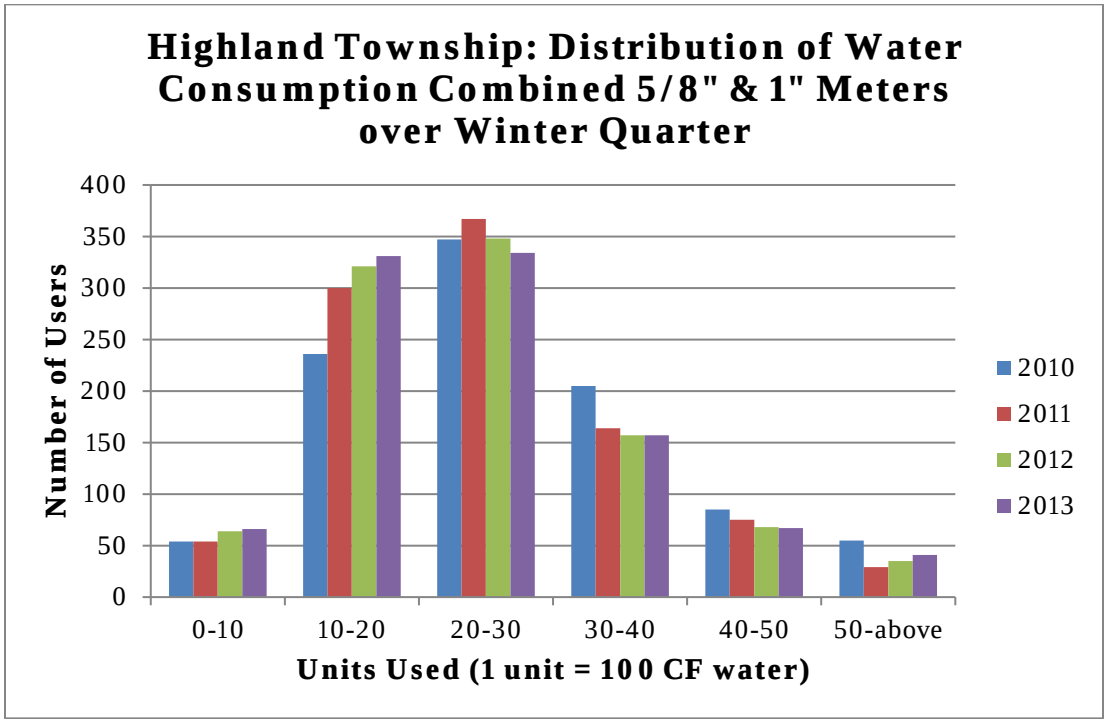


Figure E.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (996 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 25.4 units or 2,540 cubic feet per quarter.

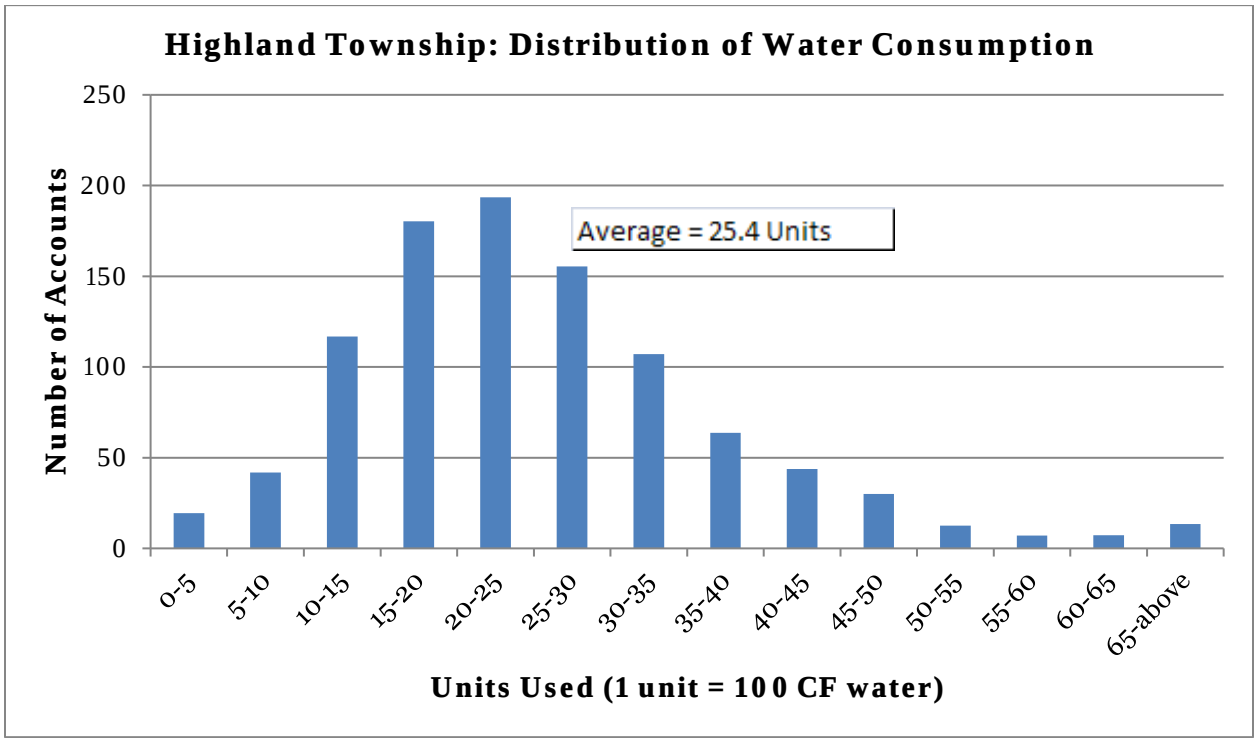


Figure E.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 24.2 units (2,420 cubic feet) as shown below.

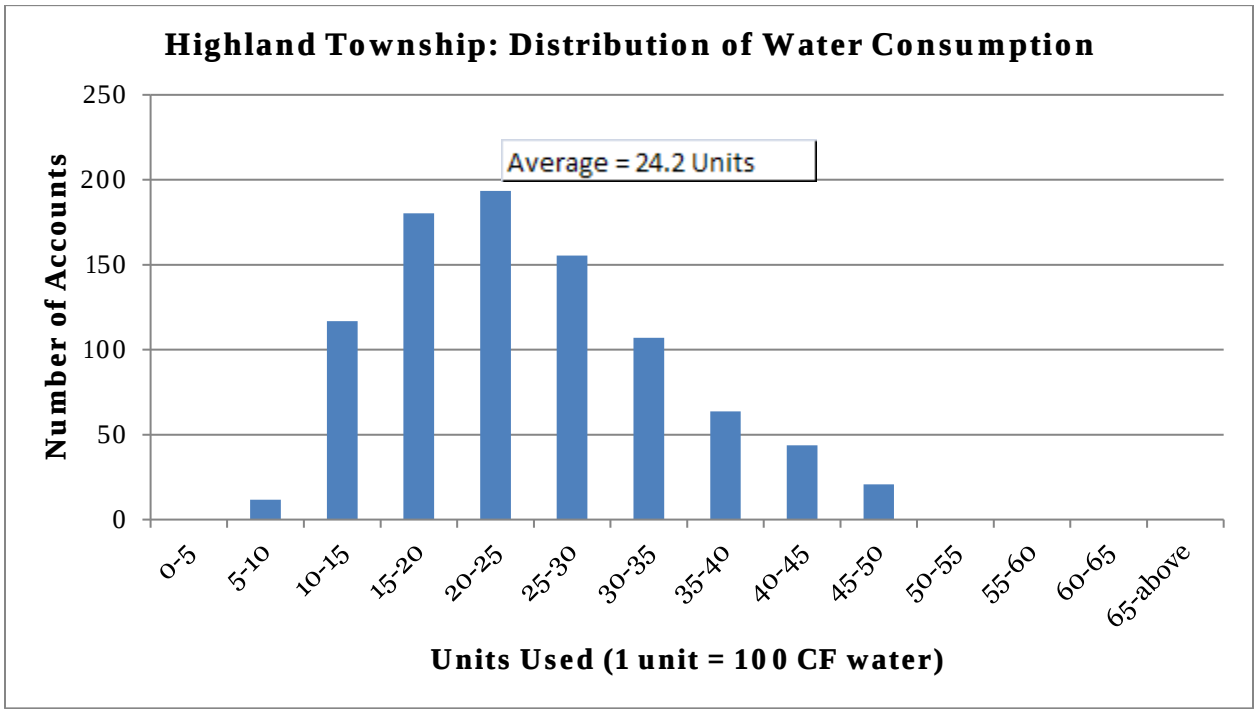


Figure E.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Highland Township. Converting the value in units/quarter to gallons/day, the recommended REU for Highland Township is 201.1 gallons per day per household, or 75.9 gallons per person per day, as shown in the following table.

Table E.08 - Highland Township Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.65	996	25.40	24.20	201.1	75.9

Calculated water use for 1 REU in Highland Township: **201.1 gal/day** with 10% of high and low end account usage analyzed

Keego Harbor

Keego Harbor represents a small portion of the single-family residential water meter data with 845 accounts. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table F.01 - Keego Harbor SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	2,970	3,090	4.0%
Occupied Units	1,292	1,338	3.6%
People per Household	2.3	2.31	0.4%
Median Housing Value	$156,900	N/A	N/A
Median Household Income	$50,159	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 79% and 1-inch meters represent 21% of the data as indicated in the table below.

Table F.02 - Keego Harbor Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
KEEGO HARBOR	2.31	845	79%	21%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

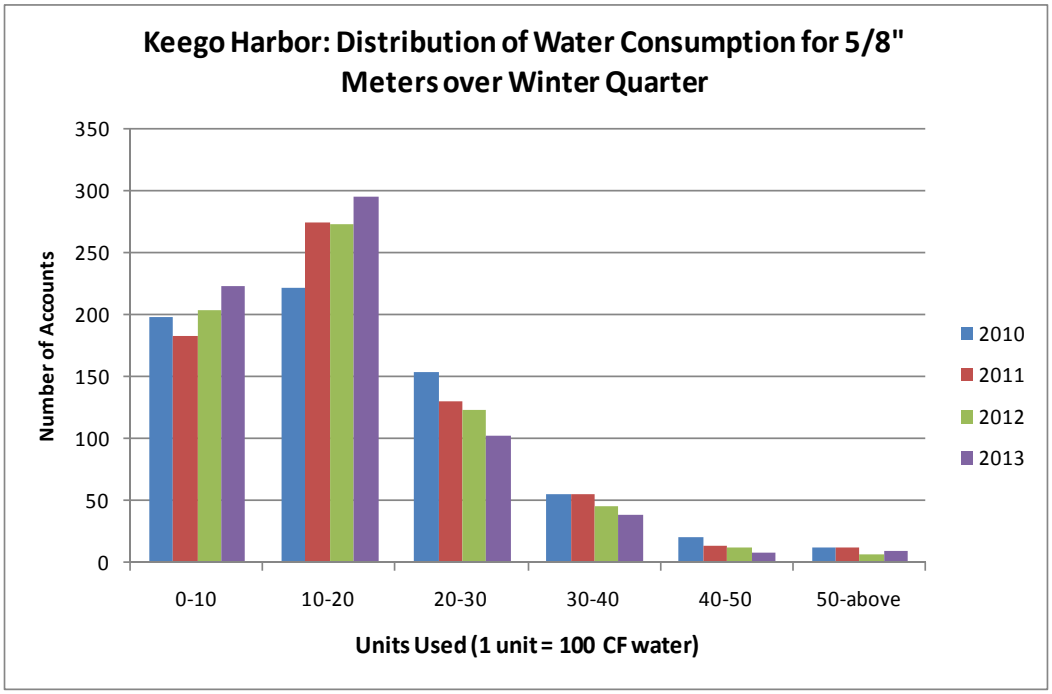


Figure F.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (668 of 845 Accounts)

The 5/8" meter graph above was created from a relatively large data set, whereas the 1" meter graph below is from a much smaller data set since the majority of residential meters in Keego Harbor are 5/8". Notice that both graphs create very similar bell-shaped distribution patterns.

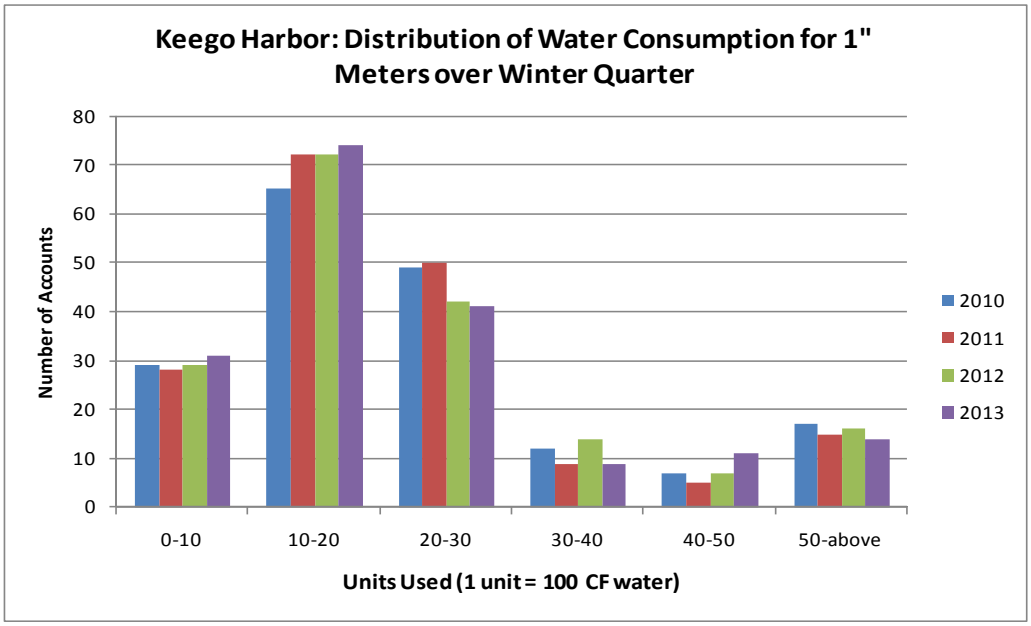


Figure F.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (177 of 845 Accounts)

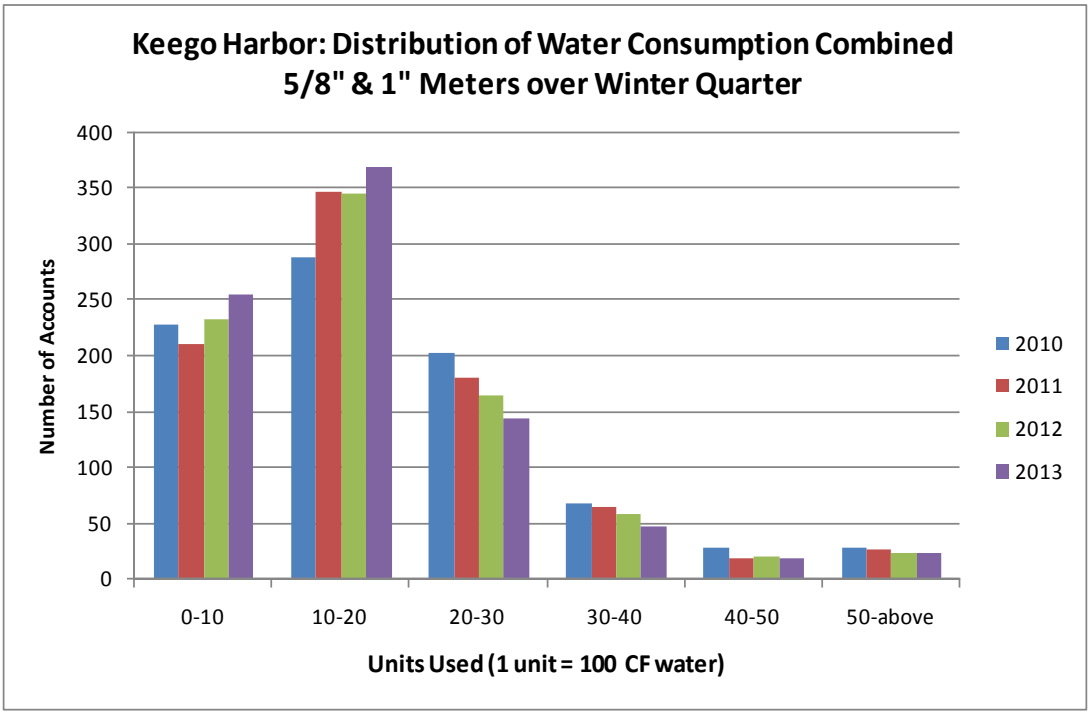


Figure F.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (845 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph on the following page displays this distribution with an average consumption value of 18.78 units or 1,878 cubic feet per quarter.

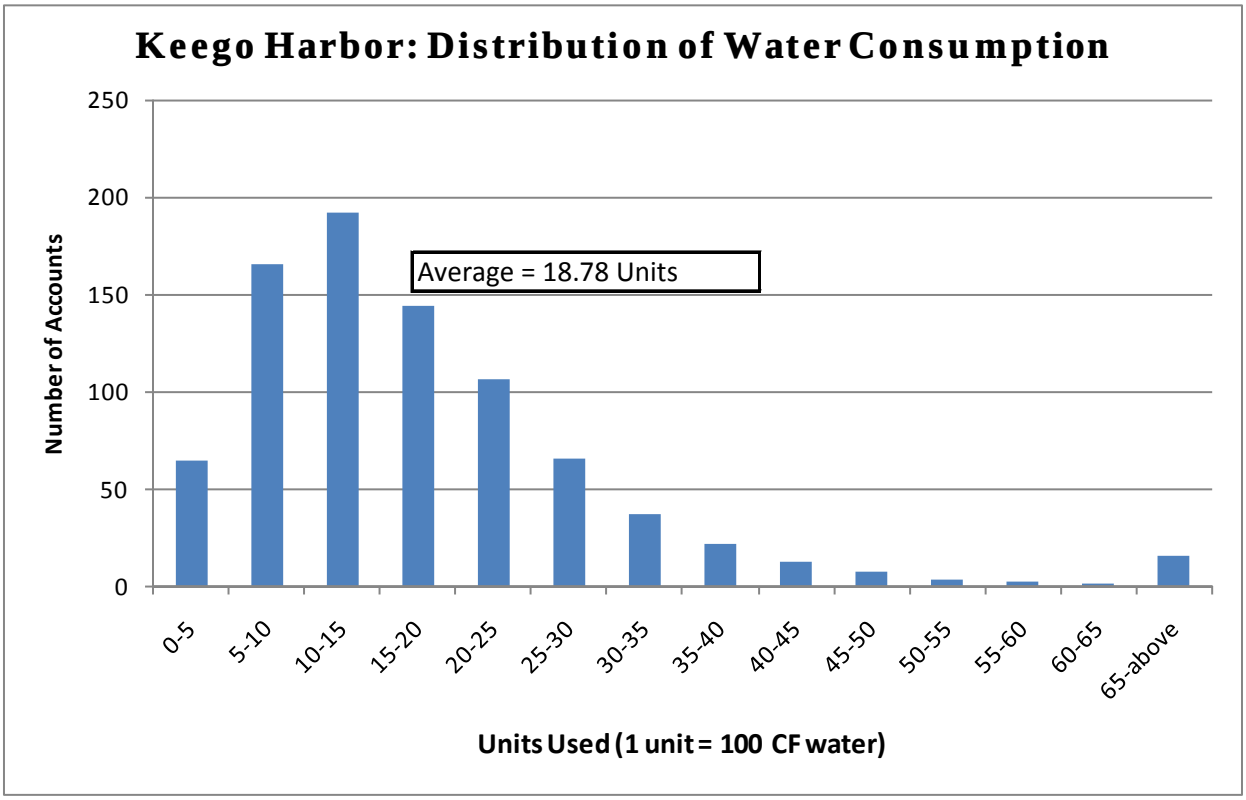


Figure F.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 16.19 units (1,619 cubic feet) as shown below.

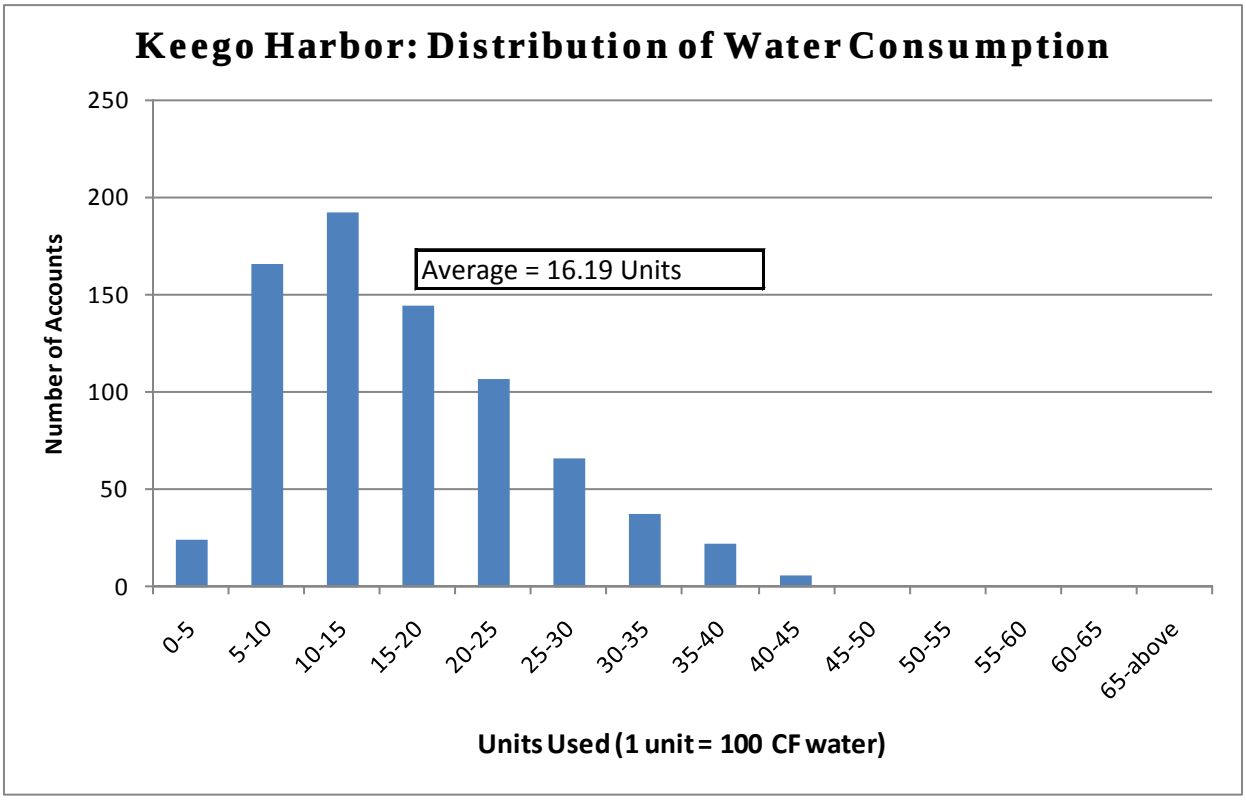


Figure F.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Keego Harbor. Converting the value in units/quarter to gallons/day, the recommended REU for Keego Harbor is 134.6 gallons per day per household, or 58.2 gallons per person per day, as shown in the following table.

Table F.08 - Keego Harbor Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.31	845	18.78	16.19	134.6	58.2

Calculated water use for 1 REU in Keego Harbor: **134.6 gal/day** with 10% of high and low end account usage analyzed

Lyon Township

There are 1,616 single-family residential water service accounts in Lyon Township. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table G.01 - Lyon Township SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	14,545	16,630	14.3%
Occupied Units	5,226	6,017	15.1%
People per Household	2.78	2.76	-0.7%
Median Housing Value	$242,400	N/A	N/A
Median Household Income	$79,375	N/A	N/A

There are no 5/8-inch meters on record for Lyon Township, all meters are 1" as indicated in the table below.

Table G.02 - Lyon Township Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
LYON TOWNSHIP	2.76	1,616	0%	100%

Following the process described in the Data Analysis Process section of this report, a graph was produced from the set of 1" water meter data for winter quarters. Residential meter data provided was for Lyon Township consisted of all 1" meters and no 5/8" meters. Therefore, the analysis was done based only on 1" meter data.

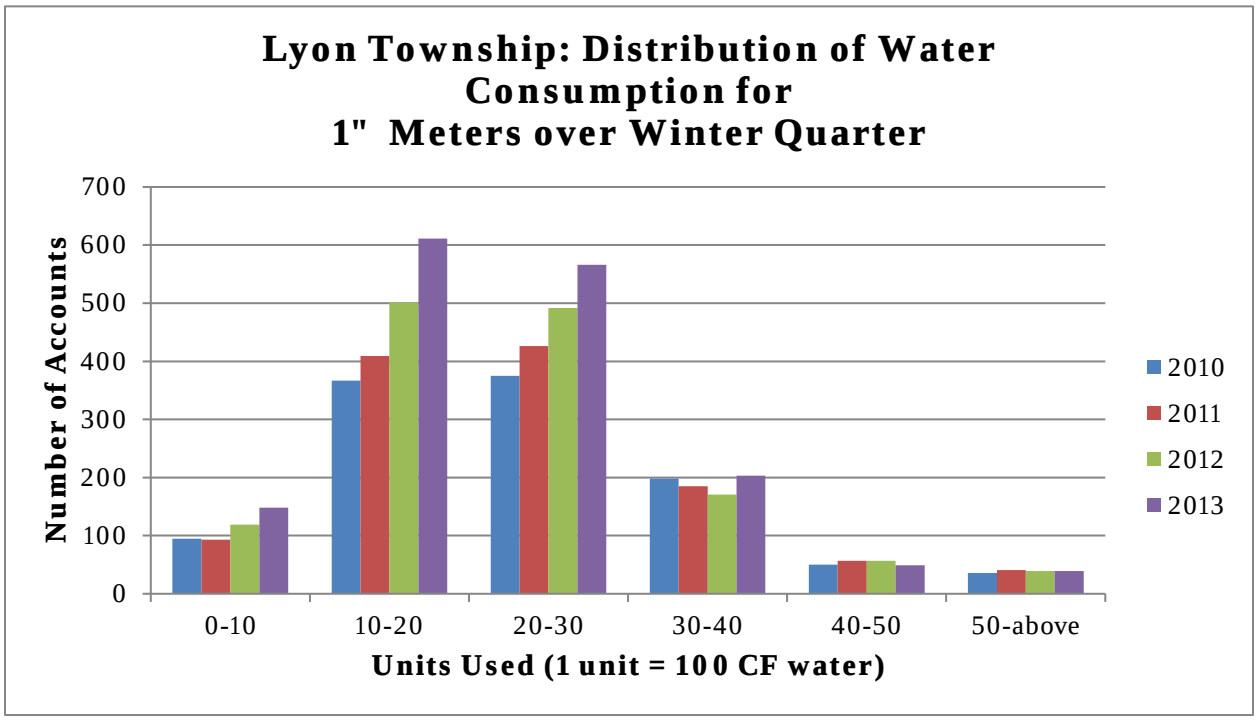


Figure G.03 - 1" Meter Data from 2010 to 2013 Winter Quarters (1,616 Accounts)

Because there are no 5/8" meters, this data set is considered to be representative of all residential water consumption across the community.

The data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 23.06 units or 2,306 cubic feet per quarter.

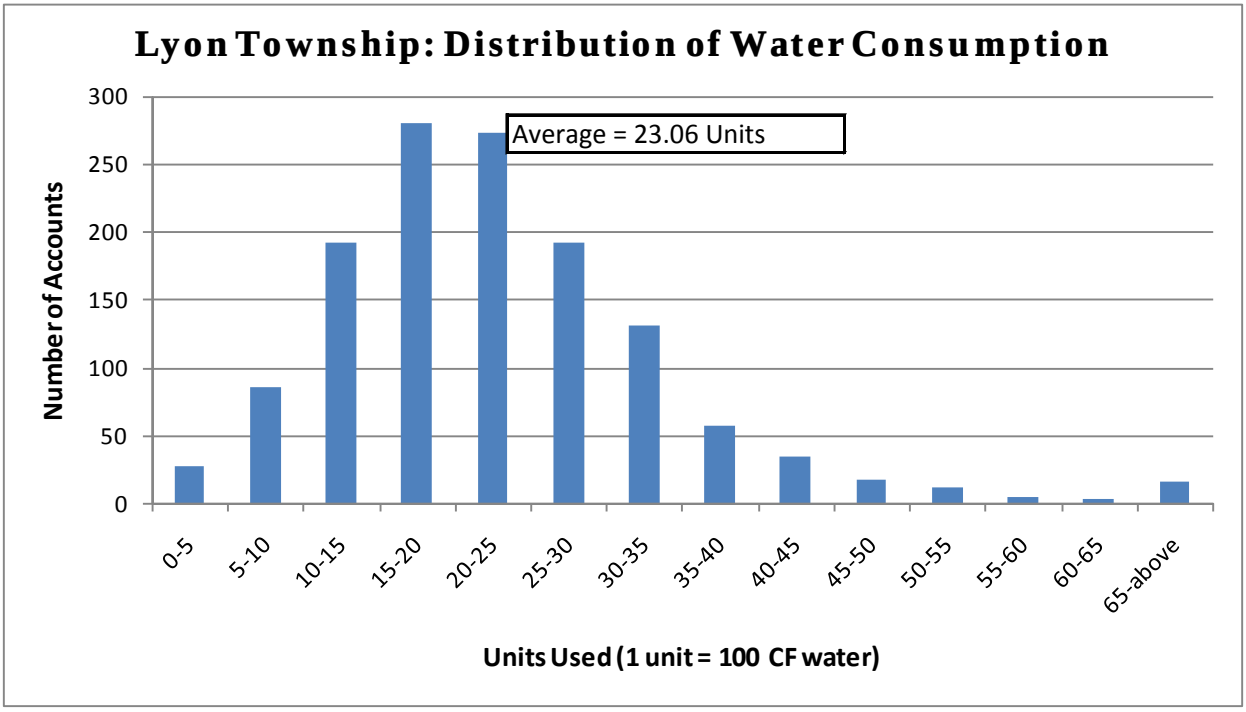


Figure G.04 - 1" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 21.71 units (2,171 cubic feet) as shown below.

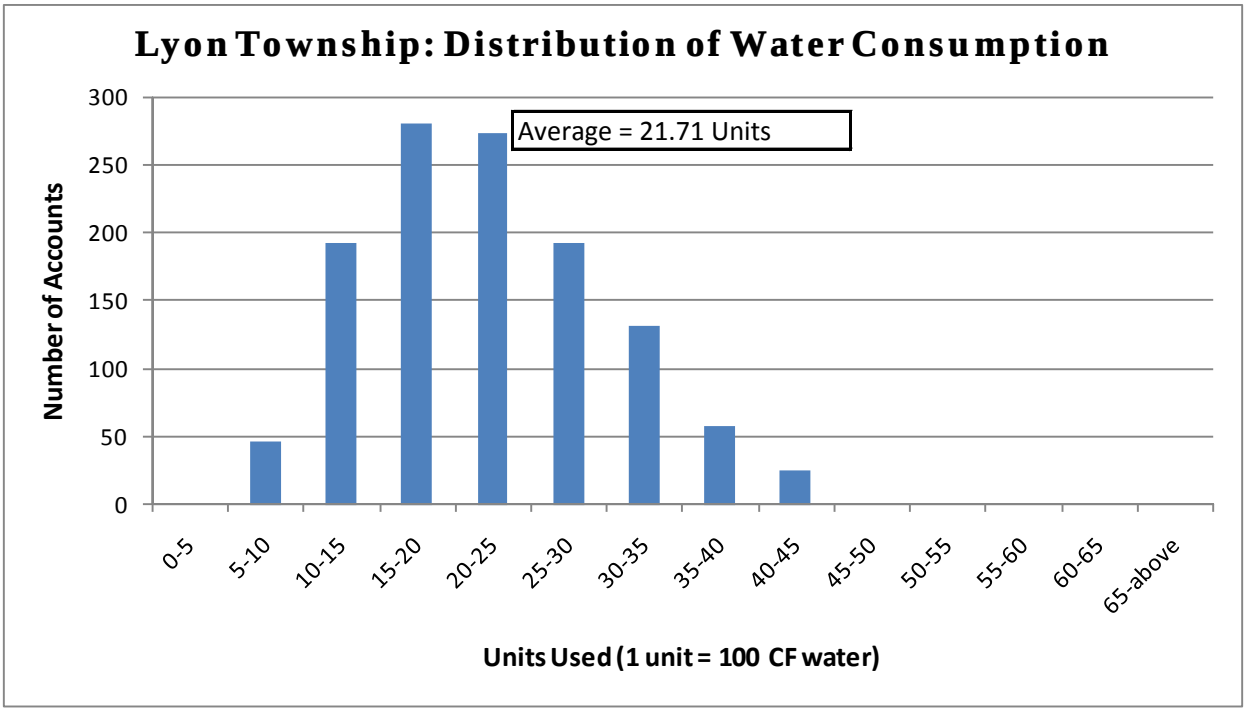


Figure G.05 - Middle 90% of 1" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Lyon Township. Converting the value in units/quarter to gallons/day, the recommended REU for Lyon Township is 180.43 gallons per day per household, or 65.37 gallons per person per day, as shown in the following table.

Table G.06 - Lyon Township Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.76	1,616	23.06	21.71	180.43	65.37

Calculated water use for 1 REU in Lyon Township: **180.43 gal/day** with 10% of high and low end account usage analyzed

Oakland Township

Oakland Township represents a large portion of the single-family residential water meter data with a total of 2,633 accounts. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table H.01 - Oakland Township SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	16,779	17,301	3.1%
Occupied Units	5,777	6,027	4.3%
People per Household	2.9	2.87	-1.0%
Median Housing Value	$342,000	N/A	N/A
Median Household Income	$111,206	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 7% and 1-inch meters represent 93% of the data as indicated in the table below.

Table H.02 - Oakland Township Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
OAKLAND TOWNSHIP	2.87	2,633	7%	93%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

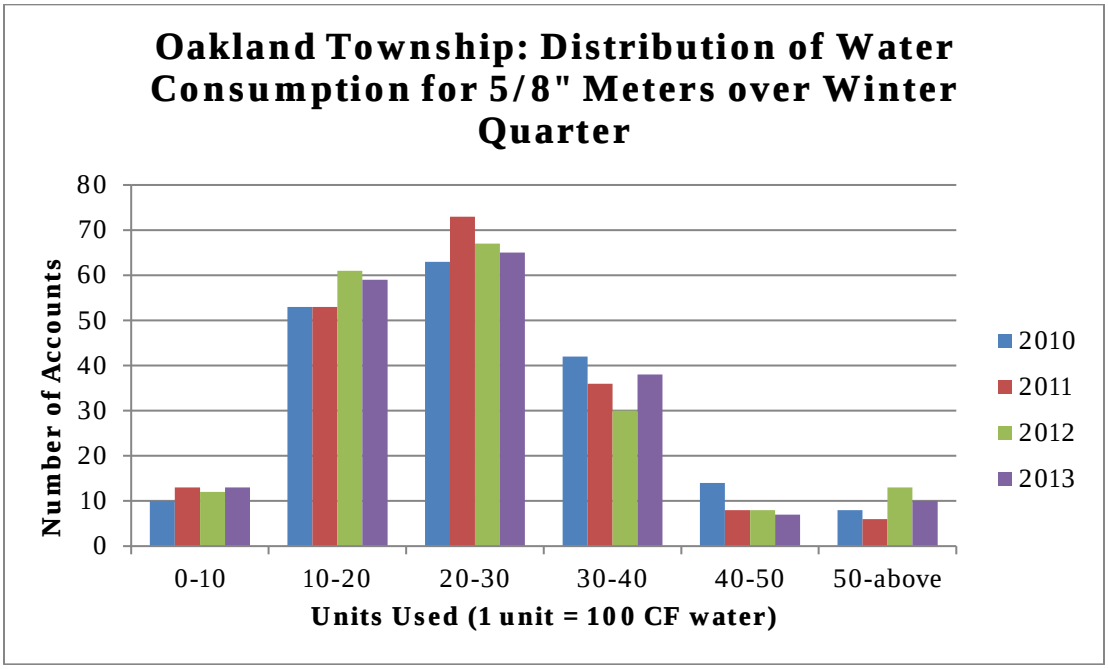


Figure H.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (184 of 2,633 Accounts)

The 5/8" meter graph above was created from a small data set, whereas the 1" meter graph below is from a much larger data set since the majority of residential meters in Oakland Township are 1". Notice that both graphs create very similar bell-shaped distribution patterns.

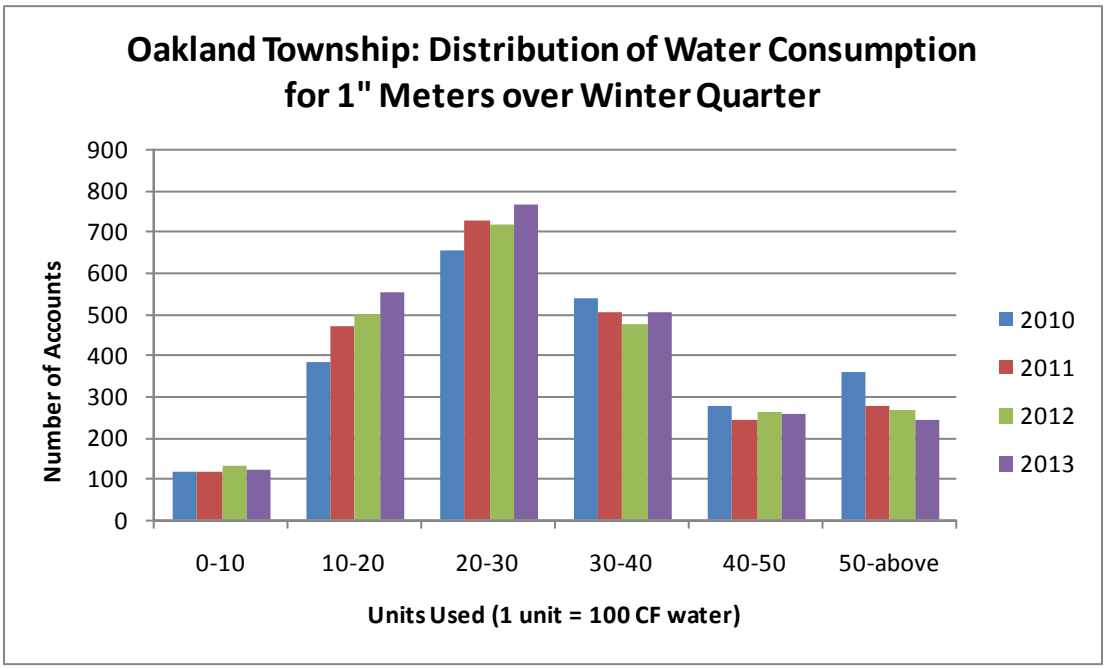


Figure H.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (2,449 of 2,633 Accounts)

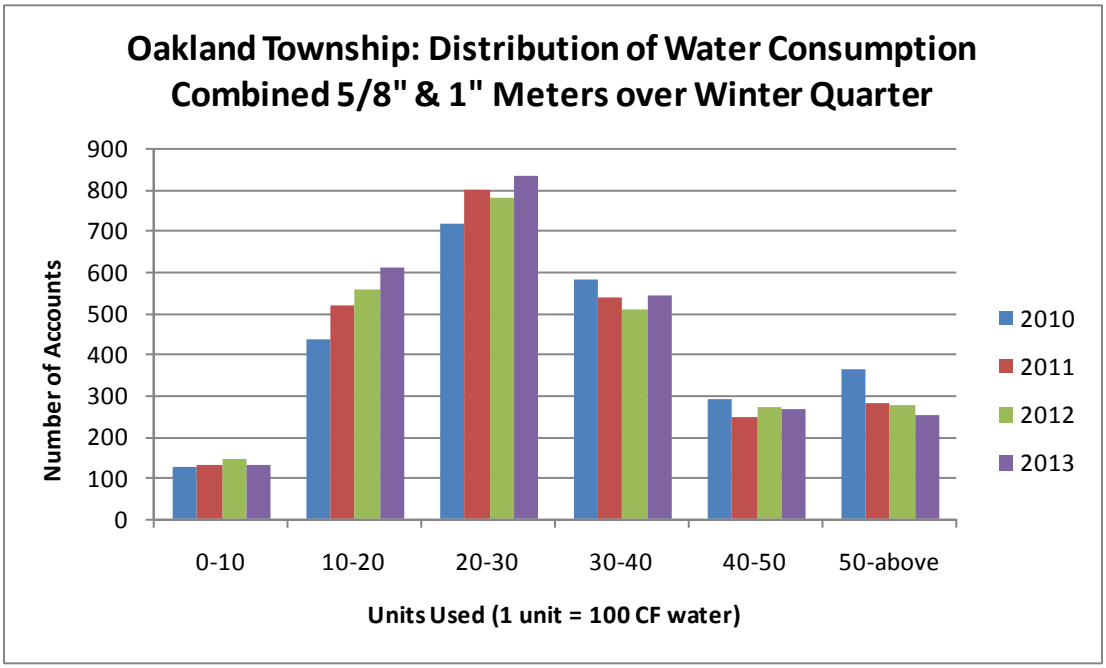


Figure H.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (2,633 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 31.04 units or 3,104 cubic feet per quarter.

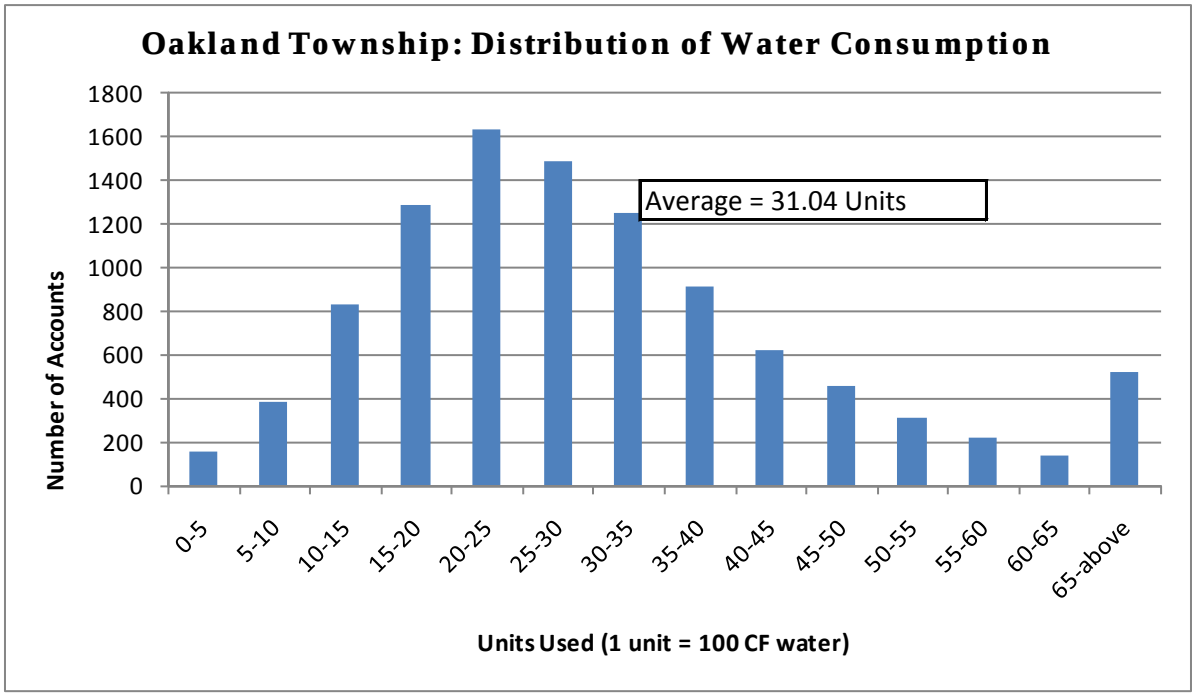


Figure H.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 29.05 units (2,905 cubic feet) as shown below.

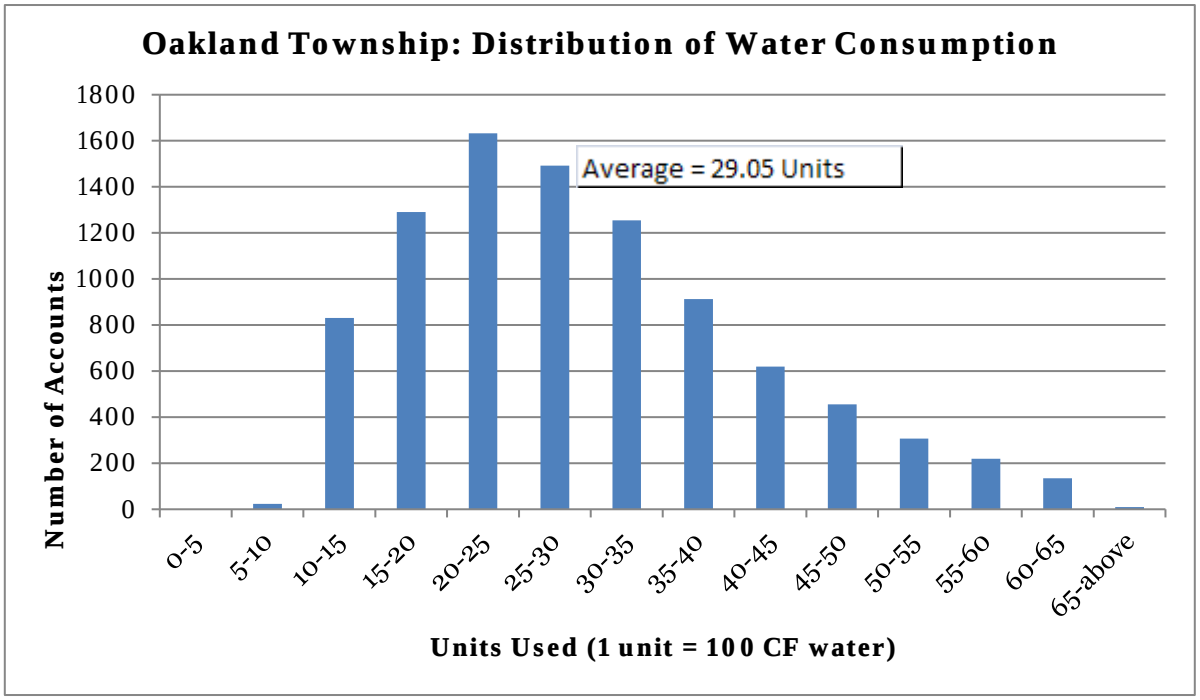


Figure H.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Oakland Township. Converting the value in units/quarter to gallons/day, the recommended REU for Oakland Township is 241.44 gallons per day per household, or 84.12 gallons per person per day, as shown in the following table.

Table H.08 - Oakland Township Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.87	2,633	31.04	29.05	241.4	84.12

Calculated water use for 1 REU in Oakland Township: **241.4 gal/day** with 10% of high and low end account usage analyzed

Orchard Lake

There are 620 single-family residential water service accounts on record in Orchard Lake. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table I.01 - Orchard Lake SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	2,375	2,360	-0.6%
Occupied Units	802	812	1.2%
People per Household	2.78	2.73	-1.8%
Median Housing Value	$588,200	N/A	N/A
Median Household Income	$149,250	N/A	N/A

From the 620 accounts with either 5/8-inch or 1-inch meters, 6% are 5/8-inch meters and 94% are 1-inch meters as indicated in the table below.

Table I.02 - Orchard Lake Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
ORCHARD LAKE	2.73	620	6%	94%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

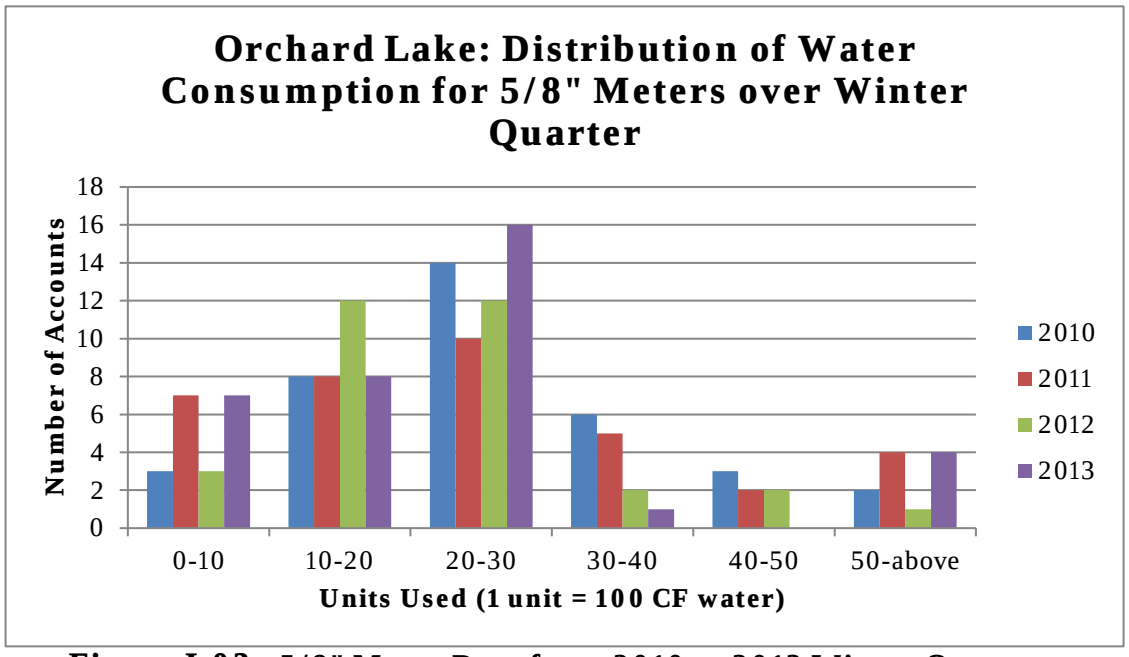


Figure I.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (37 of 620 Accounts)

The 5/8" meter graph above was created from a small data set, whereas the 1" meter graph below is from a much larger data set since the majority of residential meters in Orchard Lake are 1". Notice that both graphs create very similar bell-shaped distribution patterns.

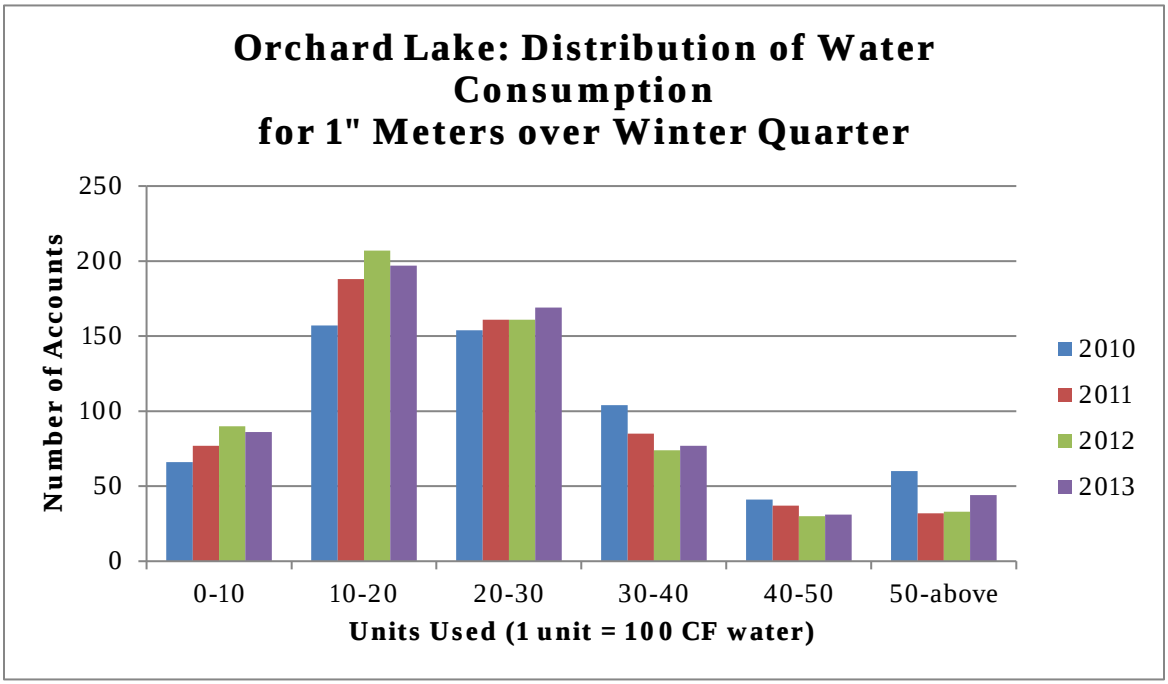


Figure I.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (583 of 620 Accounts)

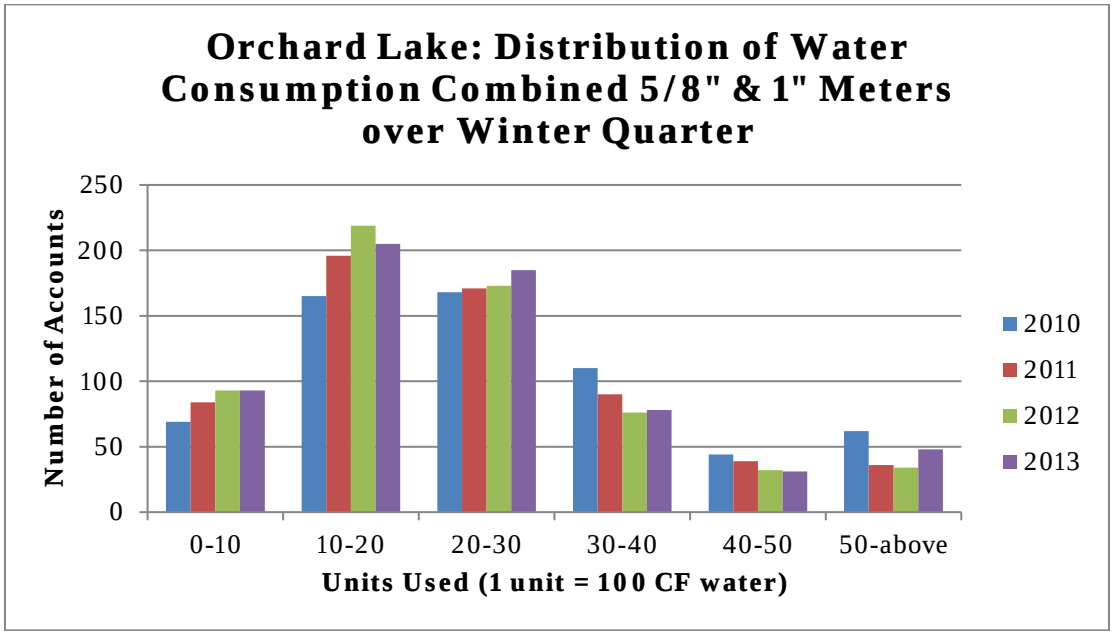


Figure I.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (620 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 25.31 units or 2,531 cubic feet per quarter.

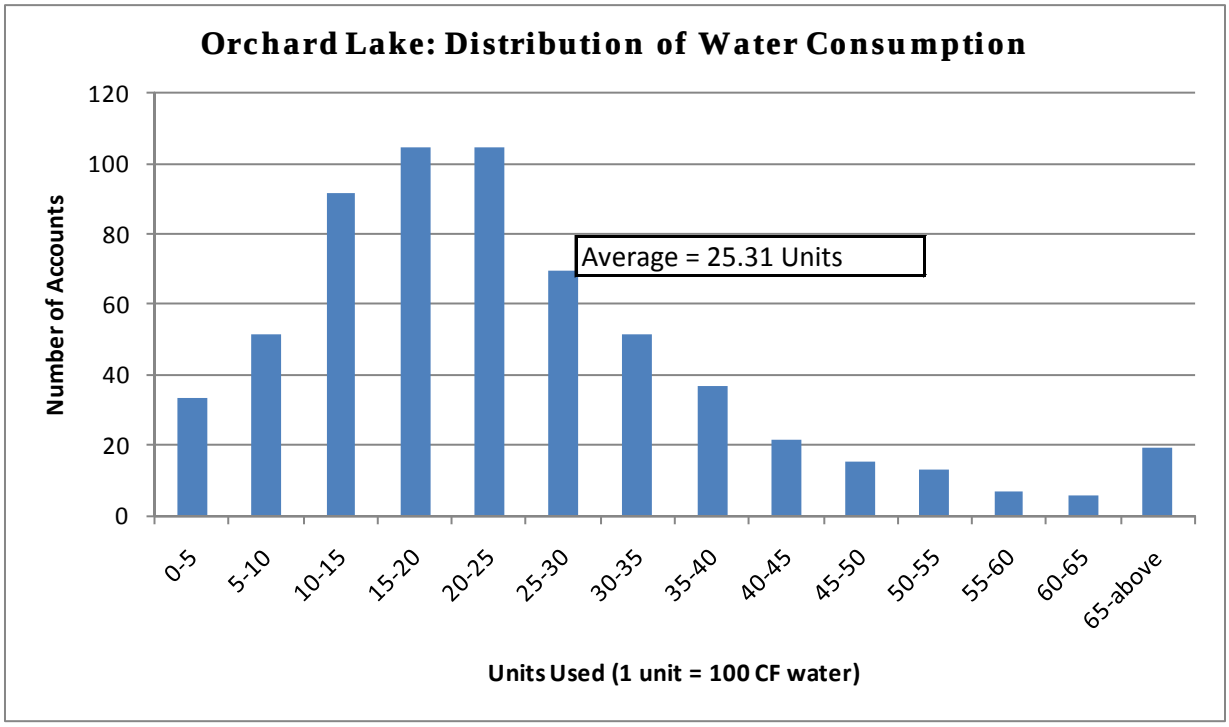


Figure I.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 22.78 units (2,278 cubic feet) as shown below.

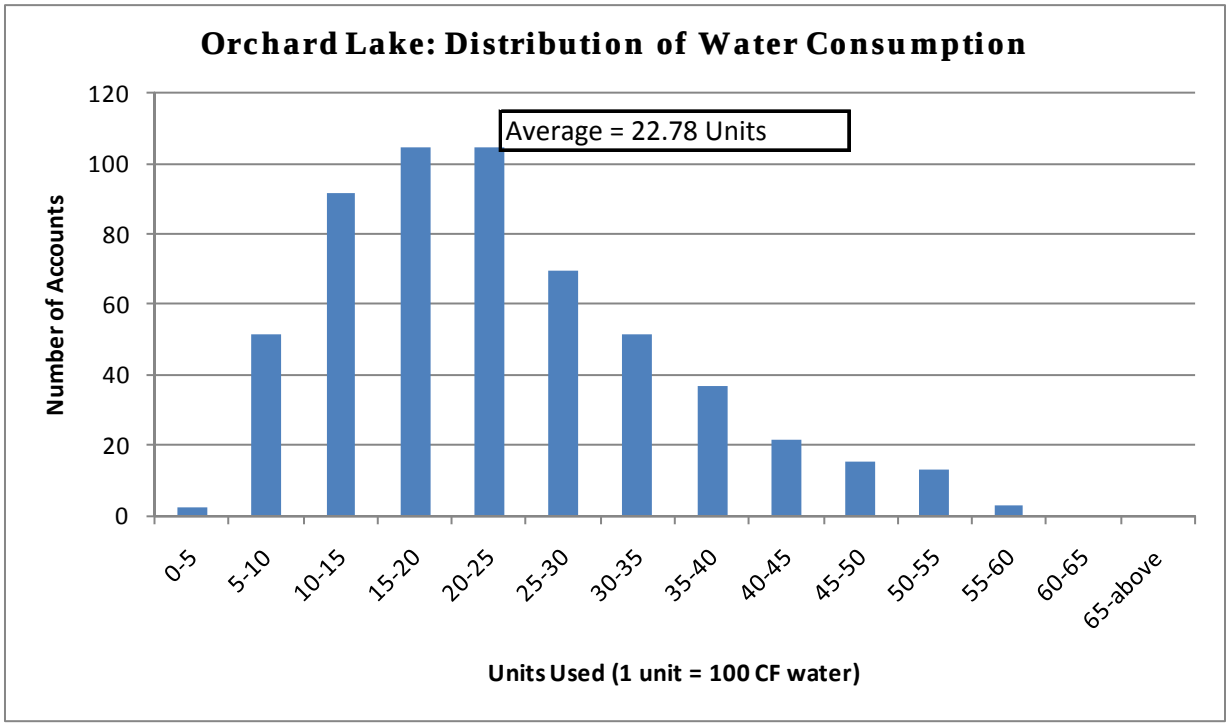


Figure I.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Orchard Lake. Converting the value in units/quarter to gallons/day, the recommended REU for Orchard Lake is 189.33 gallons per day per household, or 69.35 gallons per person per day, as shown in the following table.

Table I.08 - Orchard Lake Analysis Summary

People / House-hold	Residential Accounts	4-Year Avg. Winter Use (units /quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.73	620	25.31	22.78	189.3	69.35

Calculated water use for 1 REU in Orchard Lake: **189.3 gal/day** with 10% of high and low end account usage analyzed

Oxford Township

Oxford Township has a total of 2,319 single-family residential water service accounts. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table J.01 - Oxford Township SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	17,090	17,429	2.0%
Occupied Units	6,063	6,205	2.3%
People per Household	2.8	2.79	-0.4%
Median Housing Value	$213,900	N/A	N/A
Median Household Income	$80,664	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 6% and 1-inch meters represent 94% of the data as indicated in the table below.

Table J.02 - Oxford Township Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
OXFORD TOWNSHIP	2.79	2,319	6%	94%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

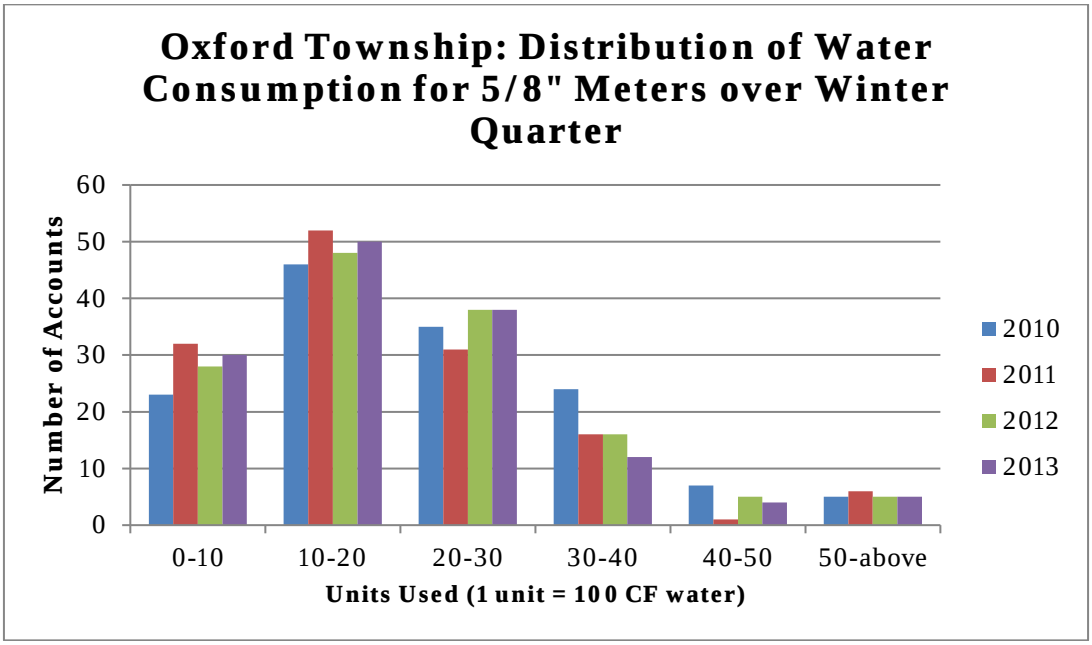


Figure J.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (139 of 2,319 Accounts)

The 5/8" meter graph above was created from a small data set, whereas the 1" meter graph below is from a much larger data set since the majority of residential meters in Oxford Township are 1". Notice that both graphs create similar bell-shaped distributions.

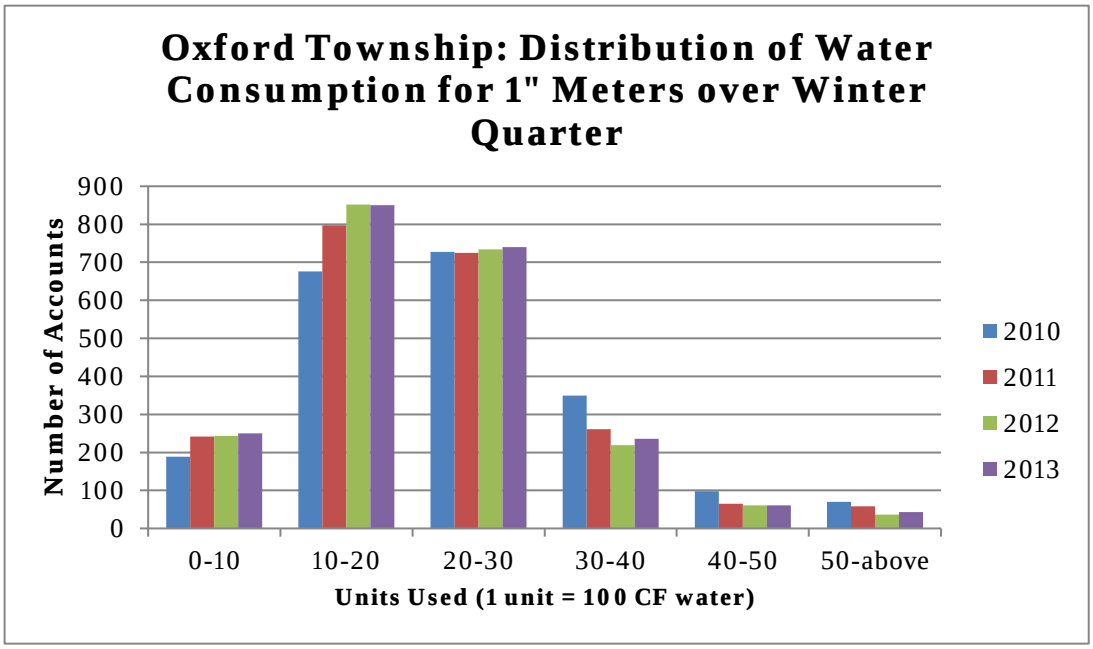


Figure J.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (2,180 of 2,319 Accounts)

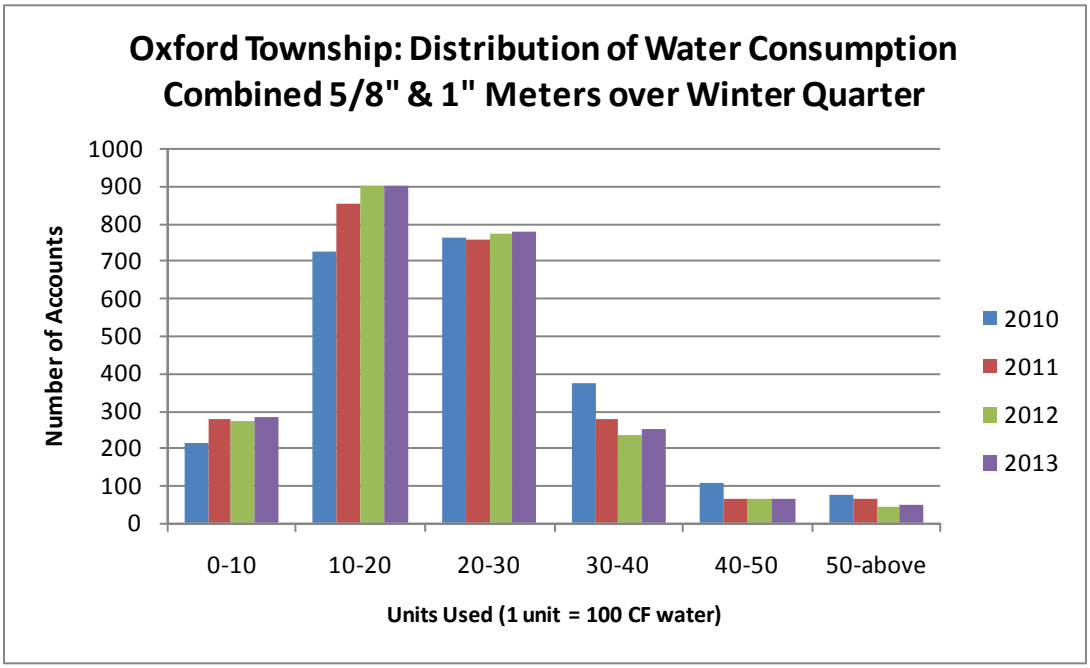


Figure J.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (2,319 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph below displays this distribution with an average consumption value of 22.09 units or 2,209 cubic feet per quarter.

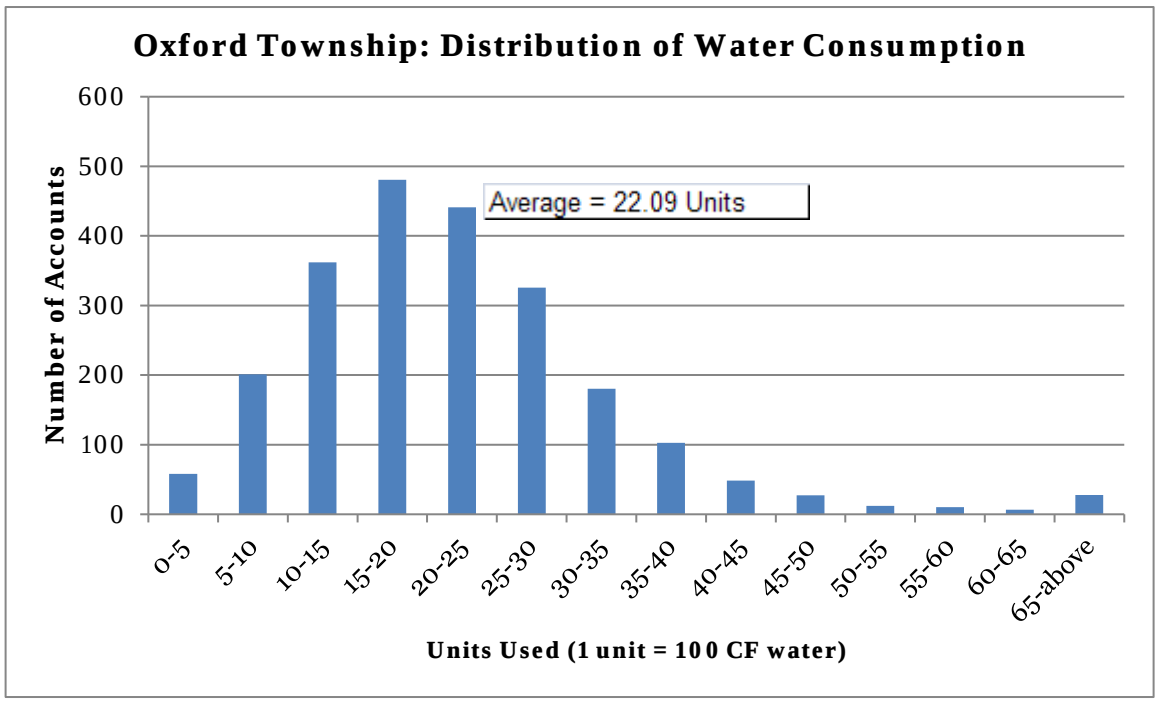


Figure J.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 20.62 units (2,062 cubic feet) as shown below.

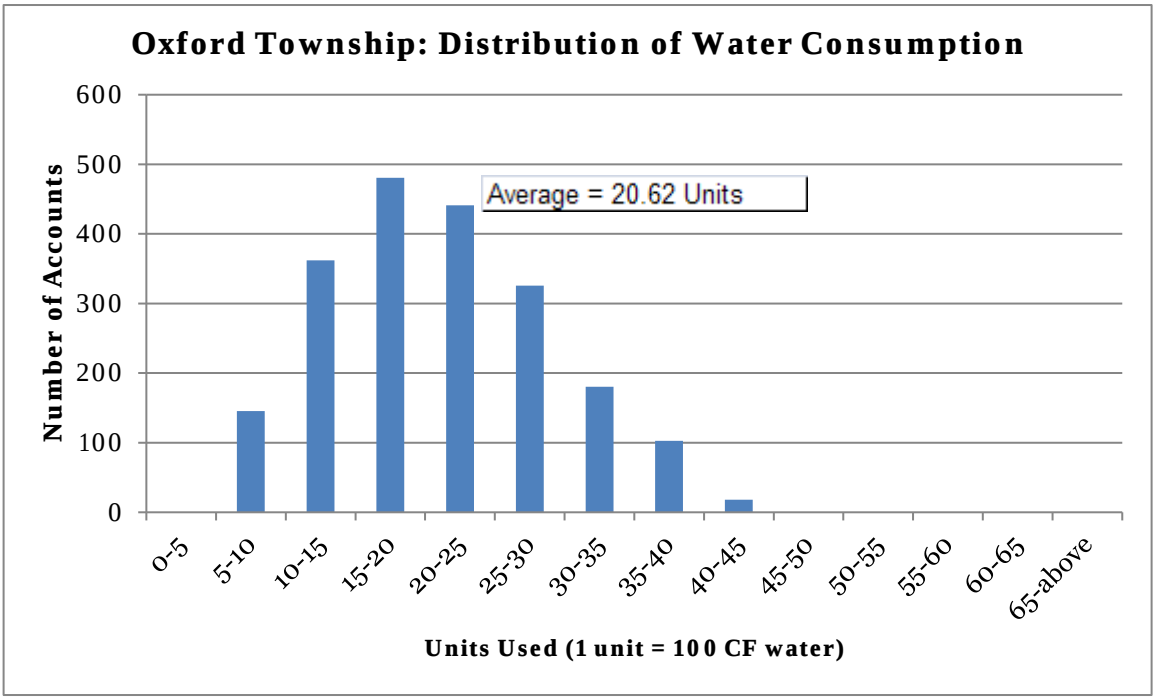


Figure J.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Oxford Township. Converting the value in units/quarter to gallons/day, the recommended REU for Oxford Township is 171.4 gallons per day per household, or 61.4 gallons per person per day, as shown in the following table.

Table J.08 - Oxford Township Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/person/ day
2.79	2,319	22.09	20.62	171.4	61.4

Calculated water use for 1 REU in Oxford Township: **171.4 gal/day** with 10% of high and low end account usage analyzed

Royal Oak Township

There are 570 single-family residential water service accounts in Royal Oak Township. The following demographic information was gathered from SEMCOG, which highlight a few of the community characteristics related to water consumption.

Table K.01 - Royal Oak Township SEMCOG Data

Demographics	2010	2013	Change (2010-2013)
Population	2,419	2,466	1.9%
Occupied Units	1,024	1,012	-1.2%
People per Household	2.36	2.44	3.4%
Median Housing Value	$99,800	N/A	N/A
Median Household Income	$25,515	N/A	N/A

From the total number of 5/8-inch and 1-inch meters, 5/8-inch meters represent 97% and 1-inch meters represent only 3% of the data as indicated in the table below.

Table. K.02 - Royal Oak Township Water Meter Size Distribution

Community	People/ House-hold	Residential Accounts	% of 5/8" Residential Meters	% of 1" Residential Meters
ROYAL OAK TOWNSHIP	2.44	570	97%	3%

Following the process described in the Data Analysis Process section of this report, three graphs were produced from winter quarter billing data. The first graph represents all 5/8-inch meters, the second represents all 1-inch meter data and the third represents a combination of data from 5/8-inch and 1-inch meters.

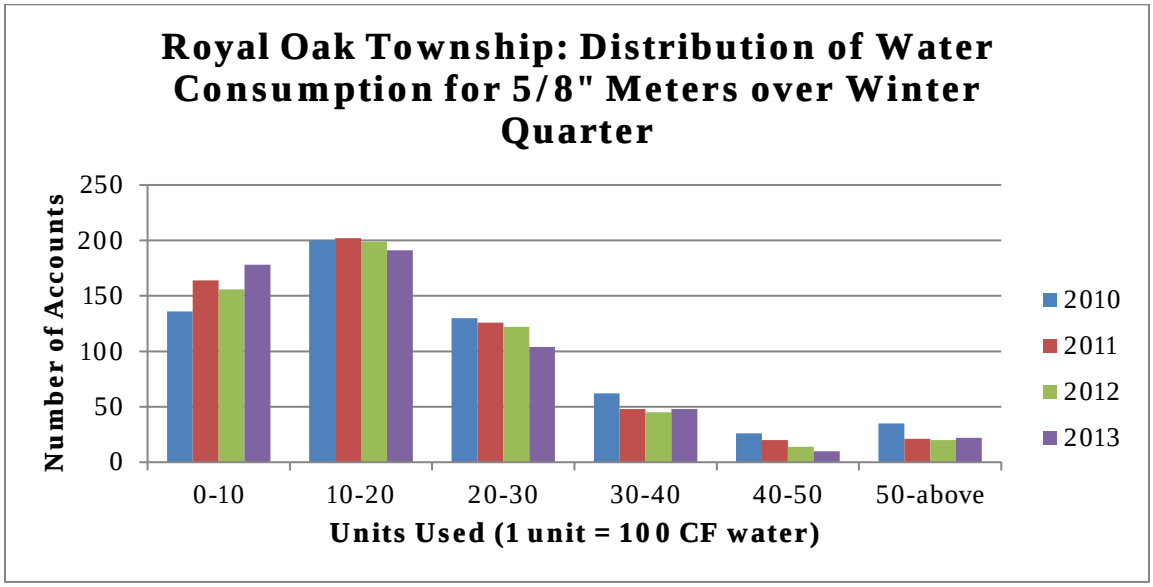


Figure K.03 - 5/8" Meter Data from 2010 to 2013 Winter Quarters (553 of 570 Accounts)

The 5/8" meter graph above was created from a relatively large data set, whereas the 1" meter graph below is from a much smaller data set since the majority of residential meters in Royal Oak Township are 5/8". Notice that both graphs create bell-shaped distributions with peaks in the 10-20 units range.

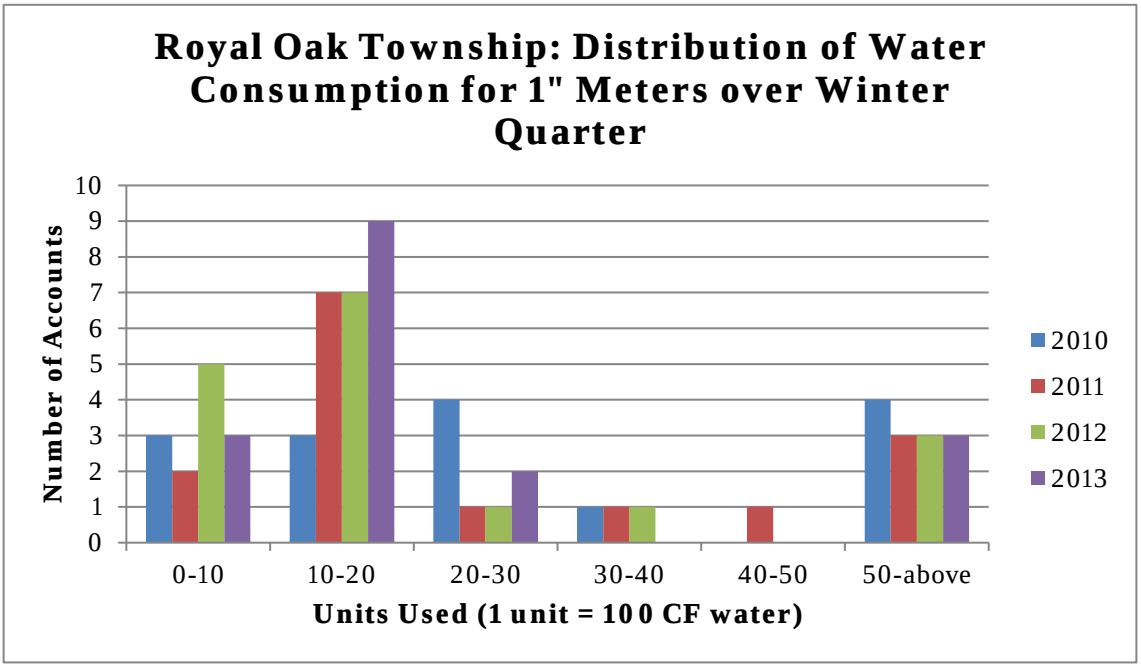


Figure K.04 - 1" Meter Data from 2010 to 2013 Winter Quarters (17 of 570 Accounts)

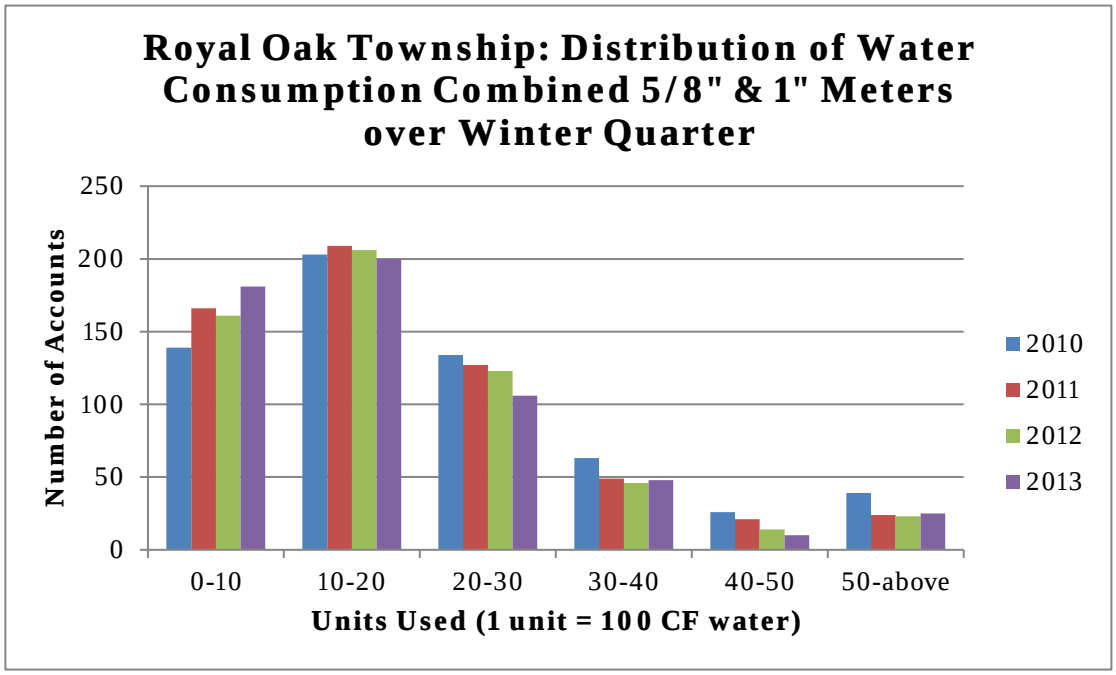


Figure K.05 – Combined 5/8" & 1" Meter Data from 2010 to 2013 Winter Quarters (570 Accounts)

The combined 5/8" & 1" meter data produced a graph which is consistent with the individual meter size graphs. Because both meter sizes are included, this data set is considered to be more representative of typical residential water consumption across the community and will be used for the remaining analysis.

The same data set was then averaged over the past four years and plotted at intervals of 500 cubic feet to produce a higher resolution graph. The graph on the following page displays this distribution with an average consumption value of 20.3 units or 2,030 cubic feet per quarter.

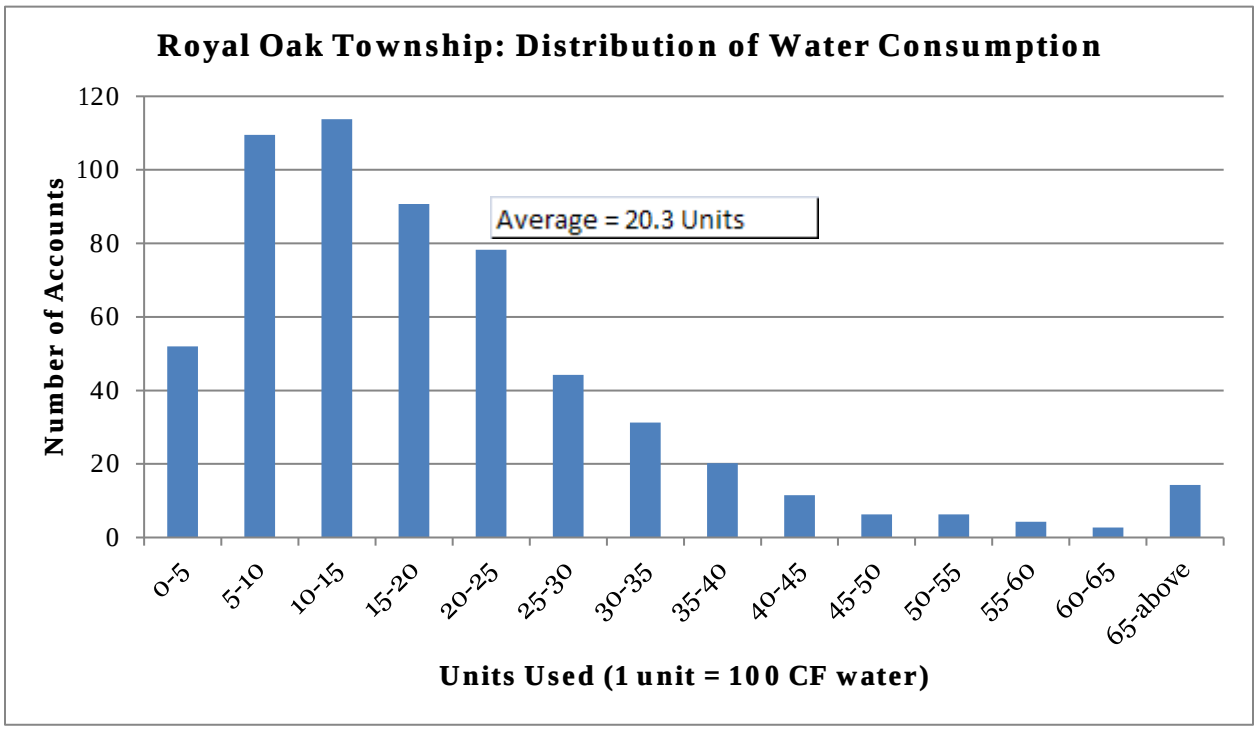


Figure K.06 - 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

To reduce the impact of outliers, the data was statistically reduced as described in the Data Analysis Process section. From the remaining 90% of combined 5/8-inch and 1-inch meter data, the average water consumption was found to be 17.2 units (1,720 cubic feet) as shown below.

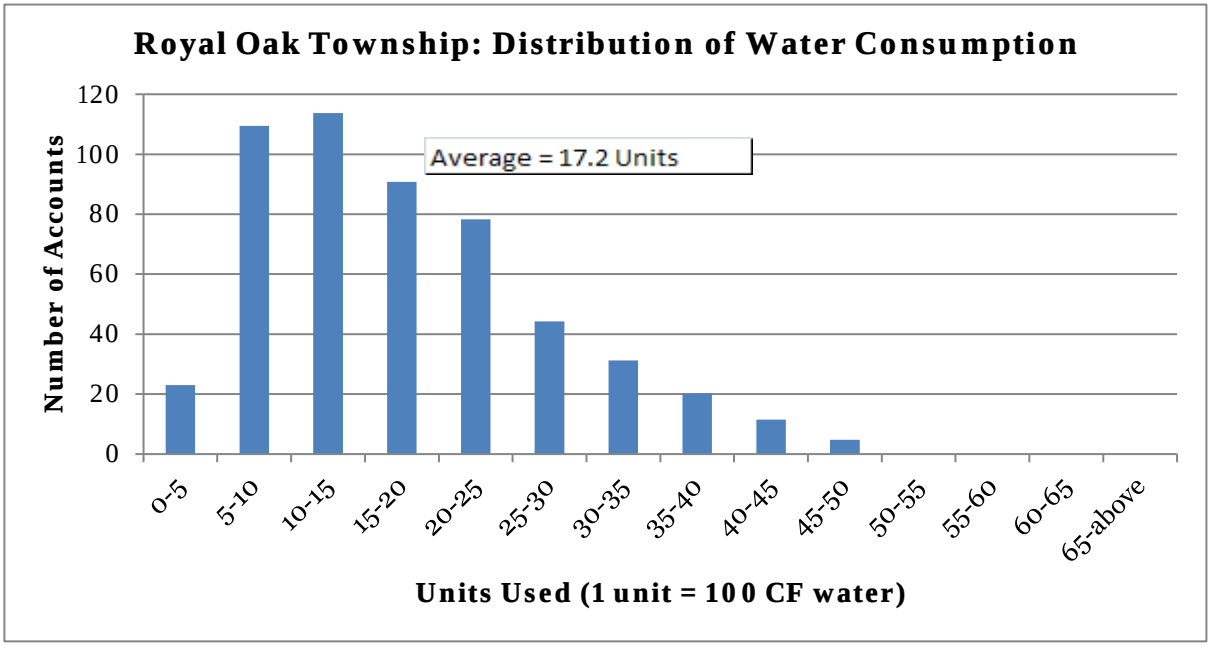


Figure K.07 - Middle 90% of 1" & 5/8" Meter Data Averaged from 2010 to 2013 Winter Quarters

Royal Oak Township

The average of the statistically reduced set of winter quarterly water meter readings was used to recommend a value for an REU in Royal Oak Township. Converting the value in units/quarter to gallons/day, the recommended REU for Royal Oak Township is 143.0 gallons per day per household, or 58.6 gallons per person per day, as shown in the following table.

Table K.08 - Royal Oak Township Analysis Summary

People/ House-hold	Residential Accounts	4-Year Avg. Winter Use (units/ quarter)	Avg. from Statistically Reduced Data (units/ quarter)	Gal/day/house-hold	Gal/day/house-hold
2.44	570	20.3	17.2	143.0	58.6

Calculated water use for 1 REU in Royal Oak Township: **143.0 gal/day** with 10% of high and low end account usage analyzed

2.3 - Demographic Analysis

Water consumption for each community was compared to several demographic characteristics in search of correlations. Demographic data such as people per household, average home value, and average household income was used for comparison. This data was taken from SEMCOG and plotted against water use within each community. We also attempted to look at the cost of water to see if there is a use correlation.

Figure 2.31 compares water use to the average number of people per household in each community.

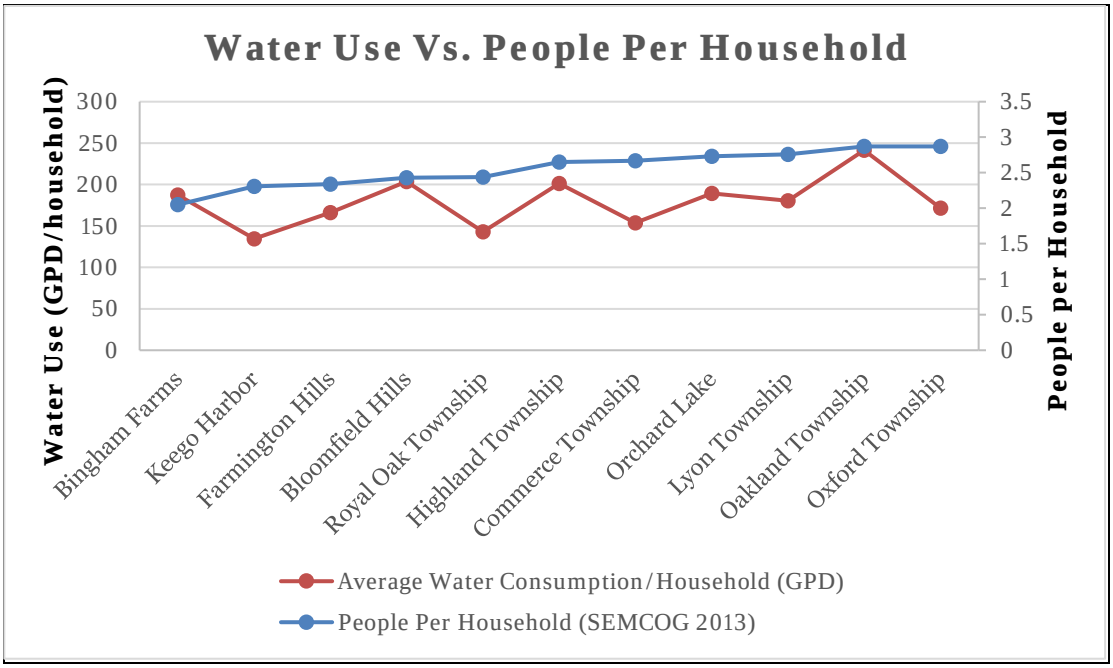


Figure 2.31 - Water Use Versus People per Household

The communities were sorted in increasing order of people per household and the corresponding average water use was plotted on the same chart. The results fail to definitively show a correlation between average water use and people per household.

Figure 2.32 compares water use to the average home value in each community.

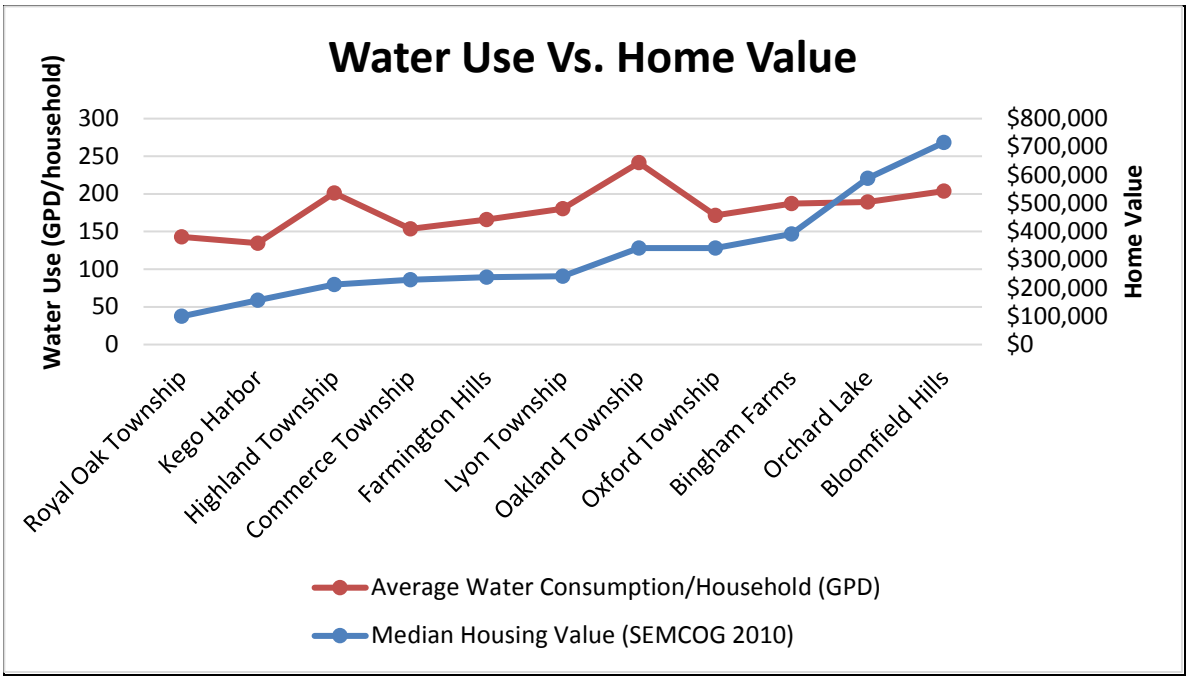


Figure 2.32 - Water Use Versus Average Home Value

The communities were sorted in increasing order of average home value and the corresponding average water use was plotted on the same chart. The results show a slight correlation between average water use and average home value with the water use showing a general increase in value.

Figure 2.33 compares water use to the average household income in each community.

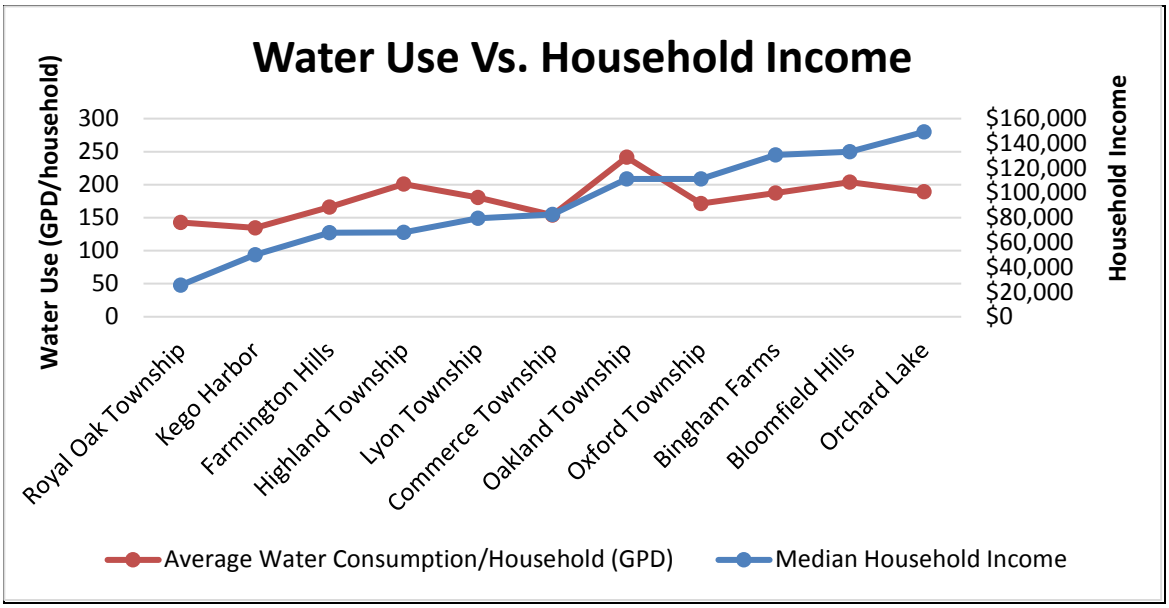


Figure 2.33 - Water Use Versus Average Household Income

The communities were sorted in increasing order of average household income and the corresponding average water use was plotted on the same chart. The results fail to demonstrate a correlation between average water use and average household income.

Figure 2.34 compares water use to the average water rates in each community.

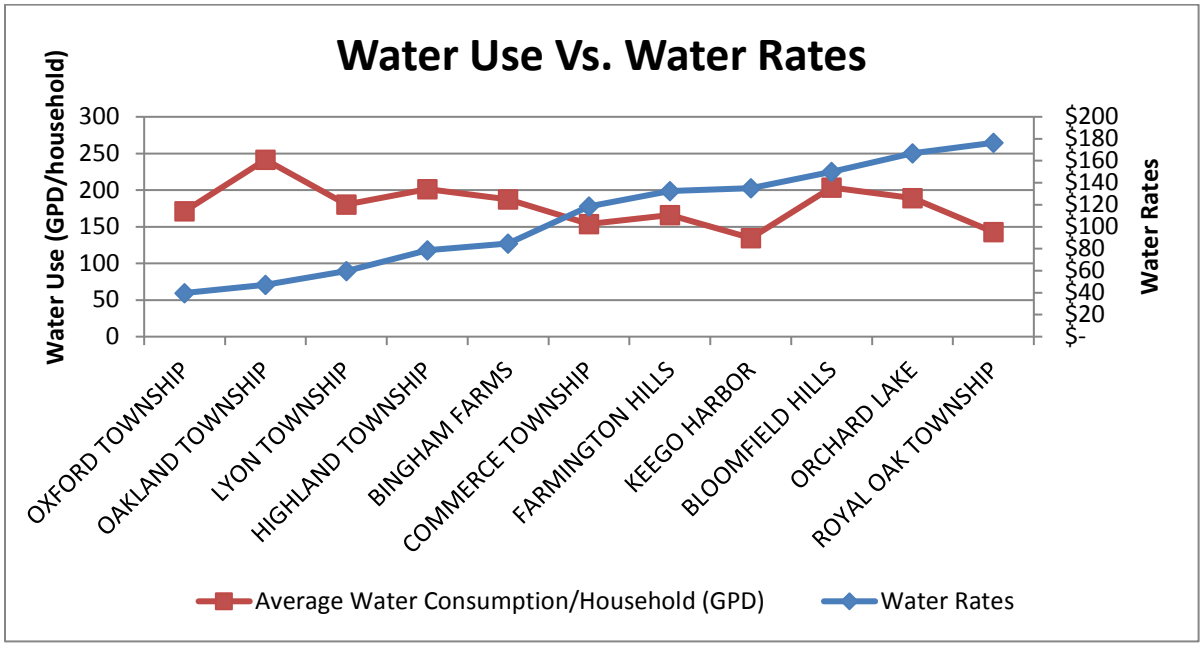


Figure 2.34 - Water Use Versus Billing Rate

3.0 – Phase II

Purpose

The Phase II study was designed to:

- utilize the Phase I quantified and adopted REU of **2,106 CF per quarter** as the basis for business (non-residential) category REU calculations;
- update and summarize business categories; and
- provide the ability to calculate business REU's using multiple service use types and the resulting strength of their statistical correlation between service use type and resulting usage to provide accurate business REU quantification.

The updated Schedule of Unit Assignment Factors is provided in Section 4.0 and in Appendix VI.

3.1 – Formation of a Steering Committee

The Phase II Study involved the development and coordination of a Steering Committee comprised of municipal and some of their consulting personnel to serve as the guiding body for the review and development of an updated Schedule of Unit Assignment Factor classification and quantification. Members of the committee included: Civil Engineering Solutions, Commerce Township, City of Farmington Hills, Giffels Webster, J&A, Lyon Township, City of Novi, Oakland County Water Resources Commission, City of Walled Lake, Waterford Township, West Bloomfield Township, and White Lake Township.

As part of the Phase II study, the Committee also reviewed the Phase I study and provided guidance recommendations to include further analysis of the impact of modifying the high and low end usage data as well as returned water to the wastewater system and infiltration and inflow contribution. Usage analysis included using 100% of the consumption data, 95% of the consumption data (eliminating the 2.5% high end and 2.5% low end usage), and 90% of the consumption data (eliminating the 5% of high end and 5% low end usage) of the accounts. Water usage was also analyzed by comparing 80%, 90%, and 95% of the water usage being returned to the wastewater system as well as private property sewer lead infiltration rates of 5%, 10%, and 15% of usage being returned to the wastewater system.

After reviewing published national sewer usage values, current SEMCOG demographical information, consumption data for the 11 WRC billing communities in the study and the revised analysis parameters, the Steering Committee adopted a revised single family residential usage of 21.06 units per quarter or **2,106 CF per quarter** with 1 unit equaling 100 CF. The adopted REU value was based on utilization of:

- 95% of the usage data,
- 95% of the usage being returned to the wastewater system, and
- 5% of the usage being contributed as infiltration and inflow.

As a result, the Committee adopted single family residential usage value of 2,106 CF per quarter was utilized in the development of REU unit factor values related to business class usage in the updated Schedule of Unit Assignment Factor document.

The Steering Committee also reviewed the current non-residential categories within the Schedule of Unit Assignment Factors Table and updated them based on current demographics and development trends.

The Committee decided to eliminate the following business classifications in the 1998 Schedule, because they felt they were outdated and no longer applicable:

- Boarding Houses
- Boarding Schools
- Bus Maintenance Facilities
- Cleaners (pickup only)
- Drug Stores with fountain service
- Fraternal Organizations (members only)
- Racquet Clubs

- Rooming Houses
- Summer Camps
- Theatres (Drive-In)
- Tourist Courts

A few business classifications were also added based on current development trends:

- Auto Service/Repair
- Nail Salons
- Kids Indoor Play Centers
- Early Learning/Day Care
- Police Stations
- Fire Stations
- Pet Care Kennels
- Pet Care Grooming
- Wet Process Manufacturing

The original Table had 55 non-residential categories listed with the updated Table having 51 categories. The Committee also decided to re-format the existing Table and create 'main categories' (i.e. Auto; Food, Beverage & Retail; Personal Care; etc.) and subcategories within these main categories (Auto Dealership, Country Clubs, etc.) to provide further business use resolution. The existing and proposed categories are presented in Tables 3.10 and 3.11 respectively on the following pages.

The Committee met periodically throughout the year and provided input during the data collection process.

Table 3.10 – Existing Schedule of Unit Assignment Factors Major Non-Residential Categories

Usage	Unit Factor	Usage	Unit Factor
Single Family Residential	1.0 per dwelling	Factories	.50 per 1,000 sq. ft.
Auto Dealers	.30 per 1,000 sq. ft.	Fraternal Organizations (members only	1.0 per hall
Banquet Hall	.50 per 1,000 sq. ft.	Fraternal Organizations (members & rentals)	2.0 per hall
Barber Shops	1.0 per 1,000 sq. ft.	Funeral Homes, including one residence	2.2 per funeral home
Bars	.044 per seat	Grocery Stores & Supermarkets	0.31 per 1,000 sq. ft.
Beauty Shops	0.223 per booth	Health Clubs w/ showers and/or pool	2.3 per 1,000 sq. ft.
Boarding Houses	.16 per person	Health Clubs w/o showers and/or pool	.26 per 1,000 sq. ft.

Usage	Unit Factor	Usage	Unit Factor
Hospitals	1.22 per bed	Hotels and/or Motels (exclusive of swimming pools, bars, restaurants)	.38 per room
Boarding Schools	.27 per person	Laundry (self-service)	.54 per washer
Bowling Alleys (no bars, lunch facilities)	.16 per alley	Mobile Home Parks	.60 per mobile home
Manual Do-It Yourself Car Wash	2.5 per stall	Multiple Family Residence	.60 per residence
Semi-Automatic Car War (w/o conveyor)	12.5 per stall	Office Building	.40 per 1,000 sq. ft.
Automatic Car Wash w/ Conveyor	33.0 per lane	Public Institutions other than Hospitals	.32 per employee
Automatic Car Wash w/ recycling water	8.4 per lane	Racquet Clubs	.82 per tennis or handball court
Churches	.008 per seat	Conventional Type Restaurants	.13 per seat
Cleaners (pickup only)	.048 per employee	Quick Service Restaurants w/o dishes	5.6 per restaurant
Cleaning (pressing facilities)	1.25 per press	All other Restaurants	1.8 per restaurant
Medical Clinic	1.00 per doctor	Rooming Houses (no meals)	.13 per person
Dental Clinic	1.40 per dentist	Elementary Schools	.012 per student
Convalescent and/or Nursing Homes	.3 per bed	Junior or Middle High Schools	.020 per student
Convents	.20 per person	Senior High Schools	.038 per student
Country Clubs	.08 per member	Bus Maintenance Facility	.165 per 1,000 sq. ft.
Drug Stores w/ fountain service	.08 per seat + .14 per 1,000 sq. ft.	Service Station	.24 per pump
Drug Stores w/o fountain service	.14 per 1,000 sq. ft.	Store (other than specifically listed)	.16 per employee
Summer Camps	.14 per housing unit	Theatres (indoor)	.008 per seat
Swimming Pool (single family residential excluded)	3.00 per 1,000 sq. ft.	Tourist Courts (individual bath units)	.27 per cubical
Theatres (drive-in)	.012 per car space	Warehouses	.10 per 1,000 sq. ft.

Table 3.11 – Proposed Schedule of Unit Assignment Factors Major Non-Residential Categories

Auto
Auto Showroom/Dealership
Auto Service Repair
Auto Service/Convenience Stations

Self-Serve Car Washes
Fully & Semi-Automatic Car Washes
Food, Beverage & Retail
Banquet Halls
Country Clubs
Convenience Store w/ Pharmacy
Full Service Grocery Store (w/ florist, eye care, etc.)
Grocery Store w/o Full Service
Stores (other than specifically listed)
Fraternal Organizations
Restaurants w/ Liquor
Restaurants w/o Liquor
Quick Service Restaurants w/ dining & restrooms
Quick Service Restaurants w/o dining & restrooms
Personal Care
Barber Shops
Beauty Salons
Nail Salons
Entertainment/Health & Fitness
Bowling Alleys
Kids Indoor Play Centers
Theatres
Health Club/Fitness Center w/ Showers &/or Pool
Health Club/Fitness Center w/o Showers &/or Pool
Swimming Pools
Service Providers
Dry Cleaners
Self Service Laundry Facilities
Funeral Homes
Pet Care Grooming
Pet Care Kennels
Hotels
Motels
Office/General Use/Assembly
Offices – General
Warehouses & Storage
Public Institutions (other than hospitals, schools)
Churches
Medical/Wellness
Medical Clinics
Dental Clinics
Retirement Homes/Assisted Living
Hospitals
Government
Daycare/Early Learning
Elementary Schools
Junior or Middle Schools
Senior High Schools
Police Stations
Fire Stations
Housing
Single Family Residential
Multiple Family Residences

Mobile Home Parks
Convents & Seminaries
Manufacturing
Wet Process
Dry Process

3.2 – Phase II Data Analysis Process

Data collection for the non-residential properties (businesses) included specific water usage data for the same Phase I study period of years 2010-2013 during the winter months. Usage and business category data included the original 11 WRC billing communities from Phase I and was expanded to include data from the City of Novi and Bloomfield Township, West Bloomfield Township, and Waterford Township.

Summer quarter water usage data was collected for the outdoor swimming pools since these clubs are closed during fall and winter months.

Annual water usage data was also calculated for each category and compared with the 1998 annual water usage values. This information is found in Appendix IV.

The water usage data received from the WRC was reviewed and filtered for the process of collecting up to 5 representative properties within each non-residential subcategory. In some instances, where a wide variation in water usage was anticipated, additional properties were gathered (i.e. Stores (other than specifically listed) and Offices-General). An average water usage was then calculated for each non-residential property within the survey.

Service use data was also collected from sources such as SEMCOG, field visits, and phone calls to the various non-residential types to calculate non-residential REU unit factors for business categories including:

- Square footage
- Number of fixtures
- Number of employees
- Number of seats (collected for restaurants and banquet halls)
- Number of beds (collected for hospitals and retirement homes)
- Number of students (collected for schools)
- Number of dentists (collected for dental offices)
- Number of doctors (collected for medical offices)
- Number of rooms/seats (collected for medical/dental offices)
- Number of stalls/bays (collected for auto service repair and car washes)
- Number of gas pumps (collected for convenience stores)

Meter sizes and usage were also compared, however no strong correlation existed between larger meters resulting in more usage for the non-residential categories.

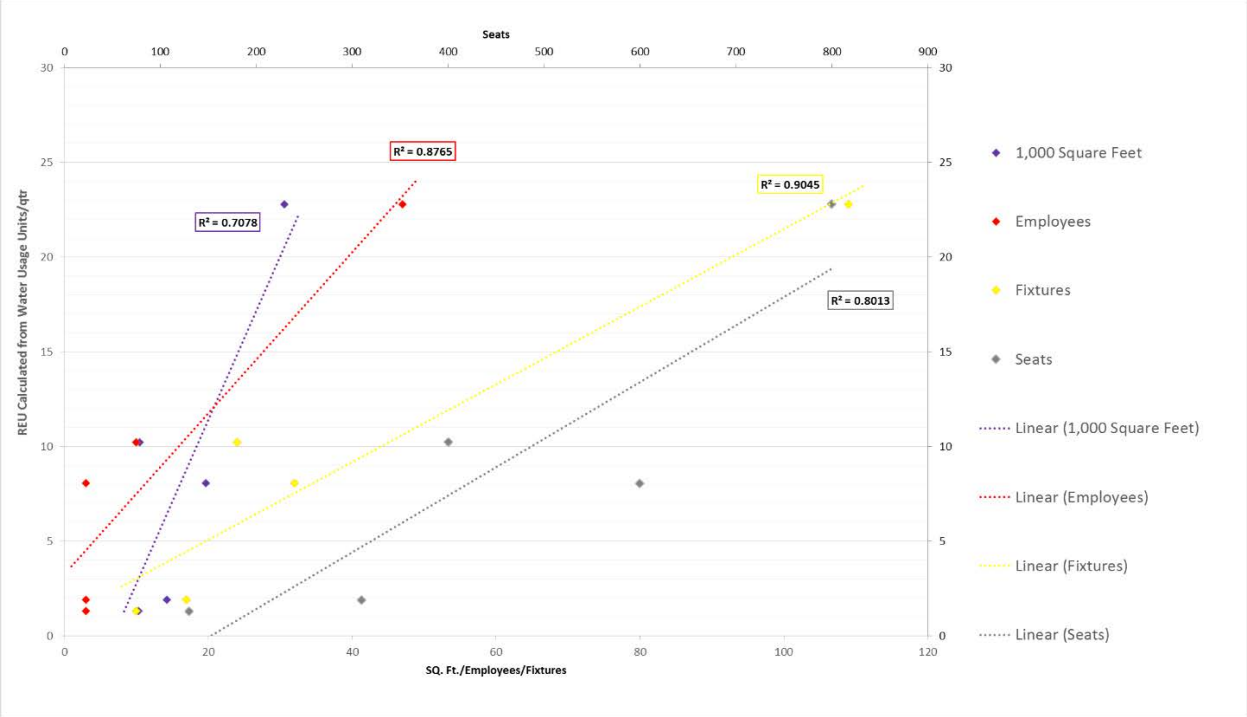
Once all the data was gathered for each business type, a regression analysis was derived to calculate the relationship strength between usage and the various business service use categories to update the WRC Schedule of Unit Assignment Factors. Both positive and negative correlations with water usage were identified on the graphs.

The graphs on the following pages identify an R^2 value for a specific service use related to the type of development, where 'R^2' illustrates a positive or negative correlation between

the service unit and water usage. The closer the R^2 value is to 1.00, the stronger the correlation to water usage. The R^2 values are presented in text boxes next to each service unit line. The number of data points surveyed for each business category service unit are also presented on the graph. The REU calculated from water usage (units per quarter) is illustrated on the Y axis and the service units (square footage, fixtures, employees, etc.) are presented on the X axis.

An example of a regression analysis for a sub-category office business type and the resulting correlation strength between calculated REU per service use type is presented in Table 3.20. In this example, 'Banquet Halls', please note that the strongest correlation is between water usage and fixtures with an R^2 value of 0.9045. The resulting R^2 number between water usage and employees is 0.8765 while water usage and fixtures and square footage are 0.8013 and 0.7078 respectively.

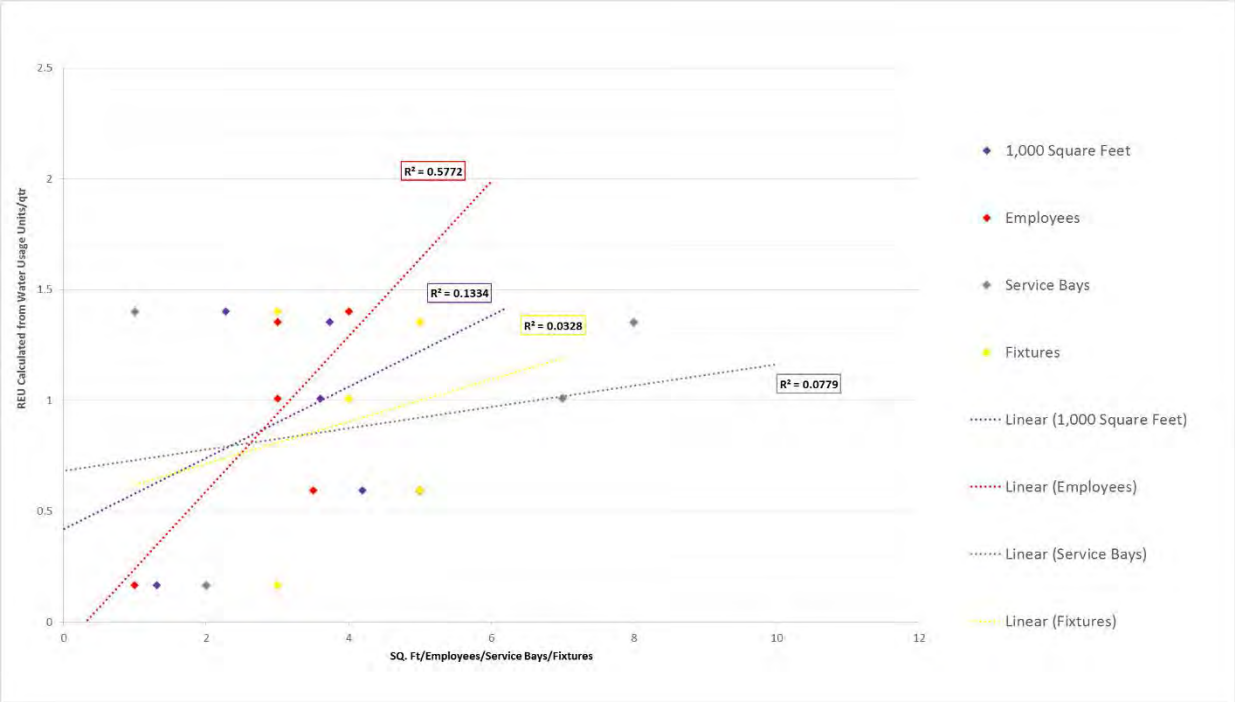
Table 3.20– Banquet Halls Regression Example Table



Copies of these graphs are also provided in Section 3.3 and Appendix IX. Based on the regression analyses, recommended Unit Assignment Factors were assigned to each business classification based on the strongest correlated service use type. A summary table identifying these recommendations and comparing them with the 1998 Unit Assignment Factors is provided in Section 4.0 and Appendix VIII.

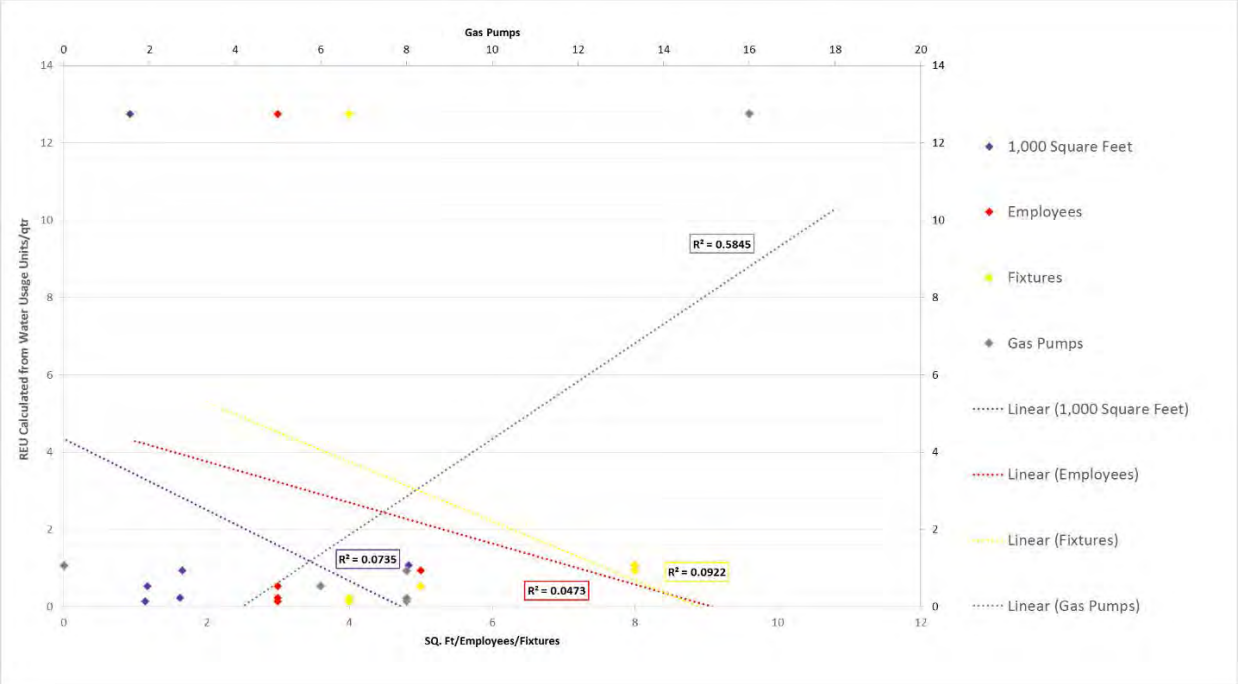
3.3 - Non-Residential Category Data Analysis

Table 3.31 – Auto Service/Repair Regression Analysis



Based on available data, the recommended REU value for this category is 0.29 per employee, with an R^2 value of 0.58. This was the only strong positive correlation identified, therefore it was the chosen as the final recommendation.

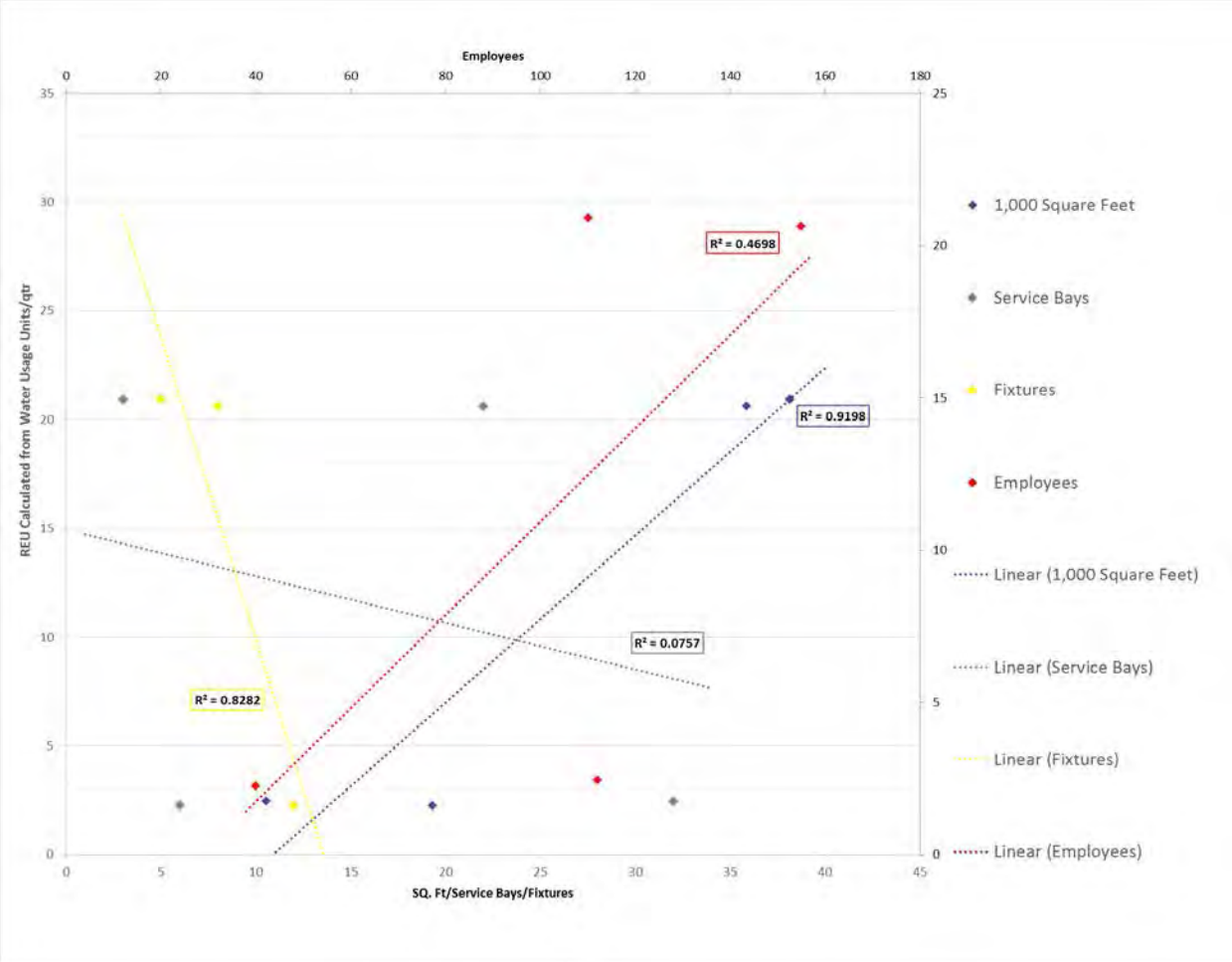
Table 3.32 – Auto Service/Convenience Stations Regression Analysis



3.3 - Non-Residential Category Data Analysis

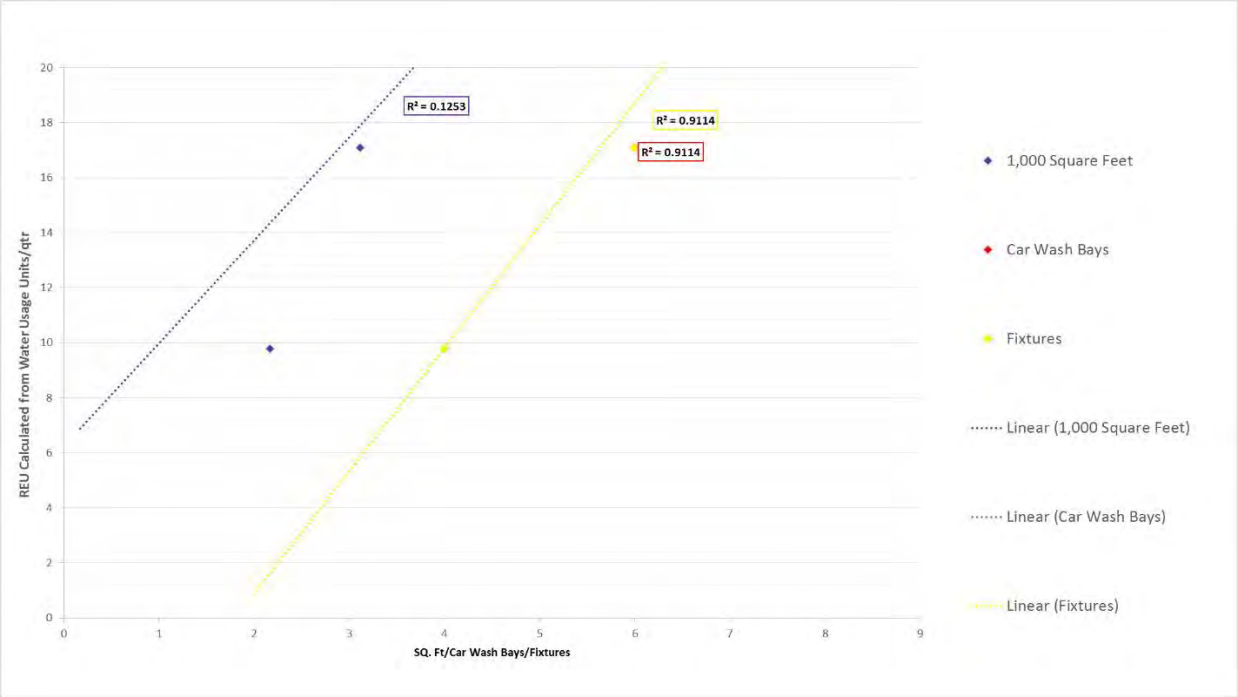
Based on available data, the recommended REU value for this category is 0.21 per gas pump, with an R^2 value of 0.58. Please note – this is the only positive correlation that exists.

Table 3.33 – Auto Showroom Dealership Regression Analysis



Based on available data, the recommended REU value for this category is 0.37 per 1,000 square feet, with an R^2 value of 0.92. Five (5) data points were initially collected for this category; however an outlier was identified and eliminated, thus producing a stronger regression.

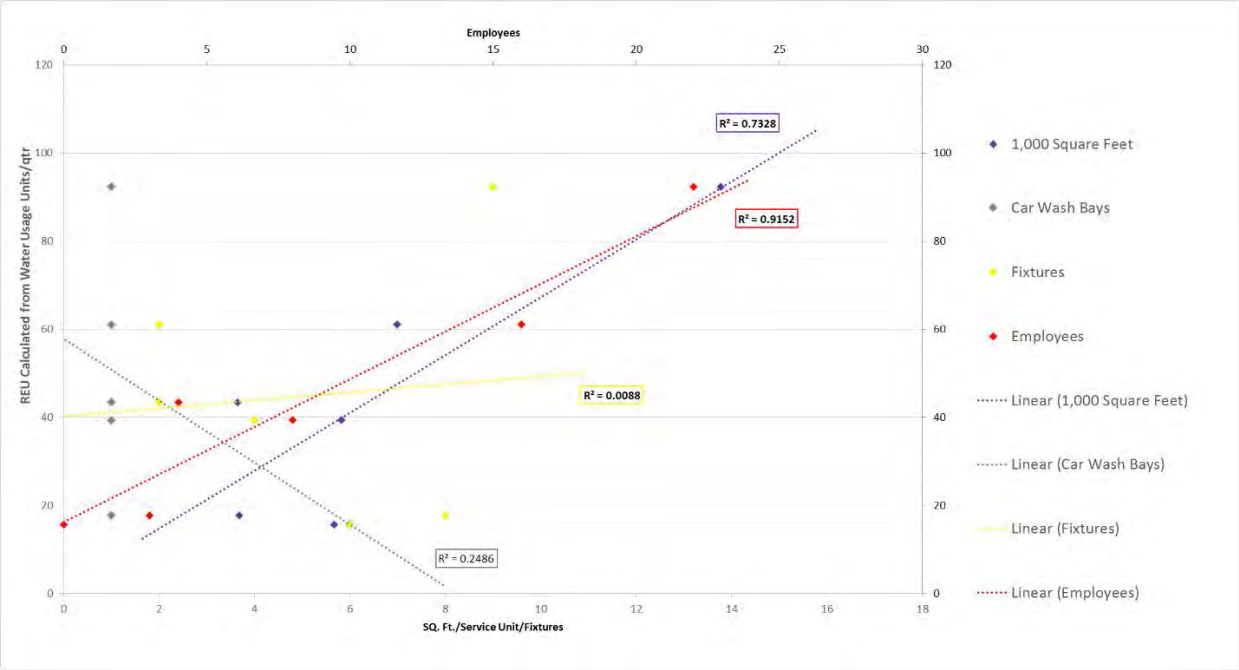
Table 3.34 – Self-Serve Car Washes Regression Analysis



Based on available data, the recommended REU value for this category is 2.89 per bay/stall, with an R^2 value of .91.

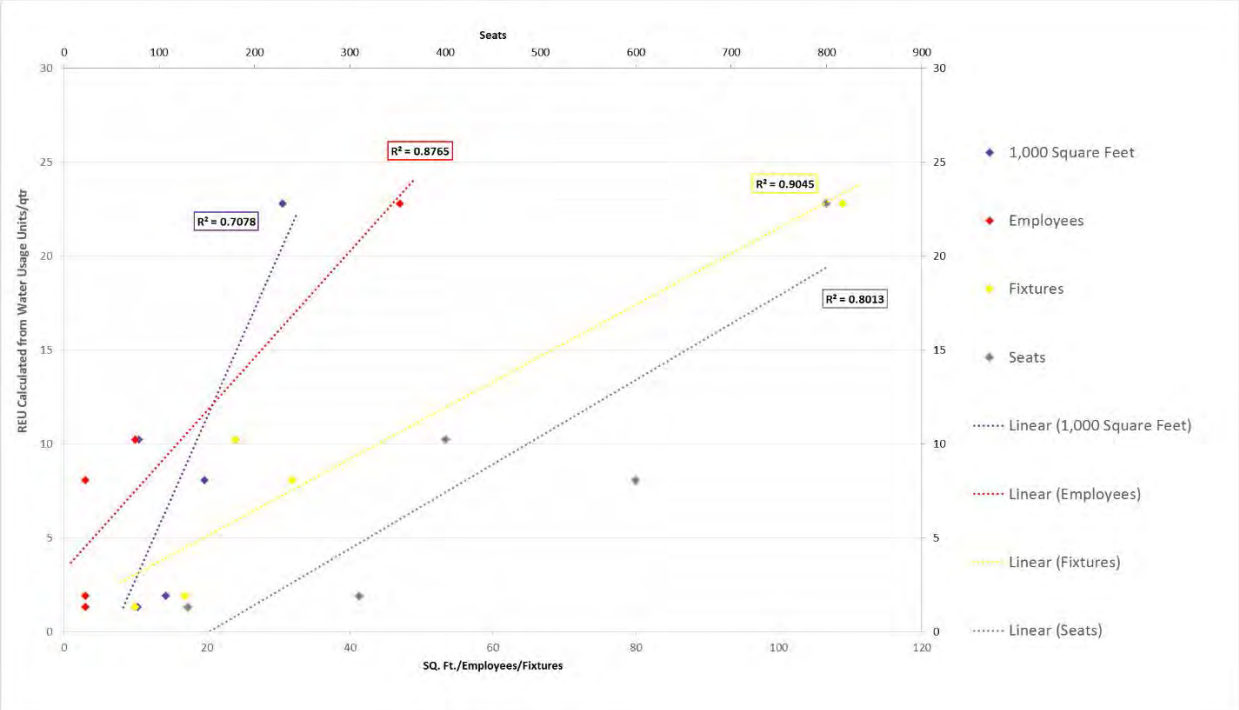
3.3 - Non-Residential Category Data Analysis

Table 3.35 – Fully & Semi-Automatic Car Washes Regression Analysis



Based on available data, the recommended REU value for this category is 6.95 per 1,000 square feet, with an R^2 value of 0.73. As shown from the graph, employee counts versus water usage produced a slightly higher regression of 0.91.

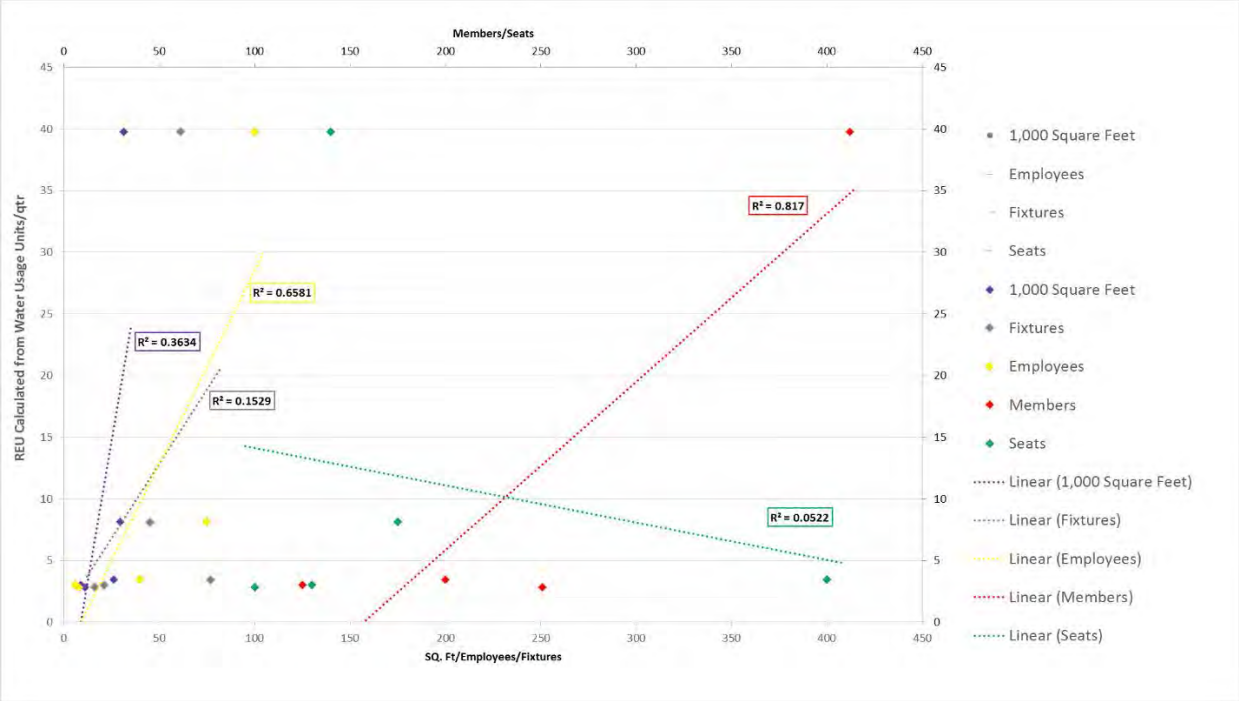
Table 3.36 – Banquet Halls Regression Analysis



3.3 - Non-Residential Category Data Analysis

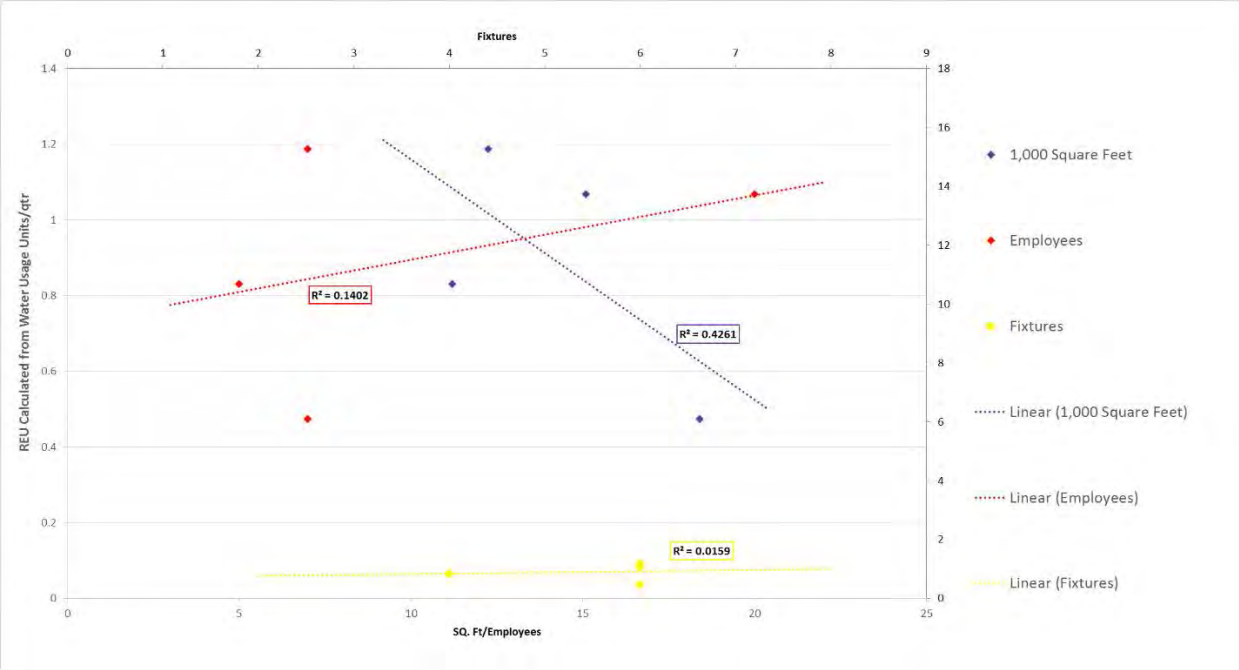
Based on available data, the recommended REU value for this category is 0.23 per fixture, with an R^2 value of 0.90.

Table 3.37 – Country Clubs Regression Analysis



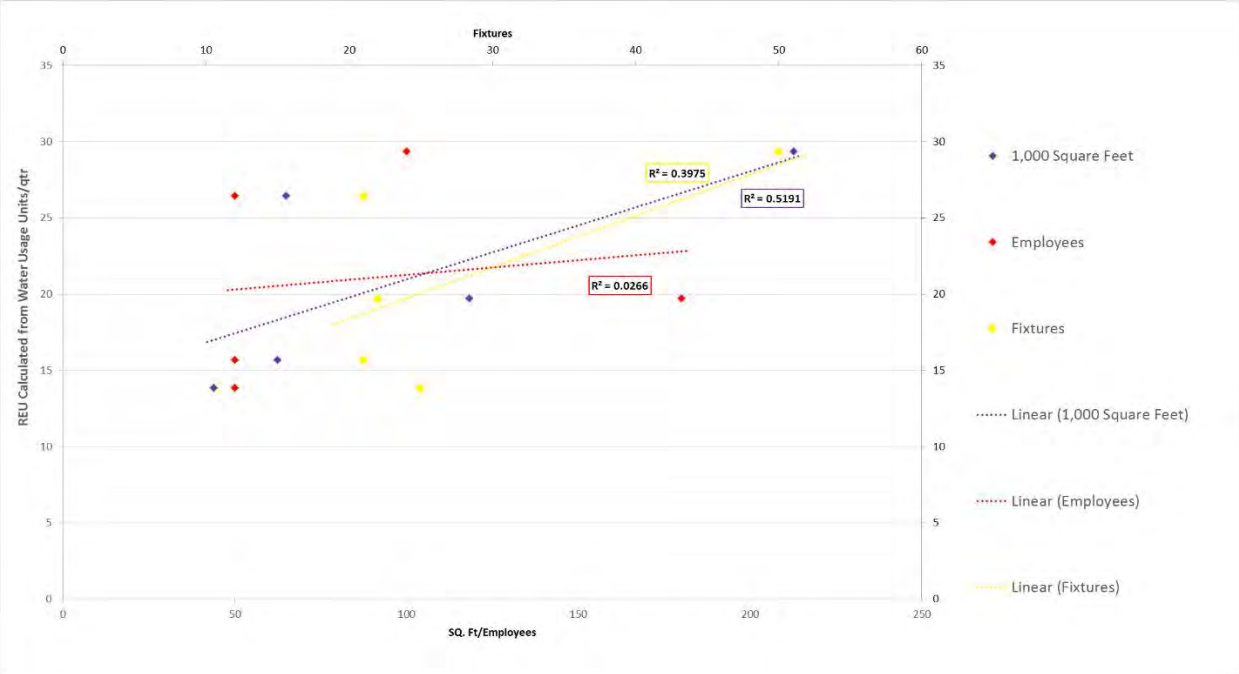
Based on available data, the recommended REU value for this category is 0.040 per member, with an R^2 value of 0.82.

Table 3.38 – Convenience Store w/Pharmacy Regression Analysis



Based on available data, the recommended REU value for this category is 1.00 per facility, because no strong positive correlations exist. Since most of these businesses do not have a public restroom, and the number of employees working at any given time is minimal, the 1.00 REU per facility recommendation is an adequate value. In fact, this graph shows negative correlations with water usage and square footage, number of employees, and fixtures.

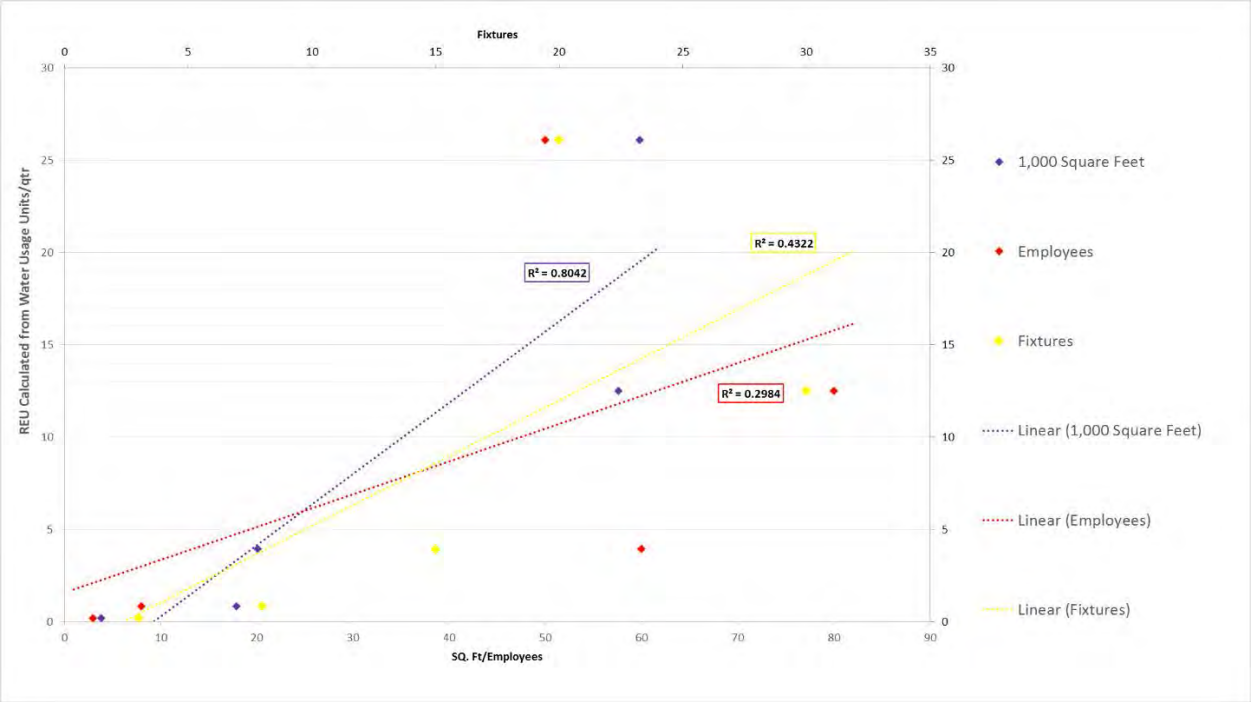
Table 3.39 – Full Service Grocery Store Regression Analysis



Grocery stores with full services include one or more of the following: a pharmacy, florist, eye care center, etc. Based on available data, the recommended REU value for this category is 0.26 per 1,000 square feet, with an R^2 value of 0.52. Six (6) data points were initially collected for this category; however an outlier was identified and eliminated, thus producing a stronger regression.

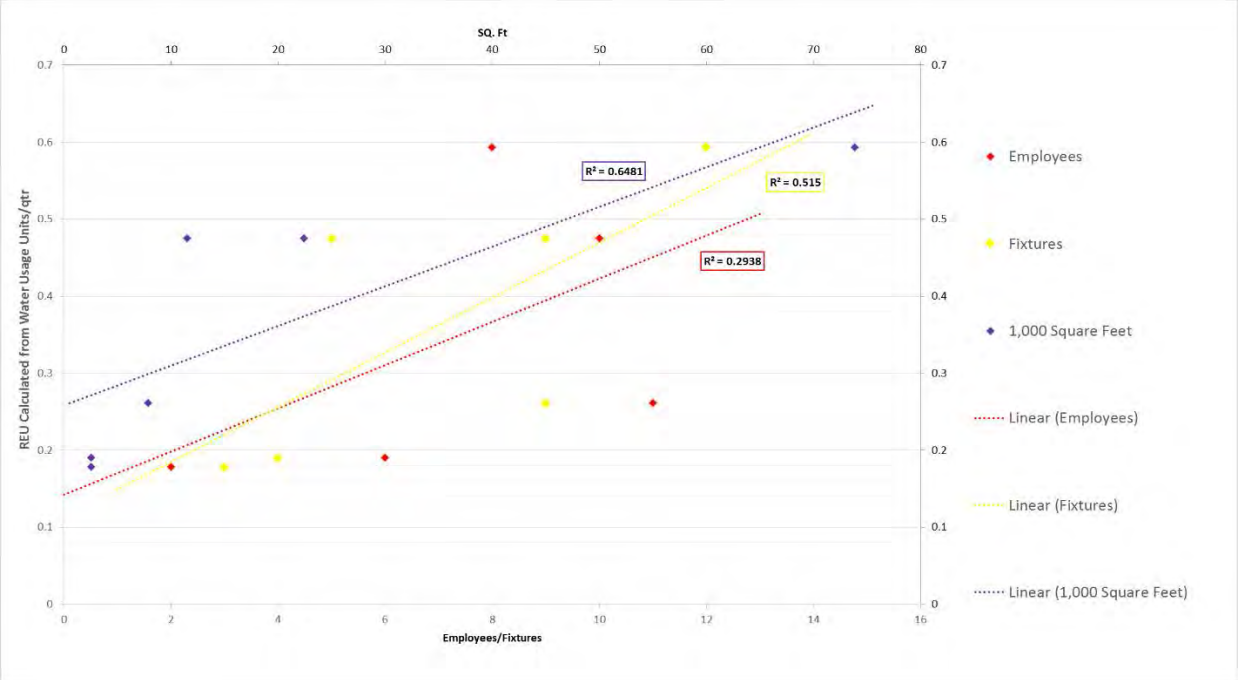
3.3 - Non-Residential Category Data Analysis

Table 3.40 – Grocery Store w/o Full Service Regression Analysis



The grocery stores without full services show a much better regression than those with full services. Based on available data, the recommended REU value for this category is 0.19 per 1,000 square feet, with an R^2 value of 0.80.

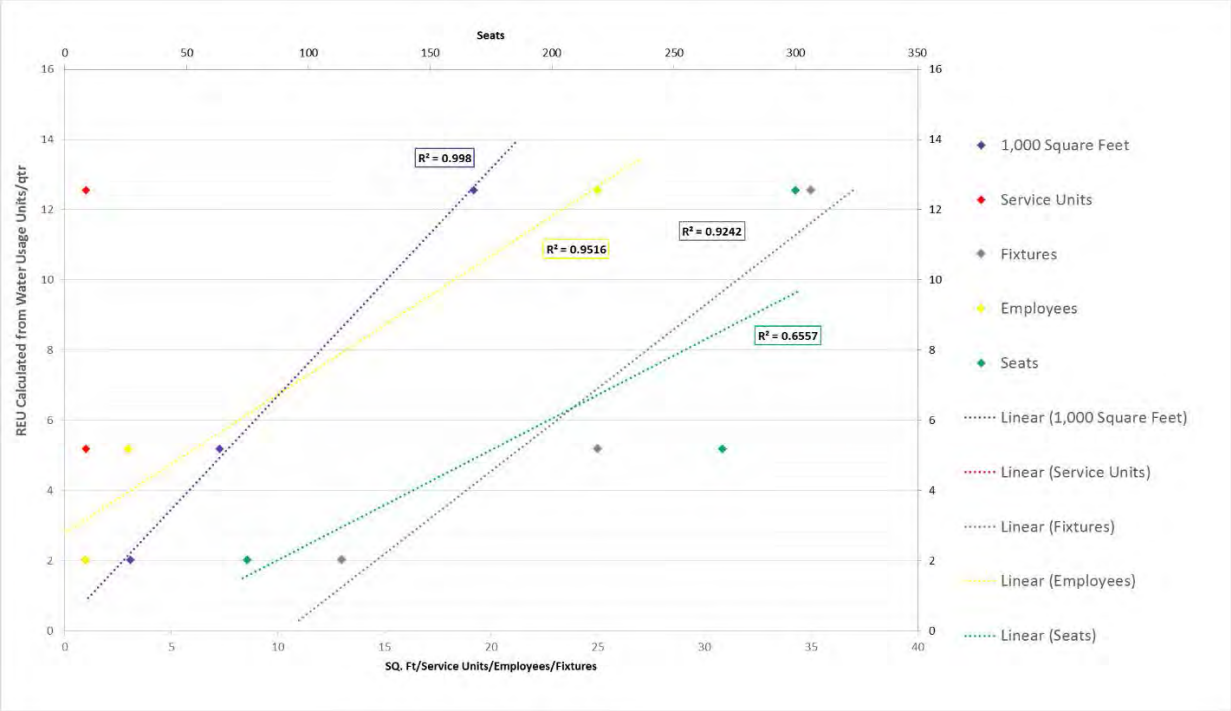
Table 3.41 – Stores (other than specifically listed) Regression Analysis



3.3 - Non-Residential Category Data Analysis

Based on available data, the recommended REU value for this category is 0.04 per 1,000 square feet, with an R^2 value of 0.65. Six (6) data points were initially collected for this category; however an outlier was identified and eliminated, thus producing a stronger regression.

Table 3.42 – Fraternal Organizations Regression Analysis

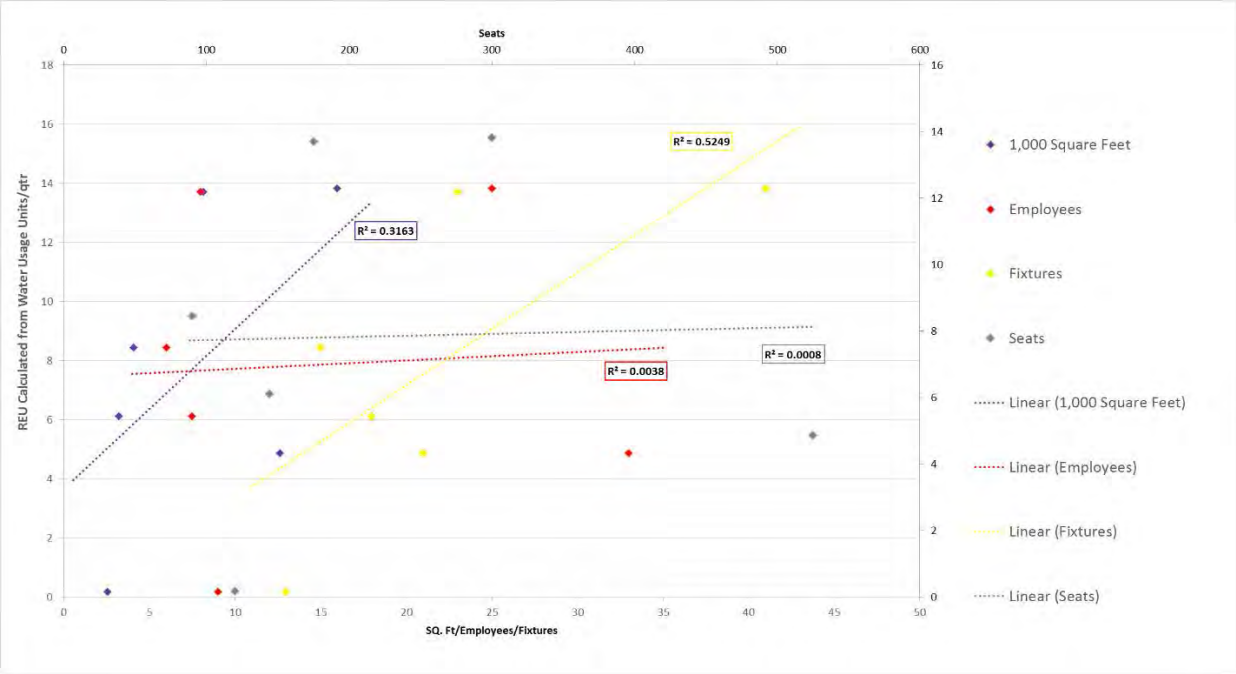


Based on available data, the recommended REU value for this category is 0.04 per 1,000 square feet, with an R^2 value of 1.00.

The 1998 Schedule lists 2 separate business classes for Fraternal Organizations: 1) members only and 2) members and rentals. The existing unit factor is based on a 'per member' service unit. It was decided to combine the 2 classifications into 1, since most current organizations are open to the general public several days of the week and are open for breakfast, lunch, and dinner for members. Therefore, a 'per member' unit factor was not calculated for this business classification.

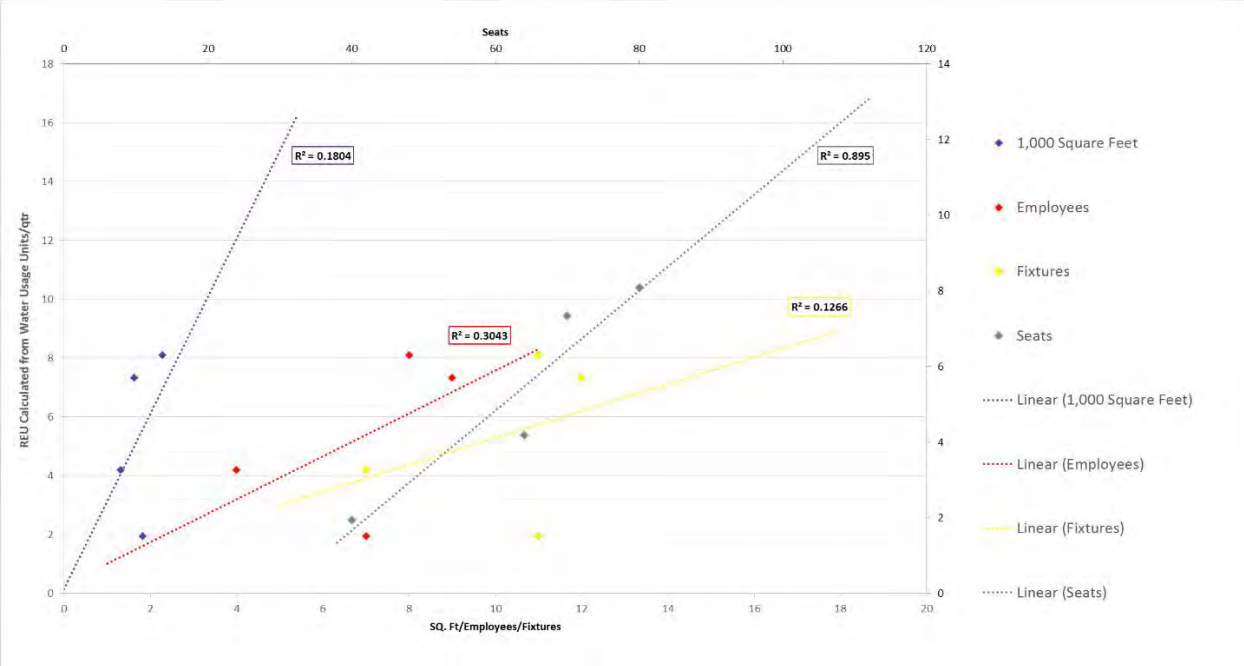
3.3 - Non-Residential Category Data Analysis

Table 3.43 – Restaurants w/ Liquor Regression Analysis



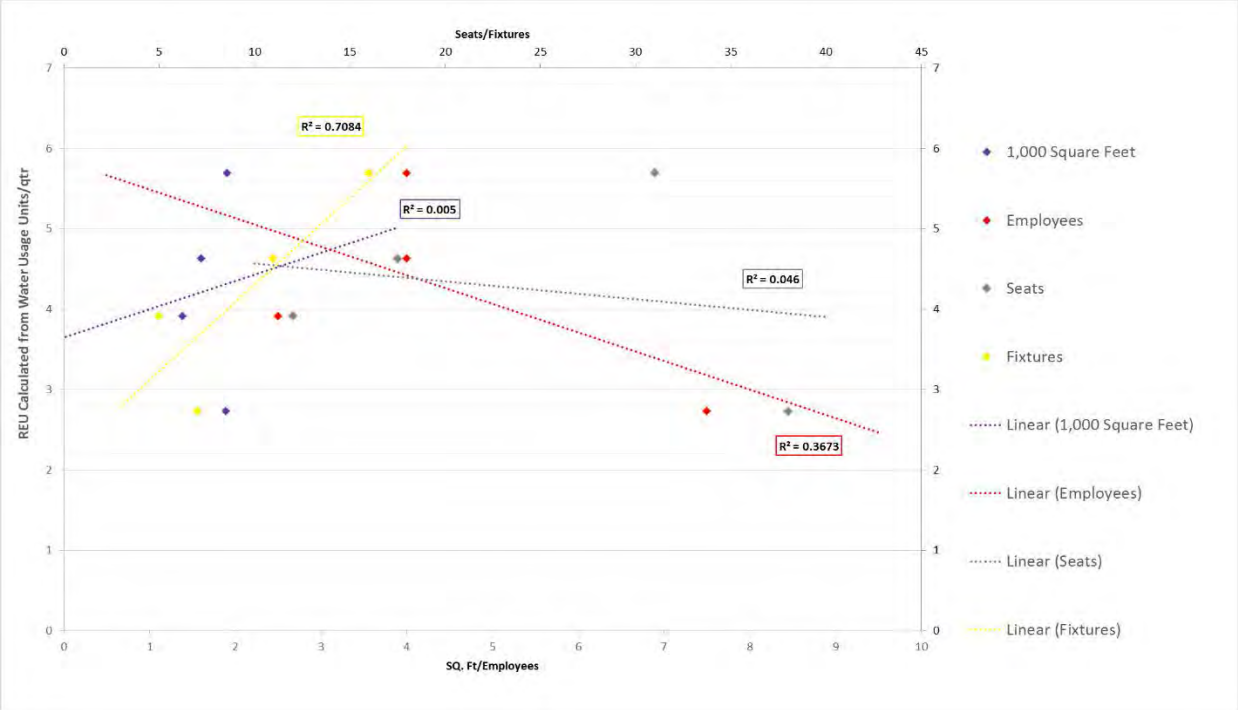
Based on available data, the recommended REU value for this category is 0.35 per fixture, with an R^2 value of 0.52. Six (6) data points were initially collected for this category; however an outlier was identified and eliminated, thus producing a stronger regression.

Table 3.44 – Restaurants w/o Liquor Regression Analysis



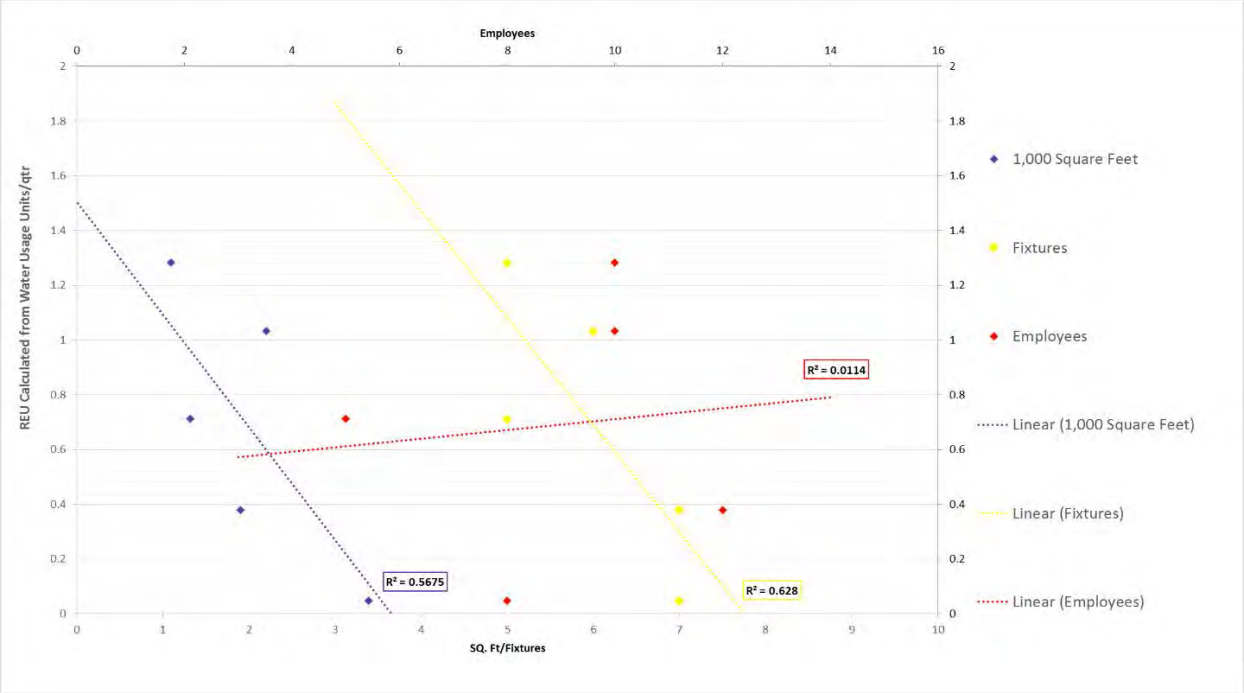
Based on available data, the recommended REU value for this category is 0.08 per seat, with an R^2 value of 0.90.

Table 3.45 – Quick Service Restaurants w/ dining & restrooms Regression Analysis



Based on available data, the recommended REU value for this category is 0.49 per fixture with an R^2 value of 0.71. Five (5) data points were initially collected for this category; however an outlier was identified and eliminated, thus producing a stronger regression.

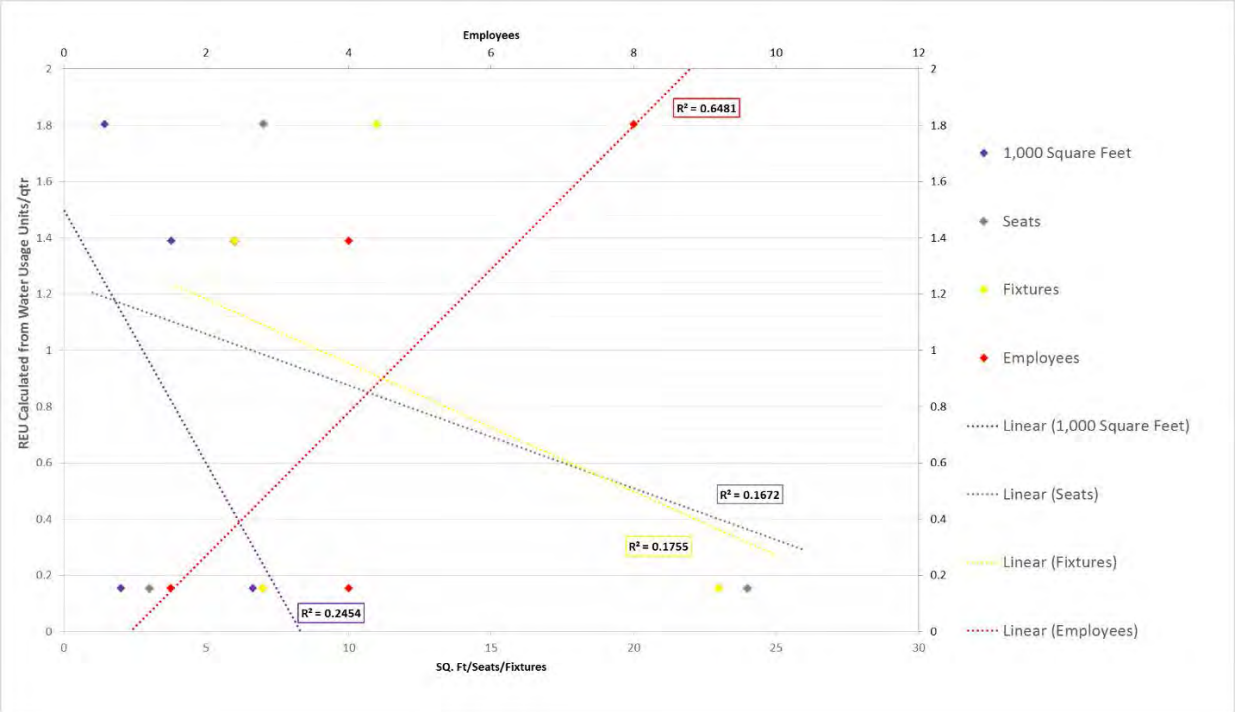
Table 3.46 – Quick Service Restaurants w/o dining & restrooms Regression Analysis



Based on available data, the recommended REU value for this category is 1.00 per restaurant, because no strong positive correlations exist. Given that there are no public restrooms at these facilities, and dishwashing is limited, 1.00 REU per restaurant is a fair assessment.

Possible alternative methods would include assigning a Meter Equivalent Unit (MEU) or utilizing the 1998 REU value for this category. Five (5) data points were collected for this category. The WRC may recommend collecting additional data to potentially producing a higher regression analysis.

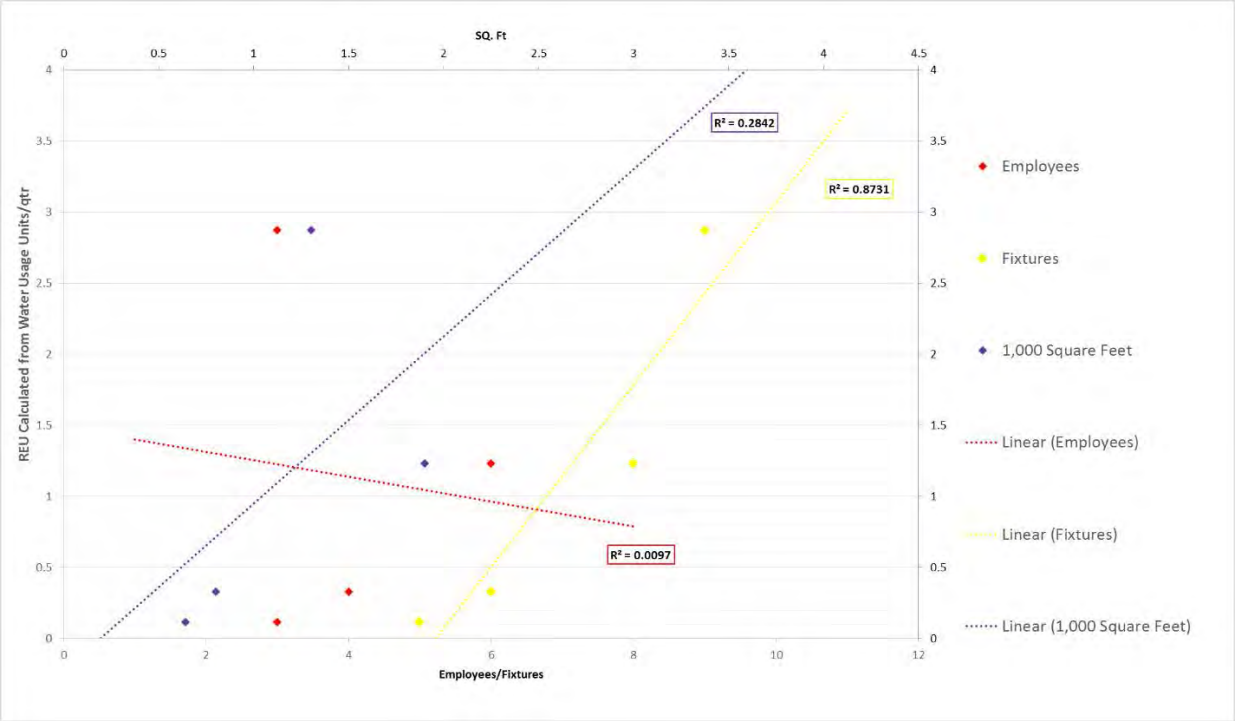
Table 3.47 – Nail Salons Regression Analysis



Based on available data, the recommended REU value for this category is 0.18 per employee, with an R^2 value of 0.65. An employee count recommendation was made, because no other positive correlations exist.

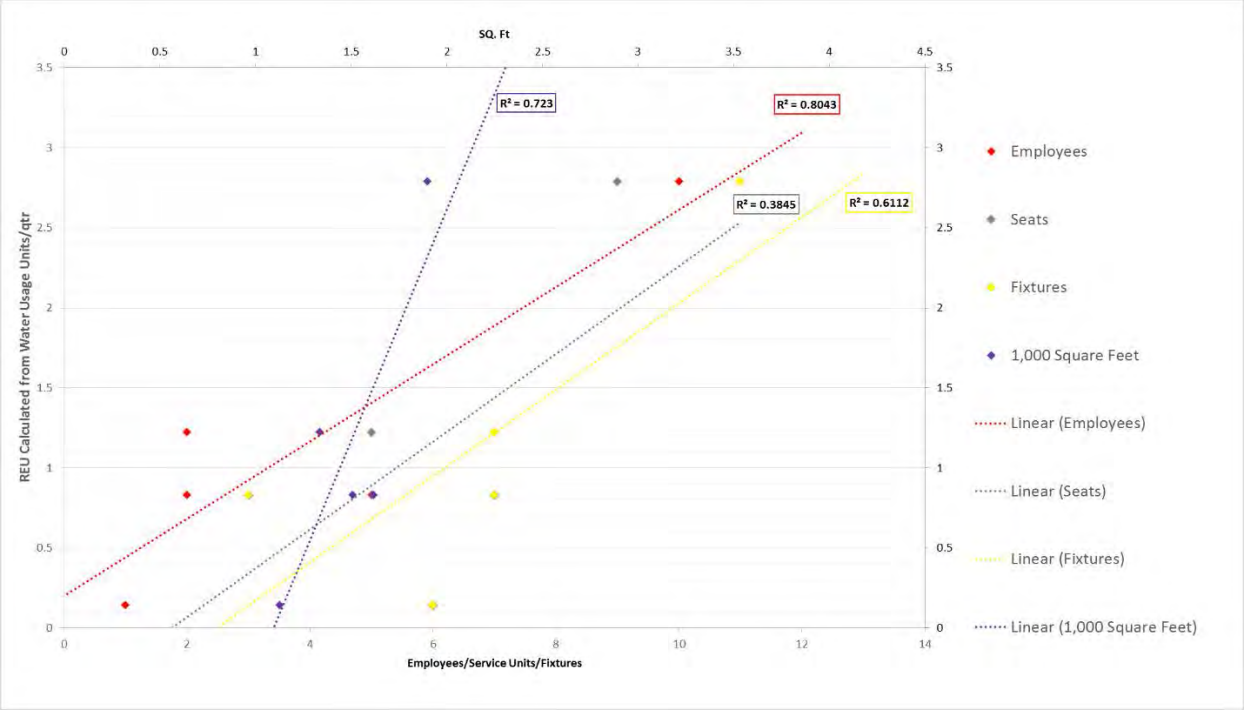
3.3 - Non-Residential Category Data Analysis

Table 3.48 – Barber Shops Regression Analysis



Based on available data, the recommended REU value for this category is 0.14 per fixture, with an R^2 value of 0.87.

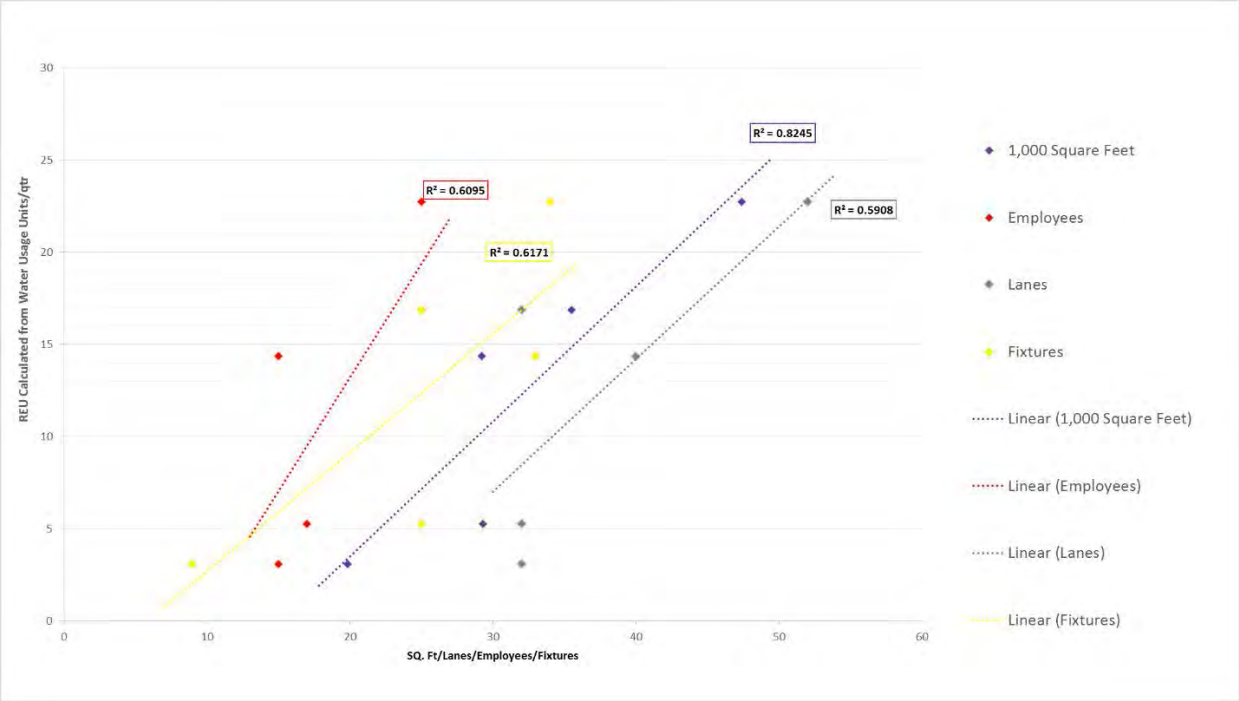
Table 3.49 – Beauty Salons Regression Analysis



3.3 - Non-Residential Category Data Analysis

Based on available data, the recommended REU value for this category is 0.71 per 1,000 square feet, with an R^2 value of 0.72. As shown from the graph, employee counts versus water usage produced a slightly higher regression of 0.80.

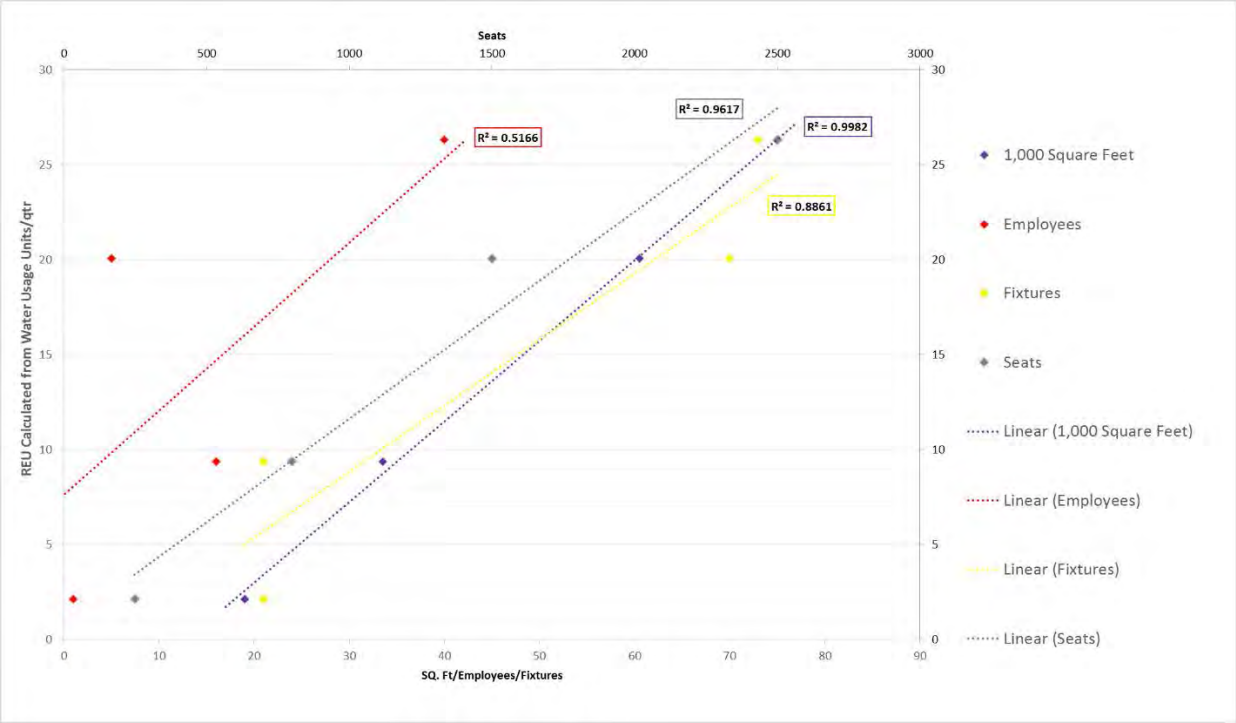
Table 3.50 – Bowling Alleys Regression Analysis



Based on available data, the recommended REU value for this category is 0.36 per 1,000 square feet, with an R^2 value of 0.82.

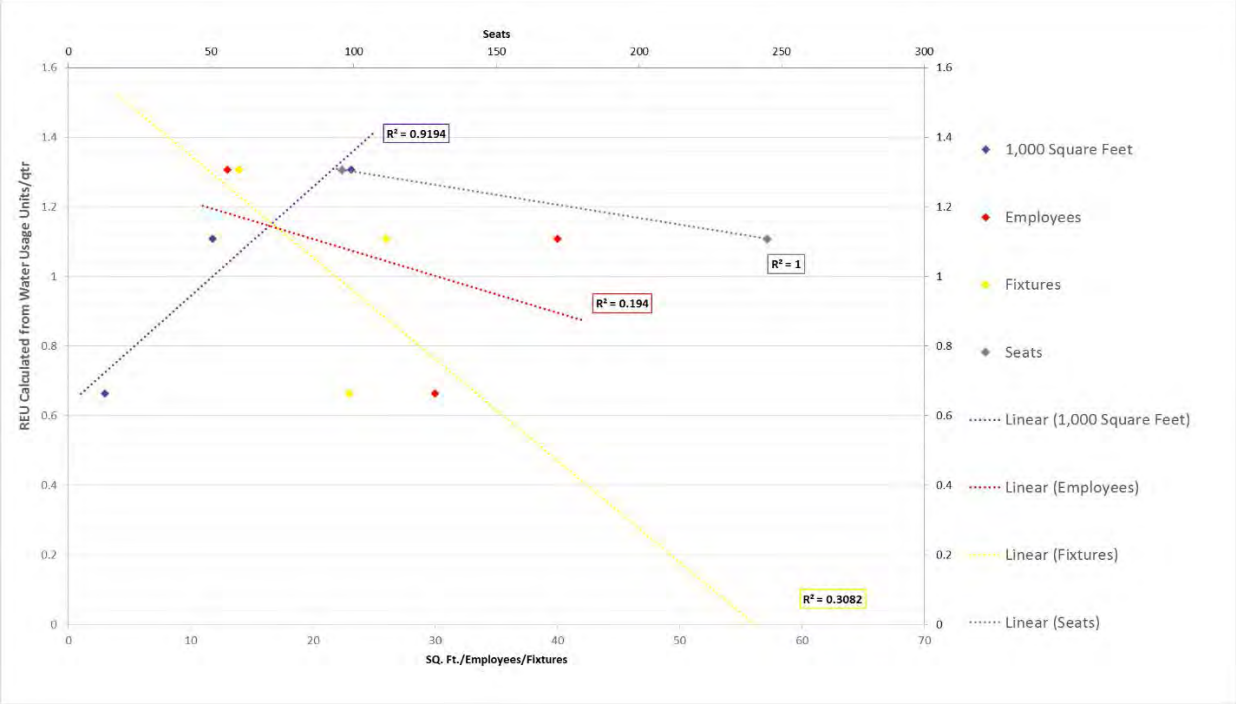
3.3 - Non-Residential Category Data Analysis

Table 3.51 – Theatres Regression Analysis



Based on available data, the recommended REU value for this category is 0.27 per 1,000 square feet, with an R^2 value of 1.00.

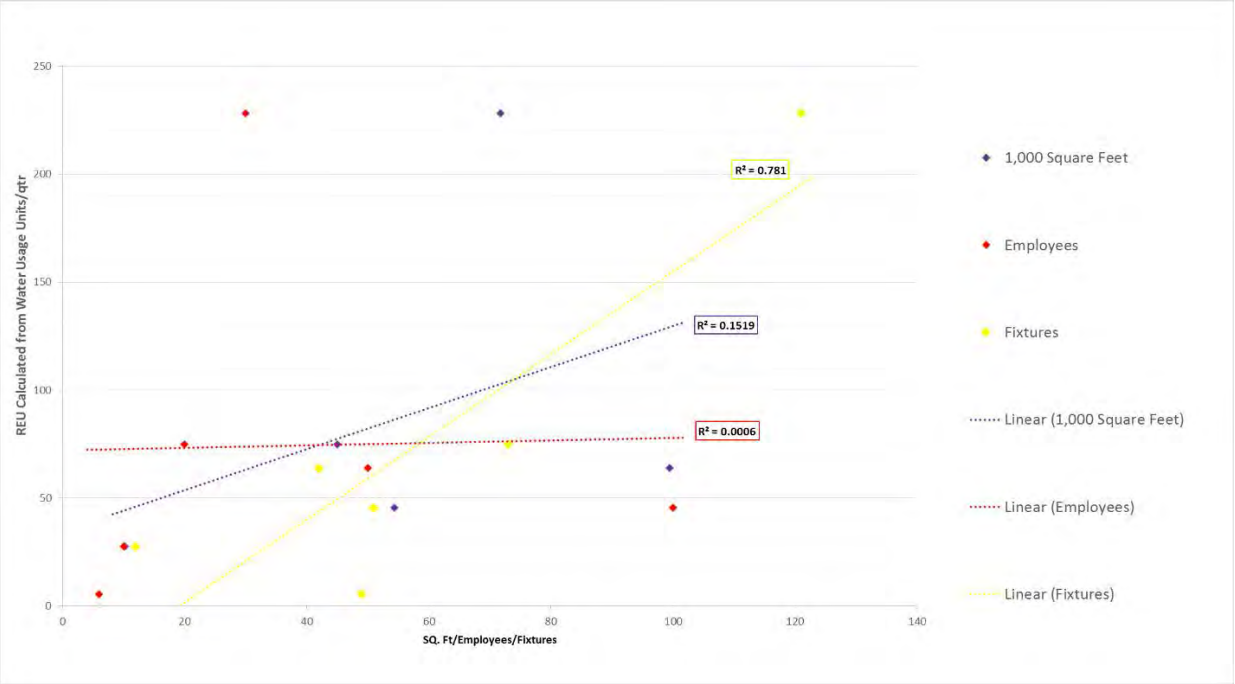
Table 3.52 – Kids Indoor Play Centers Regression Analysis



3.3 - Non-Residential Category Data Analysis

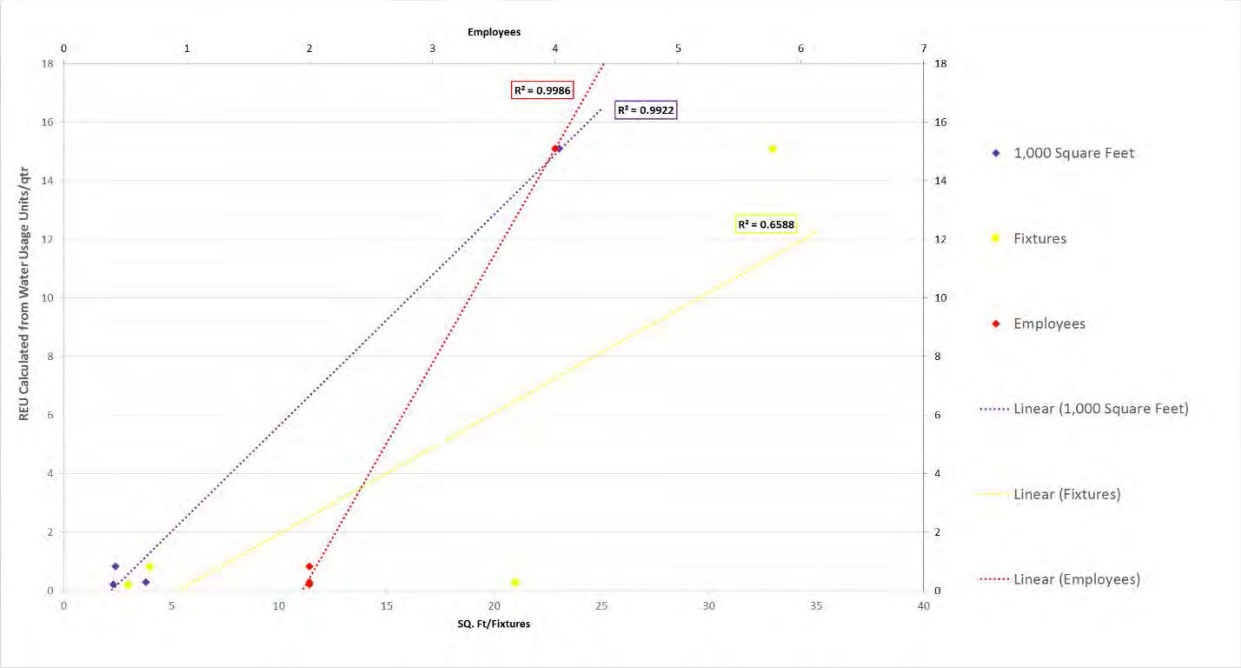
Based on available data, the recommended REU value for this category is 0.12 per 1,000 square feet, with an R^2 value of 0.92.

Table 3.53 – Health Club/Fitness Center w/ Showers &/or Pool Regression Analysis



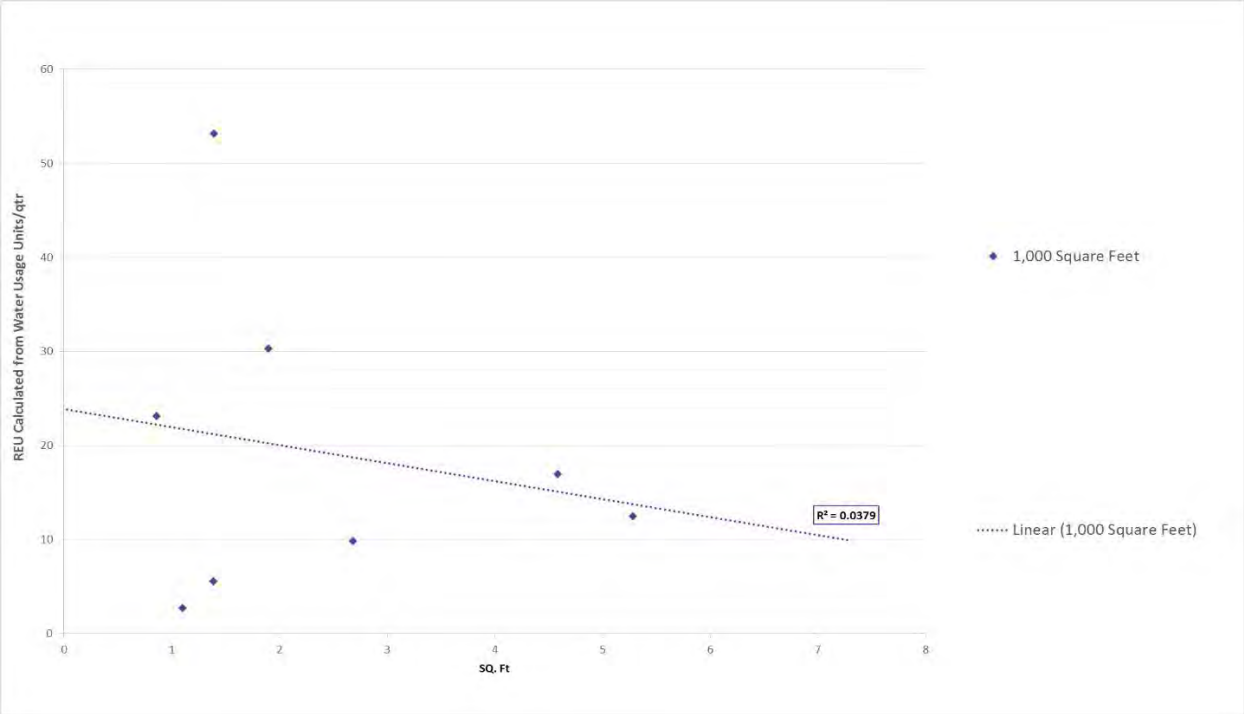
Based on available data, the recommended REU value for this category is 1.29 per fixture, with an R^2 value of 0.78.

Table 3.54 – Health Club/Fitness Center w/o Showers &/or Pool Regression Analysis



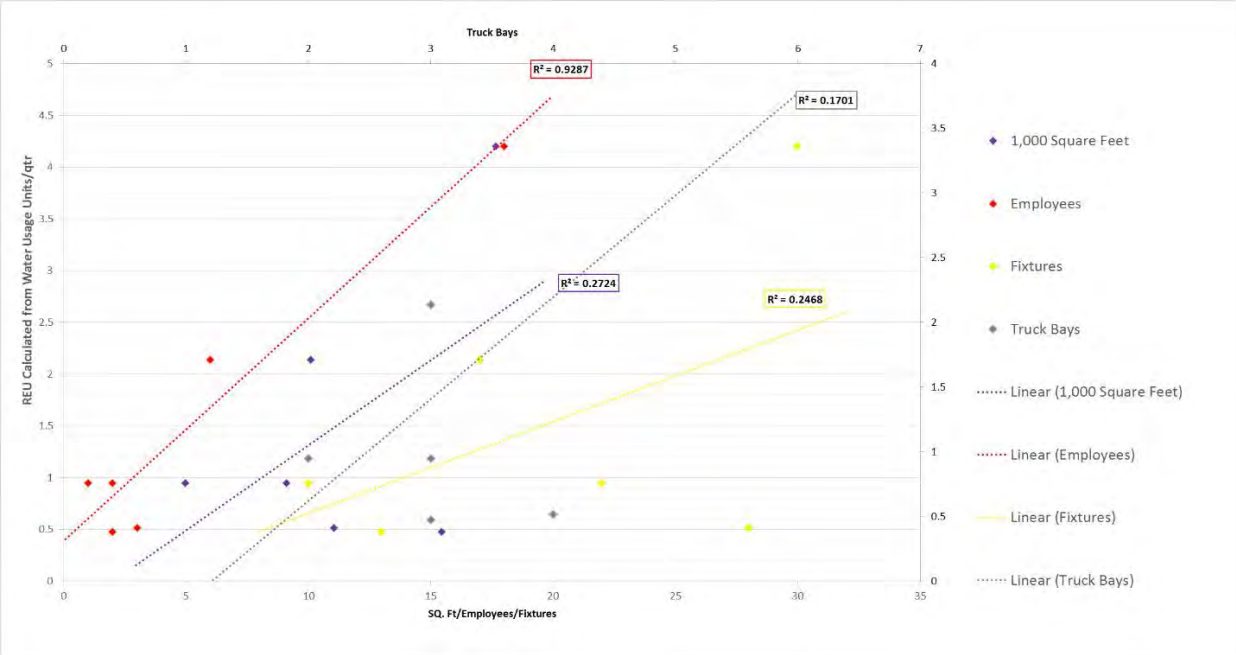
Based on available data, the recommended REU value for this category is 0.29 per 1,000 square feet, with an R^2 value of 0.99. As shown from the graph, employee counts versus water usage produced a slightly higher regression of 1.00; however the Steering Committee does not wish to utilize this REU if a strong regression exists with another service use.

Table 3.55 – Swimming Pools Regression Analysis



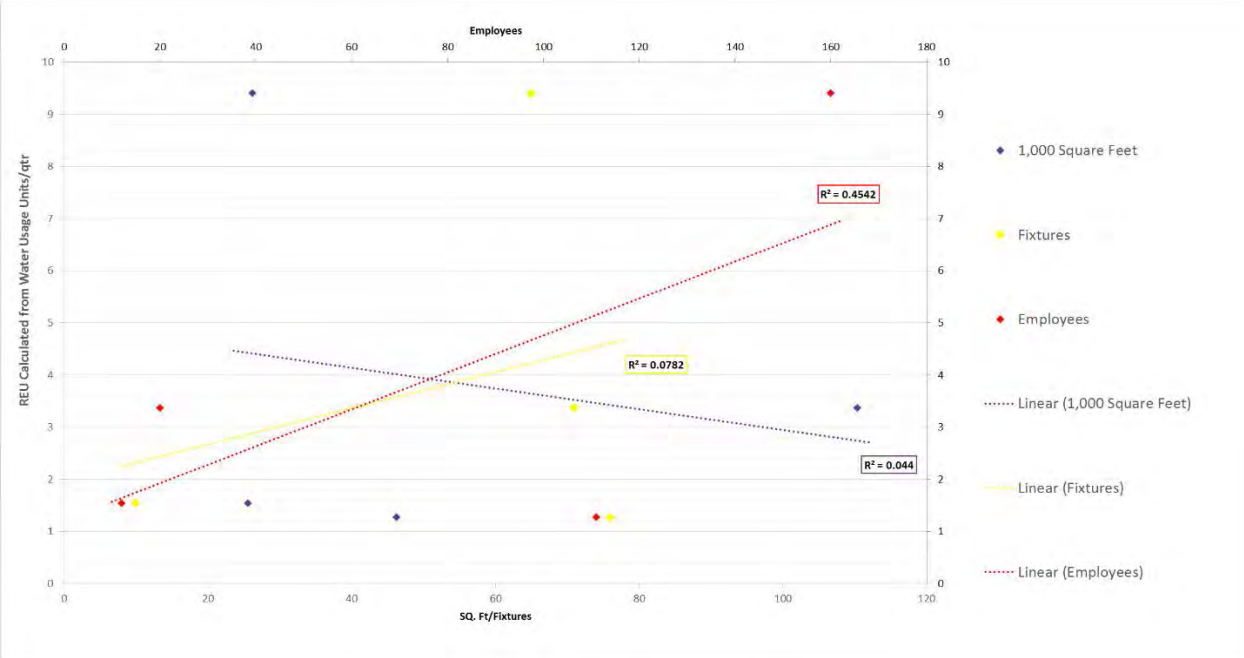
Based on available data, the recommended REU value for this category is 3.00 per 1,000 square feet (utilizing the 1998 REU value). The 'old' REU value was maintained, due to a very low regression analysis as shown in the table above. Please note – only square footage was collected for this category. Please also note – summer water consumption data was collected for this category, since the properties under this category are only open during late spring and summer months.

Table 3.56 – Fire Stations Regression Analysis



Based on available data, the recommended REU value for this category is 0.40 per employee, with an R^2 value of 0.93. An employee count recommendation was made, because no other positive correlations exist.

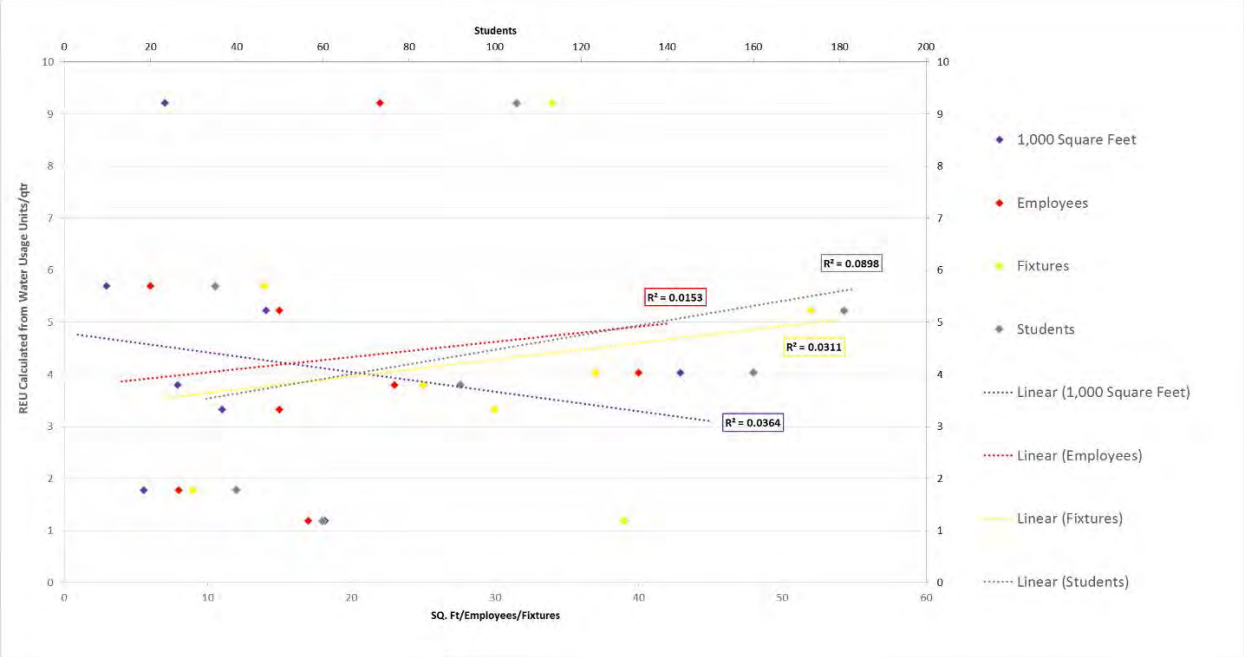
Table 3.57 – Police Stations Regression Analysis



3.3 - Non-Residential Category Data Analysis

Based on available data, the recommended REU value for this category is 0.09 per employee, with an R^2 value of 0.45. An employee count recommendation was made, because no other strong positive correlations exist.

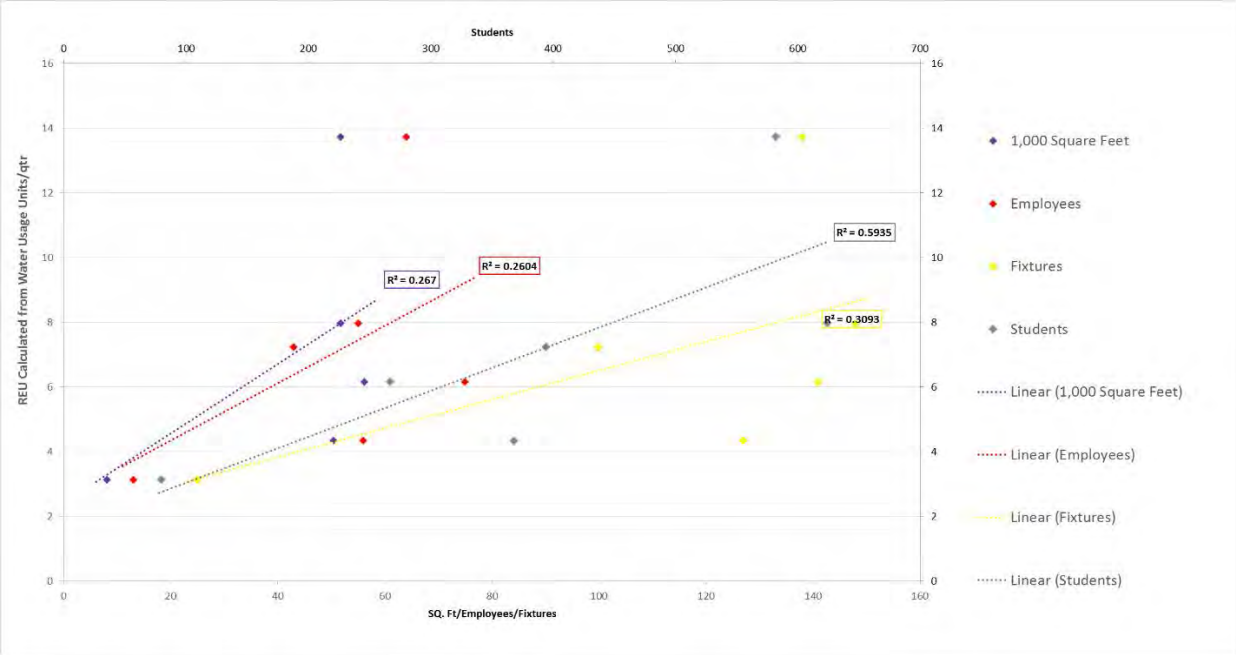
Table 3.58 – Daycare/Early Learning Regression Analysis



Based on available data, the recommended REU value for this category is 4.28 per facility, because no strong positive correlations exist.

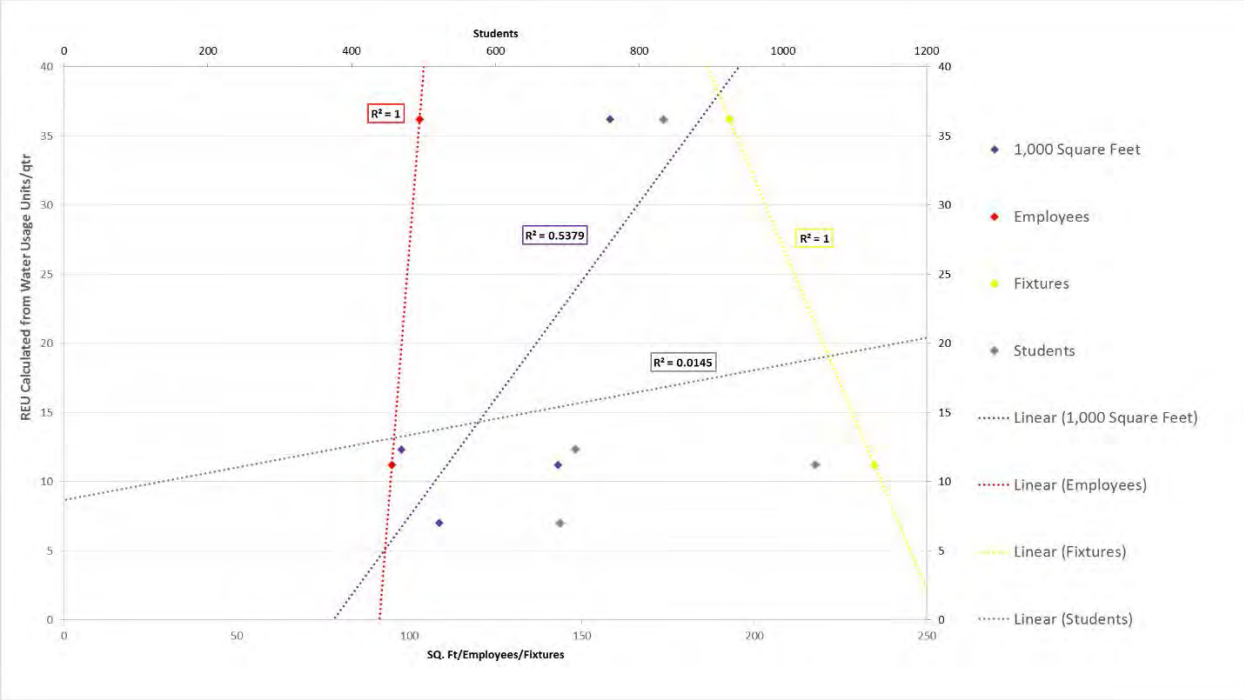
3.3 - Non-Residential Category Data Analysis

Table 3.59 – Elementary Schools Regression Analysis



Based on available data, the recommended REU value for this category is 0.02 per student, with an R^2 value of 0.59.

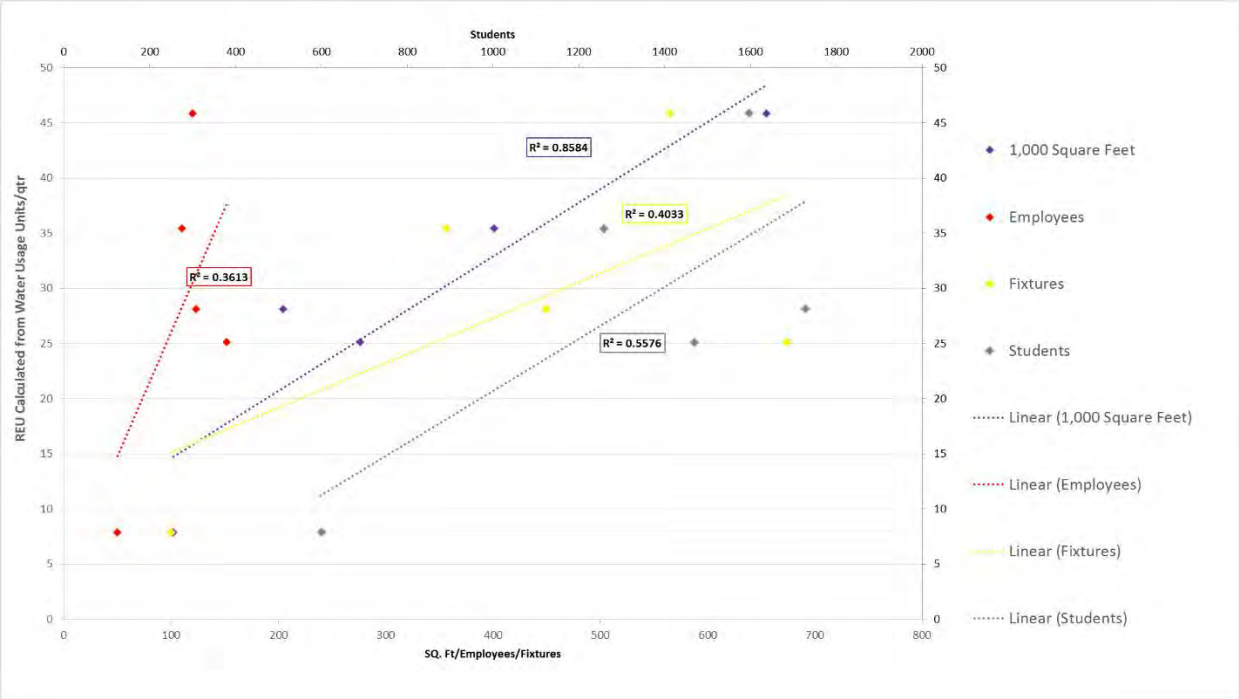
Table 3.60 – Junior or Middle Schools Regression Analysis



Based on available data, the recommended REU value for this category is 0.12 per 1,000 square feet, with an R^2 value of 0.54.

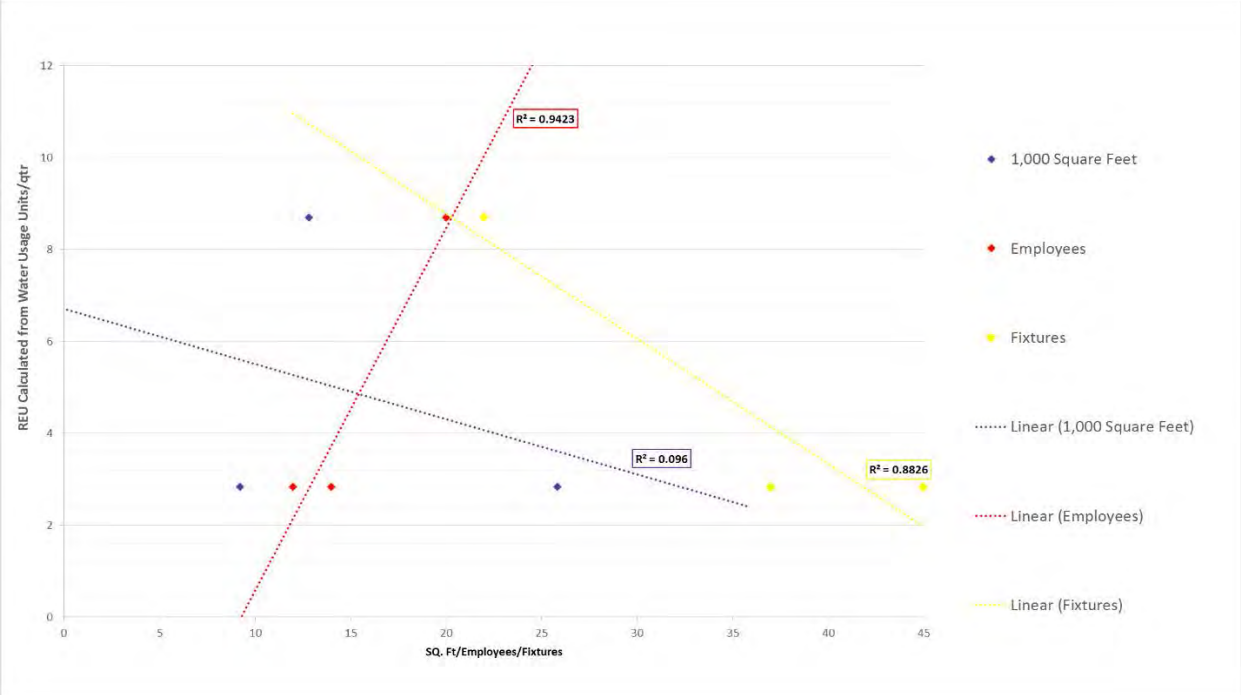
3.3 - Non-Residential Category Data Analysis

Table 3.61 – Senior High Schools Regression Analysis



Based on available data, the recommended REU value for this category is 0.09 per 1,000 square feet, with an R^2 value of 0.86.

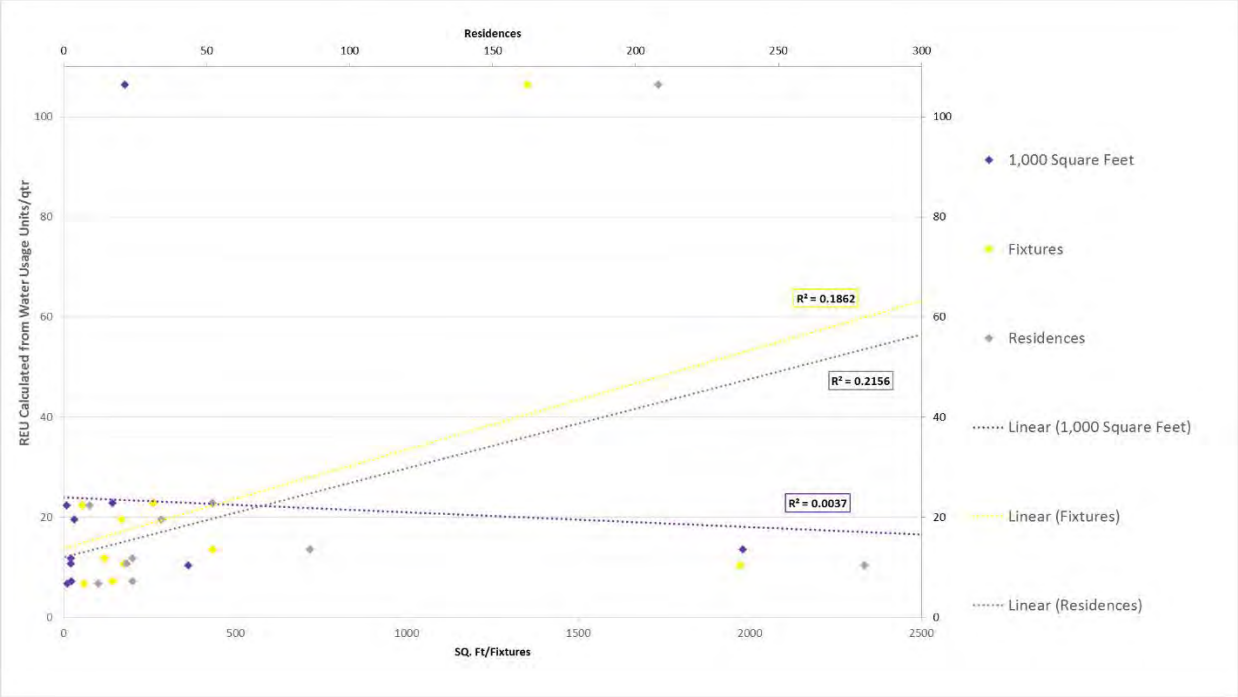
Table 3.62 – Convents & Seminaries Regression Analysis



3.3 - Non-Residential Category Data Analysis

Based on available data, the recommended REU value for this category is 0.29 per employee, with an R^2 value of 0.94, because no other strong correlations exist.

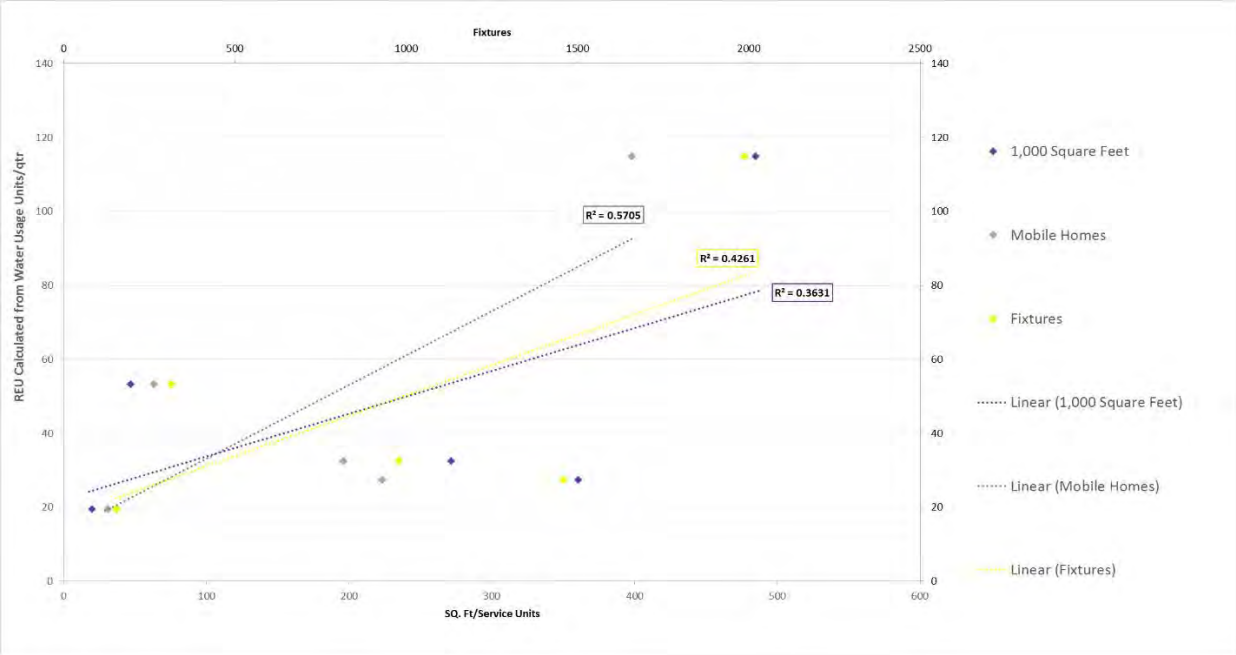
Table 3.63 – Multiple Family Residences Regression Analysis



Based on available data, the recommended REU value for this category is 0.60 per residence, with an R^2 value of 0.22. Ten (10) data points were gathered for this category, yet produced a low regression analysis.

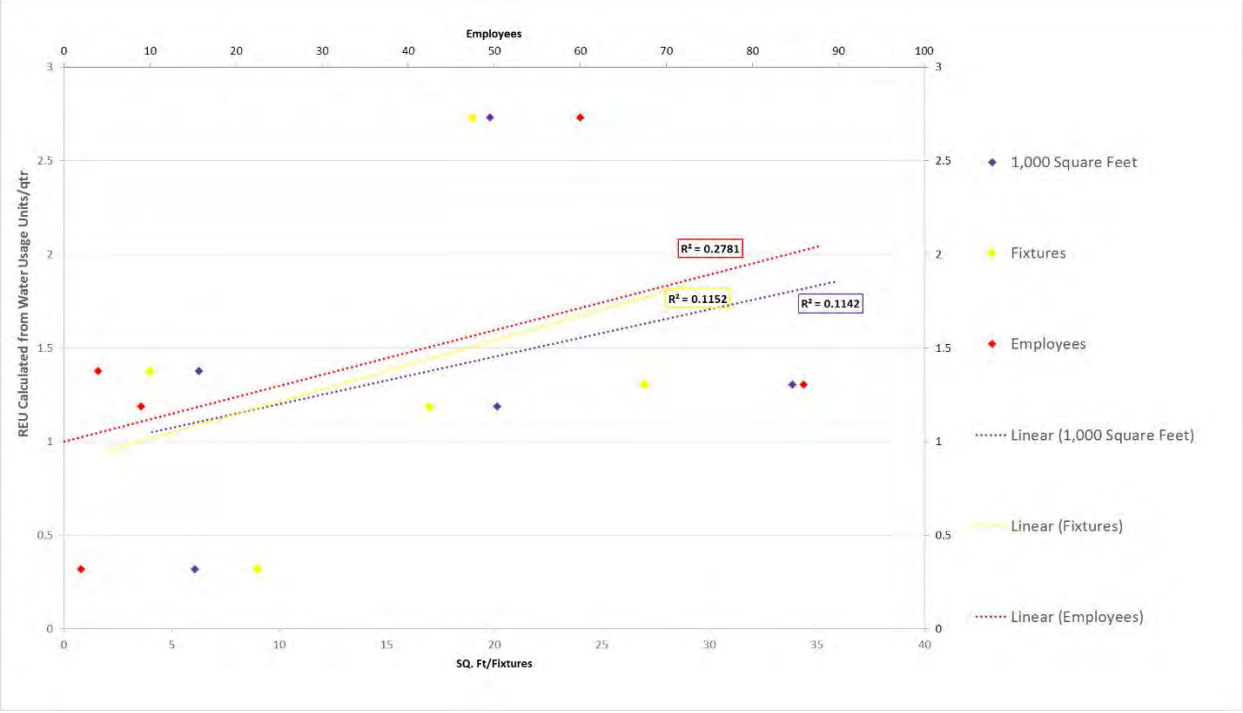
3.3 - Non-Residential Category Data Analysis

Table 3.64 – Mobile Home Parks Regression Analysis



Based on available data, the recommended REU value for this category is 0.41 per mobile home, with an R^2 value of 0.57.

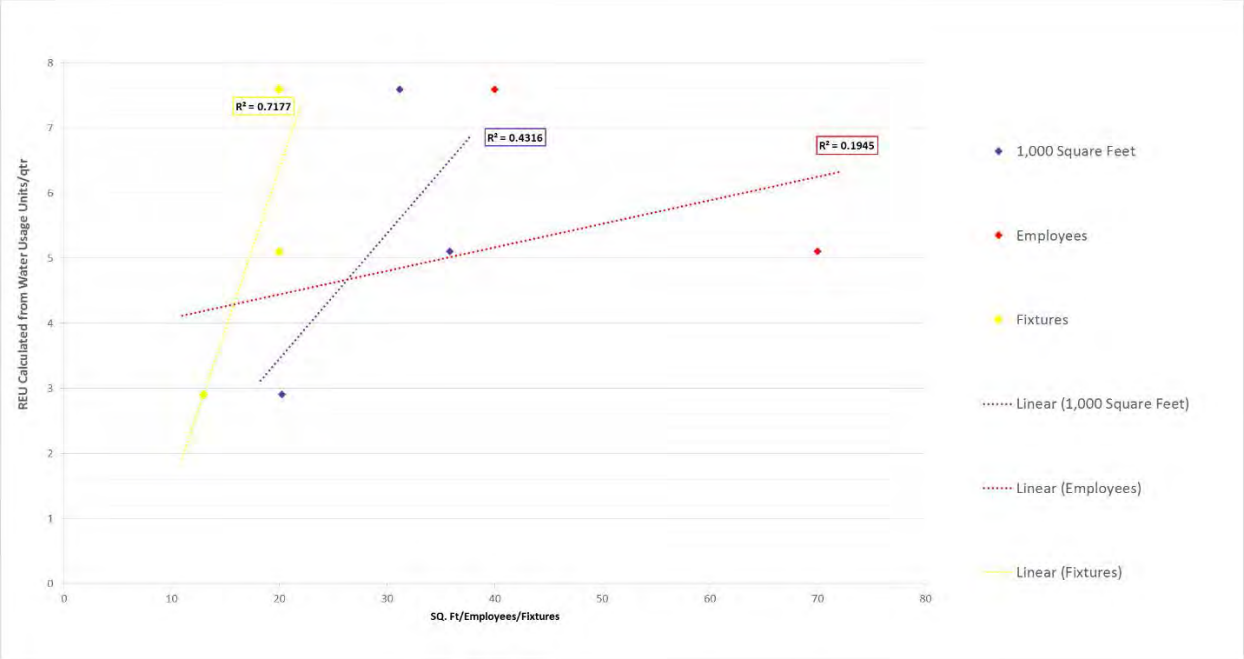
Table 3.65 – Manufacturing – Dry Process Regression Analysis



3.3 - Non-Residential Category Data Analysis

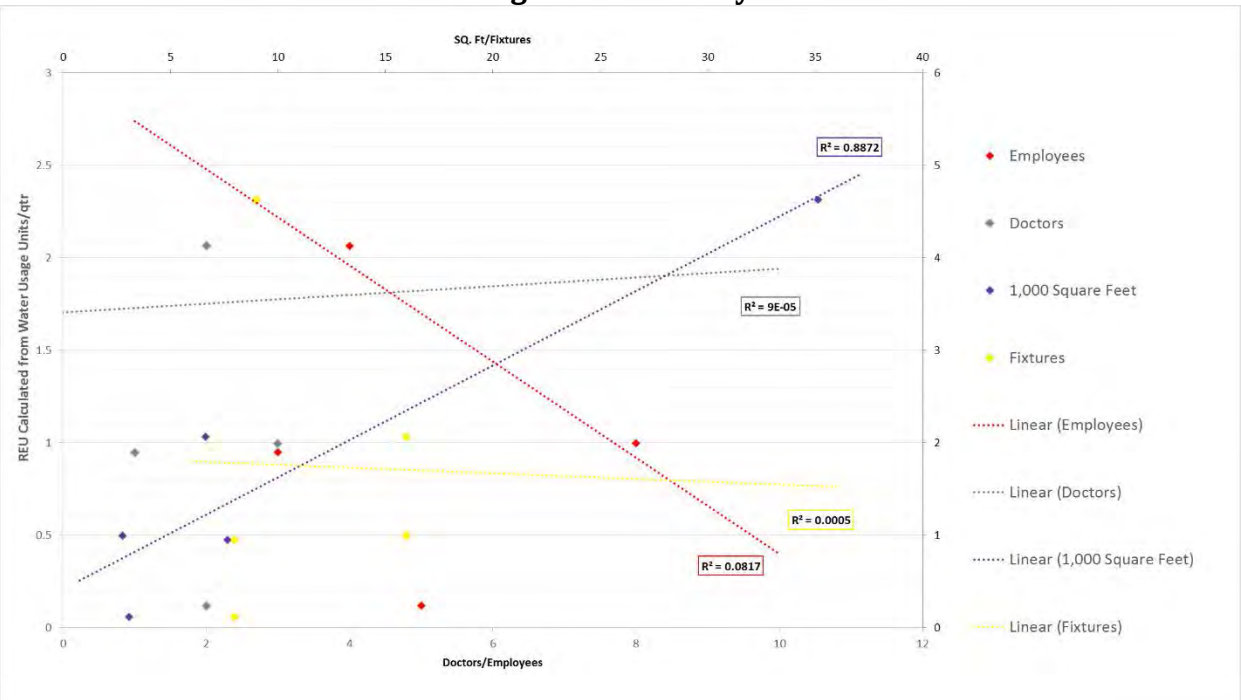
Based on available data, the recommended REU value for this category is 1.38 per facility, because no strong positive correlations exist.

Table 3.66 – Manufacturing – Wet Process Regression Analysis



Based on available data, the recommended REU value for this category is 0.29 per fixture, with an R^2 value of 0.72.

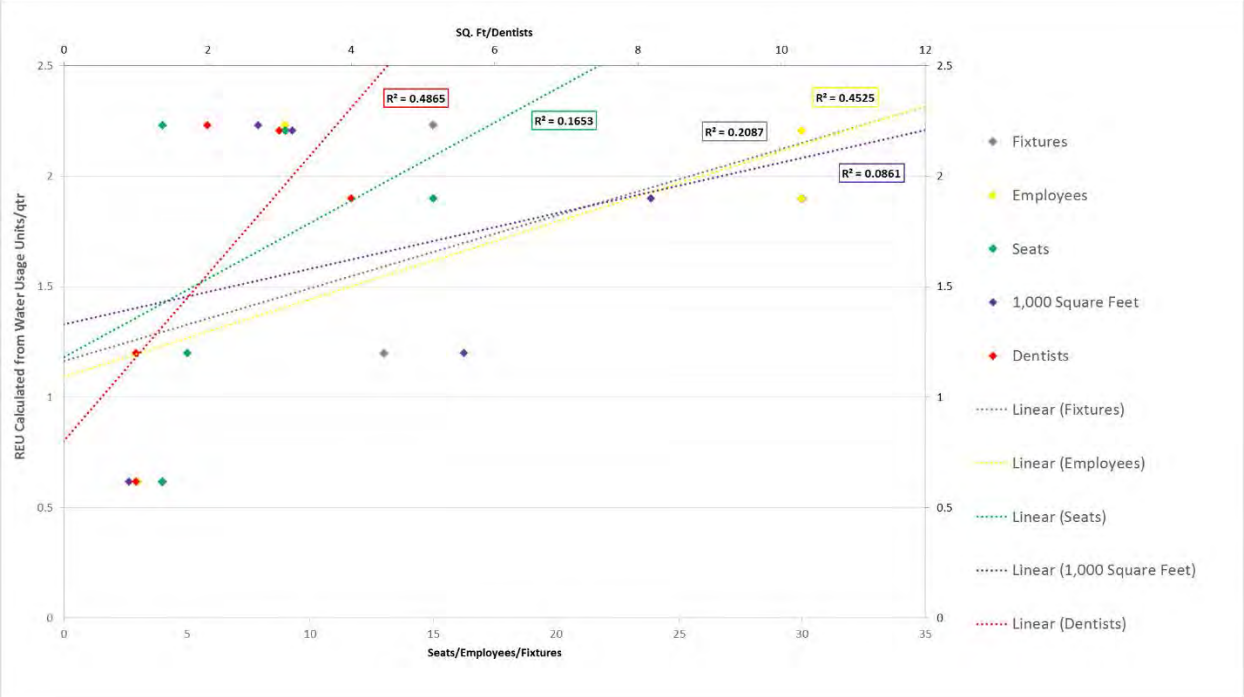
Table 3.67 – Medical Clinics Regression Analysis



3.3 - Non-Residential Category Data Analysis

Based on available data, the recommended REU value for this category is 0.19 per 1,000 square feet, with an R^2 value of 0.89.

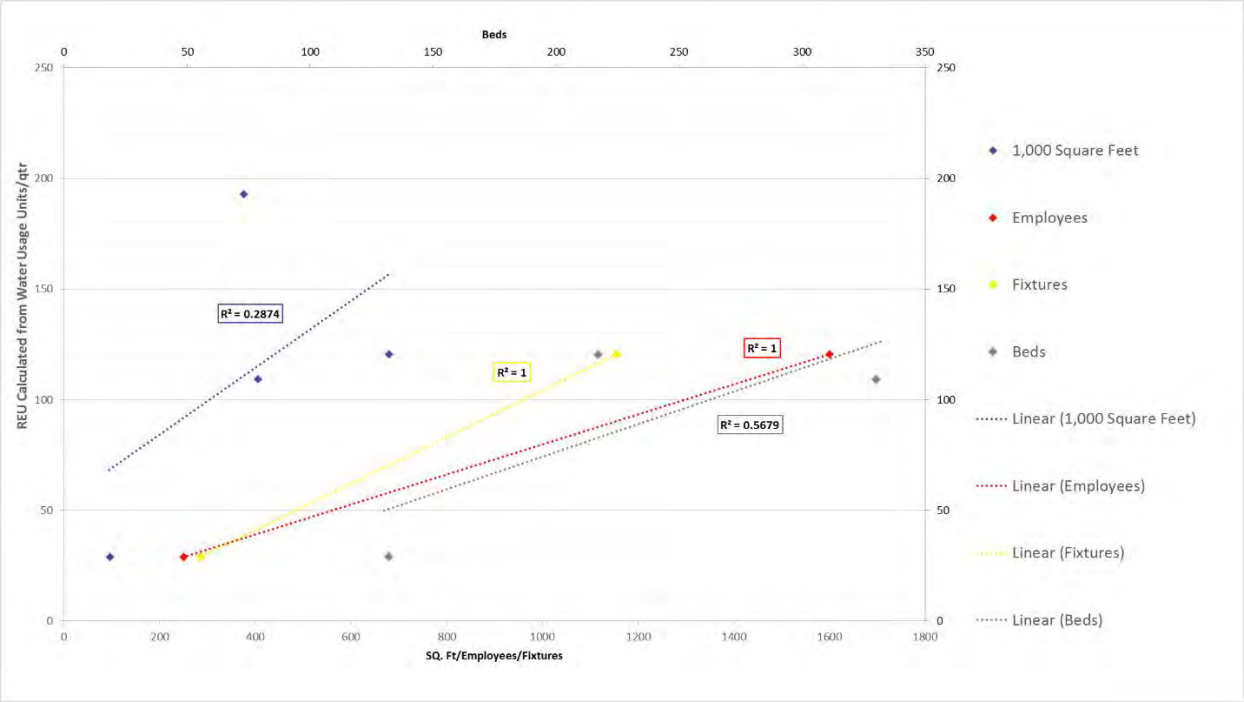
Table 3.68 – Dental Clinics Regression Analysis



Based on available data, the recommended REU value for this category is 0.83 per dentist, with an R^2 value of 0.49.

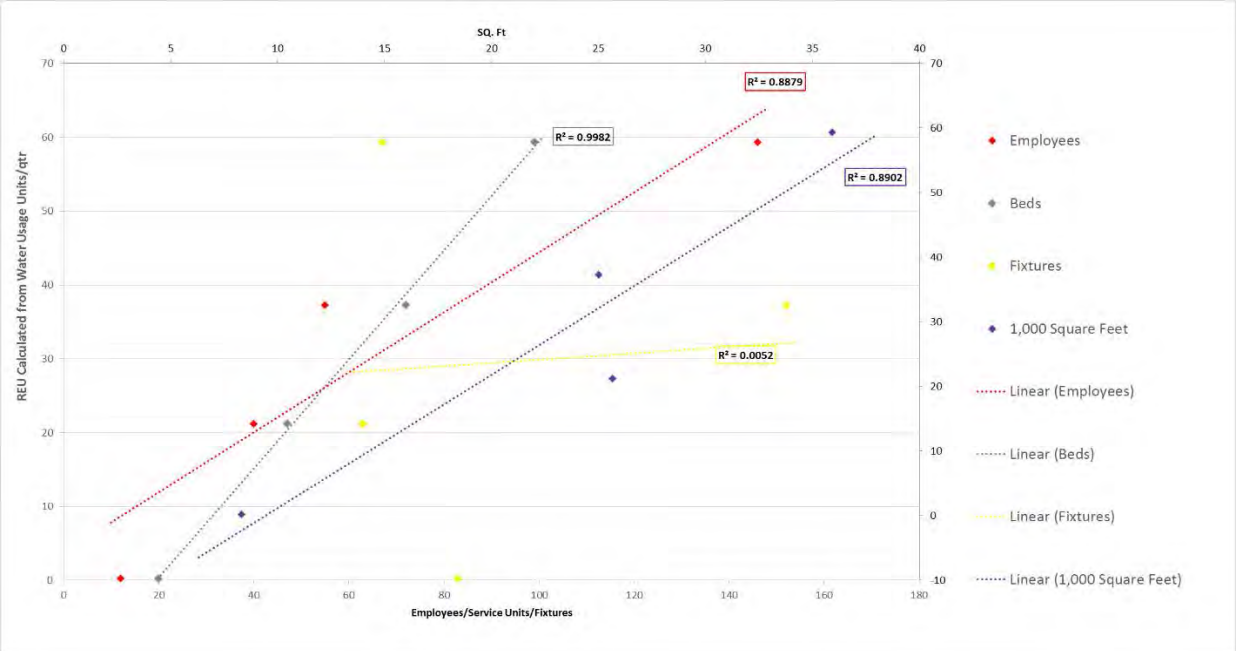
3.3 - Non-Residential Category Data Analysis

Table 3.69 – Hospitals Regression Analysis



Based on available data, the recommended REU value for this category is 1.22 per bed (utilizing the 1998 REU value). The 'old' REU value was maintained, due to lack of data as shown in the table above.

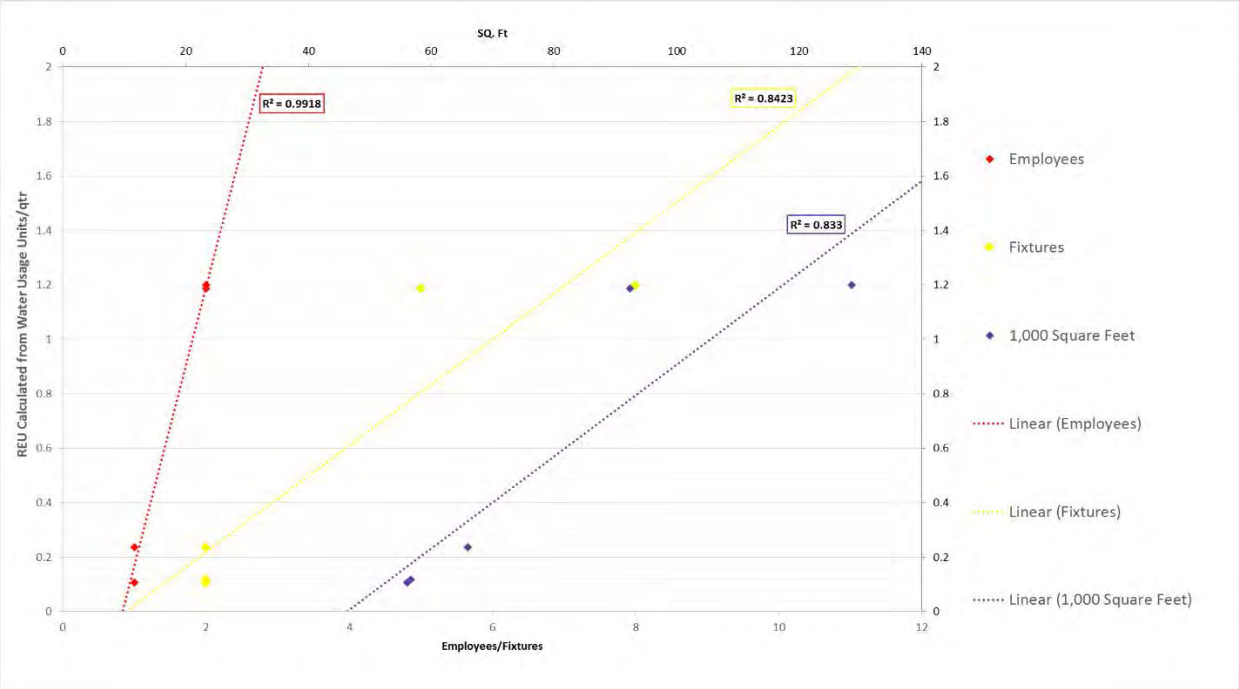
Table 3.70 – Retirement Homes/Assisted Living Regression Analysis



Based on available data, the recommended REU value for this category is 0.39 per bed, with an R^2 value of 1.00.

3.3 - Non-Residential Category Data Analysis

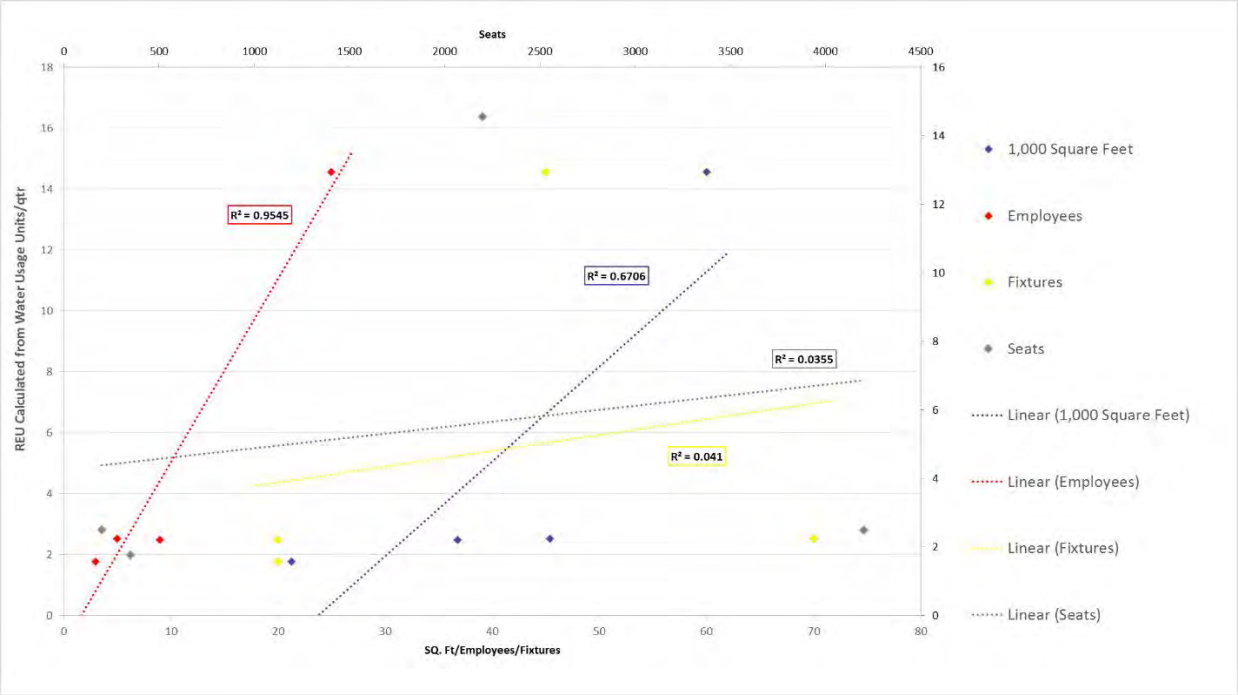
Table 3.71 – Warehouses & Storage Regression Analysis



Based on available data, the recommended REU value for this category is 0.12 per fixture, with an R^2 value of 0.84. As shown from the graph, employee counts versus water usage produced a slightly higher regression of 1.00; however the Steering Committee does not wish to utilize this REU if a strong regression exists with another parameter.

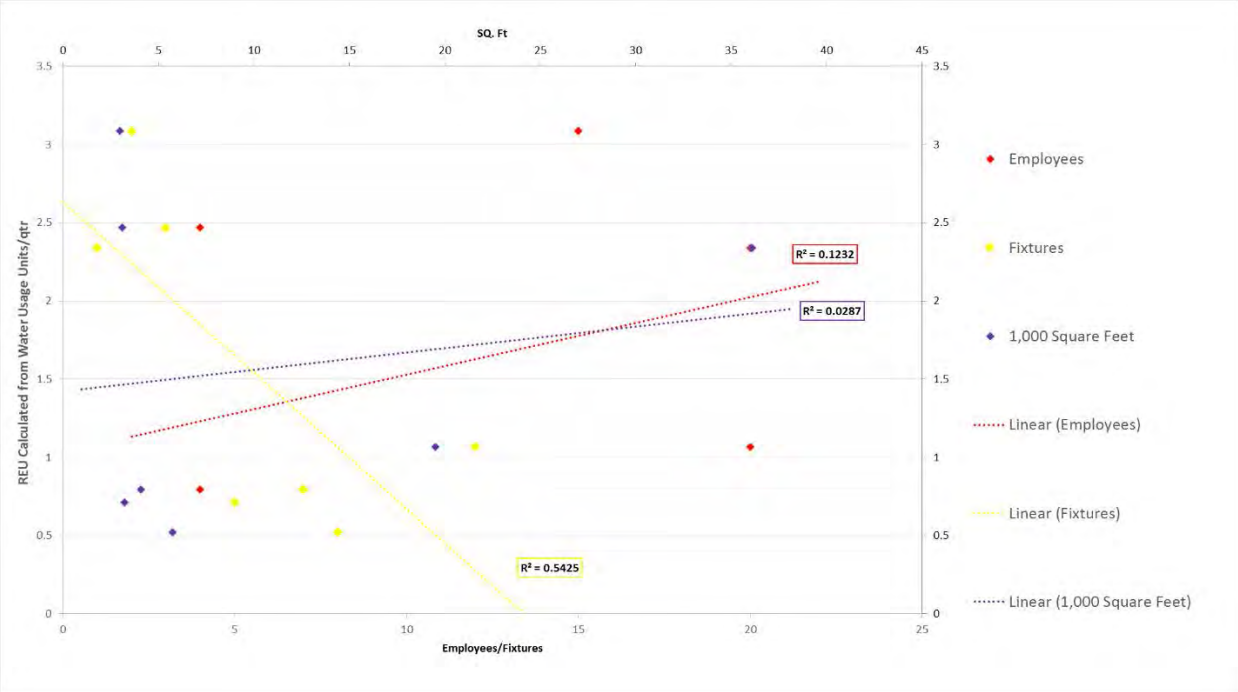
3.3 - Non-Residential Category Data Analysis

Table 3.72 – Churches Regression Analysis



Based on available data, the recommended REU value for this category is 0.11 per 1,000 square feet, with an R^2 value of 0.67.

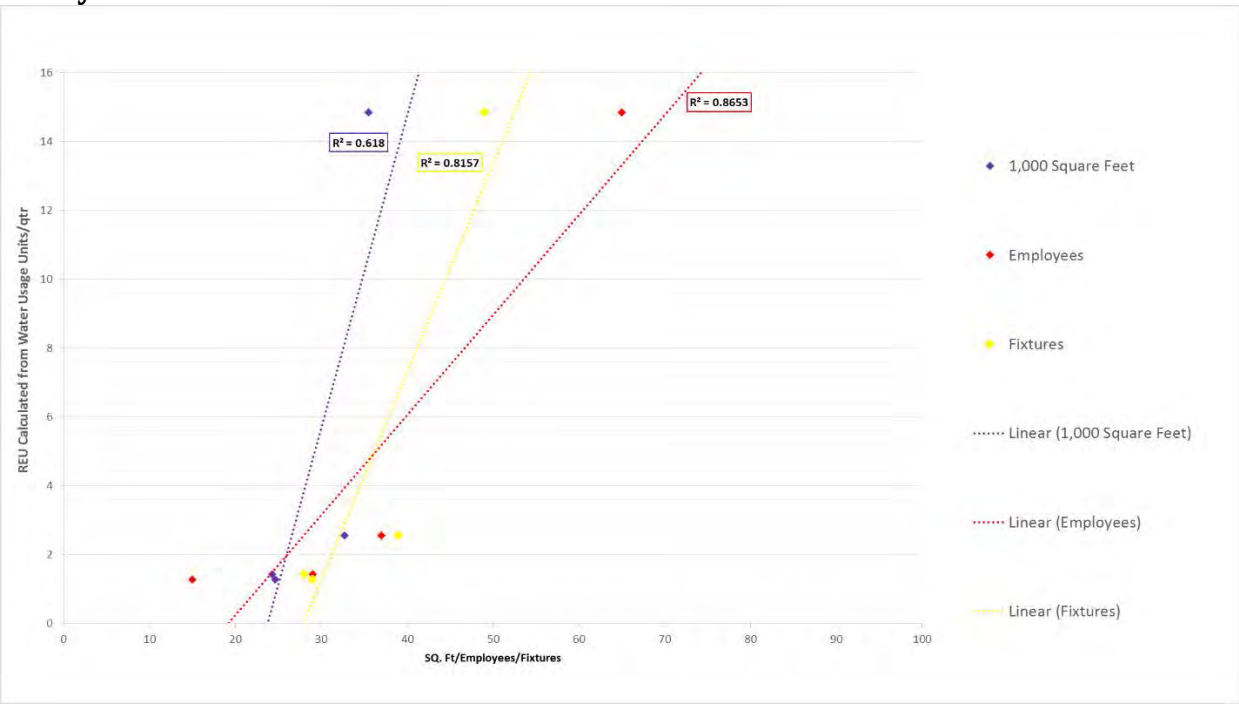
Table 3.73 – Offices-General Regression Analysis



3.3 - Non-Residential Category Data Analysis

The service use data for Offices – General does not illustrate any strong positive correlations with water usage. Therefore, the 1998 REU value of .400 per 1,000 square feet was maintained. Seven (7) data points were collected for this category.

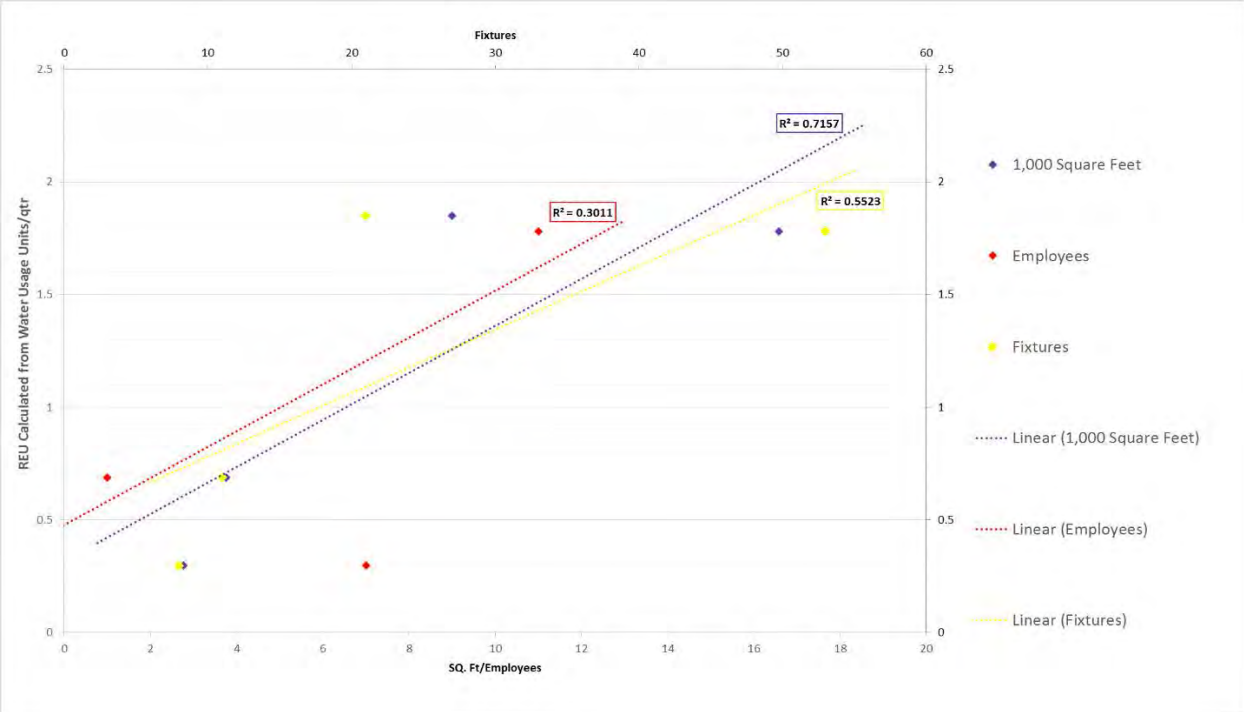
Table 3.74 – Public Institutions (other than hospitals, schools) Regression Analysis



Based on available data, the recommended REU value for this category is 0.12 per fixture, with an R^2 value of 0.82. As shown from the graph, employee counts versus water usage produced a slightly higher regression of 0.87; however the Steering Committee does not wish to utilize this REU if a strong regression exists with another parameter. Five (5) data points were initially collected for this category; however an outlier was identified and eliminated, thus producing a stronger regression.

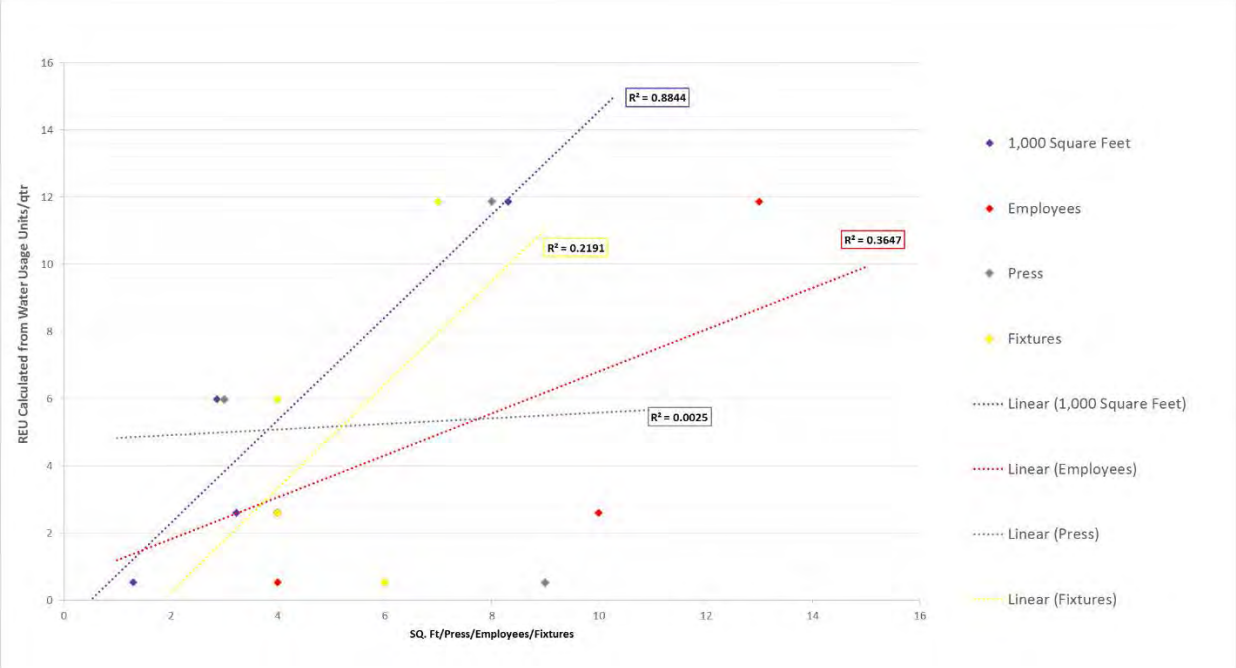
3.3 - Non-Residential Category Data Analysis

Table 3.75 – Funeral Homes Regression Analysis



Based on available data, the recommended REU value for this category is 0.15 per 1,000 square feet, with an R^2 value of 0.72. Five (5) data points were initially collected for this category; however an outlier was identified and eliminated, thus producing a stronger regression.

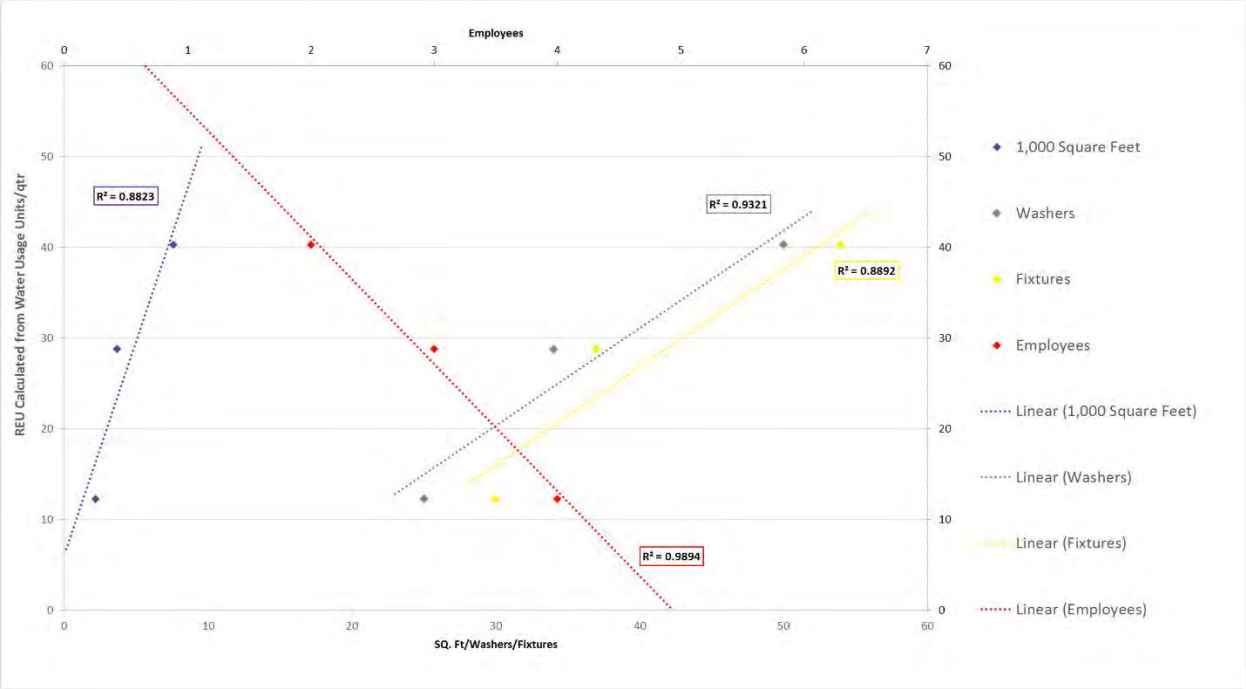
Table 3.76 – Dry Cleaners Regression Analysis



3.3 - Non-Residential Category Data Analysis

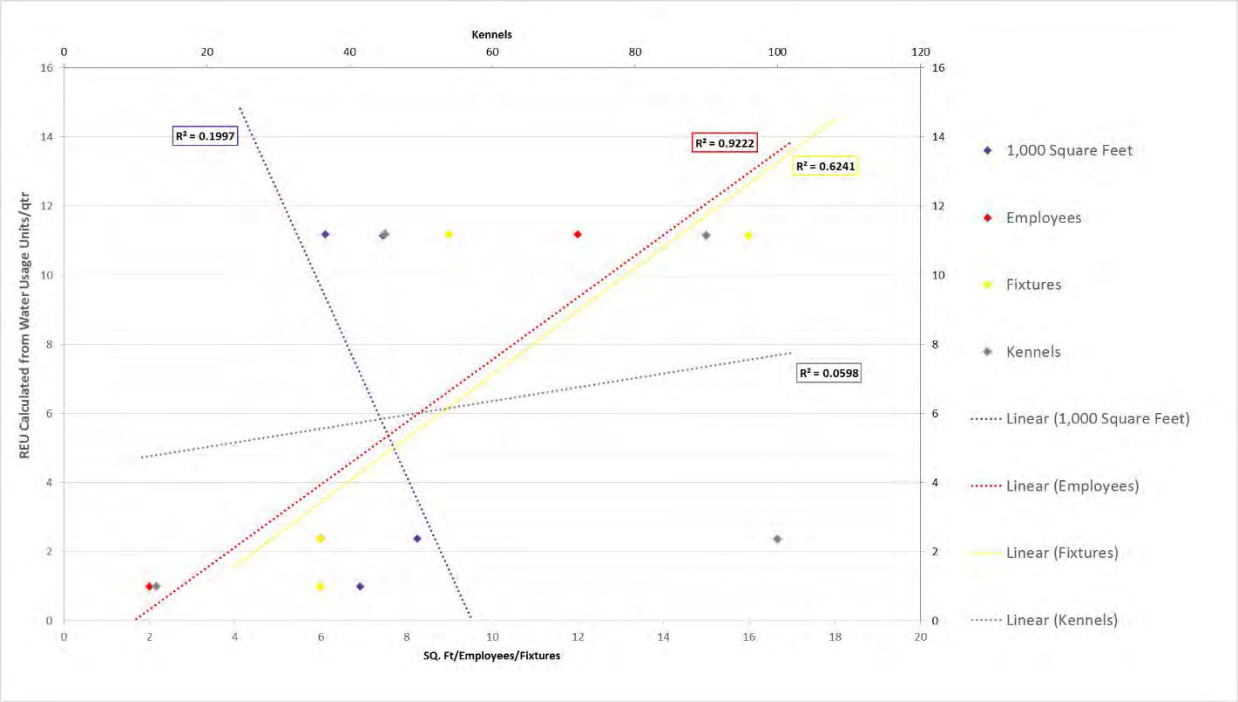
Based on available data, the recommended REU value for this category is 1.18 per 1,000 square feet, with an R^2 value of 0.88.

Table 3.77 – Self Service Laundry Facilities Regression Analysis



Based on available data, the recommended REU value for this category is 0.71 per washer, with an R^2 value of 0.93.

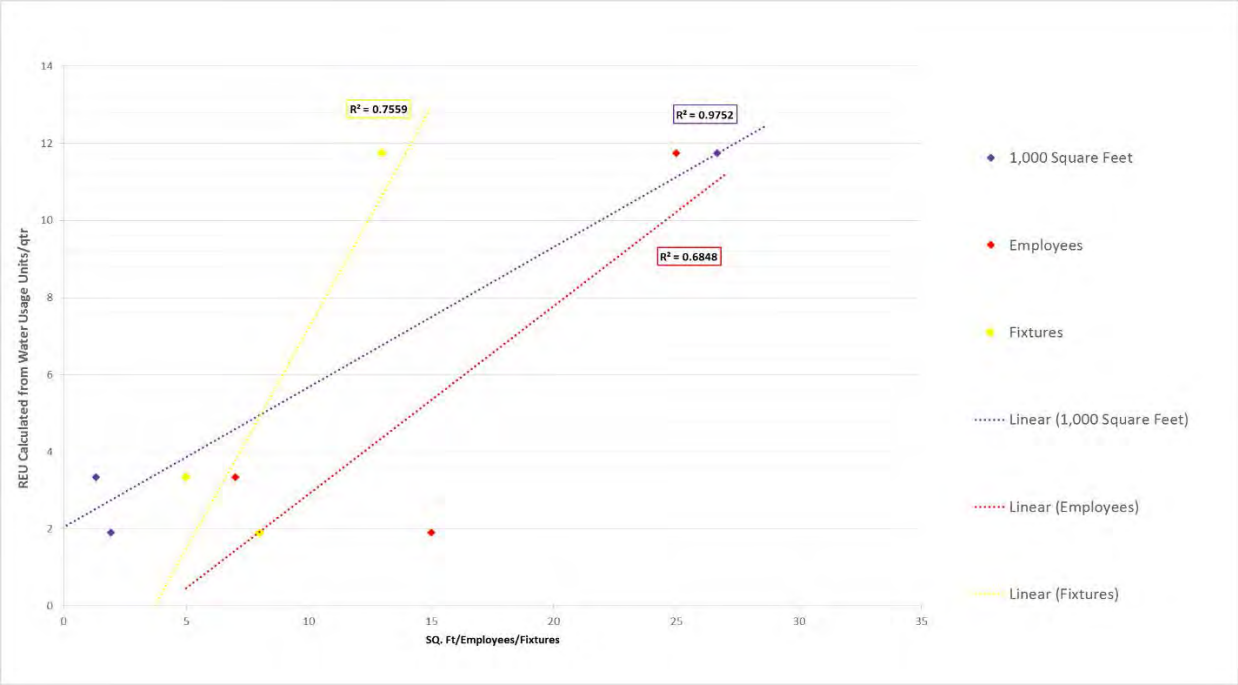
Table 3.78 – Pet Care Kennels Regression Analysis



Based on available data, the recommended REU value for this category is 0.63 per fixture, with an R^2 value of 0.62. As shown from the graph, employee counts versus water usage produced a slightly higher regression of 0.92; however the Steering Committee does not wish to utilize this REU if a strong regression exists with another parameter.

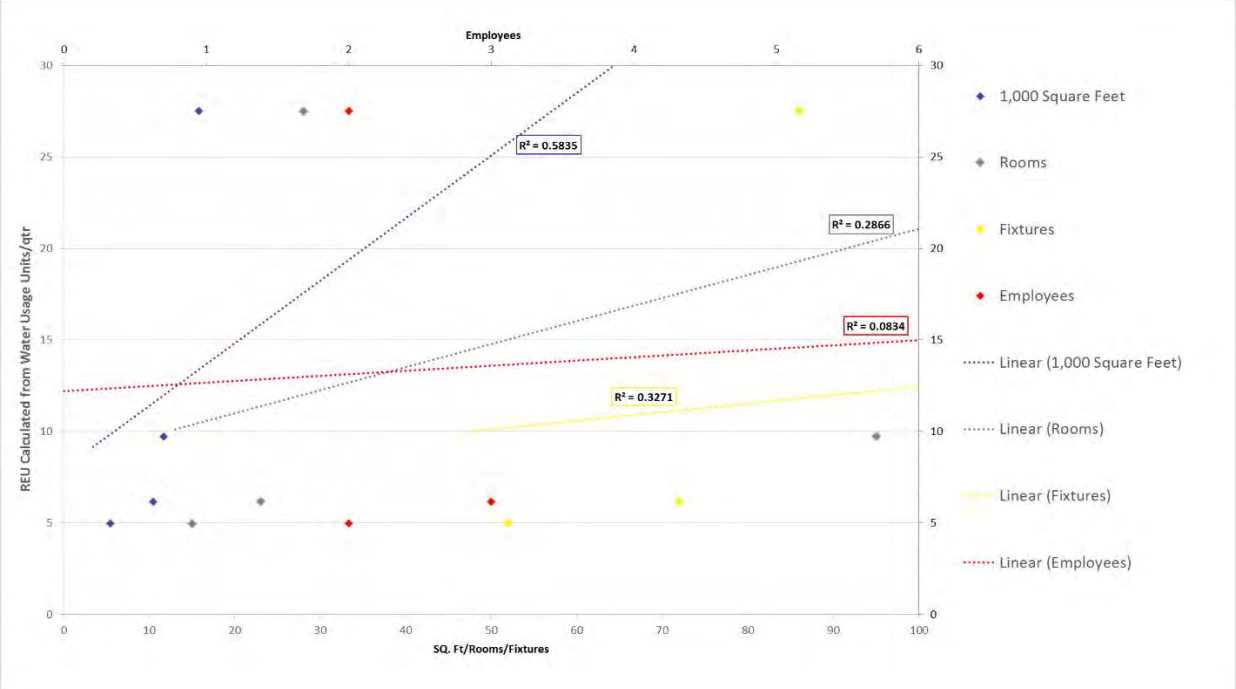
3.3 - Non-Residential Category Data Analysis

Table 3.79 – Pet Care Grooming Regression Analysis



Based on available data, the recommended REU value for this category is 1.33 per 1,000 square feet, with an R^2 value of 0.98.

Table 3.80 – Motels Regression Analysis

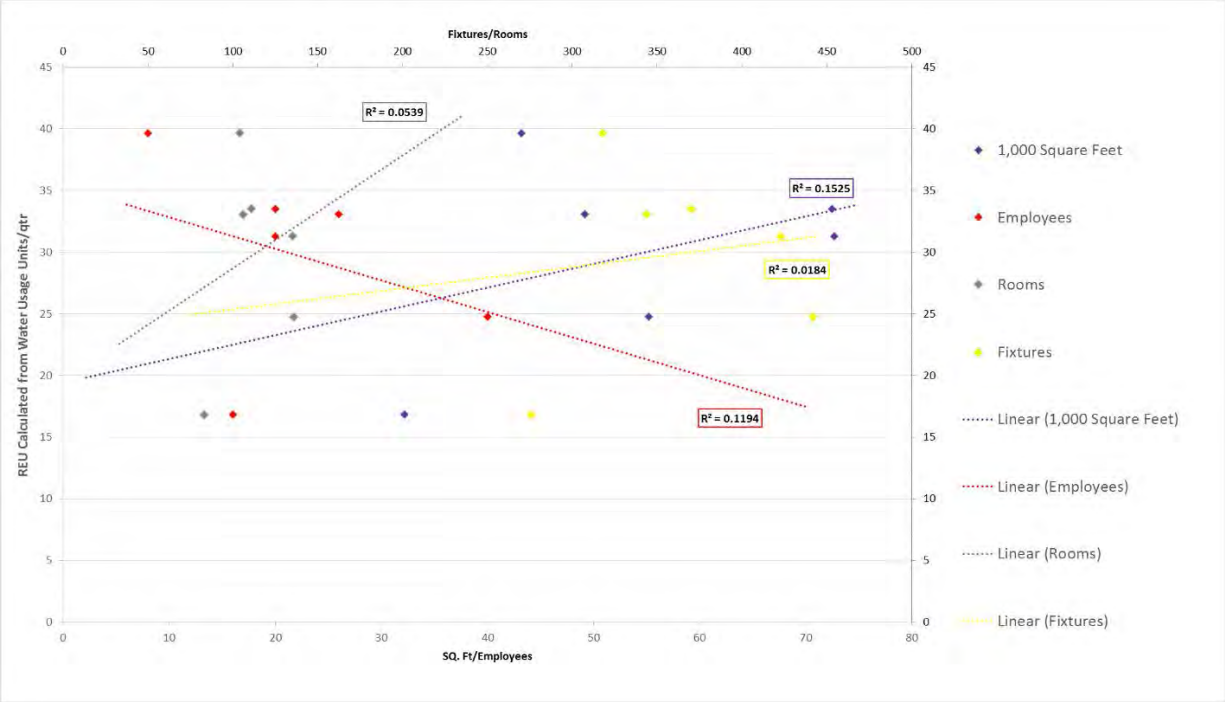


3.3 - Non-Residential Category Data Analysis

Based on available data, the recommended REU value for this category is 0.90 per 1,000 square feet, with an R^2 value of 0.58.

In the 1998 Schedule, the Hotels/Motels category is combined. After close review of the water usage data for hotels/motels, it was decided to split the categories in two (2).

Table 3.81 – Hotels Regression Analysis



The service use data for Hotels does not illustrate any strong positive correlations with water usage. Therefore, the 1998 REU value of .38 per room was maintained.

4.0 – Conclusions & Next Steps

Data Compilation Summary

For categories where only negative correlations or low positive correlations of 0.20 or less, additional data, analysis, and input from the WRC and Steering Committee were needed to determine which REU values they feel best represent the development type.

Basing an REU 'per employee' can be highly subjective and difficult to attain. If the strongest correlation to water usage is per employee, the next best correlation was utilized, if one exists. For 6 business classes, recommendations were made on a 'per employee' service unit because it either it was the only positive correlation, or no other strong correlation existed. These business classes are listed below:

- Auto Service/Repair (R^2 value = 0.58; next highest correlation is 0.13)
- Nail Salons (R^2 value = 0.65; no other positive correlations exist)
- Fire Stations (R^2 value = 0.93 next highest correlation is 0.27)
- Police Stations (R^2 value = 0.45; next highest correlation is 0.08)
- Convents & Seminaries (R^2 value = 0.94; next highest correlation is -1.0)

It must be noted that at the time of the report submittal, there was insufficient usage and service use data for some of the updated business categories. In these instances, the Steering Committee and staff from WRC determined a "best fit" recommended REU value based on the current Schedule of Unit Assignment Factors or best available data. A 'per facility' or 'per restaurant' assignment factor was recommended for a few businesses where a positive correlation currently does not exist, or a very low positive correlation exists. In these instances, possible alternative methodologies were considered, such as recommending a unit assignment factor based on Meter Equivalent Units (MEU) or temporarily utilizing the existing 1998 REU value until more data can be acquired. In addition, it was decided by WRC staff and Steering Committee members, due to a lack of data and low R^2 values for a few subcategories, that the recommended Unit Assignment Factor remain unchanged from the 1998 value. These subcategories are listed below:

- Offices – General
- Swimming Pools
- Hospitals
- Hotels

Data was collected for 245 business categories. Many factors have hampered reaching the desired business survey goal including:

- nail and tanning salons, which are typically housed in strip malls or plazas with no individual meter;
- several business owners and property managers that were unwilling to provide the information requested; and
- the majority of the 11 participating communities not containing the specific business subcategories for the survey.

In addition, as part of the QA/QC process, some businesses identified as high or low outliers (thus skewing the data) were eliminated from the category in order to produce a stronger regression.

Further investigations may be necessary in the future for these and additional businesses where very low correlations exist.

As one would expect, by reducing the current REU value by over 50% as previously outlined in this report, the updated calculated unit assignment factors would be generally lower than as outlined in the 1998 Schedule of Unit Factors table.

However, in 14 business categories, the updated unit assignment factor actually increased or remained the same from the 1998 Schedule. It's evident that for these categories, water usage has drastically increased since the original Schedule was developed. The business use categories that remained the same or increased included:

- Auto Showroom/Dealership
- Self-Serve Car Washes
- Fully & Semi-Automatic Car Washes
- Fraternal Organizations
- Bowling Alleys
- Theatres
- Health Club/Fitness Center w/o Shower &/or Pool
- Elementary Schools
- Junior or Middle Schools
- Convents & Seminaries
- Multiple Family Residences
- Retirement Homes/Assisted Living
- Self-Service Laundry Facilities
- Motels

Refer to Table 4.01 for a comparison of these unit assignment factors.

Table 4.01 – 1998 Schedule REU Values & Updated Values Comparison – Examples of Categories where Values Have Increased

Business Class	1998 Unit Assignment Factor	Calculated Unit Assignment Factor
Auto Showroom/Dealership	0.30 per 1,000 sq. ft.	0.37 per 1,000 sq. ft.
Self-Serve Car Washes	2.50 per stall	2.89 per stall
Fully & Semi-Automatic Car Washes	33.0 per lane	42.77 per lane
Fraternal Organizations	1.00 per hall	6.60 per hall
Bowling Alleys	0.160 per alley	0.320 per alley
Theatres	.008 per seat or 1,000 sq. ft.	.011 per seat / 0.27 per 1,000 square feet

Business Class	1998 Unit Assignment Factor	Calculated Unit Assignment Factor
Health Club/Fitness Center w/o Showers &/or Pool	0.26 per 1,000 sq. ft.	0.29 per 1,000 sq. ft.
Elementary Schools	0.012 per student	0.021 per student
Junior or Middle Schools	0.020 per student	0.020 per student
Convents/Seminaries	0.200 per person	0.340 per person
Retirement Homes/Assisted Living	0.300 per bed	0.390 per bed
Multiple Family Residences	0.600 per residence	0.600 per residence
Self Service Laundry Facilities	0.540 per washer	0.710 per washer
Motels	0.380 per room	0.530 per room

Table 4.02 – 1998 Schedule REU Values & Updated Values Comparison – Representative Sample of Categories where Values Have Decreased

Business Class	1998 Unit Assignment Factor	Calculated Unit Assignment Factor
Auto Service/Convenience Stations	0.240 per pump	0.210 per pump
Restaurants w/ Liquor	0.130 per seat	0.05 per seat
Barber Shops	1.00 per 1,000 sq. ft.	0.860 per 1,000 sq. ft.
Senior High Schools	0.038 per student	0.021 per student
Mobile Home Parks	0.600 per mobile home	0.410 per mobile home

Based on the regression analysis performed for each business classification, it is apparent that not all strong correlations can be made between water usage and the service units we surveyed (unlike that in which was anticipated). Further data collection and research may be needed in the future in hopes to build stronger correlations among these service unis and water usage.

The following properties, due to lack of sufficient data or low regression analysis, hold the 'old' 1998 REU value recommendations:

- Offices – General
- Hospitals
- Hotels
- Swimming Pools

Conclusions

With the completion of the Phase I and Phase II studies, the WRC has been provided with an updated quantification of a modern base REU usage which is over 50% less than the one utilized in the 1998 Schedule of Unit Factors. It has also been provided with an updated non-residential business use category table and resulting unit factors based on regression analysis correlations for various service factors such as square footage, number

of students, number of fixtures, etc. Both Phase I and Phase II methodologies have been reviewed and guided by input of a large group of community and consultant stakeholders to further validate the analysis and recommendations.

The new base REU and business category use REU unit factors are based on actual billing usage data taken during the winter months over a 4 year period from 2010-2013 and include the industry-wide water use reduction phenomenon that occurred after the great 2008 recession.

Refer to the recommended REU factors per non-residential classification below.

Table 4.03 – Recommended REU Factors per Non-Residential Classification

# of Properties Surveyed	Business Category / Use	Recommended Unit Assign Factor	R^2 Value	Comments	Calculated Unit Factor	1998 Unit Assignment Factors	
	Single Family Residential	N/A			1.00 per dwelling	1.000	per dwelling
5	Auto Service/Repair	0.29 per employee	0.58	No other strong correlations exist	N/A	N/A	N/A
6	Auto Service/Convenience Stations (Speedway, BP, etc.)	0.21 per pump	0.58		0.21 per pump	0.240	per pump
4	Auto Showroom/Dealership	0.37 per 1,000 sq. ft.	0.92		0.37 per 1,000 sq. ft.	0.300	per 1,000 sq. ft.
3	Self-Serve Car Washes	2.89 per stall	0.91		2.89 per stall	2.500	per stall
6	Fully & Semi-Automatic Car Washes	6.95 per 1,000 sq. ft.	0.73		42.77 per lane	33.0	per lane
5	Banquet Halls	0.23 per fixture	0.90		0.48 per seat	0.500	per seat
5	Country Clubs	0.04 per member	0.82		0.04 per member	0.080	per member
4	Convenience Store w/ Pharmacy	1.00 per facility	N/A		0.340 per 1,000 sq. ft.	0.140	per 1,000 sq. ft.
5	Full Service Grocery Store (produce, florist, add'l services - eye care, café, etc.)	0.26 per 1,000 sq. ft.	0.52		0.26 per 1,000 sq. ft.	0.310	per 1,000 sq. ft.
5	Grocery Store w/o Full Service	0.19 per 1,000 sq. ft.	0.80		0.19 per 1,000 sq. ft.	0.310	per 1,000 sq. ft.

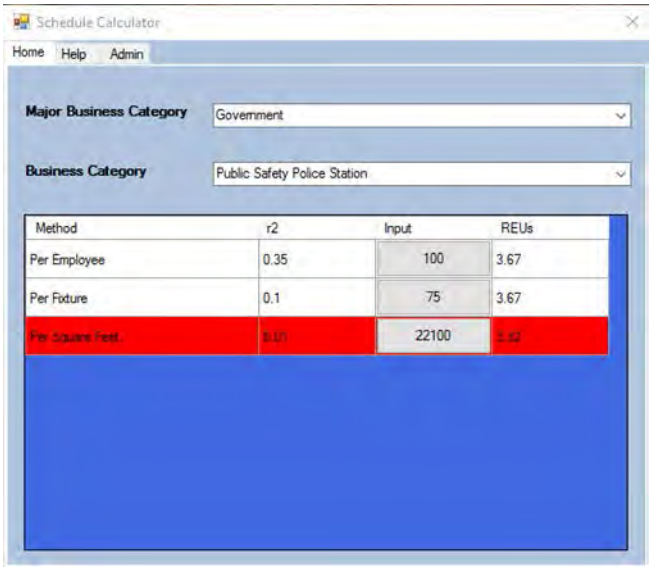
4.0 – Conclusions & Next Steps

# of Properties Surveyed	Business Category / Use	Recommended Unit Assign Factor	R^2 Value	Comments	Calculated Unit Factor	1998 Unit Assignment Factors	
6	Stores (other than specifically listed)	0.04 per 1,000 sq. ft.	0.65		0.05 per employee	0.160	per employee
3	Fraternal Organizations	0.04 per 1,000 sq. ft.	1.00		6.60 per hall	1.000	per hall
6	Restaurants w/ Liquor	0.35 per fixture	0.52		0.05 per seat	0.130 per seat	
4	Restaurants w/o Liquor	.08 per seat	0.90		0.08 per seat	0.130 per seat	
4	Quick Service Restaurants w/ dining & restrooms (Taco Bell, McDonalds, Burger King, etc.)	.49 per fixture	0.71		4.24 per restaurant	5.600 per restaurant	
5	Quick Service Restaurants w/o dining & restrooms (Jets, Little Caesars, etc.)	1.00 per restaurant	N/A	No strong positive correlations exist	1.00 per restaurant	1.80 per restaurant	
4	Nail Salons	0.18 per employee	0.65	No other strong positive correlations exist	N/A – new category added	N/A – new category added	
4	Barber Shops	0.14 per fixture	0.87		0.86 per 1,000 sq. ft.	1.00 per 1,000 sq. ft.	
5	Beauty Salons	0.71 per 1,000 sq. ft.	0.72		0.19 per booth	0.223 per booth	
5	Bowling Alleys	0.36 per 1,000 sq. ft.	0.82		0.32 per alley	0.160 per alley	
4	Theaters	0.27 per 1,000 sq. ft.	1.00		0.011 per seat / 0.27 per 1,000 sq. ft.	0.008 per seat or 1,000 sq. ft.	
3	Kids Indoor Play Center	0.12 per 1,000 sq. ft.	0.92		N/A – new category added	N/A – new category added	
6	Health Club/Fitness Center w/ Showers &/or Pool	1.29 per fixture	0.78		1.80 per 1,000 sq. ft.	2.300 per 1,000 sq. ft.	
4	Health Club/Fitness Center w/o Showers &/or Pool (yoga, kickboxing, cross-fit, etc.)	0.29 per 1,000 sq. ft.	0.99		0.29 per 1,000 sq. ft.	0.26 per 1,000 sq. ft.	
8	Swimming Pools	3.00 per 1,000 sq. ft.	-0.04	Summer Consumption/ Based on 1998 value	12.15 per 1,000 sq. ft.	3.000 per 1,000 sq. ft.	

# of Properties Surveyed	Business Category / Use	Recommended Unit Assign Factor	R^2 Value	Comments	Calculated Unit Factor	1998 Unit Assignment Factors	
6	Fire Stations	0.40 per employee	0.93	No other strong positive correlations exist	N/A – new category added	N/A – new category added	
4	Police Stations	0.09 per employee	0.45	No other strong positive correlations exist	N/A – new category added	N/A – new category added	
8	Daycare/Early Learning	4.28 per facility	N/A	No strong positive correlations exist	N/A – new category added	N/A – new category added	
6	Elementary Schools	0.02 per student	0.59		0.021 per student	0.012	per student
4	Junior or Middle Schools	0.12 per 1,000 sq. ft.	0.54		0.020 per student	0.020	per student
5	Senior High Schools	0.09 per 1,000 sq. ft.	0.86		0.021 per student	0.038	per student
3	Convents & Seminaries	0.29 per employee	0.94		0.34 per person	0.200	per person
10	Multiple Family Residences	0.60 per residence	0.22	Low positive correlation	0.60 per residence	0.600	per residence
5	Mobile Home Parks	0.41 per mobile home	0.57		0.41 per mobile home	0.600	per mobile home
5	Manufacturing – Dry Process	1.38 per facility	N/A	No strong correlations exist	0.10 per 1,000 sq. ft.	0.500	per 1,000 sq. ft.
3	Manufacturing – Wet Process	0.29 per fixture	0.72		N/A – new category added	N/A – new category added	
5	Medical Clinics	0.19 per 1,000 sq. ft.	0.89		0.94 per doctor	1.000	per doctor
5	Dental Clinics	0.83 per dentist	0.49		0.83 per dentist	1.400	per dentist
4	Hospitals	1.22 per bed	0.57	Based on 1998 value	0.37 per bed	1.220	per bed
4	Retirement Homes/Assisted Living	0.39 per bed	1.00		0.39 per bed	0.300	per bed
5	Warehouses & Storage	0.12 per fixture	0.84		0.01 per 1,000 sq. ft.	0.100	per 1,000 sq. ft.
4	Churches	0.11 per 1,000 sq. ft.	0.67		0.006 per seat	0.008	per seat
7	Offices - General	0.400 per 1,000 sq. ft.	N/A	Based on 1998 value	0.35 per 1,000 sq. ft.	0.400	per 1,000 sq. ft.
5	Public Institutions (other than hospitals, schools)	0.12 per fixture	0.82		0.11 per employee	0.320	per employee

# of Properties Surveyed	Business Category / Use	Recommended Unit Assign Factor	R^2 Value	Comments	Calculated Unit Factor	1998 Unit Assignment Factors	
4	Funeral Homes	0.15 per 1,000 sq. ft.	0.72		1.15 per funeral home	2.200	per funeral home
4	Dry Cleaners	1.18 per 1,000 sq. ft.	0.88		1.05 per press	1.250	per press
3	Self Service Laundry Facilities	0.71 per washer	0.93		0.71	0.540	per washer
4	Pet Care Kennels	0.63 per fixture	0.62		N/A – new category added	N/A – new category added	
3	Pet Care Grooming	1.33 per 1,000 sq. ft.	0.98		N/A – new category added	N/A – new category added	
5	Motels	0.90 per 1,000 sq. ft.	0.58		0.53 per room	0.38	per room
6	Hotels	0.38 per room	N/A	Based on 1998 value	0.27 per room	0.38	per room

REU Calculator Application



An REU Calculator Application was developed to allow users to select the business use category and then drill down to the strongest correlated service unit type such as square footage, number of employees, number of fixtures, etc. and then input the specific service unit quantity to calculate an REU value for the proposed business type. An example of how the Calculator is utilized is presented to the right. In this Calculator, you can use the pull down menus to choose the Major Business Category and Business Category you wish to input information on. Once you enter the 'Input' values, the calculated REU values automatically appear, thus saving time from performing the calculations individually and on paper. Service units listed in red (as shown above) are those with negative calculated correlations to water usage and should be used with caution or ignored. All Oakland County municipalities will have access to this application to aid in the calculation of business type REU values.

Next Steps

It should be noted that similar REU studies have been conducted by Giffels-Webster Engineers, Inc. in 2007 (for the Walled Lake – Novi Wastewater Treatment Plant Service Area) and Fishbeck, Thompson, Carr & Huber, Inc. (for the south Commerce Wastewater

Treatment Plant Service Area) that analyzed flow meter data with then current population information.

As a result, those studies, and the information gathered in this report, WRC is requesting to have three (3) defined service area REU allocations in accordance with the 10 States Standards for Basis of Design:

- Walled Lake – Novi Wastewater Treatment Plant (WWTP) at 2.38 persons per REU at 100 gallons per day (established in a 2013 study conducted by Fishbeck, Thompson, Carr, & Huber);
- South Commerce WWTP at 2.70 persons per REU at 100 gallons per day (established in 2007); and
- Clinton-Oakland, Evergreen-Farmington and George W. Kuhn at 2.44 persons (established in lieu of this report) as opposed to the original designation of 3.5 persons per REU at 100 gallons per day.

These new designations will change the design of every non-residential development moving forward. Virtually all of the non-residential projects in the entire Southeast Michigan District's four counties have been designed using either 3.5 or 3.15 persons per REU with 100 gallons per capita per day average flow. As stated earlier in this report, this information was derived theoretically, without the use of actual consumption data.

The WRC will be requesting that the MDEQ recognize and approve the use of the updated REU value of 2.44 persons per household, as outlined above for the Clinton-Oakland, Evergreen-Farmington, and George W. Kuhn service areas under Oakland County's jurisdiction.

Moving forward, the new Schedule will be reviewed periodically based on current development and water usage trends. **Please refer to Appendix VI for the updated Schedule of Unit Assignment Factors.**

Appendix I – Phase I Data Comparisons

Appendix I calculates water usages per household for the eleven (11) communities in the study based on current WRC parameters of 90 gallons per person per day and 3.5 people per household as compared to published industry standards and current SEMCOG people per household information. Some of the guideline usages are published as wastewater usage and need to be converted to water usage to accurately compare with the metered water usage by each of the eleven (11) communities in the study. The Section also concludes with a comparison of guideline recommendation usages to actual metered baseline and weighted average usages calculated for each of the eleven (11) communities.

Wastewater usage per person per day quantities from various government, Ten States Standards, and engineering publications is summarized below in Table I.01. These quantities need to be converted to a water usage basis to more accurately compare with metered usage data from the eleven (11) communities in the study.

Wastewater Use Guideline Recommendations:

1. Oakland County Water Resources Commissioner (WRC) is currently using assumptions of **3.5 people per household**, and a per capita flow of **90 gallons per day** in wastewater, or 315 gallons per household per day.

2. The Great Lakes – Upper Mississippi River Board (GLUMRB) (aka 10 States Standards) indicates in the 2004 Recommended Standards for Wastewater Facilities that they recommend sizing facilities based on an average per capita flow of **100 gallons per day**. This number does include flow due to normal infiltration into a system built with modern construction techniques.

3. Haestad Methods Computer Applications in Hydraulic Engineering fifth edition indicates studies have shown that, on average, a resident of middle class housing generates **74 gallons per day** in wastewater.

4. Innovyze - Comprehensive Sewer Collection Systems Analysis Handbook for Engineers and Planners 2004 indicates a typical wastewater load of **75 gallons per day** per person in single-family dwellings.

Table I.01

Source:	Recommended Value of Wastewater Use:
Oakland County (WRC)	90 gallons/person/day x 3.5 people per household
GLUMRB	100 gallons/person/day
Haestad Methods	74 gallons/person/day
Innovyze	75 gallons/person/day

Appendix I – Phase I Data Comparisons

Water usage quantities per person per day reported from various government and engineering publications is outline and summarized in Table I.02.

Water Use Guideline Recommendations:

1. The United States Geological Society (USGS) published a 2005 report on domestic water use. The total domestic per capita use in Michigan was **80 gallons per day**, the U.S. average was **98 gallons per day**. (These numbers include indoor and outdoor use)

2. A 1999 report by Aquacraft, Inc. Water Engineering and Management, sponsored and published by the AWWA Research Foundation indicates that the average per capita indoor water use was **69.3 gallons per day** for the study area.

Table I.02

Source:	Recommended Value of Water Use:
USGS (Michigan Average)	80 gallons/person/day
USGS (U.S. Average)	98 gallons/person/day
Aquacraft, Inc.	69.3 gallons/person/day

Standardizing Wastewater Vs. Water Guideline Usage Recommendations

Table I.01, on the proceeding page, quantifies wastewater volumes, which under report the actual water consumed to generate the wastewater because not all water used is returned to the system as wastewater. In order to ensure a standardized base usage for guideline water usage, wastewater guidelines need to be converted to a water usage basis. The conversion assumes an industry accepted standard that 80% of water usage is returned as wastewater to the system. Table I.03 outlines the resulting converted wastewater volumes in terms of water usage for the recommended wastewater guidelines.

Table I. 03

Source:	Recommended Wastewater Value (gallons/person/day)	Conversion factor from Wastewater to Water use	Converted Water Use Recommendation (gallons/person/day)
Oakland County (WRC)	90	1.25	112.5
GLUMRB	100	1.25	125
Haestad Methods	74	1.25	92.5
Innovyze	75	1.25	93.75

Appendix I – Phase I Data Comparisons

Table I.04 summarizes the guideline wastewater and water usage values in Tables I.02 and I.03 respectively based on recommended water usage per person per day.

Table I.04

Source:	Converted or Recommended Water Use (gallons/person/day)
Oakland County (WRC)	113
GLUMRB	125
Haestad Methods	93
Innovyze	94
USGS (Michigan Average)	80
USGS (U.S. Average)	98
Aquacraft, Inc.	69.3

Table I.05 summarizes the Table I.04 WRC converted water usage, 113 gallons per person per day, multiplied by their currently recommended 3.5 people per household number, in column A, for each of the eleven (11) communities in the study to get a daily water usage per residence per day. The remaining columns in Table I.05 summarize the Table I.04 converted guideline water usage quantities multiplied by the current SEMCOG people per household for each of the eleven (11) communities in the study to get a daily water usage per residence per day in each community.

Table I.05

	A	B	C	D	E	F	G
Community:	WRC	GLUMRB	Haestad Methods	Innovyze	USGS- MI Avg	USGS- US Avg	Aquacraft Inc.
Bingham Farms	395.0	256.3	190.7	192.7	164.0	200.9	142.1
Bloomfield Hills	395.0	303.8	226.0	228.4	194.4	238.1	168.4
Commerce Township	395.0	333.8	248.3	251.0	213.6	261.7	185.0
Farmington Hills	395.0	292.5	217.6	220.0	187.2	229.3	162.2
Highland Township	395.0	331.3	246.5	249.1	212.0	259.7	183.6
Keego Harbor	395.0	288.8	214.8	217.1	184.8	226.4	160.1
Lyon Township	395.0	345.0	256.7	259.4	220.8	270.5	191.3
Oakland Township	395.0	358.8	266.9	269.8	229.6	281.3	198.9
Orchard Lake	395.0	341.3	253.9	256.6	218.4	267.5	189.2
Oxford Township	395.0	348.8	259.5	262.3	223.2	273.4	193.3
Royal Oak Township	395.0	305.0	226.9	229.4	195.2	239.1	169.1
Weighted Average	**395.0**	**311.3**	**231.6**	**234.1**	**199.2**	**244.0**	**172.6**

A) WRC using 3.5 people per household (Gal/Household/Day)
B) GLUMRB using SEMCOG data for people per household (Gal/Household/Day)
C) Haestad Methods using SEMCOG data for people per household (Gal/Household/Day)
D) Innovyze using SEMCOG data for people per household (Gal/Household/Day)
E) USGS (Michigan Average) using SEMCOG data for people per household (Gal/Household/Day)
F) USGS (U.S. Average) using SEMCOG data for people per household (Gal/Household/Day)
G) Aquacraft, Inc. using SEMCOG data for people per household (Gal/Household/Day)

The WRC water usage per household per day in Table I.05 is very high compared to the rest of the recommended water usage guideline recommendations. This is due, in large part, to WRC's assumption of 3.5 people per household which, in general, is much higher than current SEMCOG data for each of the communities in the study. The WRC assumed gallons per person per day of 90 gallons converted to a water usage basis of 113 gallons is also higher than all published assumptions except for GLUMRB.

Actual Metered Residential Water Usage Standardized to Wastewater Flow

Table I.06 outlines actual meter water usages per person per day for the baseline winter months for the eleven (11) communities in the study as well as the total per house per day average for each of the communities using the SEMCOG people per household number for each community. It also summarizes a weighted average of per person per day and household usage based on the communities' representative portion of population.

The table also summarizes a water use per day reduction due to an assumed 80% factor of water used returned to the system as wastewater as well as an assumed 15% infiltration and inflow factor increase per household per day. To determine a more accurate water return to the wastewater system, sewer flow data from each community broken down into residential quantities would need to be included in the analysis, which is beyond the scope of this study. Based on the summarized usages in Table I.06, the weighted actual usage (172.2 gallons per house per day) is over 50% less than the current WRC usage calculation of (395 gallons per house per day summarized in Table I.05) and less than most of the usage guideline recommendations per house per day. Figure IV.04 provides data on additional scenarios for wastewater return and infiltration and inflow.

Table I.06

Community:	People per Household (SEMCOG 2013)	Water Use Derived from Analysis (Gal/Person/Day)	Water Use Derived from Analysis (Gal/Household/Day)	80% Wastewater Use Derived from Analysis (Gal/Household/Day)	Wastewater Use Derived from Analysis Including I/I (Gal/Household/Day)
Bingham Farms	2.05	91.3	187.2	149.8	172.2
Bloomfield Hills	2.43	83.8	203.6	162.9	187.3
Commerce Township	2.67	57.6	153.7	123.0	141.4
Farmington Hills	2.34	70.9	166.0	132.8	152.7
Highland Township	2.65	75.9	201.1	160.9	185.0
Keego Harbor	2.31	58.2	134.6	107.7	123.8
Lyon Township	2.76	65.4	180.4	144.3	166.0
Oakland Township	2.87	84.1	241.4	193.1	222.1
Orchard Lake	2.73	69.4	189.3	151.4	174.2
Oxford Township	2.79	61.4	171.4	137.1	157.7
Royal Oak Township	2.44	58.6	143.0	114.4	131.6
Weighted Average	**2.49**	**69.2**	**172.2**	**137.8**	**158.4**

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SEMCOG DATA BY COMMUNITY

BINGHAM FARMS

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	1111	81	7.9%	1086	1136
Housing Units	549	72	15.1%	550	
Occupied Units	527	82	18.4	531	551
Res. Vacancy Rate	4.0%	-2.7%		3.5%	
People per Household	2.11	-0.21		2.05	2.06
Median Housing Value	$391,900	-$105,133	21.2%		
Median Household Income	$130,625	-$31,374	-19.4%		

BLOOMFIELD HILLS

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	3869	-71	-1.8%	4045	4179
Housing Units	1659	31	1.9%	1672	
Occupied Units	1489	-31	-2	1565	1545
Res. Vacancy Rate	10.2%	3.6%		6.4%	
People per Household	2.44	-0.02		2.43	2.52
Median Housing Value	$715,300	-$323,494	-31.3%		
Median Household Income	$133,370	-$90,170	-40.3%		

COMMERCE TOWNSHIP

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	35874	5525	18.2%	36570	41628
Housing Units	13967	2776	24.8%	14226	
Occupied Units	13220	2512	23.5	13674	16306
Res. Vacancy Rate	5.3%	1.0%		3.9%	
People per Household	2.71	-0.12		2.67	2.55
Median Housing Value	$229,300	-$26,143	-10.2%		
Median Household Income	$82,691	-$14,741	-15.1%		

FARMINGTON HILLS

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	79740	-2371	-2.9%	81171	81897
Housing Units	36178	1320	3.8%	36244	
Occupied Units	33559	0	0	34411	34383
Res. Vacancy Rate	7.2%	3.5%		5.1%	
People per Household	2.36	-0.05		2.34	2.36
Median Housing Value	$238,300	-$52,504	-18.1%		
Median Household Income	$67,803	-$20,536	-23.2%		

Appendix II – SEMCOG Demographic Data

HIGHLAND TOWNSHIP

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	19202	33	0.2%	19144	18427
Housing Units	7688	509	7.1%	7710	
Occupied Units	7125	339	5	7217	7623
Res. Vacancy Rate	7.3%	1.8%		6.4%	
People per Household	2.69	-0.13		2.65	2.41
Median Housing Value	$212,900	$3,241	1.5%		
Median Household Income	$68,227	-$13,976	-17.0%		

KEEGO HARBOR

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	2970	201	7.3%	3090	3169
Housing Units	1473	156	11.8%	1471	
Occupied Units	1292	69	5.6	1338	1394
Res. Vacancy Rate	12.3%	5.2%		9.0%	
People per Household	2.3	0.03		2.31	2.27
Median Housing Value	$156,900	$15,720	11.1%		
Median Household Income	$50,159	-$10,771	-17.7%		

LYON TOWNSHIP

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	14545	3504	31.7%	16630	19621
Housing Units	5615	1550	38.1%	6257	
Occupied Units	5226	1339	34.4	6017	7142
Res. Vacancy Rate	6.9%	2.5%		3.8%	
People per Household	2.78	-0.06		2.76	2.74
Median Housing Value	$242,400	-$8,293	-3.3%		
Median Household Income	$79,375	-$8,696	-9.9%		

OAKLAND TOWNSHIP

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	16779	3708	28.4%	17301	20400
Housing Units	6075	1546	34.1%	6290	
Occupied Units	5777	1436	33.1	6027	7345
Res. Vacancy Rate	4.9%	0.8%		4.2%	
People per Household	2.9	-0.11		2.87	2.77
Median Housing Value	$342,000	-$53,040	-13.4%		
Median Household Income	$111,206	-$22,342	-16.7%		

Appendix II – SEMCOG Demographic Data

ORCHARD LAKE

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	2375	160	7.2%	2360	2499
Housing Units	869	64	8.0%	871	
Occupied Units	802	52	6.9	812	893
Res. Vacancy Rate	7.7%	0.9%		6.8%	
People per Household	2.78	-0.16		2.73	2.62
Median Housing Value	$588,200	-$160,581	-21.4%		
Median Household Income	$149,250	-$9,287	-5.9%		

OXFORD TOWNSHIP

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	17090	4605	36.9%	17429	19167
Housing Units	6467	1792	38.3%	6526	
Occupied Units	6063	1678	38.3	6205	6952
Res. Vacancy Rate	6.2%	0.0%		4.9%	
People per Household	2.8	-0.03		2.79	2.74
Median Housing Value	$213,900	-$3,939	-1.8%		
Median Household Income	$80,664	-$6,670	-7.6%		

ROYAL OAK TOWNSHIP

Population & Households	Census 2010	Change (2000-2010)	Pct Change (2000-2010)	SEMCOG (Jul 2013)	SEMCOG (2040)
Total Population	2419	-3027	-55.6%	2466	2908
Housing Units	1111	-1484	-57.2%	1105	
Occupied Units	1024	-1487	-59.2	1012	1137
Res. Vacancy Rate	7.8%	4.6%		8.4%	
People per Household	2.36	0.21		2.44	2.56
Median Housing Value	$99,800	$5,856	6.2%		
Median Household Income	$25,515	-$5,518	-17.8%		

OAKLAND COUNTY

Year	1975	1980	1990	2000	2010	2013
Population	957,300	1,011,793	1,083,592	1,194,156	1,202,362	1,230,009
Avg. Household Size	2.94*	2.76*	2.63*	2.62*	2.46	2.44

* national average

Appendix III – Demographic Analysis

Table III.01 - Consumption versus number of people per household

COMMUNITY	Consumption/ household (gpd)	Avg. # of people per household
BINGHAM FARMS	187.2	2.05
BLOOMFIELD HILLS	203.6	2.43
COMMERCE TOWNSHIP	153.7	2.67
FARMINGTON HILLS	166.0	2.34
HIGHLAND TOWNSHIP	201.1	2.65
KEEGO HARBOR	134.6	2.31
LYON TOWNSHIP	180.4	2.76
OAKLAND TOWNSHIP	241.4	2.87
ORCHARD LAKE	189.3	2.73
OXFORD TOWNSHIP	171.4	2.79
ROYAL OAK TOWNSHIP	143.0	2.44
OAKLAND COUNTY (weighted average)	**179.3**	**2.49**

Table III.02 - Consumption versus average household income

COMMUNITY	Consumption/ household (gpd)	Avg. Household Income
BINGHAM FARMS	187.2	$130,625
BLOOMFIELD HILLS	203.6	$133,370
COMMERCE TOWNSHIP	153.7	$82,691
FARMINGTON HILLS	166.0	$67,803
HIGHLAND TOWNSHIP	201.1	$68,227
KEEGO HARBOR	134.6	$50,159
LYON TOWNSHIP	180.4	$79,375
OAKLAND TOWNSHIP	241.4	$111,206
ORCHARD LAKE	189.3	$149,250
OXFORD TOWNSHIP	171.4	$80,664
ROYAL OAK TOWNSHIP	143.0	$25,515
OAKLAND COUNTY	**179.3**	

Table III.03 - Consumption versus average household value

COMMUNITY	Consumption/ household (gpd)	Avg. Household Value
BINGHAM FARMS	187.2	$391,900
BLOOMFIELD HILLS	203.6	$715,300
COMMERCE TOWNSHIP	153.7	$229,300
FARMINGTON HILLS	166.0	$238,300
HIGHLAND TOWNSHIP	201.1	$212,900
KEEGO HARBOR	134.6	$156,900
LYON TOWNSHIP	180.4	$242,400
OAKLAND TOWNSHIP	241.4	$342,000
ORCHARD LAKE	189.3	$588,200
OXFORD TOWNSHIP	171.4	$213,900
ROYAL OAK TOWNSHIP	143.0	$99,800
OAKLAND COUNTY	**179.3**	

Appendix IV – Usage Summary Tables

Figure IV.01- Water Usage by Community

			5/8" Water Meters		1" Water Meters		5/8" & 1" Water Meters				
Community:	People per Household	Residential Accounts	% of Residential Meters	Avg Units Used	% of Residential Meters	Avg Units Used	Avg Units Used	Avg from Statistically Reduced Data	Avg Use	Avg Use	Avg Use
	2013 SEMCOG								gal/household/qtr	gal/household/day	gal/person/day
Bingham Farms	2.05	206	12	25.04	88	23.94	24.08	22.53	16852	187.2	91.3
Bloomfield Hills	2.43	803	19	23.1	81	28.5	27.5	24.5	18326	203.6	83.8
Commerce Township	2.67	4912	29	16.08	71	20.61	19.26	18.49	13831	153.7	57.6
Farmington Hills	2.34	19329	64	20.06	36	24.74	21.76	19.97	14938	166	70.9
Highland Township	2.65	996	22	22.8	78	26.1	25.4	24.2	18102	201.1	75.9
Keego Harbor	2.31	845	79	16.46	21	27.24	18.78	16.19	12110	134.6	58.2
Lyon Township	2.76	1616	0	0	100	23.06	23.06	21.71	16239	180.4	65.4
Oakland Township	2.87	2633	7	25.66	93	31.48	31.04	29.05	21729	241.4	84.1
Orchard Lake	2.73	620	6	24.31	94	25.37	25.31	22.78	17039	189.3	69.4
Oxford Township	2.79	2319	6	21.51	94	22.12	22.09	20.62	15424	171.4	61.4
Royal Oak Township	2.44	570	97	20.09	3	27.97	20.3	17.2	12866	143	58.6
Weighted Average	2.49	34849					22.41	20.72	15502.2	172.2	69.2

Various sources recommend Average Water Use for comparison to Oakland County Usage Data.	
Source	Avg Use gal/person/day
GLUMRB	125
USGS (Michigan Average)	80
USGS (U.S. Average)	98
Haestad Methods	93
Aquacraft, Inc.	69.3
Innovyze	94

Figure IV.02 – Weighted Average Calculations by Community

Community	Percentage of total accounts	People/ Household	Avg Units Used	Avg from Statistically Reduced Data	Avg Use Gal/Household/Qtr	Avg Use Gal/Household/Day	Avg Use Gal/Person/Day
BINGHAM FARMS	0.6	0.012	0.142	0.133	99.6	1.11	0.54
BLOOMFIELD HILLS	2.3	0.056	0.634	0.565	422.3	4.69	1.931
COMMERCE TOWNSHIP	14.1	0.376	7.715	2.606	1949.4	21.66	8.112
FARMINGTON HILLS	55.5	1.298	12.069	11.076	8285.1	92.06	39.341
HIGHLAND TOWNSHIP	2.9	0.076	0.726	0.692	517.4	5.75	2.169
KEEGO HARBOR	2.4	0.056	0.455	0.393	293.6	3.26	1.412
LYON TOWNSHIP	4.6	0.128	1.069	1.007	753	8.37	3.032
OAKLAND TOWNSHIP	7.6	0.217	2.345	2.195	1641.8	18.24	6.356
ORCHARD LAKE	1.8	0.049	0.45	0.405	303.1	3.37	1.234
OXFORD TOWNSHIP	6.7	0.186	1.47	1.372	1026.4	11.4	4.087
ROYAL OAK TOWNSHIP	1.6	0.04	0.332	0.281	0.281	2.34	0.958
Weighted Average of 11 Surveyed Oakland County Communities		2.49	22.41	20.72	15502.2	172.25	69.17

Appendix IV – Usage Summary Tables

Figure IV.03 – Water Billing Calculations by Community

Community	Avg from Statistically Reduced Data	Avg Usage of 11 Communities	Avg Use	Minimum Billed	Cost Above Minimum	Minimum Billed	Cost Above Minimum	Total Water Bill
			Gal/House hold/Day	Water		Sewer		
BINGHAM FARMS	20.62	20.72	171.4			$34.00	$5.72	$39.72
BLOOMFIELD HILLS	29.05	20.72	241.4			$39.25	$7.84	$47.09
COMMERCE TOWNSHIP	21.71	20.72	180.4			$52.25	$7.55	$59.80
FARMINGTON HILLS	24.2	20.72	201.1			$71.00	$7.72	$78.72
HIGHLAND TOWNSHIP	22.53	20.72	187.2	$43.20	$1.56	$38.60	$1.39	$84.74
KEEGO HARBOR	18.49	20.72	153.7	$52.00	$4.20	-	$62.16	$118.36
LYON TOWNSHIP	19.97	20.72	166.0	$58.44	$17.23	$43.94	$12.93	$132.54
OAKLAND TOWNSHIP	16.19	20.72	134.6	$37.60	$10.81	$66.88	$19.73	$135.02
ORCHARD LAKE	24.5	20.72	203.6	$80.66	$2.90	$64.16	$2.30	$150.03
OXFORD TOWNSHIP	22.78	20.72	189.3	$73.56	$2.64	$73.22	$17.28	$166.70
ROYAL OAK TOWNSHIP	17.2	20.72	143.0	$54.86	$1.97	$114.40	$4.15	$176.39

OAKLAND COUNTY DRAIN COMMISSIONER

Schedule of Unit Assignment Factors July 1, 1998

Usage		Unit Factors	Information Source
Single Family Residential	1.0	per dwelling	
Auto Dealers	.30	per 1,000 sq. ft	D
Banquet Hall	.50	per 1,000 sq. ft	D
Barber Shops	1.0	per 1,000 sq. ft	D
Bars	.044	per seat	D
Beauty Shops	0.223	per booth	D
Boarding Houses	.16	per person	A-C
Boarding Schools	.27	per person	A-C
Bowling Alleys (no bars, lunch facilities)	.16	per alley	D
Car Wash			
a. Manual, Do-It Yourself	2.5	per stall	D
b. Semi-Automatic (Mechanical without conveyor)	12.5	per stall	D
c. Automatic with conveyor	33.0	per lane	D
d. Automatic with conveyor conserving and (recycling water)	8.4	per lane	D
Churches	.008	per seat	D
Cleaners (pickup only)	.048	per employee	D
Cleaners (pressing facilities)	1.25	per press	D
Clinics			
a. Medical	1.00	per doctor	D
b. Dental	1.40	per dentist	D
Convalescent and/or Nursing Homes	.3	per bed	D
Convents	.20	per person	D
Country Clubs	.08	per member	A-C
Drug Stores			
a. With fountain service	.08	per seat + .14 per 1,000 sq. ft.	D
b. Without fountain service	.14	per 1,000 sq. ft.	D

Usage		Unit Factors	Information Source
Factories (exclusive of excessive industrial use)	.50	per 1,000 sq. ft.	D
Fraternal Organizations (members only)	1.0	per hall	D
Fraternal Organization (members & rentals)	2.0	per hall	D
Funeral Homes, including one residence	2.2	per funeral home	D
Grocery Stores & Supermarkets	0.31	per 1,000 sq. ft.	D
Health Clubs			
a. With showers and/or pool	2.3	per 1,000 sq. ft.	D
b. Without showers and/or pool	.26	per 1,000 sq. ft.	D
Hospitals	1.22	per bed	D
Hotels and/or Motels (exclusive of swimming pools, bars, restaurants, etc.)	.38	per room	D
Laundry (self-service)	.54	per washer	D
Mobile Home Parks	0.60	per mobile home	D
Multiple Family Residence	0.60	per residence	D
Office Building	.40	per 1,000 sq. ft.	D
Public Institutions other than Hospitals	.32	per employee	A-C
Racquet Clubs	.82	per tennis or handball court	D
Restaurants			
a. Conventional type with or without drinks	0.13	per seat	A-B
b. Quick service franchise type, without dishes, dealing mainly in hamburgers with or without eating in building (includes but not necessarily limited to McDonald's, Burger Chef, Burger King, Red Barn and Hardees).	5.6	per restaurant	D
c. All other restaurants (includes but not necessarily limited to drive-ins, snack bars, carry outs, such as fried chicken and pizzas; could have some eating in building, all without dishes.	1.8	per restaurant	D
Rooming Houses (no meals)	.13	per person	A-C

Usage		Unit Factors	Information Source
Schools			
a. Elementary	.012	per student	D
b. Junior or Middle High	.020	per student	D
c. Senior High	.038	per student	D
d. Bus Maintenance Facility	.165	per 1,000 sq. ft.	D
Service Station	.24	per pump	D
Store (other than specifically listed)	. 16	per employee	D
Summer Camps	.14	per housing unit	D
Swimming Pool (Single family residential excluded)	3.00	per 1,000 sq. ft.	D
Theaters (Drive-In)	.012	per car space	D
Theaters (indoor)	.008	per seat	D
Tourist Courts (individual bath units)	.27	per cubical	A-B-C
Warehouses	.10	per 1,000 sq. ft.	D

A - Cincinnati Report
B - Gordon MacDougall Report to Wayne County
C - Manual of Septic Tank Practices Publication No. 526, U.S. Department of Health
D - Oakland County Dept. of Public Work Studies

Note: New Unit Factors are Underlined

JEP/kes/banquet.wk4

WRC
WATER RESOURCES COMMISSIONER
Jim Nash

Appendix VI
Oakland County Water Resources Commissioner
Schedule of Unit Assignment Factors
2017

Business/Category Use	Unit Factors		Information Source
Single Family Residential	1.00	per dwelling	
Auto			
Auto Showroom/Dealership	0.37	per 1,000 sq. ft.	2016 Data Collection
Auto Service/Repair	0.29	per employee	2016 Data Collection
Auto Service/Convenience Stations	0.21	per pump	2016 Data Collection
Self-Serve Car Washes	2.89	per stall	2016 Data Collection
Fully & Semi-Automatic Car Washes	6.95	per 1,000 sq. ft.	2016 Data Collection
Food, Beverage & Retail			
Banquet Halls	0.23	per fixture	2016 Data Collection
Country Clubs	0.04	per member	2016 Data Collection
Convenience Store w/ Pharmacy	1.00	per facility	2016 Data Collection
Full Service Grocery Store (w/ florist, eye care, etc.)	0.26	per 1,000 sq. ft.	2016 Data Collection
Grocery Store w/o Full Service	0.19	per 1,000 sq. ft.	2016 Data Collection
Fraternal Organizations	0.04	per 1,000 sq. ft.	2016 Data Collection
Restaurants w/ Liquor	0.35	per fixture	2016 Data Collection
Restaurants w/o Liquor	0.08	per seat	2016 Data Collection
Quick Service Restaurants w/ dining & restrooms	0.49	per fixture	2016 Data Collection
Quick Service Restaurants w/o dining & restrooms	1.00	per restaurant	2016 Data Collection
Stores (other than specifically listed)	0.04	per 1,000 sq. ft.	2016 Data Collection
Personal Care			
Nail Salons	0.18	per employee	2016 Data Collection
Barber Shops	0.14	per fixture	2016 Data Collection
Beauty Salons	0.71	per 1,000 sq. ft.	2016 Data Collection
Entertainment/Health & Fitness			
Bowling Alleys	0.36	per 1,000 sq. ft.	2016 Data Collection
Theatres	0.27	per 1,000 sq. ft.	2016 Data Collection
Kids Indoor Play Centers	0.12	per 1,000 sq. ft.	2016 Data Collection
Health Club/Fitness Center w/ Showers &/or Pool	1.29	per fixture	2016 Data Collection
Health Club/Fitness Center w/o Showers &/or Pool	0.29	per 1,000 sq. ft.	2016 Data Collection
Swimming Pools	3.00	per 1,000 sq. ft.	1970-1998 Data Collection
Service Providers			
Funeral Homes	0.15	per 1,000 sq. ft.	2016 Data Collection
Dry Cleaners	1.18	per 1,000 sq. ft.	2016 Data Collection
Self Service Laundry Facilities	0.71	per washer	2016 Data Collection

WRC
WATER RESOURCES COMMISSIONER
Jim Nash

Appendix VI
Oakland County Water Resources Commissioner
Schedule of Unit Assignment Factors
March 2017

Service Providers			
Pet Care Kennels	0.63	per fixture	2016 Data Collection
Pet Care Grooming	1.33	per 1,000 sq. ft.	2016 Data Collection
Hotels	0.38	per room	1970-1998 Data Collection
Motels	0.90	per 1,000 sq. ft.	2016 Data Collection
Medical/Wellness			
Medical Clinics	0.19	per 1,000 sq. ft.	2016 Data Collection
Dental Clinics	0.83	per dentist	2016 Data Collection
Hospitals	1.22	per bed	1970-1998 Data Collection
Retirement Homes/Assisted Living	0.39	per bed	2016 Data Collection
Office/General Use/Assembly			
Churches	0.11	per 1,000 sq. ft.	2016 Data Collection
Warehouses & Storage	0.12	per fixture	2016 Data Collection
Offices – General	0.40	per 1,000 sq. ft.	1970-1998 Data Collection
Public Institutions (other than hospitals, schools)	0.12	per fixture	2016 Data Collection
Government			
Fire Stations	0.40	per employee	2016 Data Collection
Police Stations	0.09	per employee	2016 Data Collection
Daycare/Early Learning	4.28	per facility	2016 Data Collection
Elementary Schools	0.02	per student	2016 Data Collection
Junior or Middle Schools	0.12	per 1,000 sq. ft.	2016 Data Collection
Senior High Schools	0.09	per 1,000 sq. ft.	2016 Data Collection
Manufacturing			
Dry Process	1.38	per facility	2016 Data Collection
Wet Process	0.29	per fixture	2016 Data Collection
Housing			
Convents & Seminaries	0.29	per employee	2016 Data Collection
Multiple Family Residences	0.60	per residence	2016 Data Collection
Mobile Home Parks	0.41	per mobile home	2016 Data Collection

Summary of Return Wastewater to System for Various Scenarios

	Units are CCF/Qtr														
Percent of Data Analyzed	100	95	90	100	95	90	100	95	90	100	95	90	100	95	90
Community	Raw Water Usage			80% Return, 15% I/I			80% Return, 5% I/I			90% Return, 10% I/I			95% Return, 15% I/I		
Bingham Farms	24.08	22.84	22.53	22.15	21.01	**20.73**	20.23	19.19	**18.93**	23.84	**22.61**	22.30	**26.31**	24.95	24.61
Bloomfield Hills	27.5	25.1	24.5	25.30	23.09	**22.54**	23.10	21.08	**20.58**	27.23	**24.85**	24.26	**30.04**	27.42	26.77
Commerce Township	19.26	18.67	18.49	17.72	17.18	**17.01**	16.18	15.68	**15.53**	19.07	**18.48**	18.31	**21.04**	20.40	20.20
Farmington Hills	21.76	20.29	19.97	20.02	18.67	**18.37**	18.28	17.04	**16.77**	21.54	**20.09**	19.77	**23.77**	22.17	21.82
Highland Township	25.4	24.5	24.2	23.37	22.54	**22.26**	21.34	20.58	**20.33**	25.15	**24.26**	23.96	**27.75**	26.77	26.44
Keego Harbor	18.78	16.65	16.19	17.28	15.32	**14.89**	15.78	13.99	**13.60**	18.59	**16.48**	16.03	**20.52**	18.19	17.69
Lyon Township	23.06	21.96	21.71	21.22	20.20	**19.97**	19.37	18.45	**18.24**	22.83	**21.74**	21.49	**25.19**	23.99	23.72
Oakland Township	31.04	29.65	29.05	28.56	27.28	**26.73**	26.07	24.91	**24.40**	30.73	**29.35**	28.76	**33.91**	32.39	31.74
Orchard Lake	25.31	23.34	22.78	23.29	21.47	**20.96**	21.26	19.61	**19.14**	25.06	**23.11**	22.55	**27.65**	25.50	24.89
Oxford Township	22.09	20.86	20.62	20.32	19.19	**18.97**	18.56	17.52	**17.32**	21.87	**20.65**	20.41	**24.13**	22.79	22.53
Royal Oak Township	20.3	17.79	17.2	18.68	16.37	**15.82**	17.05	14.94	**14.45**	20.10	**17.61**	17.03	**22.18**	19.44	18.79
Weighted Average	22.41	21.06	20.72	20.62	19.37	**19.07**	18.82	17.69	**17.41**	22.18	**20.85**	20.52	**24.48**	23.00	22.64
				Original REU in Phase I Report			Low			Medium			High		

Notes

CCF = 100 Cubic Feet, Qtr = Quarter, 1 Unit = 100 Cubic Feet, Gal = Gallons, GPD = Gallons per Day

The percent of the data analyzed was brought from 100 to 90 to 95 to reduce outliers, described in 3.0 Usage Analysis Process

The Return component is defined as water that is returned into the system as wastewater

The I/I component is defined as infiltration and inflow from wet weather

90% Data Analyzed = eliminating the 5% high end and 5% low end outliers for a statistically reduced data set analysis

95% Data Analyzed = eliminating the 2.5% high end and 2.5% low end outliers for a statistically reduced data set analysis

100% Data Analyzed = eliminating the 0% high end and 0% low end outliers

80% Return, 15% I/I was the original method for wastewater conversion in 2.0 Executive Summary of the Phase I REU Report - yielding 19.07 CCF/Qtr at 90% data analyzed

80% Return, 5% I/I is the low method for wastewater conversion - yielding 17.41 CCF/Qtr at 90% data analyzed (excluding 5% of high end and 5% low end outliers)

90% Return, 10% I/I is the medium method for wastewater conversion - yielding 20.85 CCF/Qtr at 95% data analyzed (excluding 2.5% of high end and 2.5% low end outliers)

95% Return, 15% I/I is the high method for wastewater conversion - yielding 24.48 CCF/Qtr at 100% data analyzed (excluding 0% outliers)

This analysis was performed for the winter quarters (November-April from 2010-2013) to exclude sprinkler use

Appendix VIII
Final Data Summary
December 2017

				Recommendations (based on Winter Quarter data)				Comparison To 1998						CATEGORY AVERAGES														
Category ID	Major Business Category	# of Water Use Accounts Surveyed	Business Category / Use	Recommended Unit Assign Factor (Draft)		R^2 Correlation	Data Review Comments	1998 Unit Assignment Factors	Consumption calculated using 1998 assignment (Winter Quarters)	% Difference (Winter Quarters)	Consumption calculated using 1998 method (All Quarters)	% Difference (All Quarters)		REU Average Consumption Value (CCF/Winter Quarter) (Calculated Using Phase 1 Study Value)	REU Average Consumption Value (CCF/Annual Quarter) (Calculated Using Phase 1 Study Value)	Square Footage	* REU / 1000 Sqft	R^2 Value (REU/1000 SqFt)	* REU / Emp.	R^2 Value (REU/Emp)	* REU / Service Unit	Definition / Service Unit	R^2 Value (REU/Service Unit)	* REU / Fixture	R^2 Value (REU/Fixture)	* REU / Seat	R^2 Value (REU/Seat)	* REU / Student	R^2 Value (REU/Student)
1	Auto	5	Autoo Service/Repair	0.29	per employee	[0.58]	No other strong positive correlations exist	NA	NA	NA	NA	NA	New cateogry added	0.90	1.48	3,022	0.31	0.13	0.29	[0.58]	0.38	Service Bays	0.08	0.23	0.03				
2	Auto	6	Auto Service/Convenience Stations (Speedway, BP, etc.)	0.21	per pump	[0.58]		0.240	0.21	-13%	0.36	49%	per pump	2.61	2.81	1,894	2.53	-0.07	0.81	-0.05	0.21	Pumps	[0.58]	0.61	-0.09				
3	Auto	4	Auto Showroom/Dealership	0.37	per 1000 sqft	[0.92]		0.3	0.37	23%	1.34	346%	per 1,000 sq. ft.	11.57	50.99	25,971	0.37	[0.92]	0.10	0.47	2.09	Service Bays	-0.08	1.79	-0.83				
5	Auto	3	Self -Serve Car Washes	2.89	per stall	[0.91]		2.500	2.89	16%	1.41	-44%	per stall	15.73	8.46	2,533	6.26	0.13			2.89	Stalls	[0.91]	2.89	[0.91]				
6	Auto	6	Fully & Semi-Automatic Car Washes	6.95	per 1000 sqft	0.73		33.0	42.77	30%	20.74	-37%	per lane	44.95	22.18	6,596	6.95	0.73	5.94	[0.92]	42.77	Lanes	-0.25	12.87	0.01				
7	Food, Beverage & Retail	5	Banquet Halls	0.23	per fixture	[0.9]		0.500	0.48	-4%	0.55	9%	per 1,000 sq. ft.	8.86	9.59	17,046	0.48	0.71	1.05	0.88				0.23	[0.9]	0.017	0.80		
8	Food, Beverage & Retail	5	Country Clubs	0.04	per member	[0.82]		0.080	0.04	-53%	0.06	-28%	per member	11.44	18.59	21,418	0.45	0.36	0.29	0.66	0.04	Members	[0.82]	0.24	0.15	0.08	-0.05		
9	Food, Beverage & Retail	4	Convenience Store w/ Pharmacy	1.00	per facility		No strong positive correlations exist	0.140	0.07	-52%	0.16	14%	per 1,000 sq. ft.	0.89	2.21	14,240	0.07	-0.43	0.11	[0.14]				0.17	0.02				
10	Food, Beverage & Retail	5	Full Service Grocery Store (produce, florist, add'l services - eye care, café, etc.)	0.26	per 1000 sqft	[0.52]		0.310	0.26	-18%	0.27	-13%	per 1,000 sq. ft.	21.00	25.63	100,456	0.26	[0.52]	0.30	0.03				0.81	0.40				
11	Food, Beverage & Retail	5	Grocery Store w/o Full Service	0.19	per 1000 sqft	[0.8]		0.310	0.19	-38%	0.17	-47%	per 1,000 sq. ft.	8.72	7.45	31,832	0.19	[0.8]	0.18	0.30				0.43	0.43				
12	Food, Beverage & Retail	6	Stores (other than specifically listed)	0.04	per 1000 sqft	[0.65]		0.160	0.05	-67%	0.06	-62%	per employee	0.36	0.45	20,134	0.04	[0.65]	0.05	0.29				0.06	0.51				
13	Food, Beverage & Retail	3	Fraternal Organizations	0.04	per 1000 sqft	[1]		1.000	6.60	560%	1.79	79%	per hall	6.60	1.79	9,839	0.68	[1]	1.42	0.95	6.60	Per Hall / Facility		0.24	0.92	0.03	0.66		
14	Food, Beverage & Retail	6	Restaurants w/ Liquor	0.35	per fixture	[0.52]		0.130	0.05	-65%	0.05	-59%	per seat	7.86	5.64	7,764	1.16	0.32	0.78	0.00				0.35	[0.52]	0.05	0.00		
15	Food, Beverage & Retail	4	Restaurants w/o Liquor	0.08	per seat	[0.9]		0.130	0.08	-38%	0.09	-32%	per seat	5.39	5.95	1,757	3.09	0.18	0.79	0.30				0.53	0.13	0.08	[0.9]		
16	Food, Beverage & Retail	5	Quick Service Restaurants w/o dining & prestrooms (Jets, Little Caesars, etc.)	1.00	per restaurant		No strong positive correlations exist	1.800	0.69	-62%	0.56	-69%	per restaurant	0.69	0.56	1,980	0.48	-0.57	0.08	0.01		Per Restaurant		0.13	-0.63	0.26	[0.15]		
17	Food, Beverage & Retail	4	Quick Service Restaurants w/ dining & restrooms (Taco Bell, McDonalds, Burger King)	0.49	per fixture	[0.71]		5.600	4.24	-24%	7.90	41%	per restaurant	4.24	7.90	1,693	2.54	0.00	1.13	-0.37		Per Restaurant		0.49	[0.71]	0.21	-0.05		
19	Personal Care	4	Nail Salons	0.18	per employee	[0.65]	No other positive correlations exist	NA	NA	NA	NA	NA	New cateogry added	0.88	0.77	3,463	0.43	-0.25	0.18	[0.65]				0.11	-0.18	0.14	-0.17		
20	Personal Care	4	Barber Shops	0.14	per fixture	[0.87]		1.000	0.86	-14%	1.20	20%	per 1,000 sq. ft.	1.14	1.66	1,161	0.86	0.28	0.32	-0.01				0.14	[0.87]				
21	Personal Care	5	Beauty Salons	0.71	per 1000 sqft	0.72		0.223	0.19	-13%	0.19	-17%	per booth	1.16	1.11	1,498	0.71	0.72	0.32	[0.8]	0.19	Booths	0.38	0.17	0.61				
22	Entertainment/Health & Fitness	5	Bowling Alleys	0.36	per 1000 sqft	[0.82]		0.160	0.32	98%	0.23	44%	per alley	12.47	8.48	32,258	0.36	[0.82]	0.61	0.61	0.32	Alley	0.59	0.47	0.62				
23	Entertainment/Health & Fitness	4	Theaters	0.27	per 1000 sqft	[1]		0.008	0.011	38%	0.01	53%	per seat or 1,000 sq. ft.	14.47	9.66	47,052	0.27	[1]	1.85	0.52				0.30	0.89	0.011	0.96		
24	Entertainment/Health & Fitness	3	Kids Indoor Play Center	0.12	per 1000 sqft	[0.92]		NA	NA	NA	NA	NA	New cateogry added	1.03	1.33	12,643	0.12	[0.92]	0.05	-0.19				0.05	-0.31	0.005	-1.00		
25	Entertainment/Health & Fitness	6	Health Club/Fitness Center w/ Showers &/or Pool	1.29	per fixture	[0.78]		2.300	1.80	-22%	0.82	-65%	per 1,000 sq. ft.	74.27	44.36	56,147	1.80	0.15	2.79	0.00				1.29	[0.78]				
26	Entertainment/Health & Fitness	4	Health Club/Fitness Center w/o Showers & /or Pool (yoga, kickboxing, cross-fit, etc.)	0.29	per 1000 sqft	0.99		0.26	0.29	13%	0.59	127%	per 1,000 sq. ft.	4.11	1.42	7,885	0.29	0.99	1.11	[1]				0.19	0.66				
27	Entertainment/Health & Fitness	8	Swimming Pools	3.00	per 1,000 sqft	[-0.04]	Based on 1998 REU Value	3.000	12.15	305%	5.74	91%	per 1,000 sq. ft.	19.26	8.74	2,398	12.15	[-0.04]											
28	Government	6	Fire Stations	0.40	per employee	[0.93]	No other strong positive correlations exist	NA	NA	NA	NA	NA	New cateogry added	1.54	6.12	11,386	0.14	0.27	0.40	[0.93]	0.47	Truck Bays	0.17	0.08	0.25				
29	Government	4	Police Stations	0.09	per employee	[0.45]	No other strong positive correlations exist	NA	NA	NA	NA	NA	New cateogry added	3.90	9.57	52,077	0.12	-0.04	0.09	[0.45]				0.09	0.08				

Appendix VIII
Final Data Summary
December 2017

				Recommendations (based on Winter Quarter data)				Comparison To 1998						CATEGORY AVERAGES														
Category ID	Major Business Category	# of Water Use Accounts Surveyed	Business Category / Use	Recommended Unit Assign Factor (Draft)		R^2 Correlation	Data Review Comments	1998 Unit Assignment Factors	Consumption calculated using 1998 assignment (Winter Quarters)	% Difference (Winter Quarters)	Consumption calculated using 1998 method (All Quarters)	% Difference (All Quarters)		REU Average Consumption Value (CCF/Winter Quarter) (Calculated Using Phase 1 Study Value)	REU Average Consumption Value (CCF/Annual Quarter) (Calculated Using Phase 1 Study Value)	Square Footage	* REU / 1000 Sqft	R^2 Value (REU/1000 SqFt)	* REU / Emp.	R^2 Value (REU/Emp)	* REU / Service Unit	Definition / Service Unit	R^2 Value (REU/Service Unit)	* REU / Fixture	R^2 Value (REU/Fixture)	* REU / Seat	R^2 Value (REU/Seat)	* REU / Student	R^2 Value (REU/Student)
30	Government	8	Daycare/Early Learning	4.28	per facility		No strong positive correlations exist	NA	NA	NA	NA	NA	New categgry added	4.28	8.86	13,693	0.61	-0.04	0.31	0.02				0.17	0.03			0.06	**[0.09]**
31	Government	6	Elementary Schools	0.02	per student	**[0.59]**		0.012	0.021	79%	0.02	60%	per student	7.10	8.82	43,539	0.20	0.27	0.15	0.26				0.07	0.31			0.021	**[0.59]**
32	Government	4	Junior or Middle Schools	0.12	per 1,000 sqft	0.54		0.020	0.020	2%	0.03	34%	per student	16.70	21.88	126,989	0.12	0.54	0.23	**[1]**				0.12	-1.00			0.020	0.01
33	Government	5	Senior High Schools	0.09	per 1000 sqft	**[0.86]**		0.038	0.021	-46%	0.02	-41%	per student	28.48	30.49	327,786	0.09	**[0.86]**	0.25	0.36				0.07	0.40			0.021	0.56
35	Housing		Single Family Residential	1.00	per dwelling			1.000					per dwelling	#N/A	#N/A	#N/A	#N/A	0.43	#N/A	0.04	#N/A		0.20	0.00	0.04	0.00	0.73	0.00	**[0.98]**
36	Housing	3	Convents & Seminaries	0.29	per employee	**[0.94]**		0.200	0.29	46%	0.57	184%	per person	4.79	8.91	19,330	0.37	-0.10	0.29	**[0.94]**	0.22	People/Capacity		0.18	-0.88				
37	Housing	10	Multiple Family Residences	0.60	per residence	**[0.22]**		0.600	0.60	1%	0.10	-84%	per residence	23.13	11.89	277,355	0.63	0.00			0.60	Residences	**[0.22]**	0.11	0.19				
38	Housing	5	Mobile Home Parks	0.41	per mobile home	**[0.57]**		0.600	0.41	-32%	0.66	10%	per mobile home	49.53	31.78	236,755	0.51	0.36			0.41	Mobile Homes	**[0.57]**	0.08	0.43				
39	Manufacturing	5	Manufacturing - Dry Process	1.38	per facility			0.500	0.10	-80%	0.14	-71%	per 1,000 sq. ft.	1.38	2.48	17,242	0.10	0.11	0.14	**[0.28]**				0.13	0.12				
40	Manufacturing	3	Manufacturing - Wet Process	0.29	per fixture	**[0.72]**		NA	NA	NA	NA	NA	New categgry added	5.20	7.86	29,094	0.18	0.43	0.16	0.19				0.29	**[0.72]**				
41	Medical/Wellness	5	Medical Clinics	0.19	per 1000 sqft	**[0.89]**		1.000	0.94	-6%	1.70	70%	per doctor	1.75	3.16	11,059	0.19	**[0.89]**	0.43	-0.08	0.94	Doctor	0.00	0.17	0.00				
42	Medical/Wellness	5	Dental Clinics	0.83	per dentist	**[0.49]**		1.400	0.83	-41%	1.66	18%	per dentist	1.63	3.45	4,108	0.53	0.09	0.17	0.45	0.83	Dentist	**[0.49]**	0.14	0.21	0.26	0.17		
43	Medical/Wellness	5	Hospitals	1.22	per bed		Based on 1998 REU Value	1.220	0.37	-70%	0.41	-67%	per bed	112.93	151.73	389,386	0.32	0.29	0.10	**[1]**	0.37	Beds	0.57	0.10	**[1]**				
44	Medical/Wellness	4	Retirement Homes/Assisted Living	0.39	per bed	**[1]**		0.300	0.39	32%	0.54	80%	per bed	29.51	36.10	23,728	1.00	0.89	0.41	0.89	0.39	Beds	**[1]**	0.37	0.01				
45	Office/General Use/Assembly	5	Warehouses & Storage	0.12	per fixture	0.84		0.100	0.01	-94%	0.02	-76%	per 1,000 sq. ft.	0.57	1.99	79,982	0.01	0.83	0.38	**[0.99]**				0.12	0.84				
46	Office/General Use/Assembly	4	Churches	0.11	per 1000 sqft	0.67		0.008	0.006	-22%	0.00	-45%	per seat	5.34	7.37	40,871	0.11	0.67	0.49	**[0.95]**				0.14	0.04	0.006	0.04		
47	Office/General Use/Assembly	7	Offices - General	0.40	per 1,000 sqft		Based on 1998 REU Value	0.400	0.35	-12%	1.42	256%	per 1,000 sq. ft.	1.57	6.36	10,689	0.35	0.03	0.20	**[0.12]**				0.73	-0.54				
48	Office/General Use/Assembly	4	Public Institutions (other than hospitals, schools)	0.12	per fixture	0.82		0.320	0.11	-66%	0.14	-55%	per employee	5.02	4.23	29,274	0.15	0.62	0.11	**[0.87]**				0.12	0.82				
49	Service Providers	4	Funeral Homes	0.15	per 1000 sqft	**[0.72]**		2.200	1.15	-48%	2.25	2%	per funeral home	1.15	2.25	8,031	0.15	**[0.72]**	0.29	0.30				0.06	0.55				
50	Service Providers	4	Cleaners	1.18	per 1000 sqft	**[0.88]**		1.250	1.05	-16%	1.02	-18%	per press	5.25	5.11	3,926	1.18	**[0.88]**	0.83	0.36	1.05	Per Press	0.00	0.98	0.22				
51	Service Providers	3	Self Service Laundry Facilities	0.71	per washer	**[0.93]**		0.540	0.71	32%	0.93	73%	per washer	27.12	31.69	4,479	6.27	0.88	10.94	-0.99	0.71	Washers	**[0.93]**	0.64	0.89				
52	Service Providers	4	Pet Care Kennels	0.63	per fixture	0.62		NA	NA	NA	NA	NA	New categgry added	6.43		7,184	0.94	-0.20	0.64	**[0.92]**	0.12	Kennels	0.06	0.63	0.62				
53	Service Providers	3	Pet Care Pet Grooming	1.33	per 1000 sqft	**[0.98]**		NA	NA	NA	NA	NA	New categgry added	5.67	7.00	9,964	1.33	**[0.98]**	0.36	0.68				0.60	0.76				
54	Service Providers	5	Motels	0.90	per 1,000 sqft	**[0.58]**		0.380	0.38	1%	0.39	1%	per room	15.94	16.68	23,212	0.90	**[0.58]**	4.17	0.08	0.38	Rooms	0.29	0.12	0.33				
55	Service Providers	6	Hotels	0.38	per room		Based on 1998 REU Value	0.380	0.27	-29%	0.37	-2%	per room	29.85	43.06	54,165	0.58	**[0.15]**	1.86	-0.12	0.27	Rooms	0.05	0.08	0.02				

Legend

- **- Negative correlations identified**

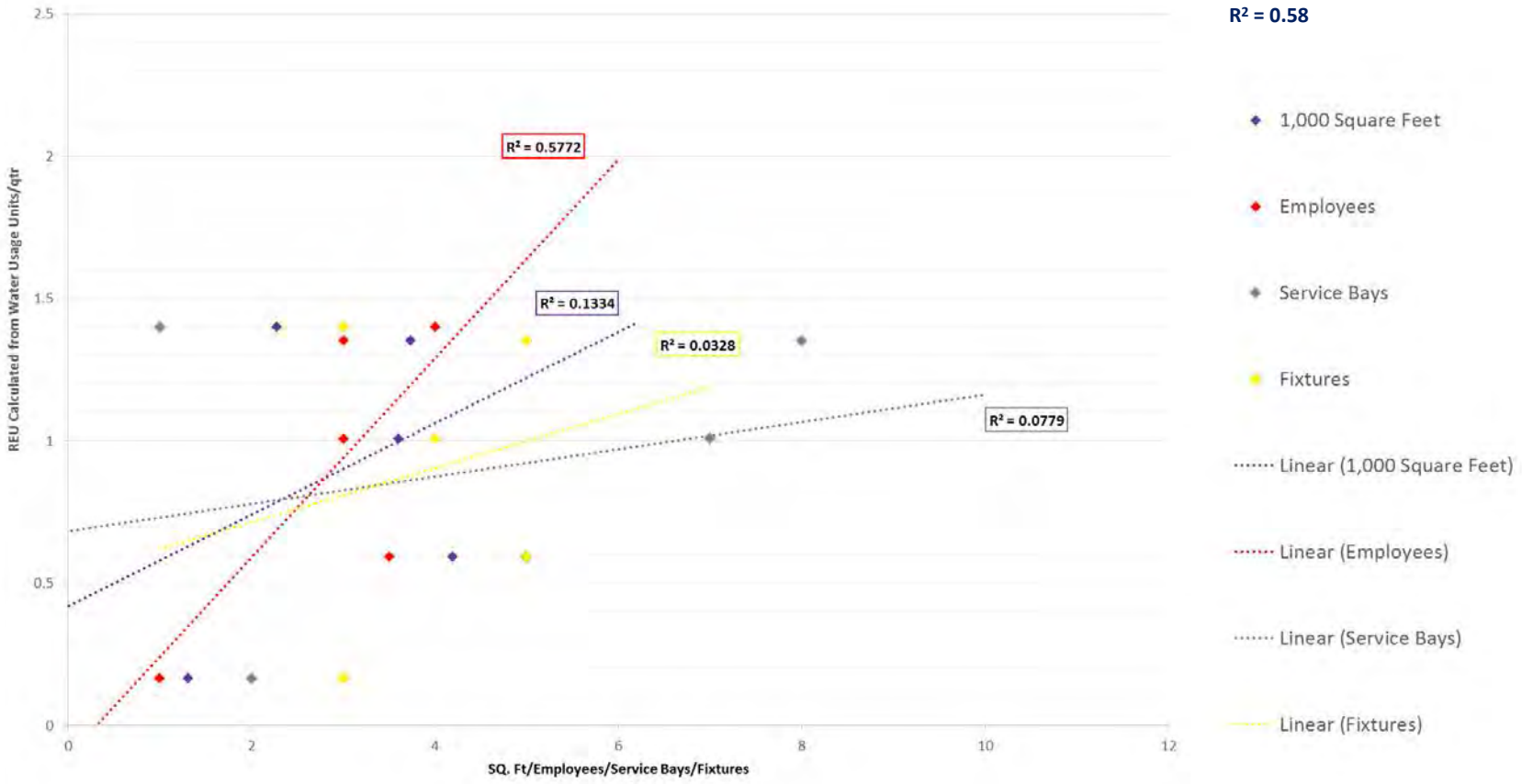
- **- Best R^2 amongst all categories**

Appendix IX – Non-Residential Classification Regression Analyses

Auto – Auto Service/Repair

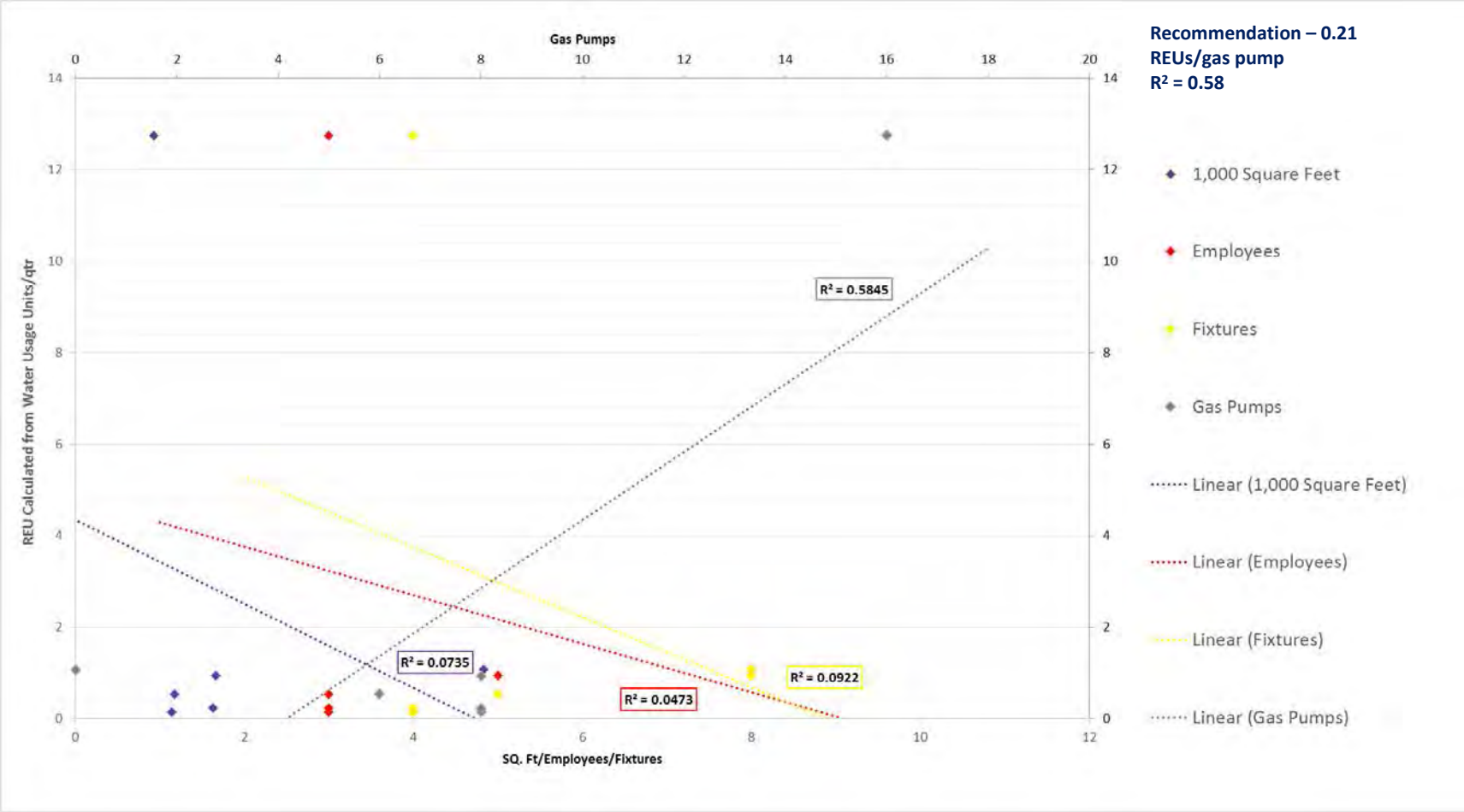
Recommendation – 0.29 REU

R^2 = 0.58



Appendix IX – Non-Residential Classification Regression Analyses

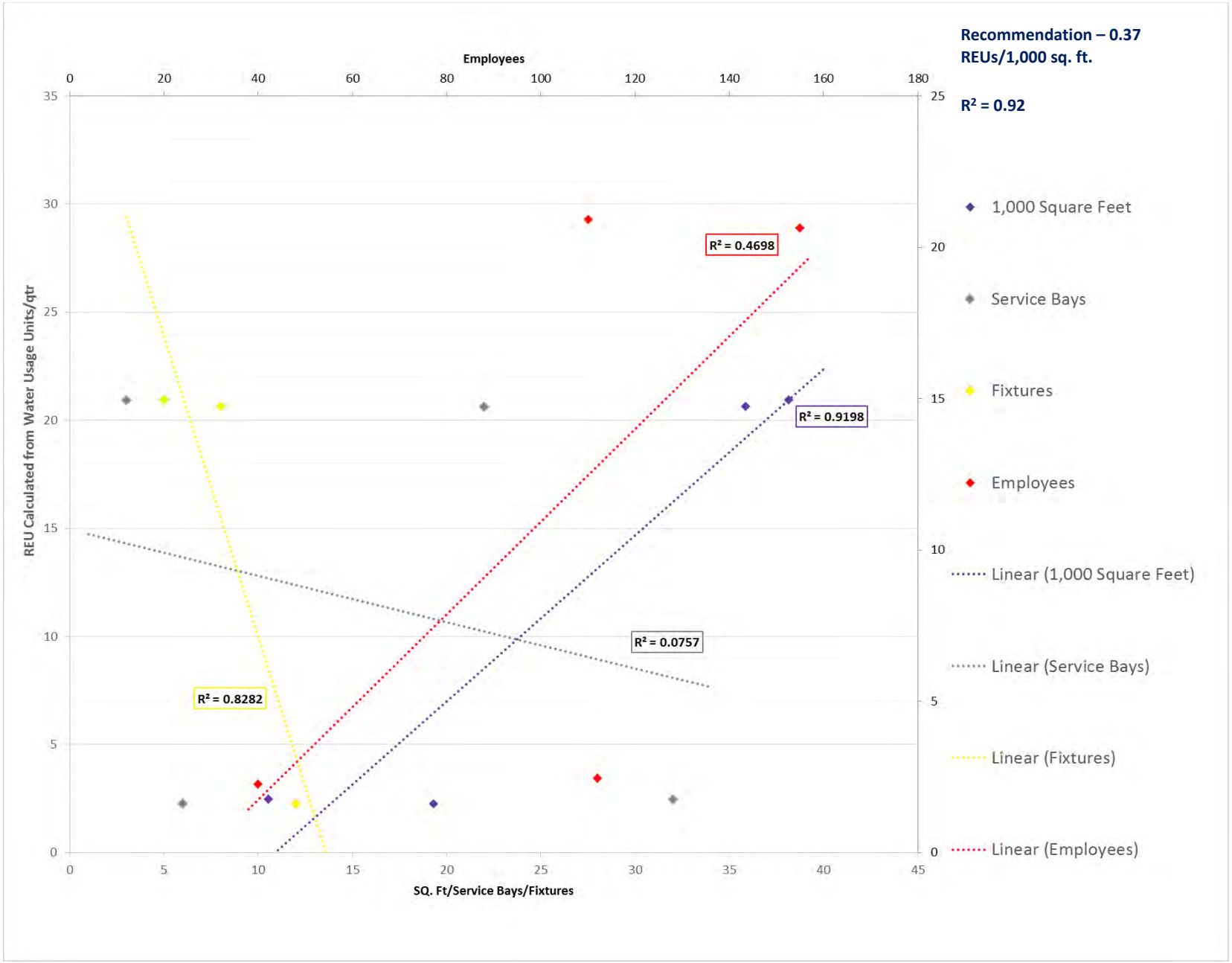
Auto – Auto Service/Convenience Stations



Recommendation – 0.21 REUs/gas pump
R^2 = 0.58

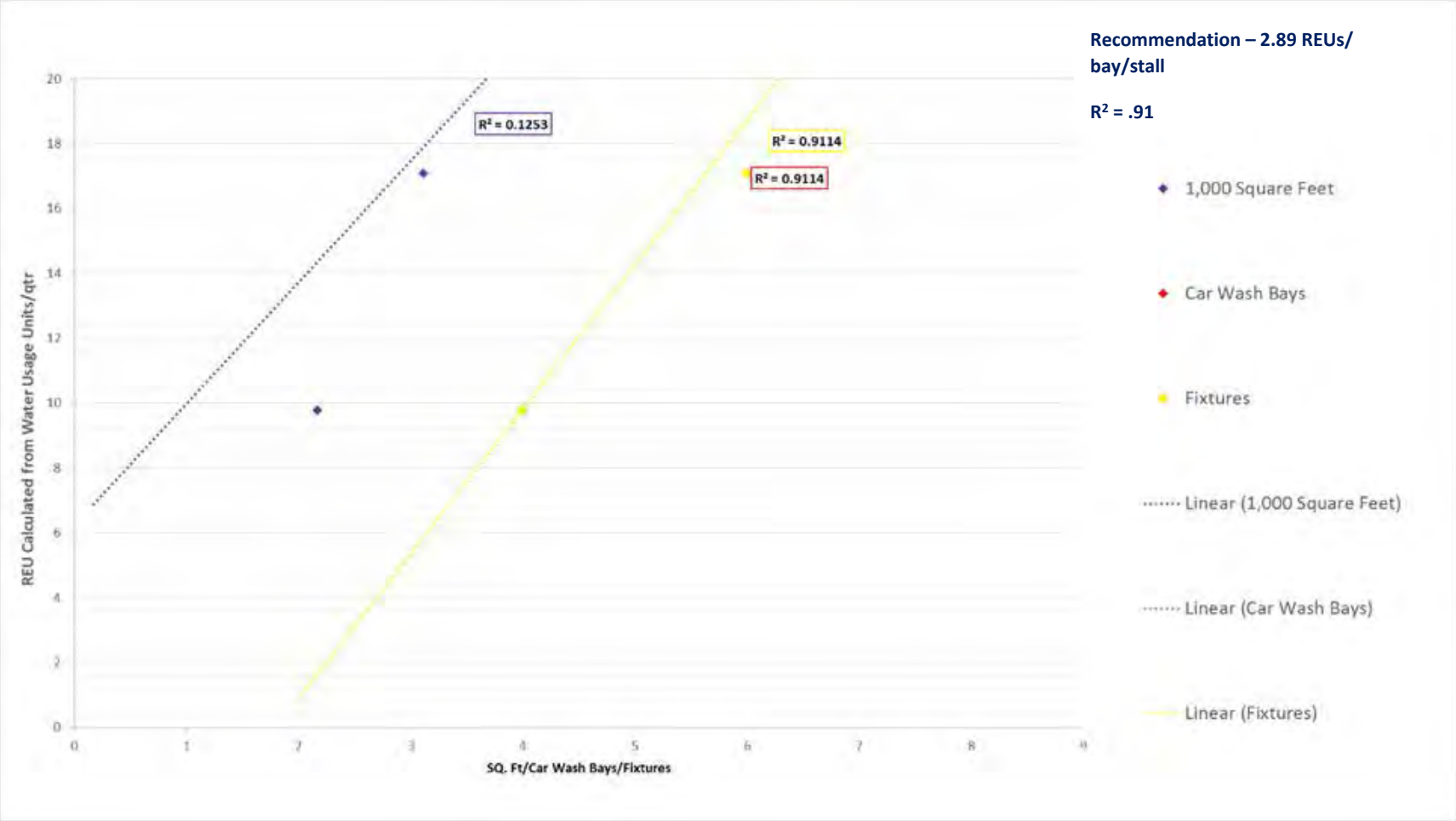
Appendix IX – Non-Residential Classification Regression Analyses

Auto – Auto Showroom/Dealership



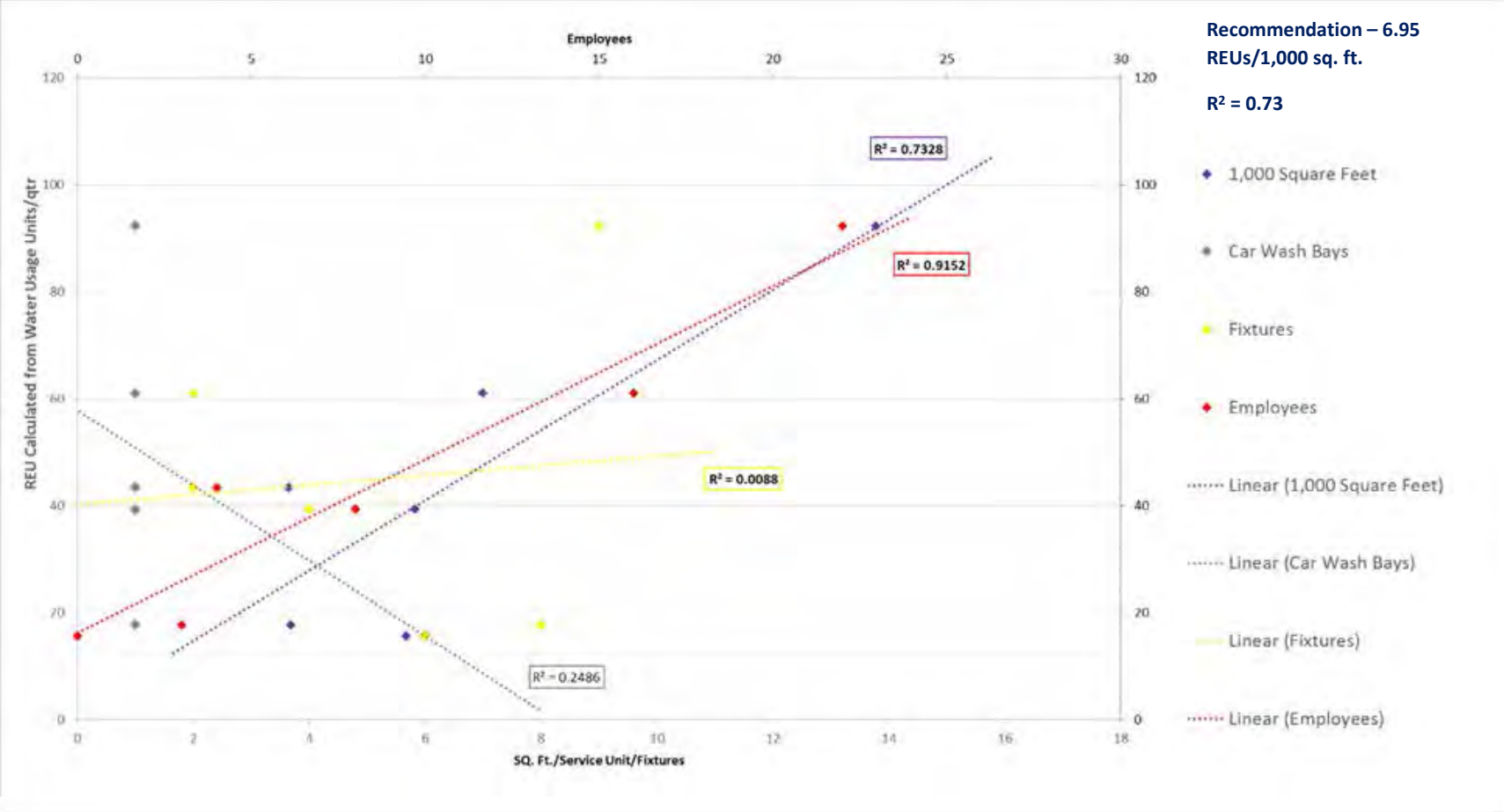
Appendix IX – Non-Residential Classification Regression Analyses

Auto – Self-Serve Car Washes



Appendix IX – Non-Residential Classification Regression Analyses

Auto – Fully & Semi-Automatic Car Washes

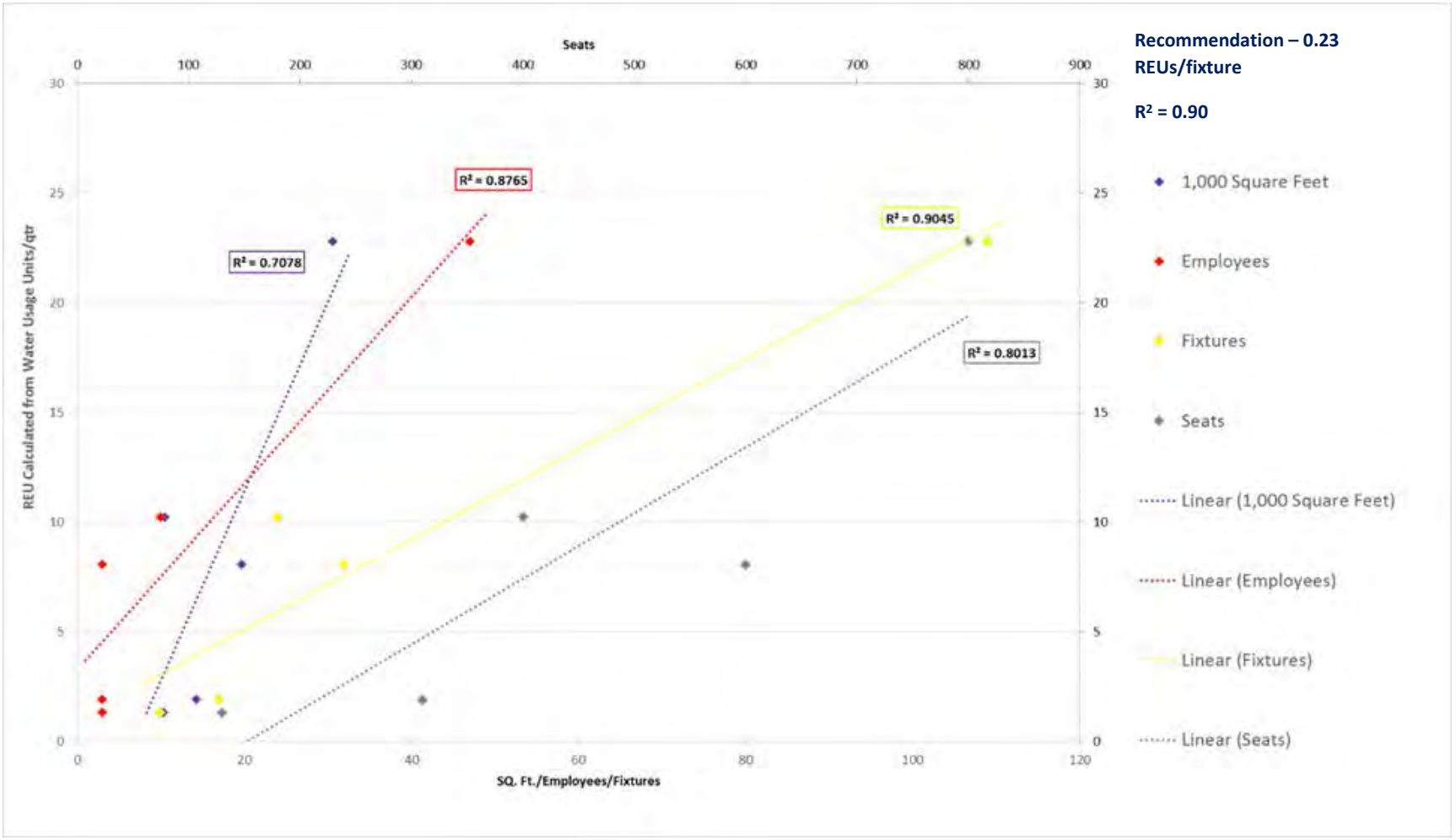


Recommendation – 6.95 REUs/1,000 sq. ft.

R^2 = 0.73

Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Banquet Halls

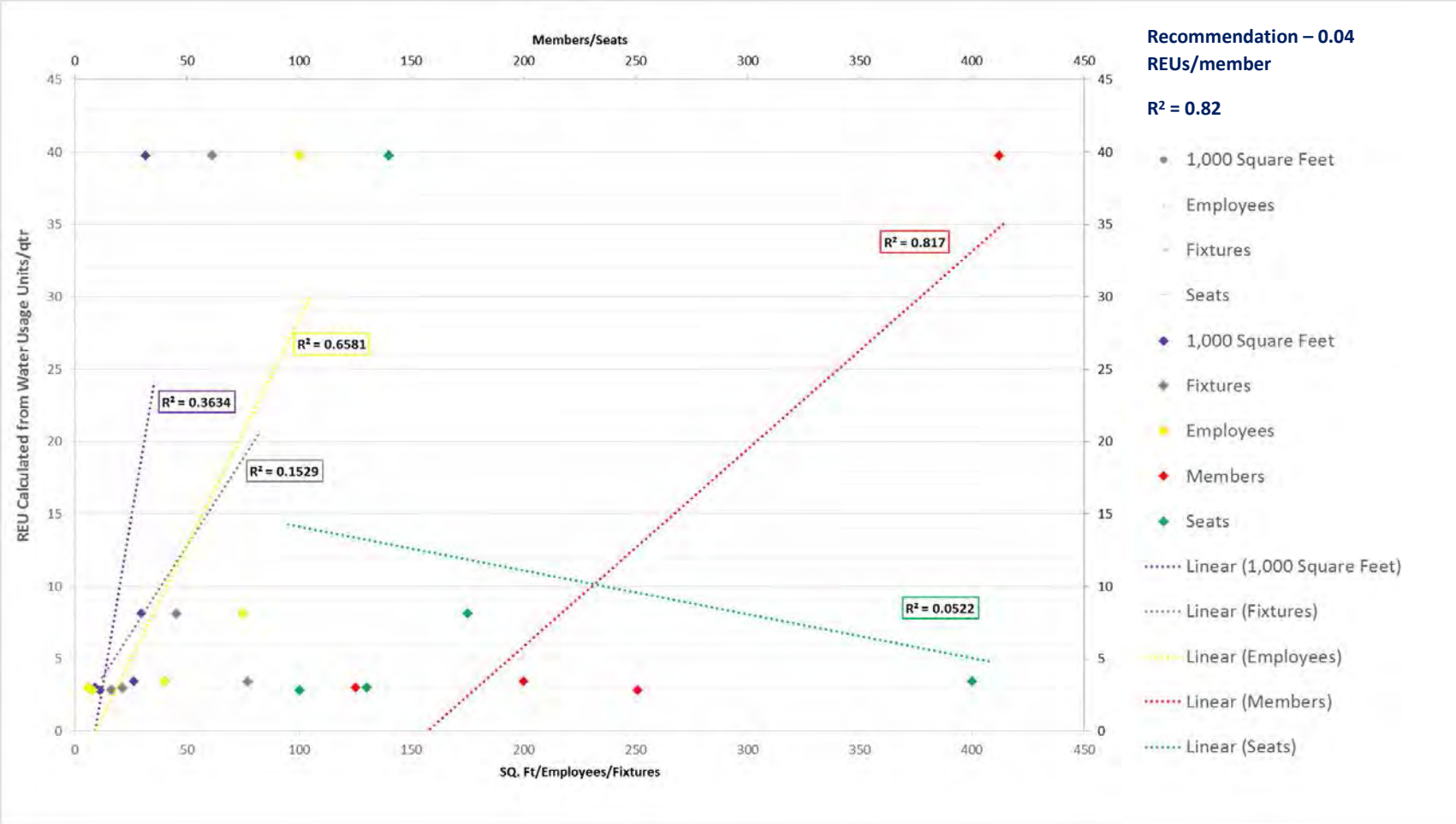


Recommendation – 0.23 REUs/fixture

R^2 = 0.90

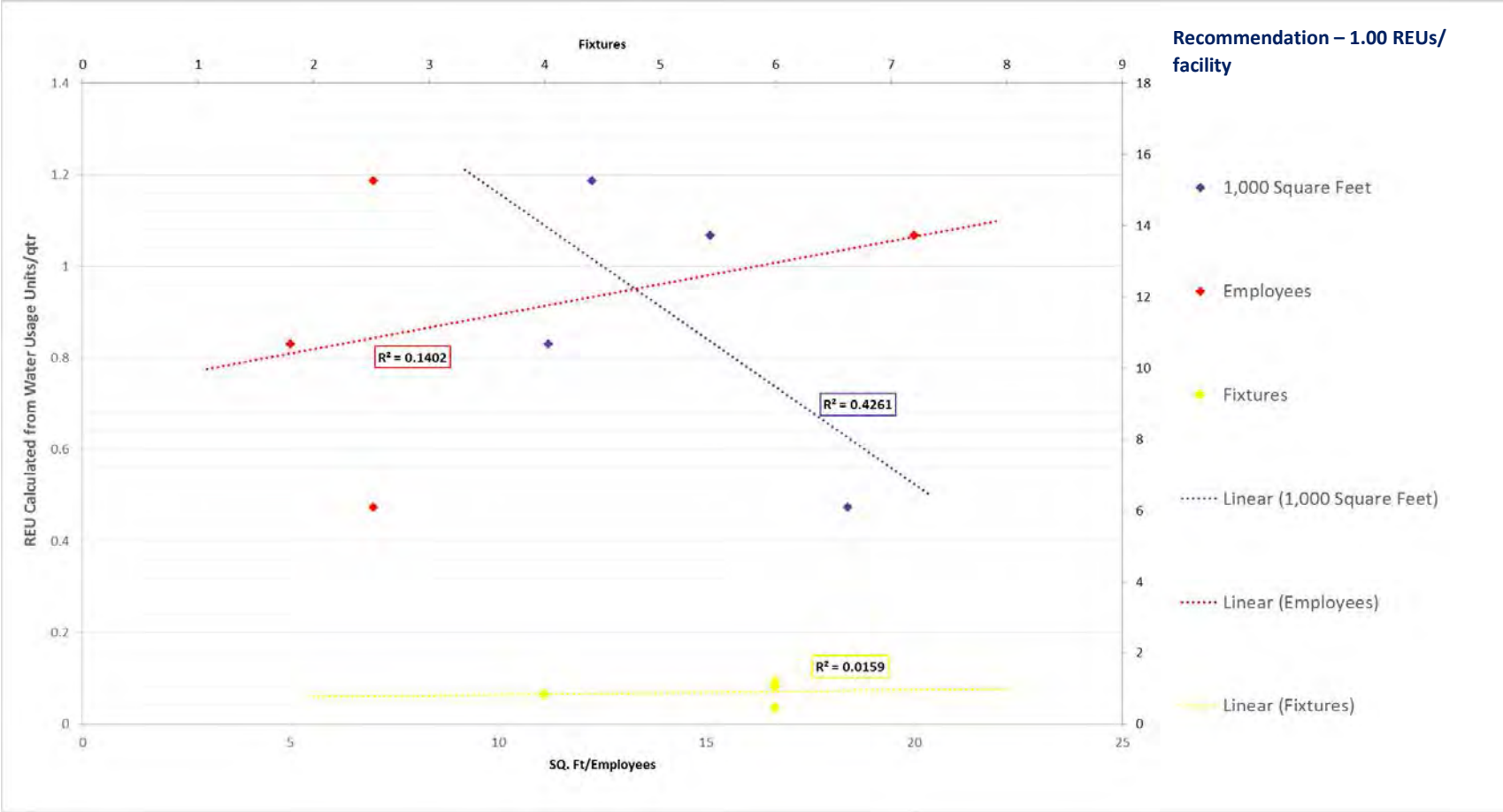
Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Country Clubs



Appendix IX – Non-Residential Classification Regression Analyses

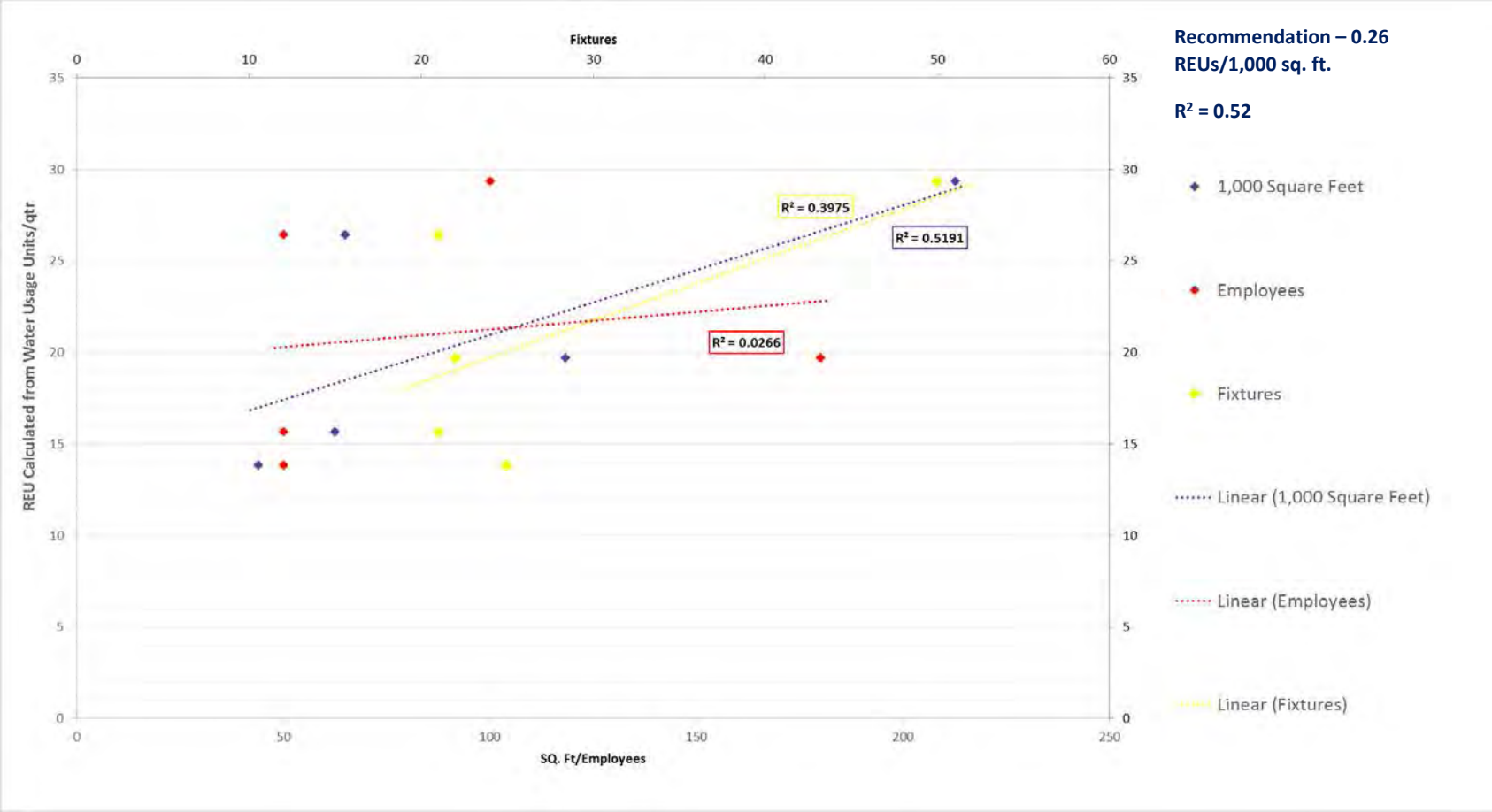
Food, Beverage & Retail – Convenience Store w/ Pharmacy



Recommendation – 1.00 REUs/ facility

Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Full Service Grocery Store

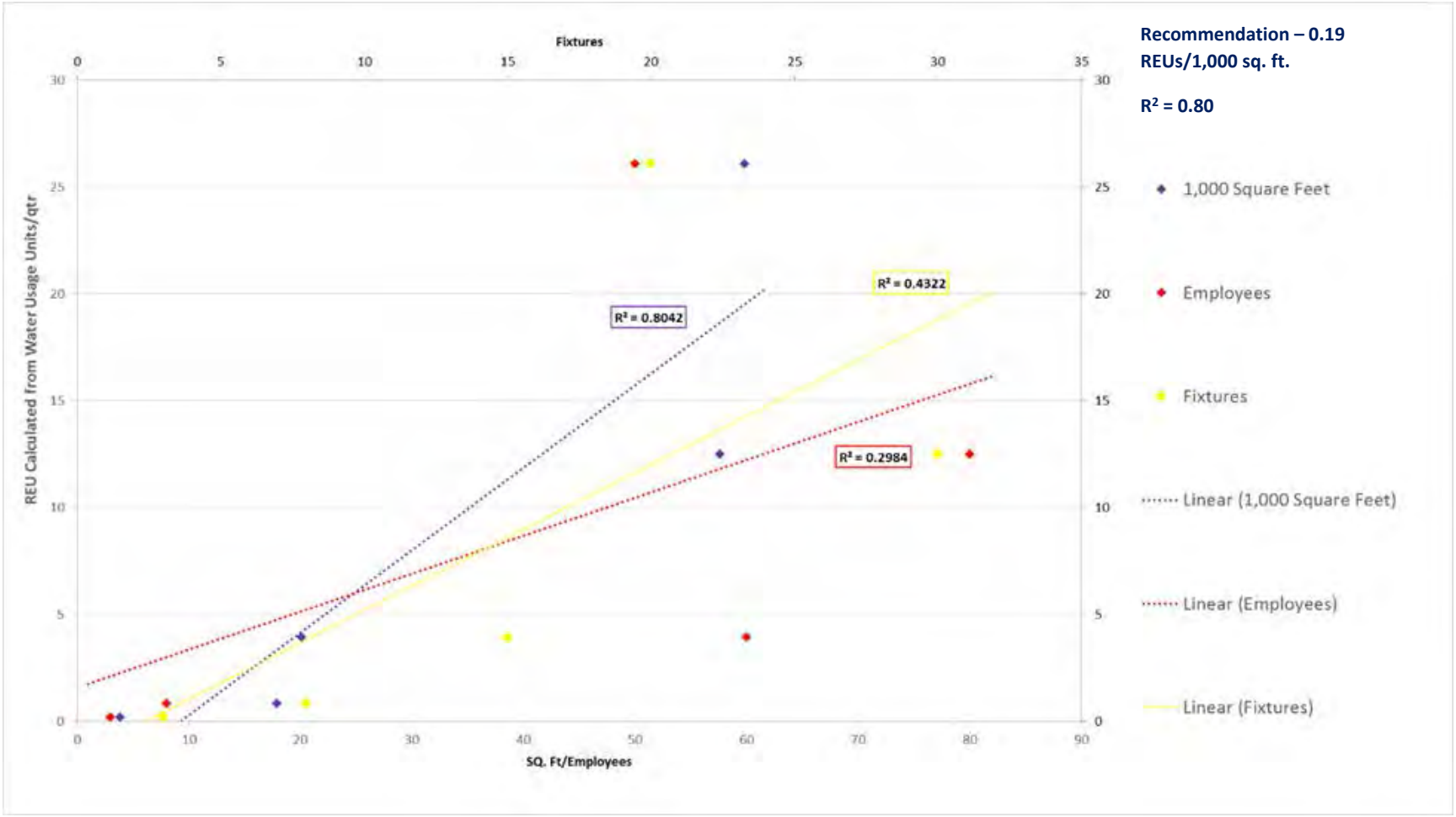


Recommendation – 0.26 REUs/1,000 sq. ft.

R^2 = 0.52

Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Grocery Store w/o Full Service

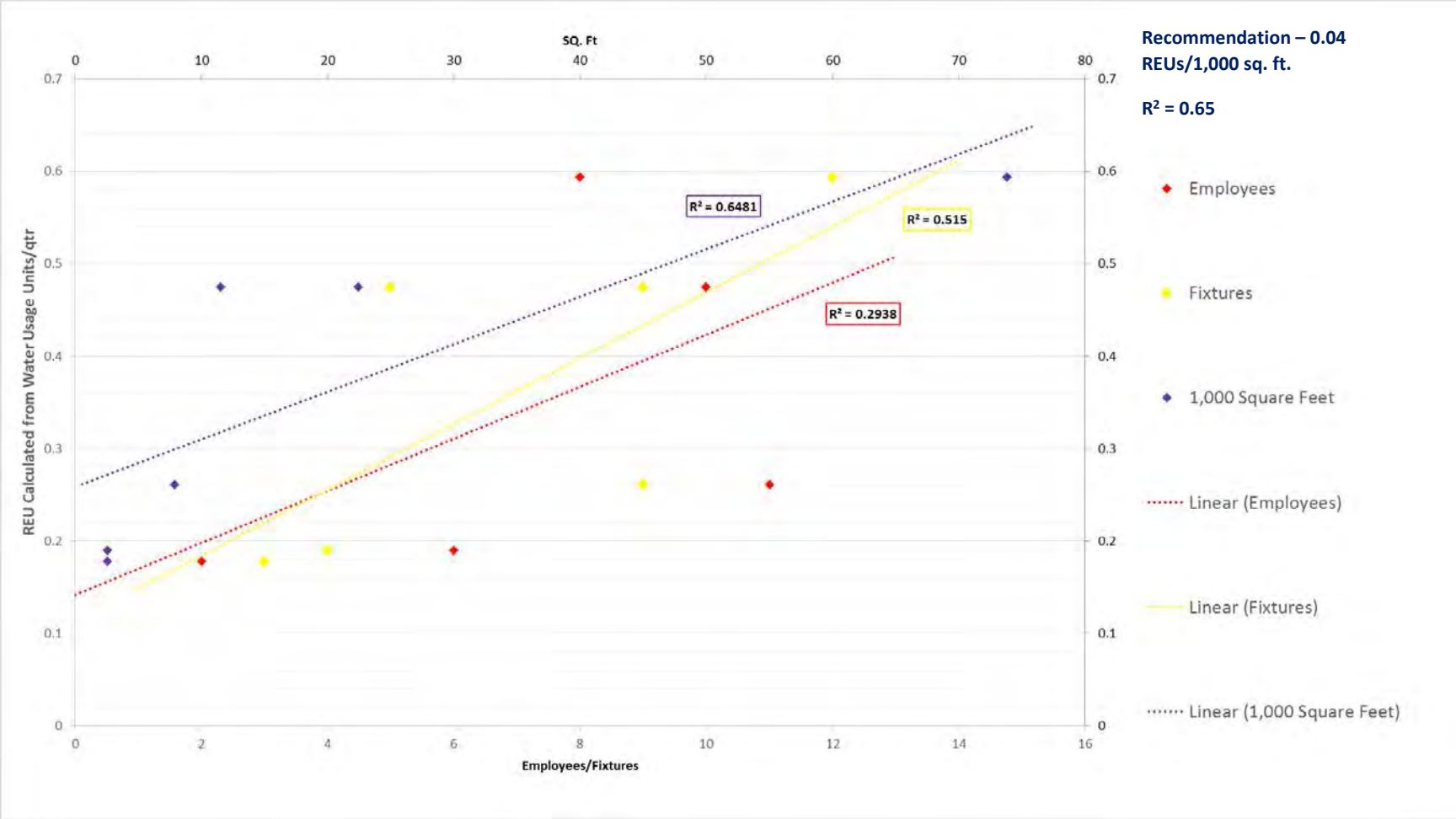


Recommendation – 0.19 REUs/1,000 sq. ft.

$R^2 = 0.80$

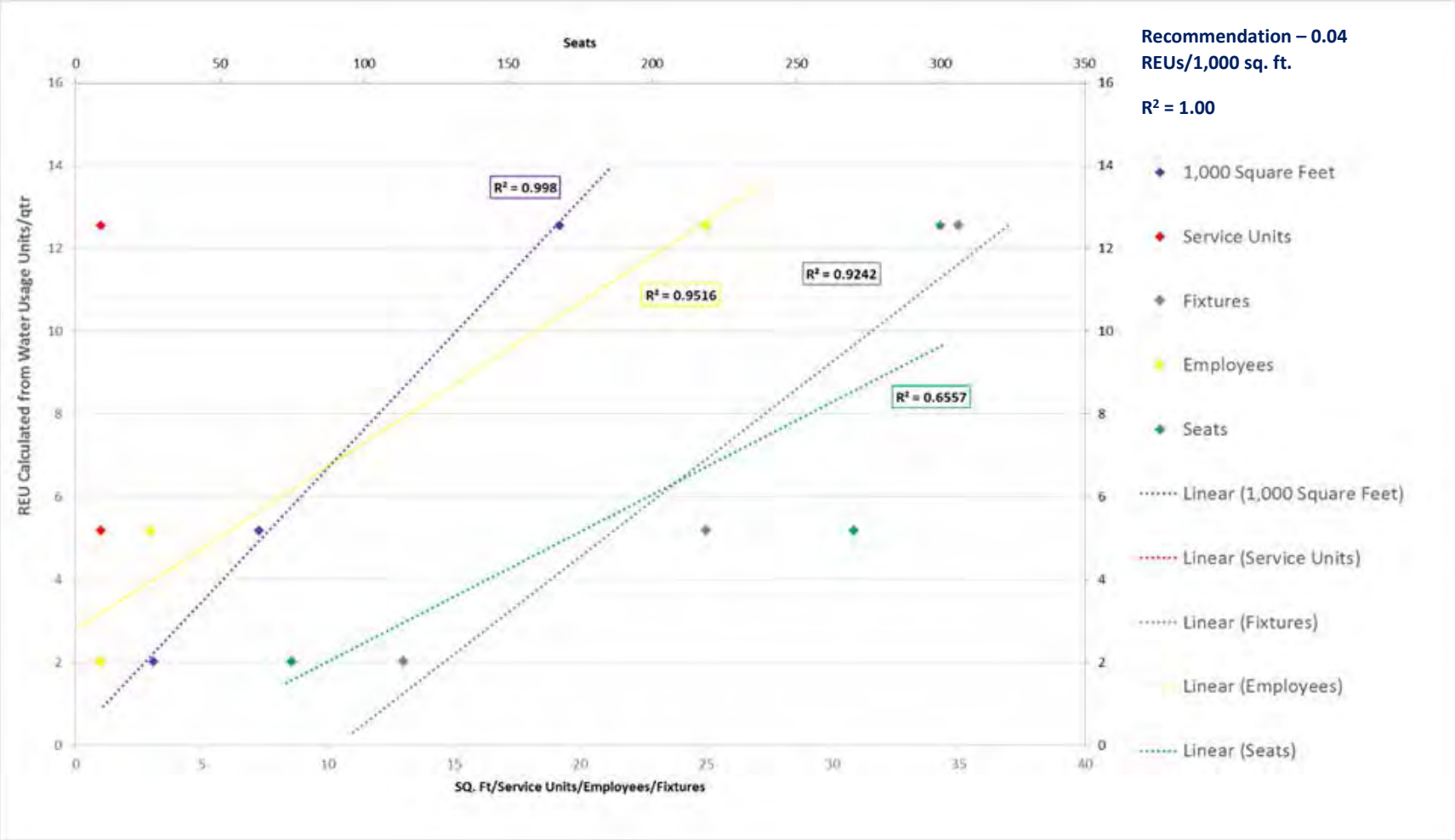
Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Stores (other than specifically listed)



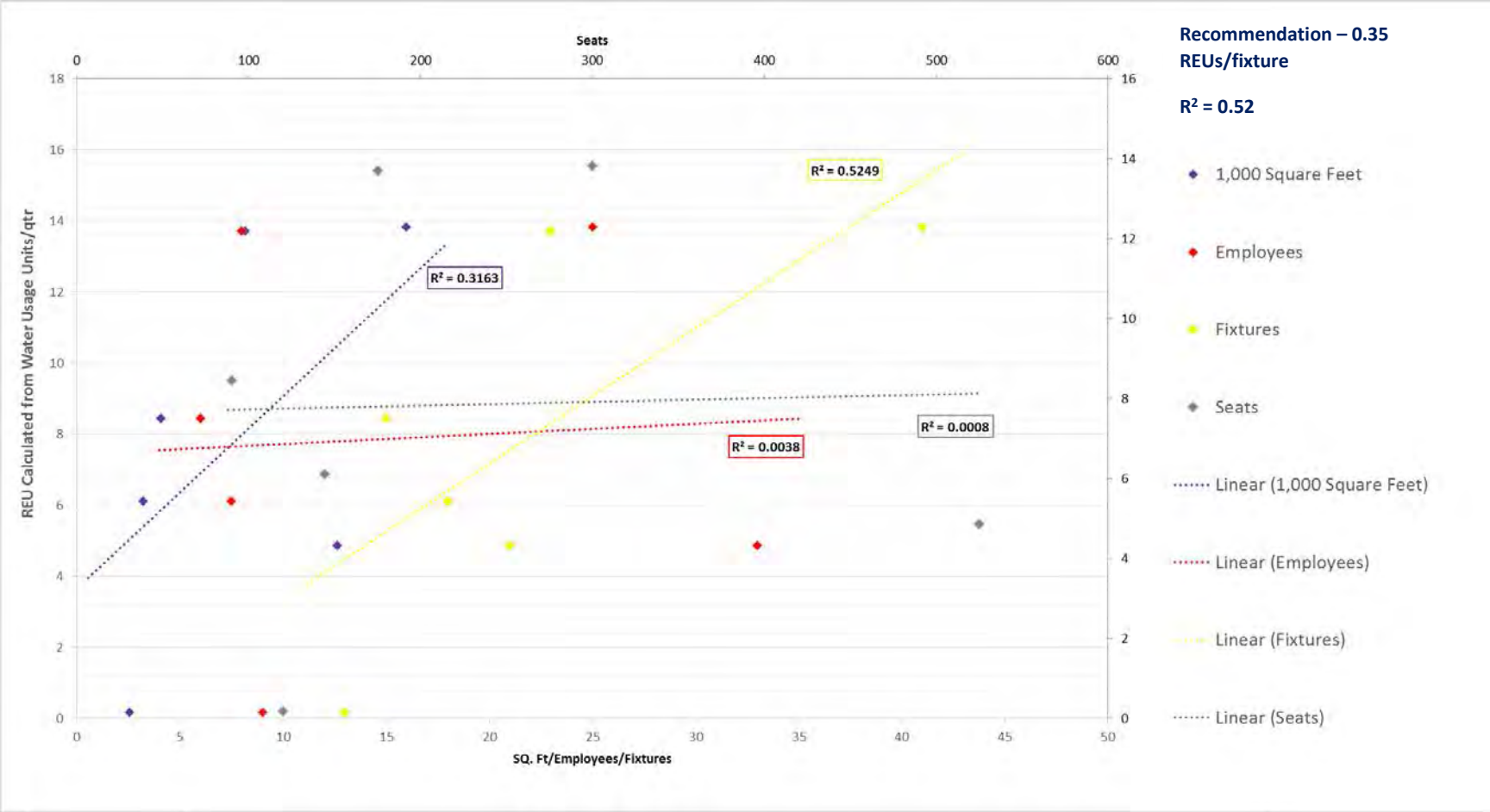
Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Fraternal Organizations



Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Restaurants w/Liquor

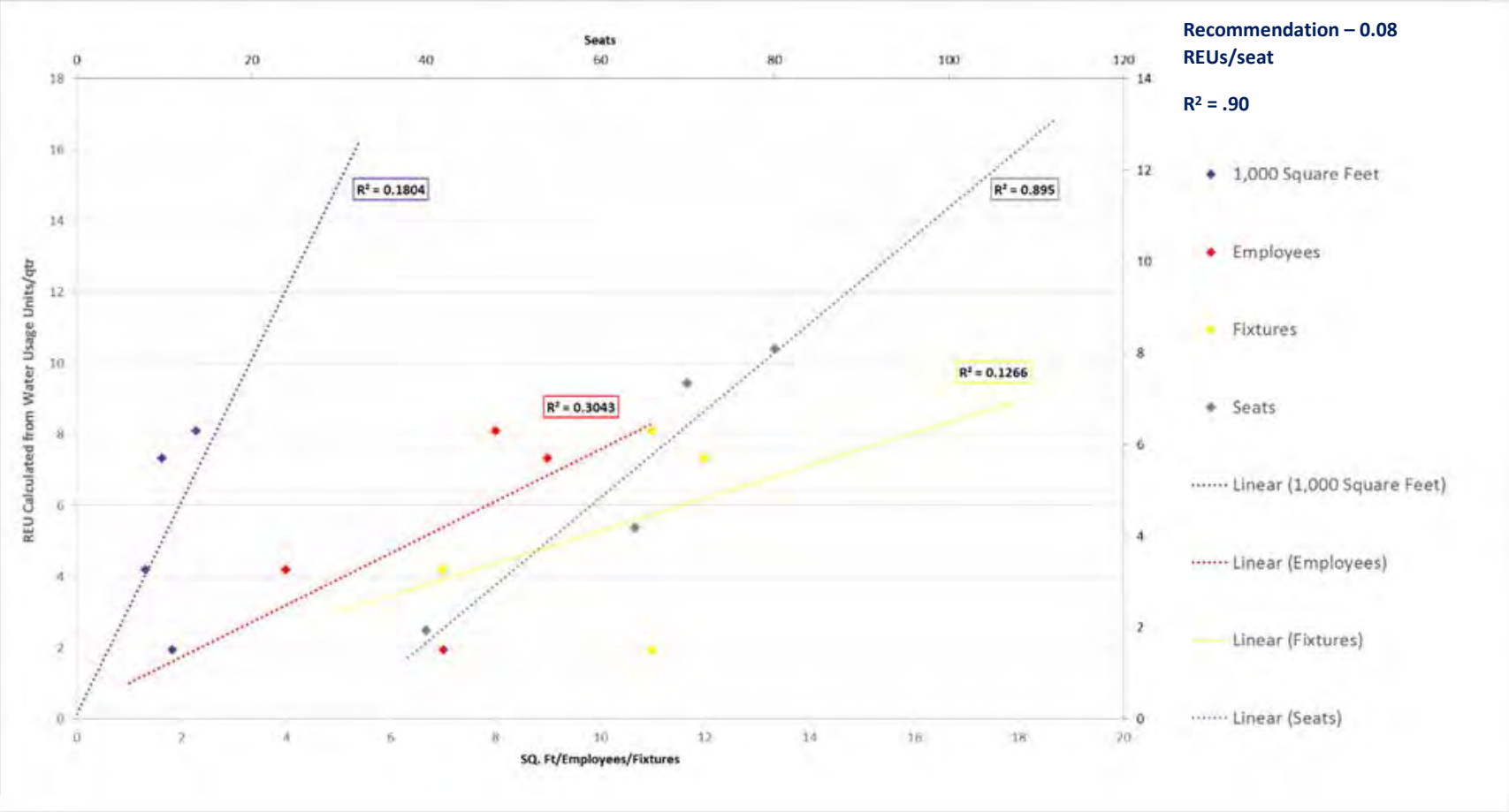


Recommendation – 0.35 REUs/fixture

R^2 = 0.52

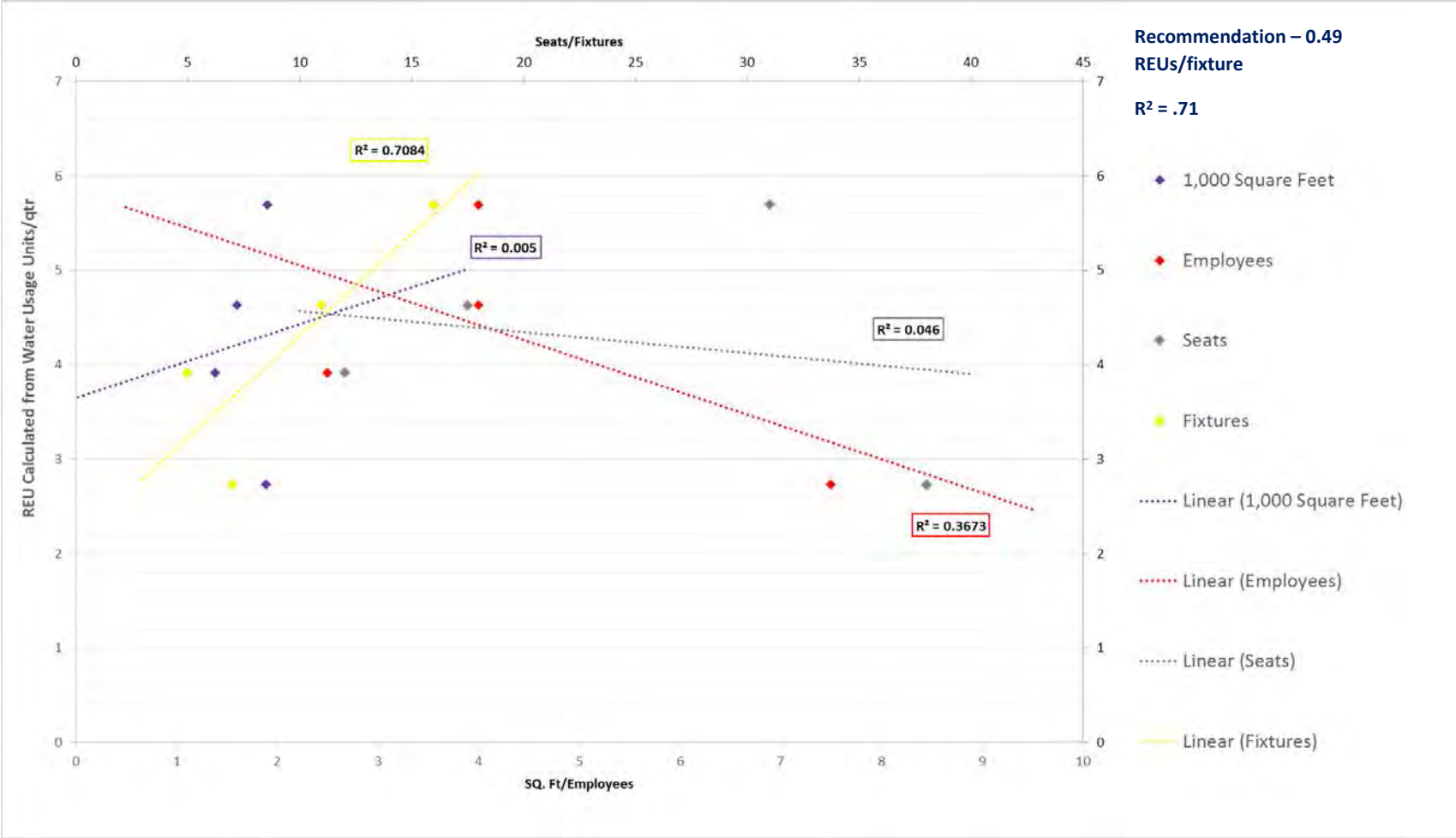
Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Restaurants w/o Liquor



Appendix IX – Non-Residential Classification Regression Analyses

Food, Beverage & Retail – Quick Service Restaurants w/ dining & restrooms

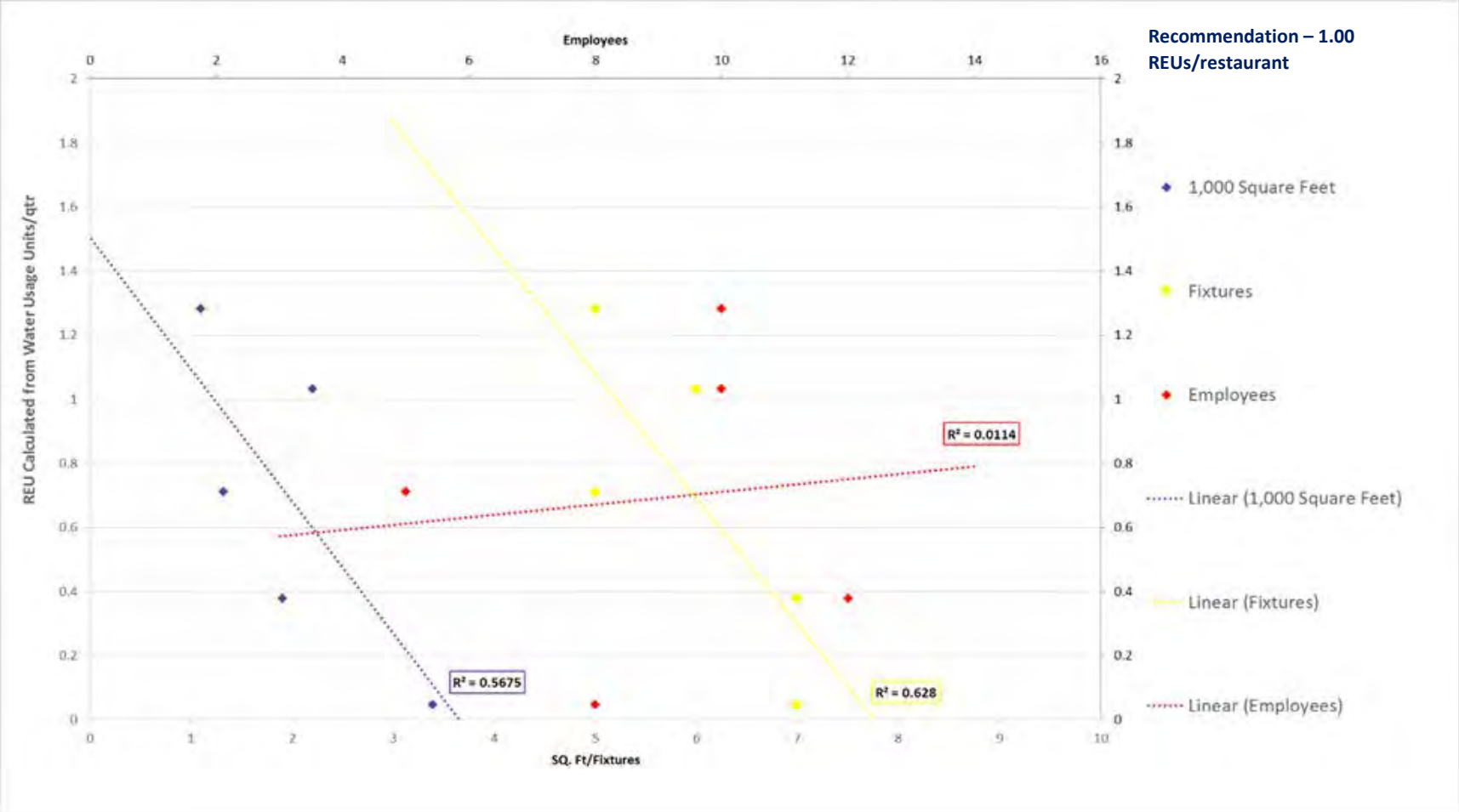


Recommendation – 0.49 REUs/fixture

R^2 = .71

Appendix IX – Non-Residential Classification Regression Analyses

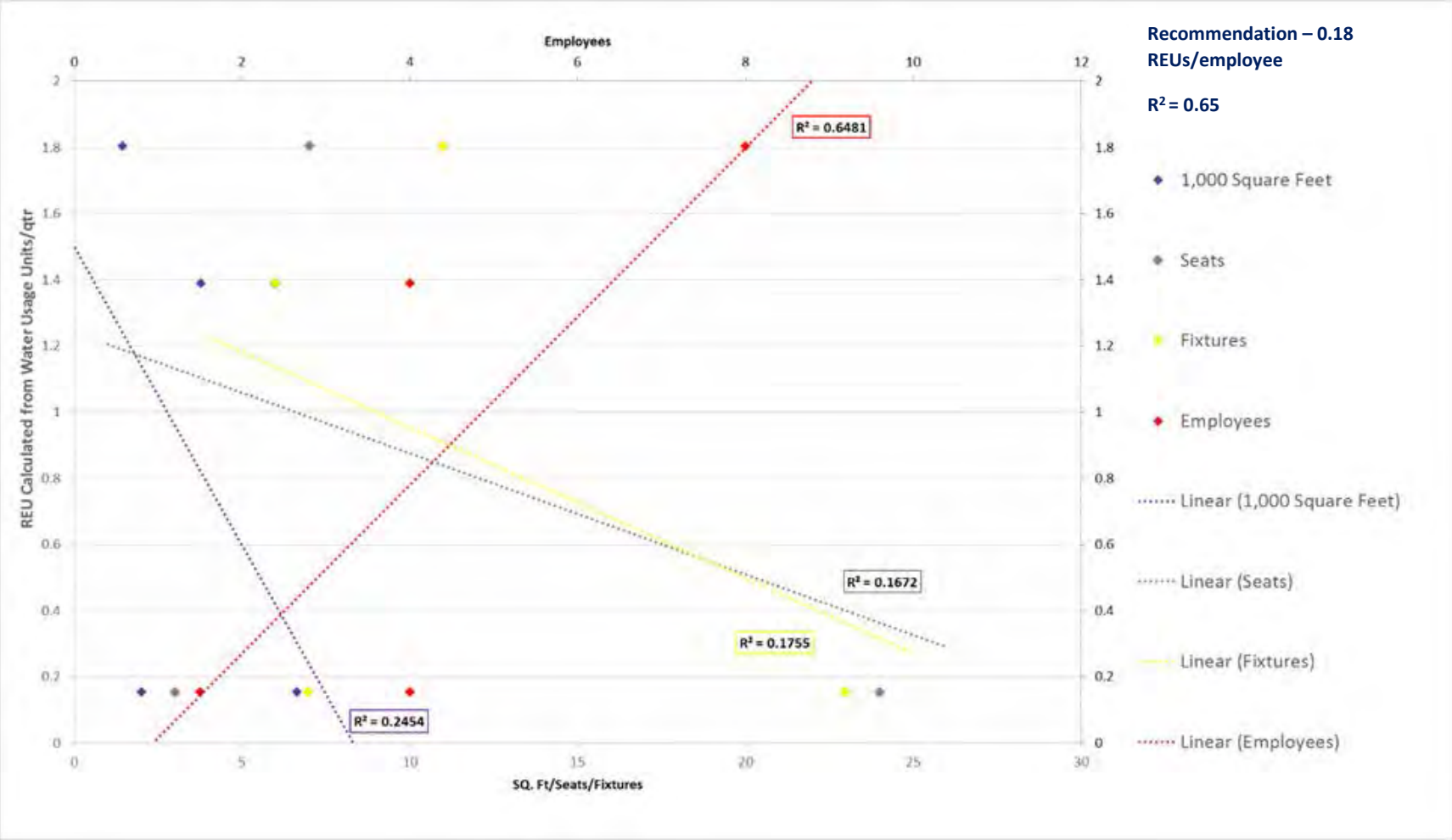
Food, Beverage & Retail – Quick Service Restaurants w/o dining & restrooms



Recommendation – 1.00 REUs/restaurant

Appendix IX – Non-Residential Classification Regression Analyses

Personal Care – Nail Salons

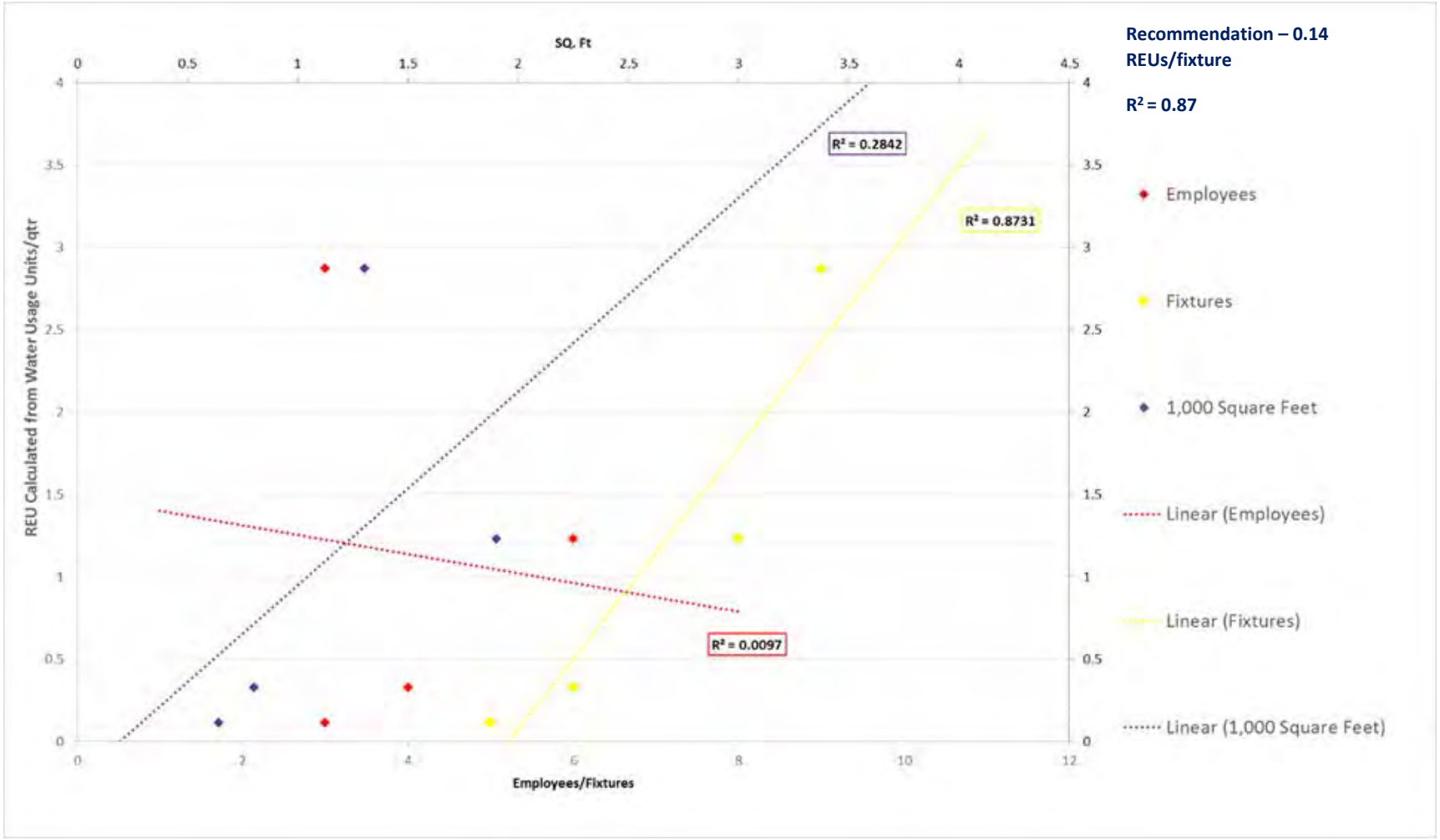


Recommendation – 0.18 REUs/employee

$R^2 = 0.65$

Appendix IX – Non-Residential Classification Regression Analyses

Personal Care – Barber Shops

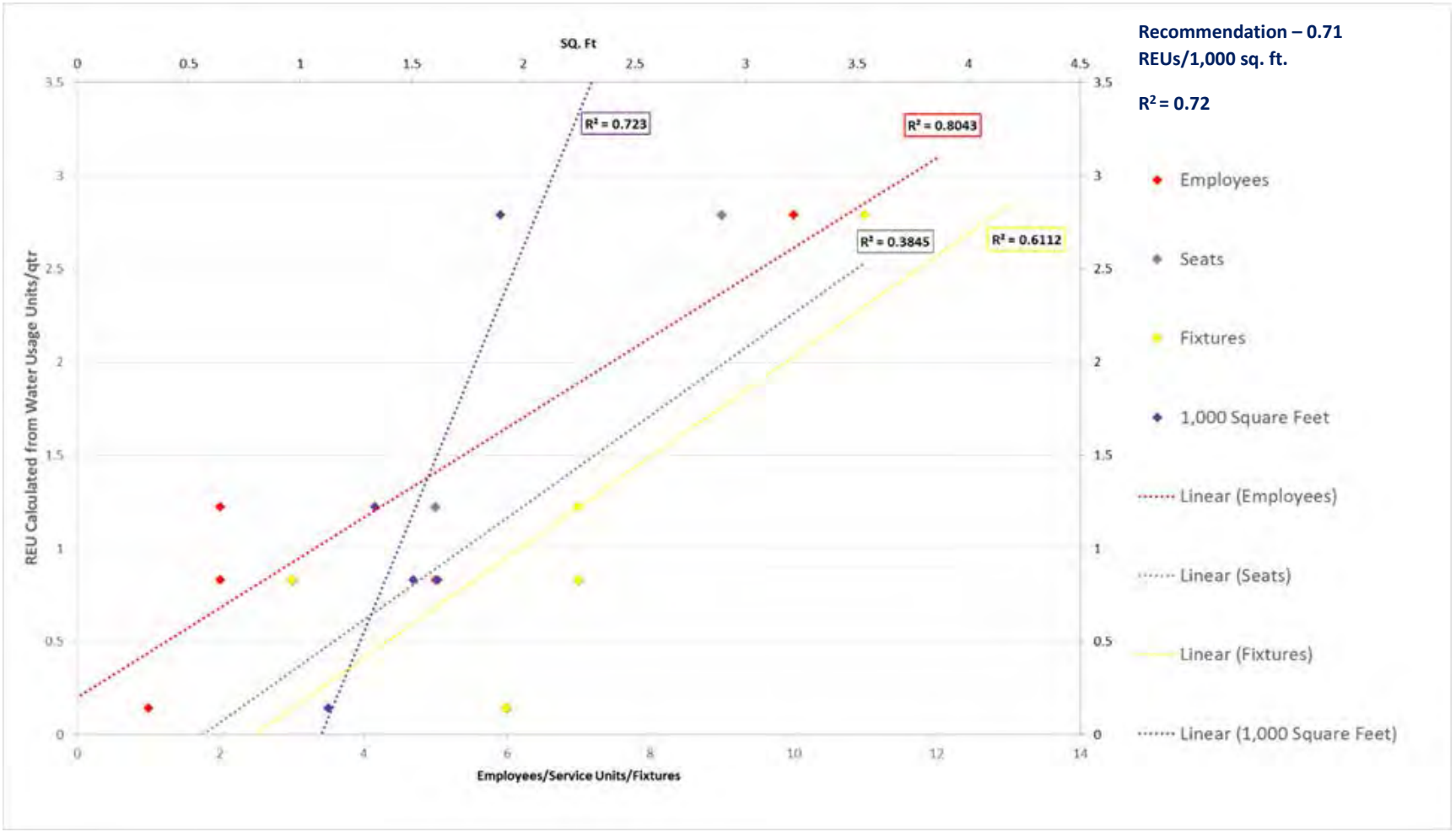


Recommendation – 0.14 REUs/fixture

$R^2 = 0.87$

Appendix IX – Non-Residential Classification Regression Analyses

Personal Care – Beauty Salons

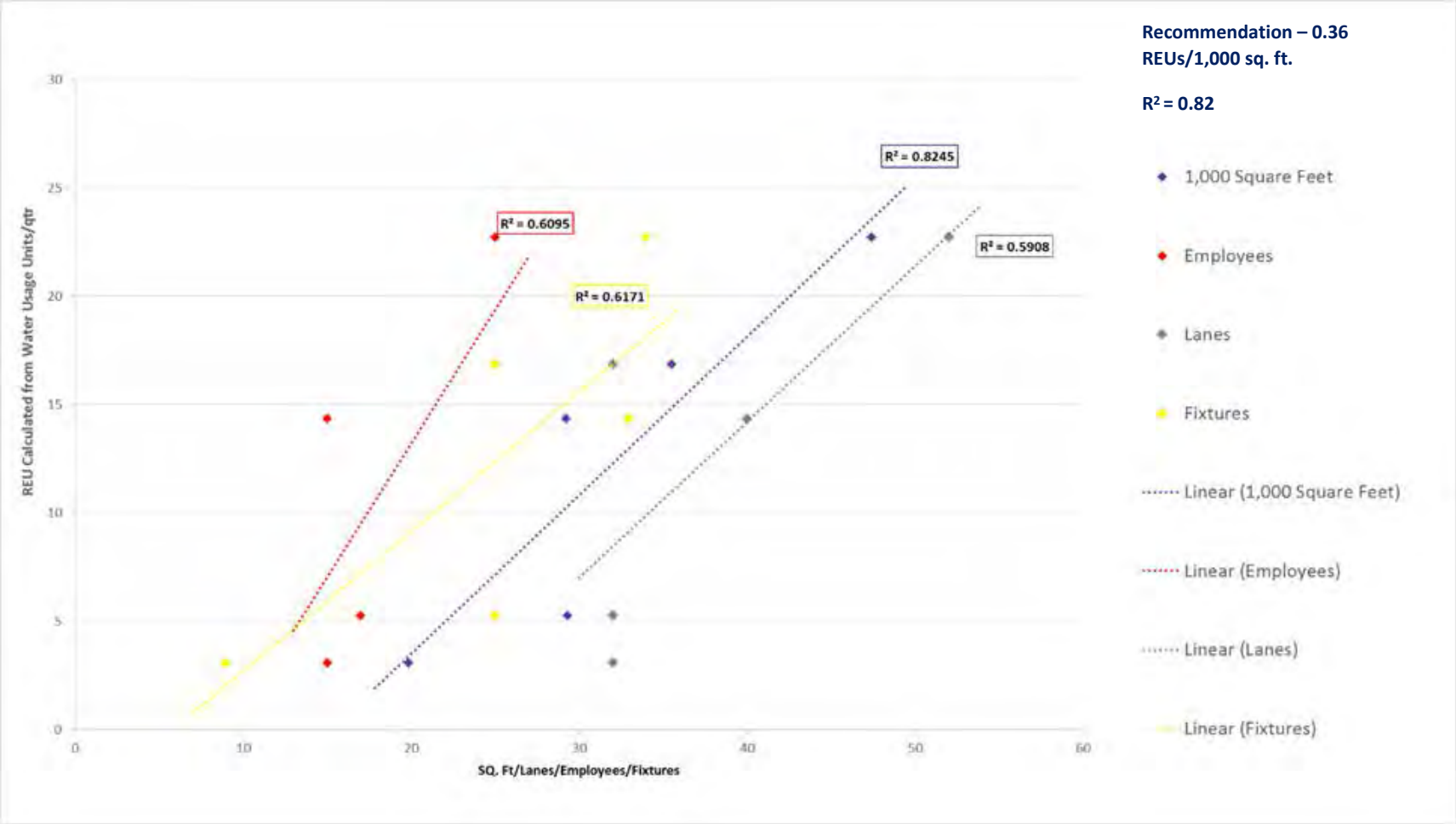


Recommendation – 0.71 REUs/1,000 sq. ft.

$R^2 = 0.72$

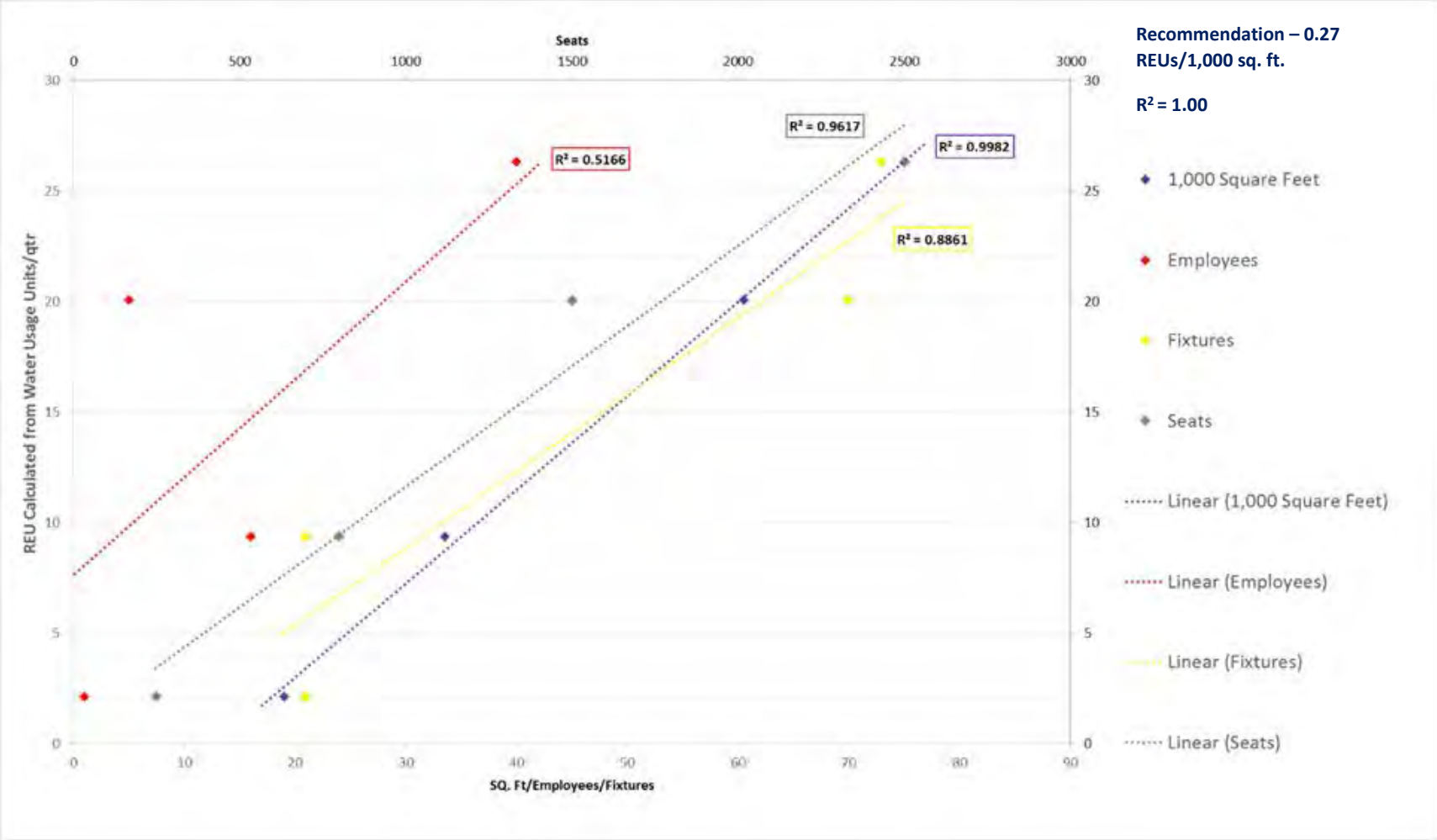
Appendix IX – Non-Residential Classification Regression Analyses

Entertainment/Health & Fitness – Bowling Alleys



Appendix IX – Non-Residential Classification Regression Analyses

Entertainment/Health & Fitness – Theatres

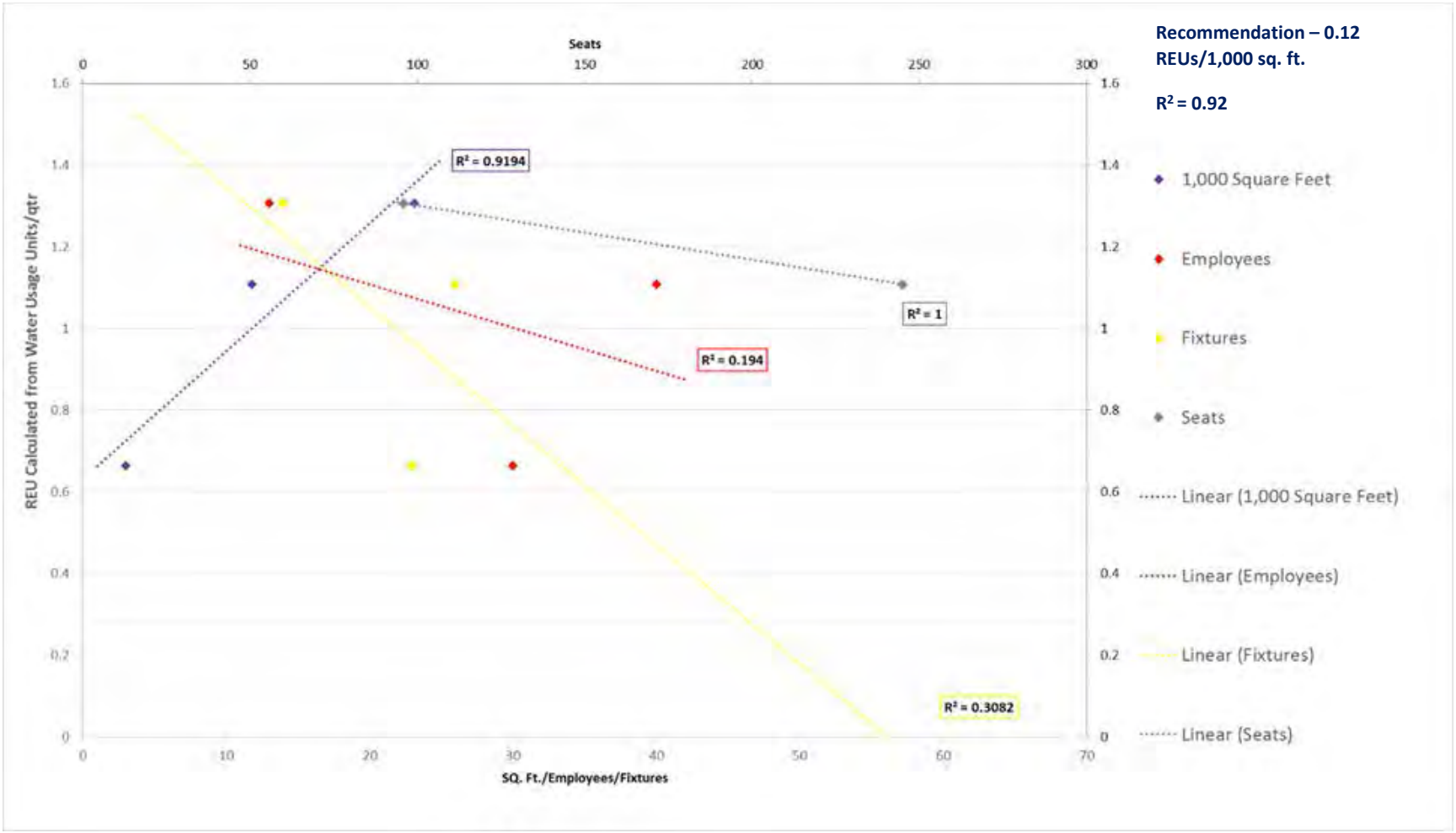


Recommendation – 0.27 REUs/1,000 sq. ft.

R^2 = 1.00

Appendix IX – Non-Residential Classification Regression Analyses

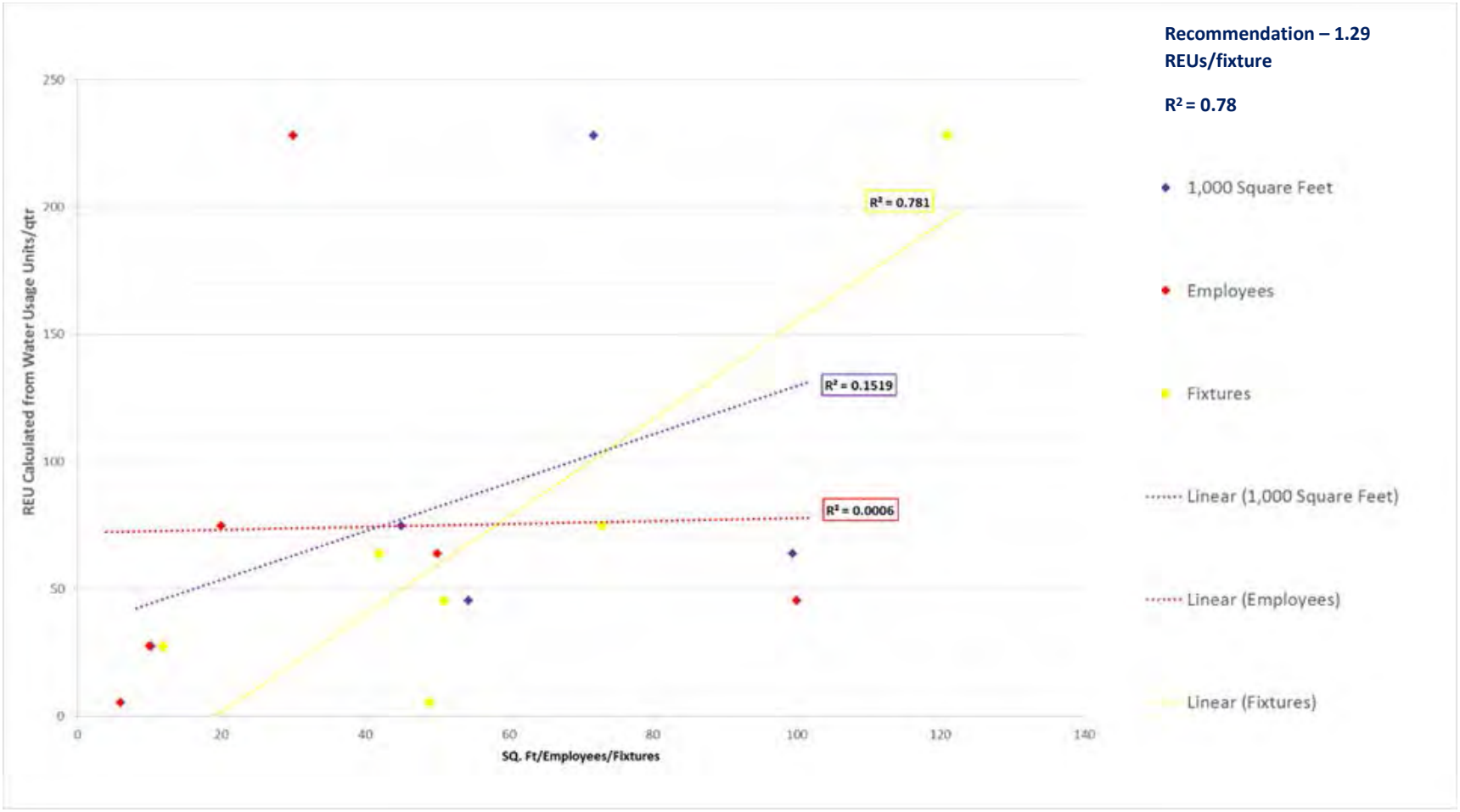
Entertainment/Health & Fitness – Kids Indoor Play Centers



Recommendation – 0.12 REUs/1,000 sq. ft.

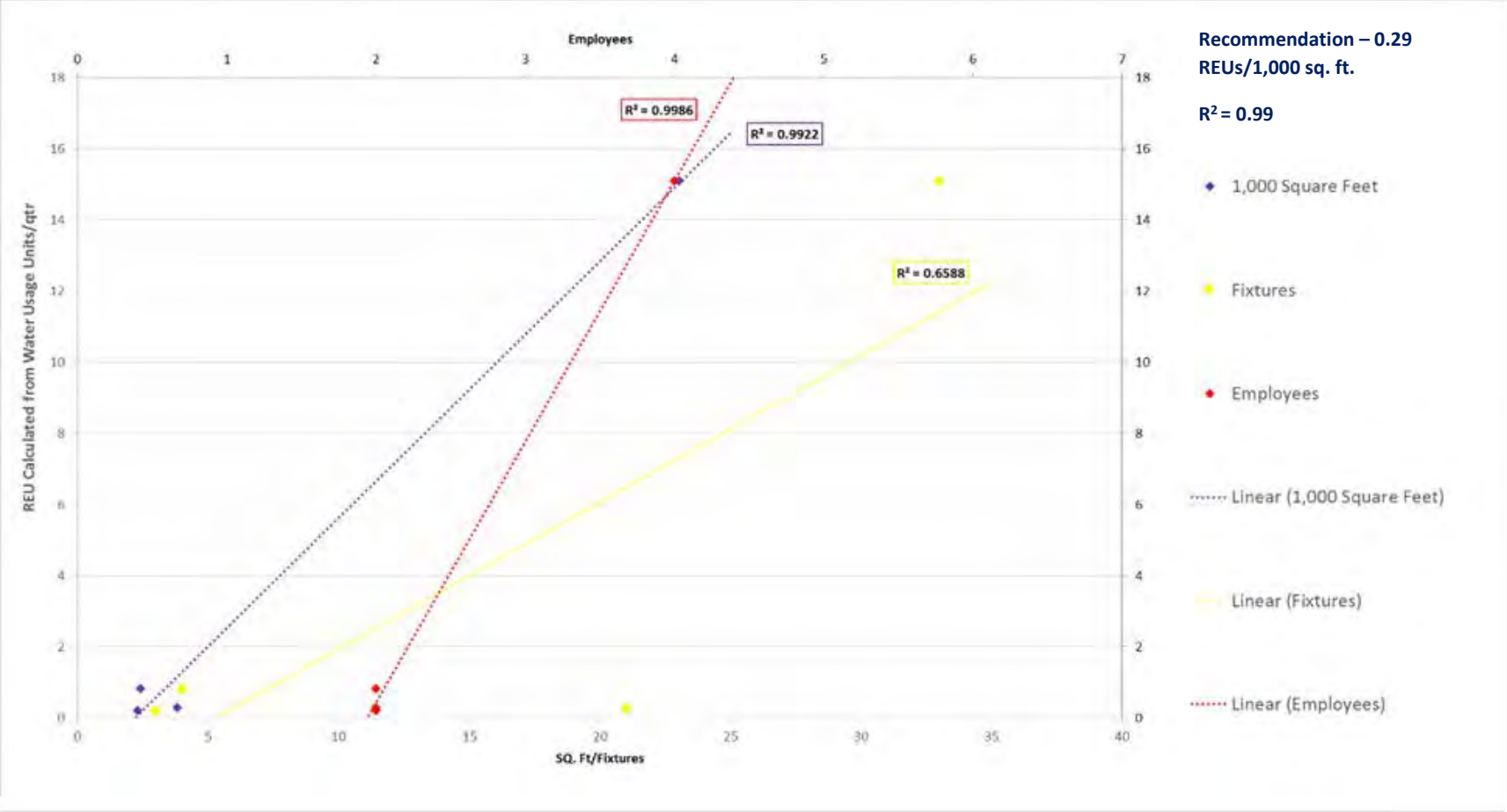
$R^2 = 0.92$

Entertainment/Health & Fitness – Health Club/Fitness Center w/ Showers &/or Pool



Appendix IX – Non-Residential Classification Regression Analyses

Entertainment/Health & Fitness – Health Club/Fitness Center w/o Showers &/or Pool



Recommendation – 0.29 REUs/1,000 sq. ft.

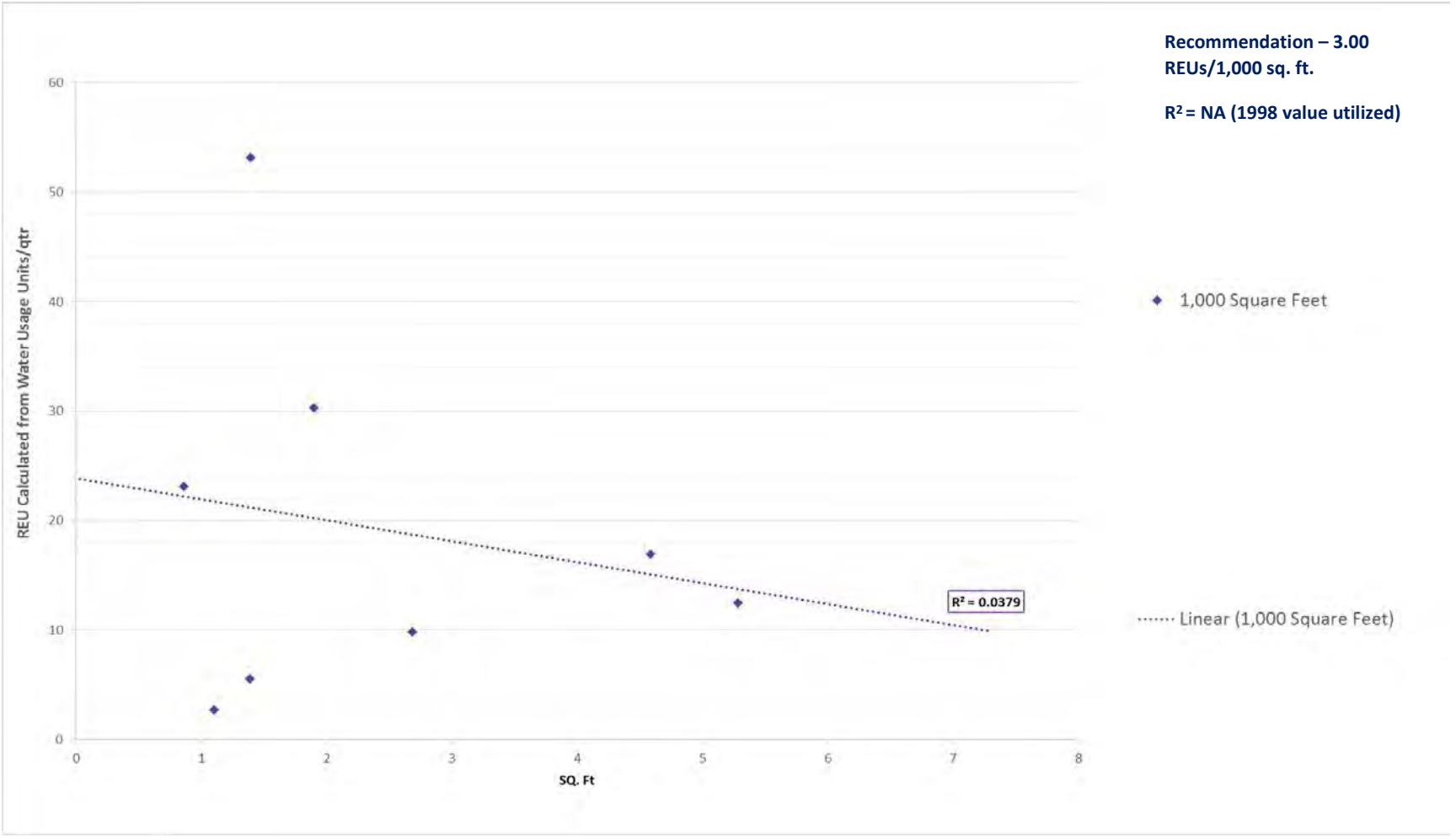
$R^2 = 0.99$

Appendix IX – Non-Residential Classification Regression Analyses

Entertainment/Health & Fitness – Swimming Pools

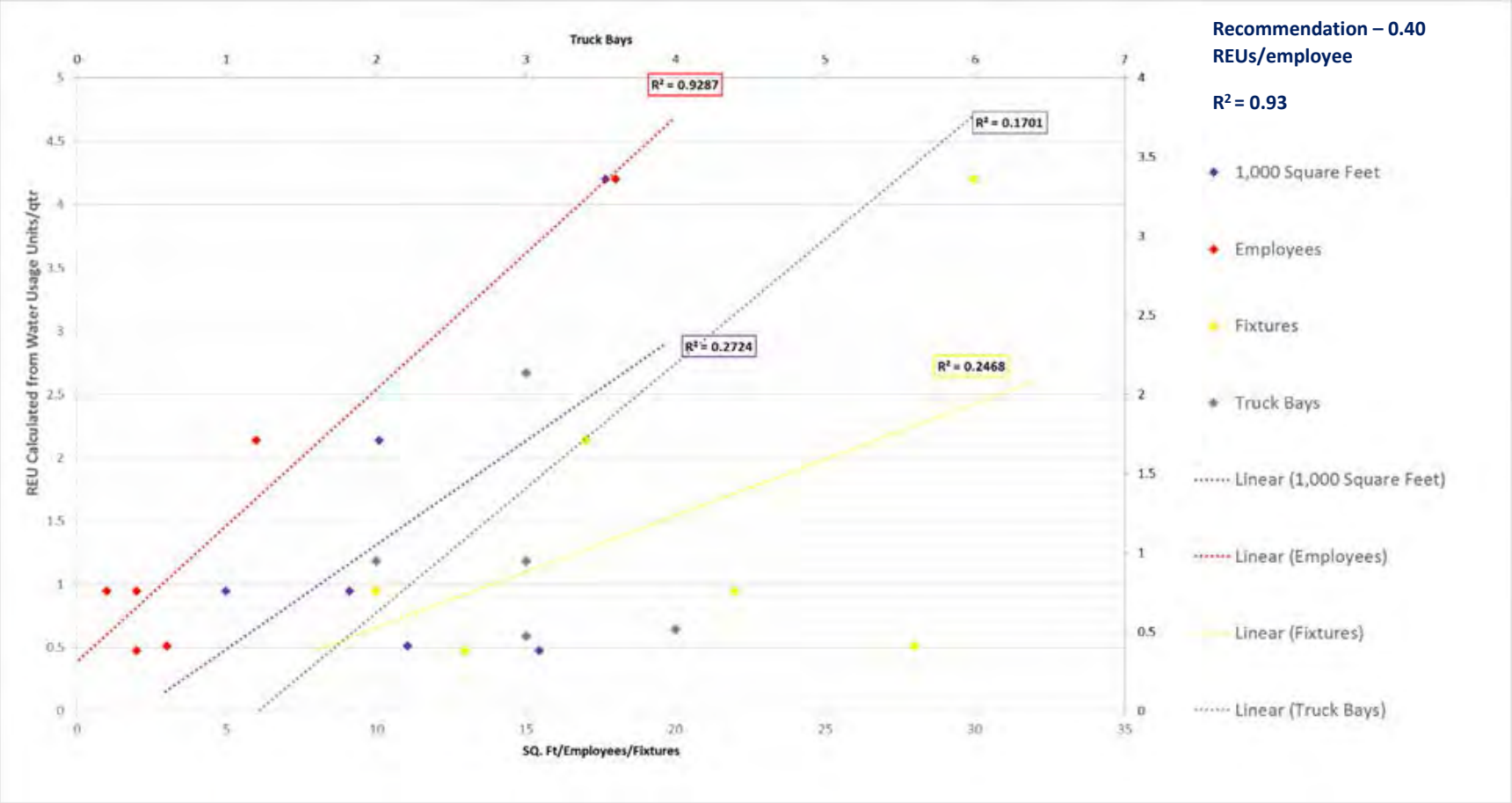
Recommendation – 3.00 REUs/1,000 sq. ft.

R^2 = NA (1998 value utilized)



Appendix IX – Non-Residential Classification Regression Analyses

Government – Fire Stations

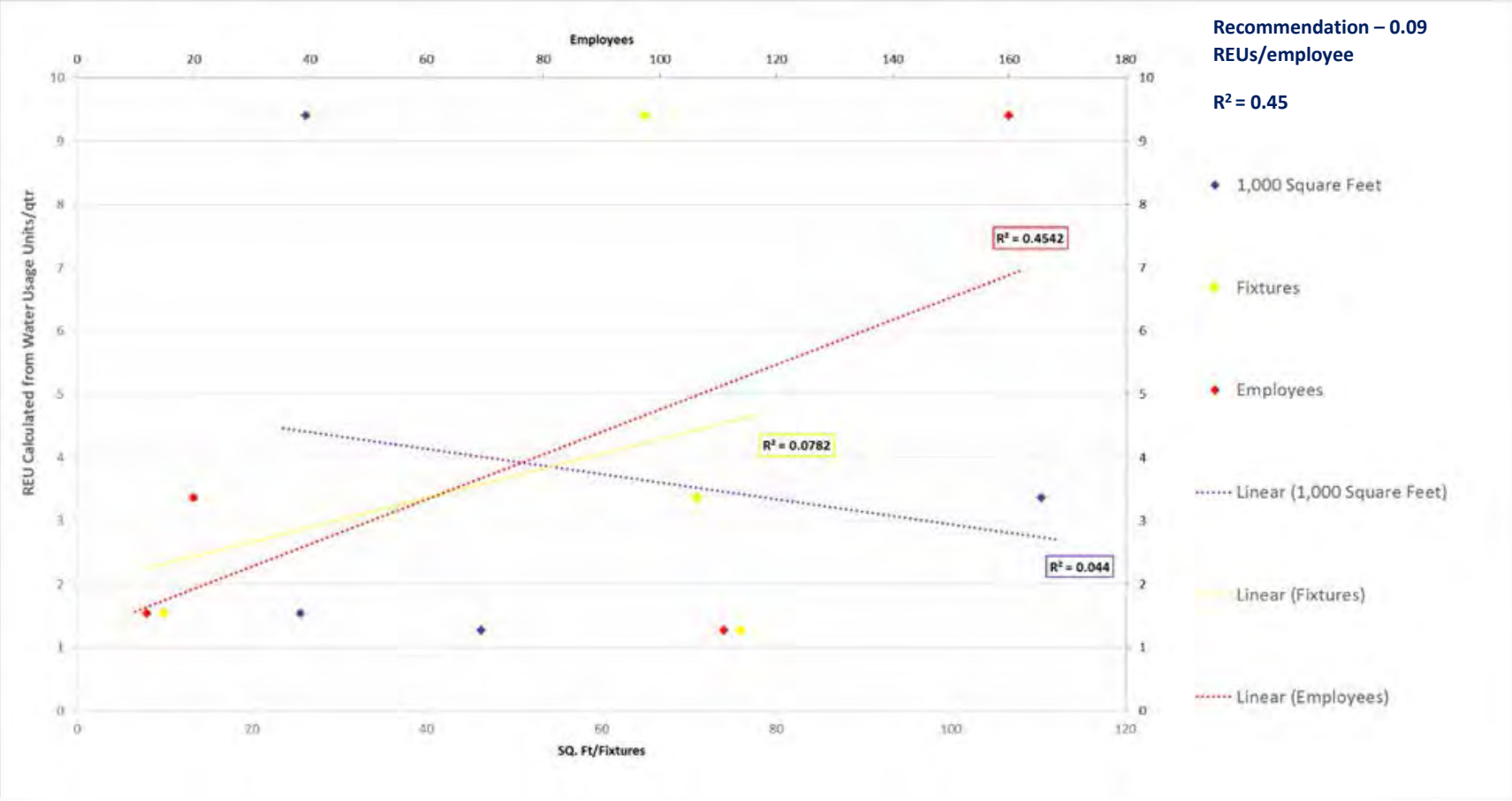


Recommendation – 0.40 REUs/employee

$R^2 = 0.93$

Appendix IX – Non-Residential Classification Regression Analyses

Government – Police Stations

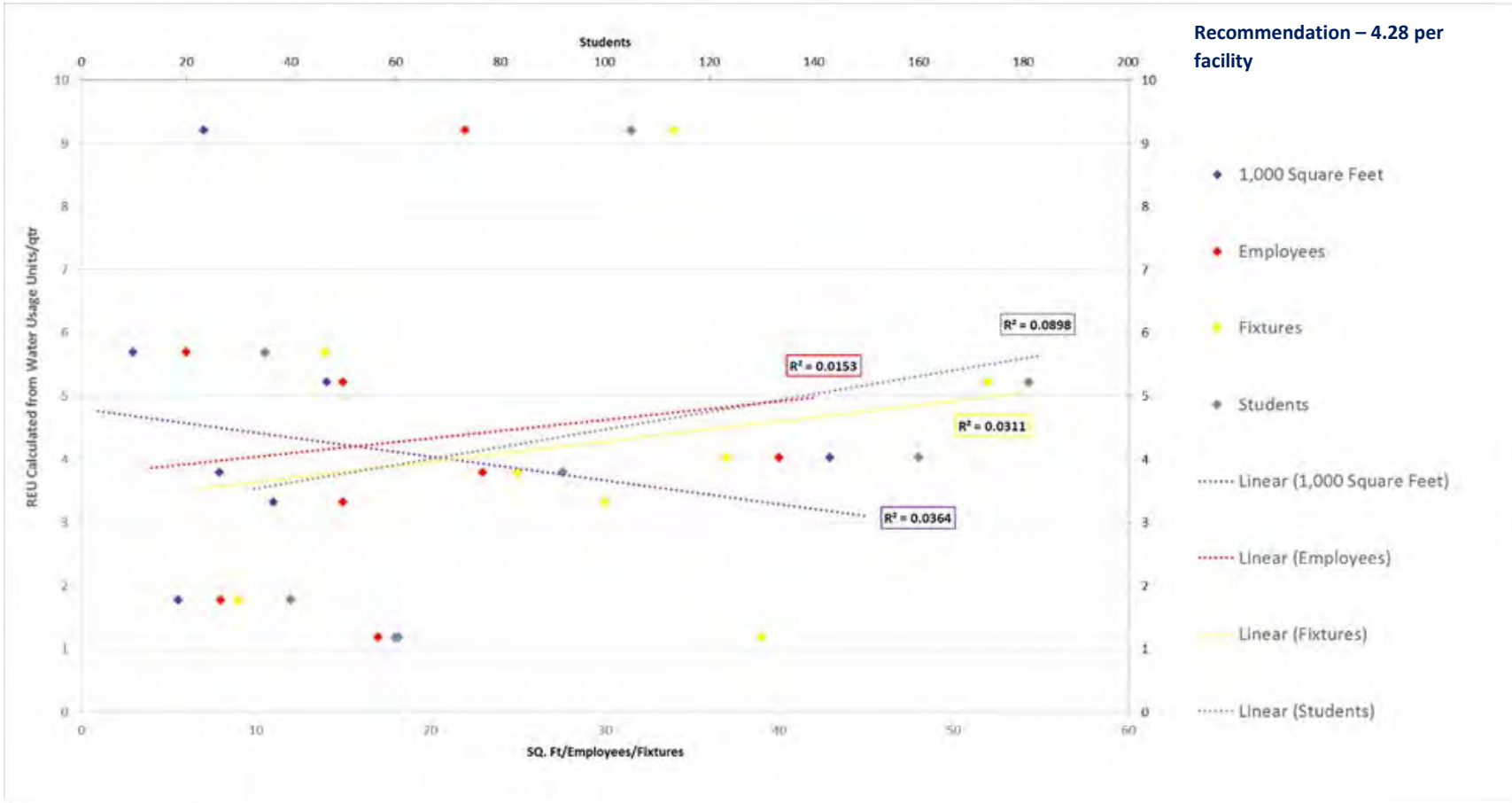


Recommendation – 0.09 REUs/employee

$R^2 = 0.45$

Appendix IX – Non-Residential Classification Regression Analyses

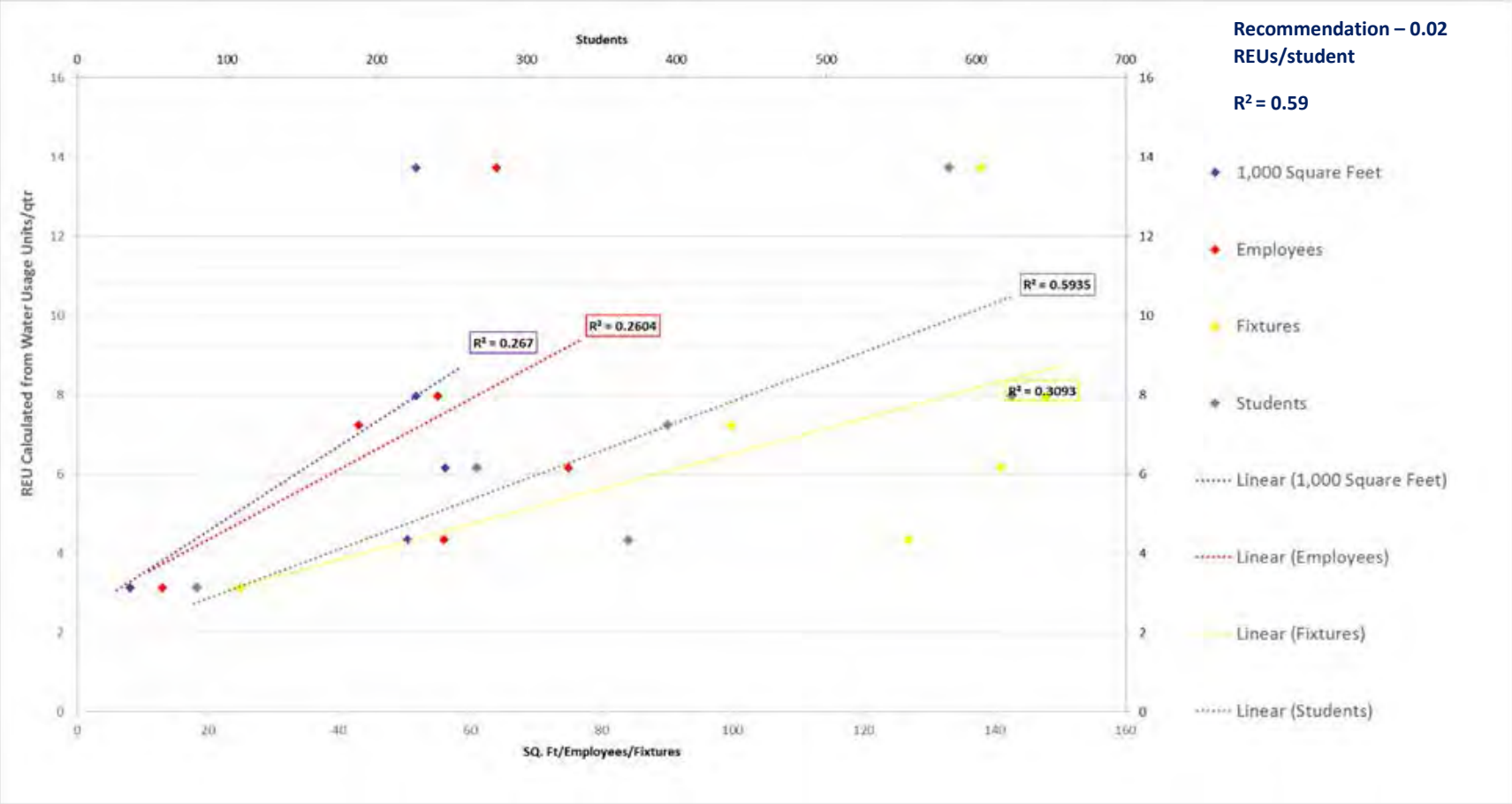
Government – Daycare/Early Learning



Recommendation – 4.28 per facility

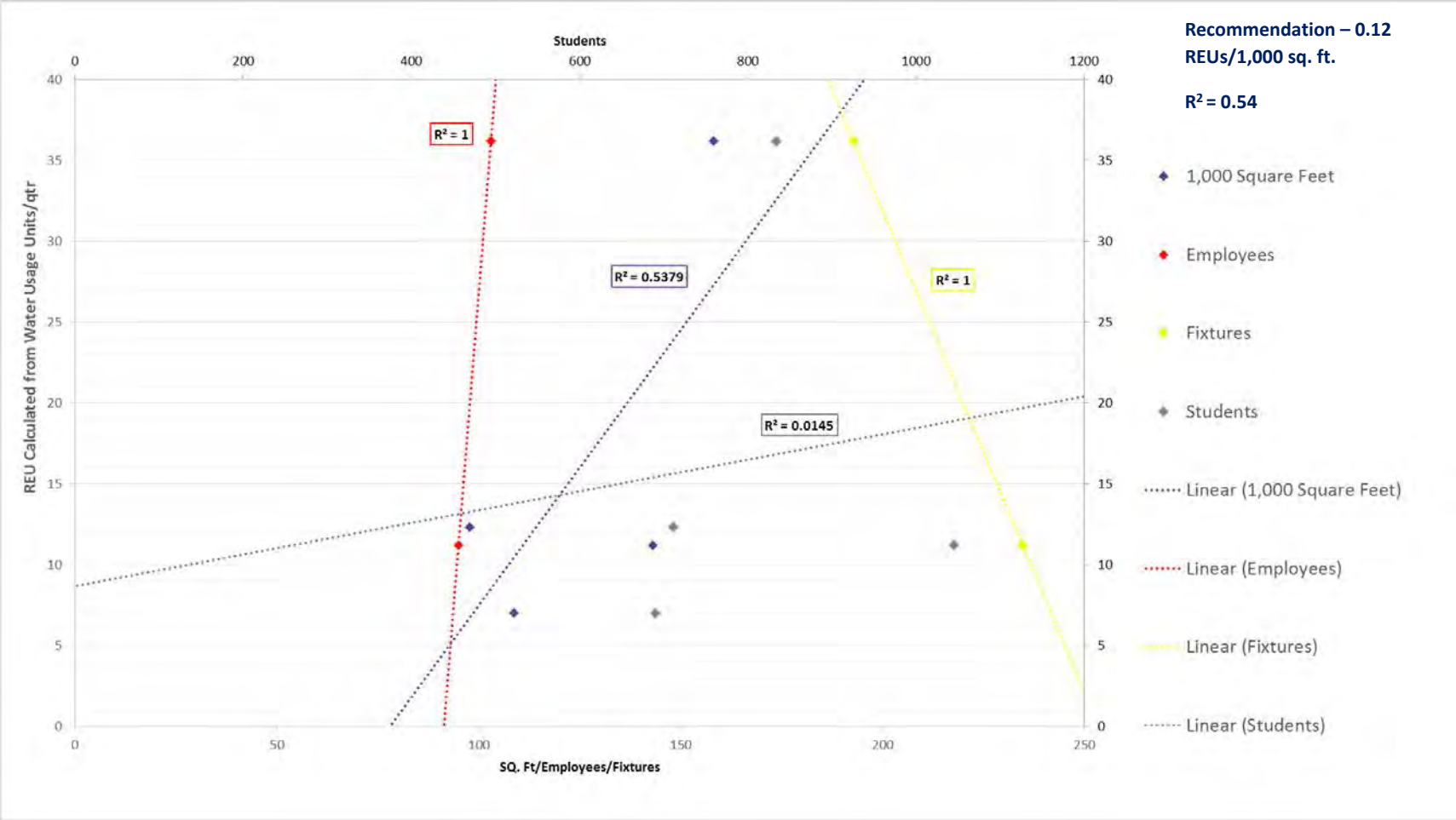
Appendix IX – Non-Residential Classification Regression Analyses

Government – Elementary Schools



Appendix IX – Non-Residential Classification Regression Analyses

Government – Junior or Middle Schools

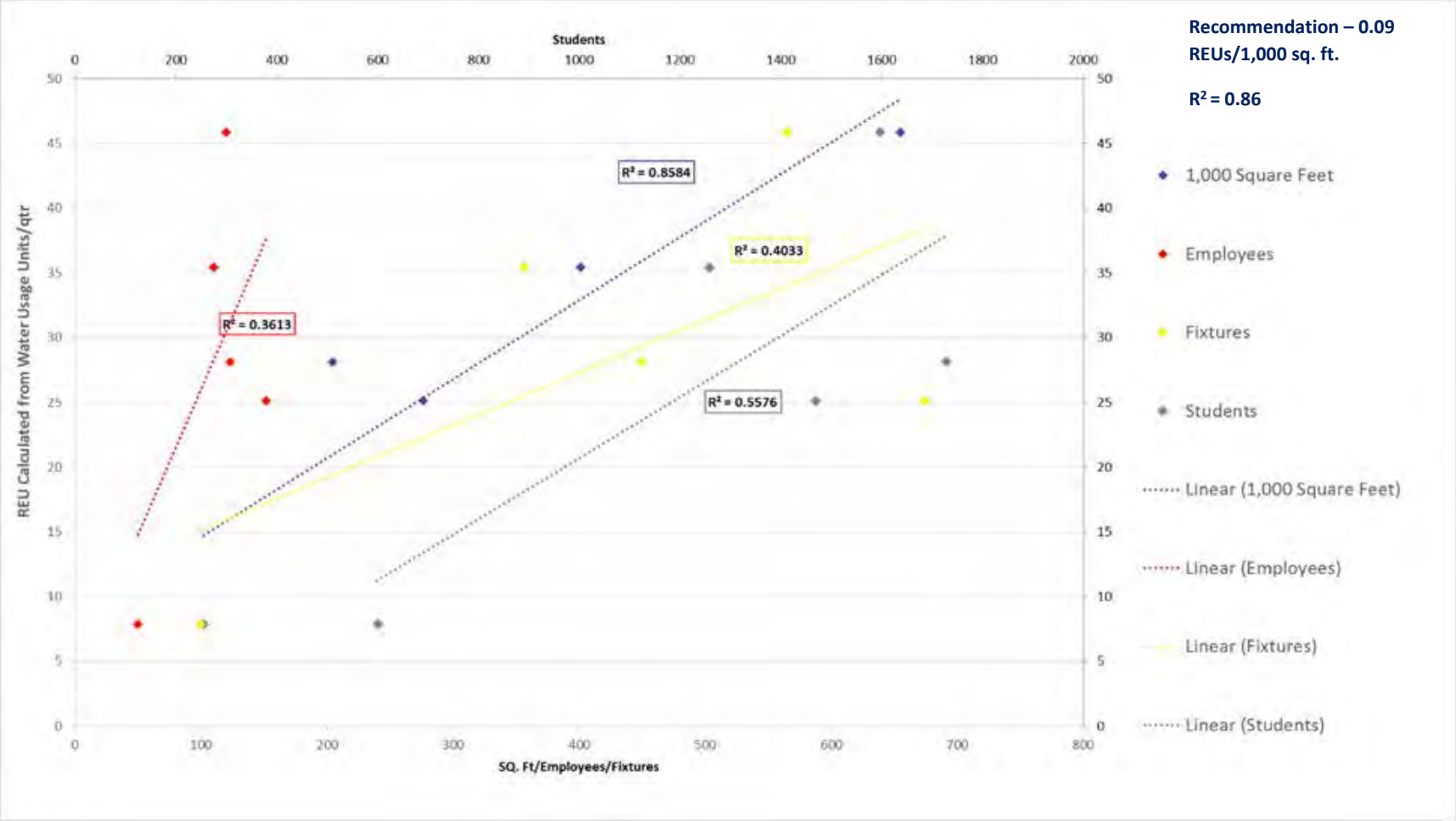


Recommendation – 0.12 REUs/1,000 sq. ft.

$R^2 = 0.54$

Appendix IX – Non-Residential Classification Regression Analyses

Government – Senior High Schools

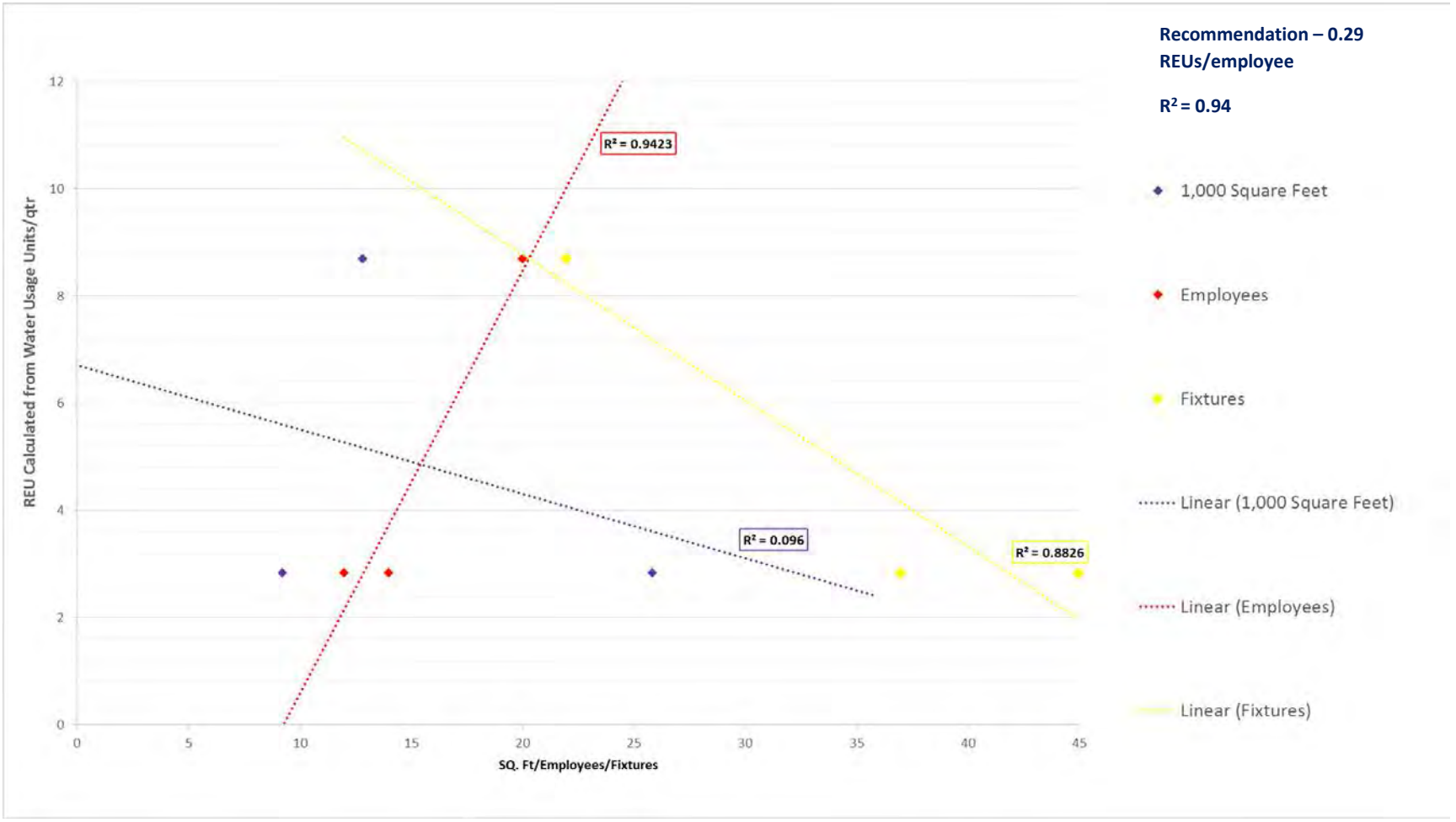


Recommendation – 0.09 REUs/1,000 sq. ft.

$R^2 = 0.86$

Appendix IX – Non-Residential Classification Regression Analyses

Housing – Convents & Seminaries

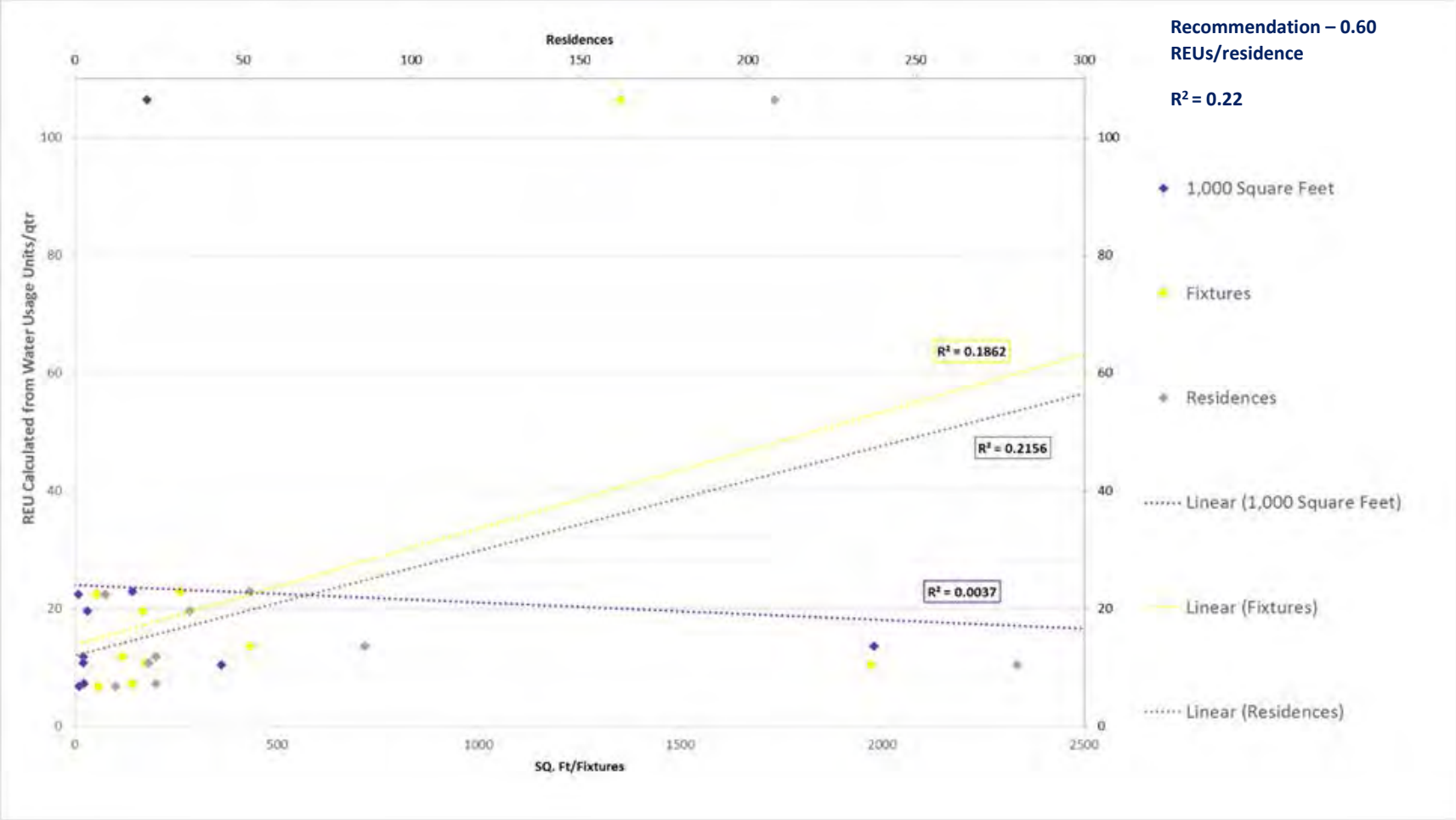


Recommendation – 0.29 REUs/employee

$R^2 = 0.94$

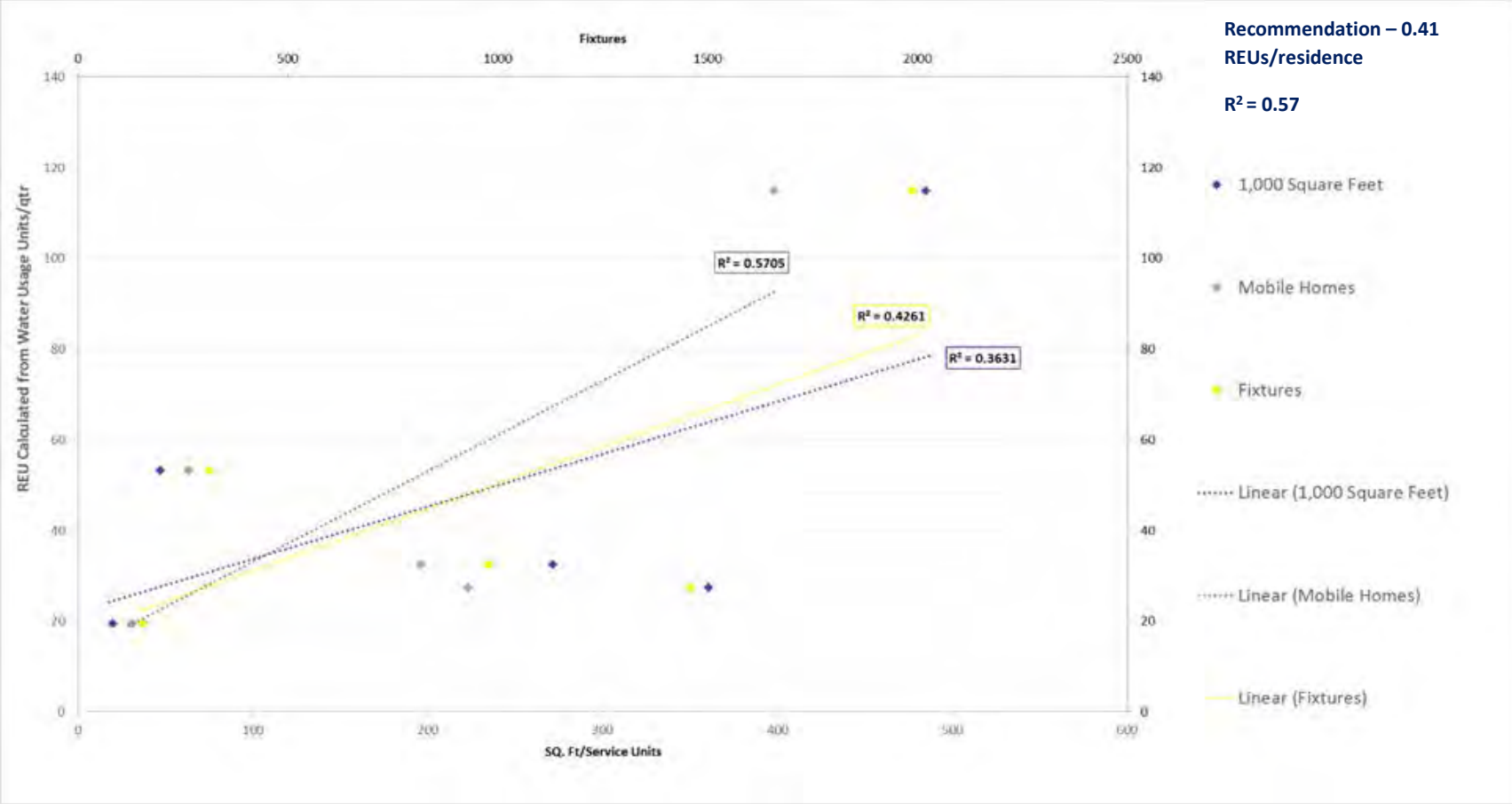
Appendix IX – Non-Residential Classification Regression Analyses

Housing – Multiple Family Residences



Appendix IX – Non-Residential Classification Regression Analyses

Housing – Mobile Home Parks

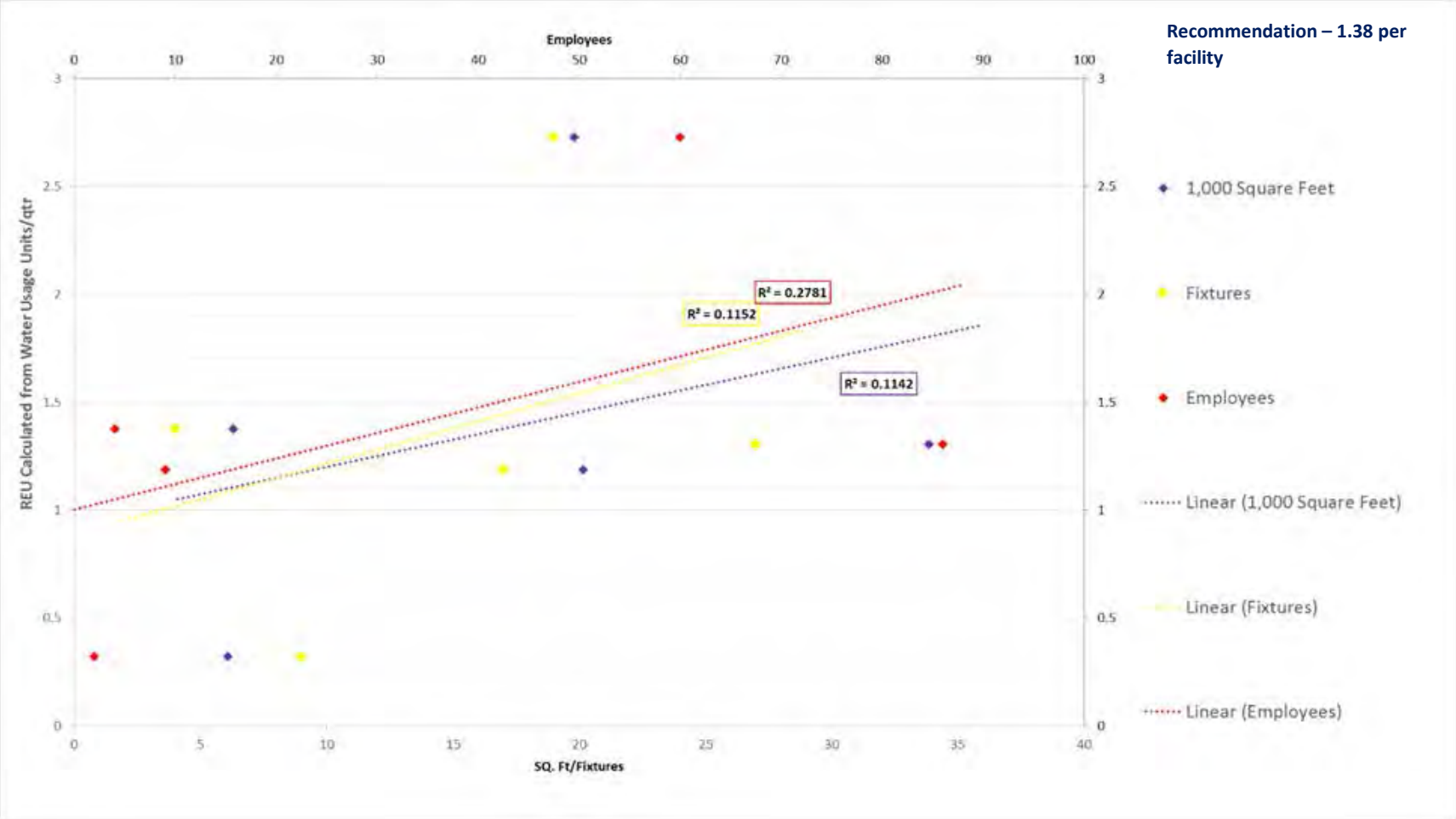


Recommendation – 0.41 REUs/residence

$R^2 = 0.57$

Appendix IX – Non-Residential Classification Regression Analyses

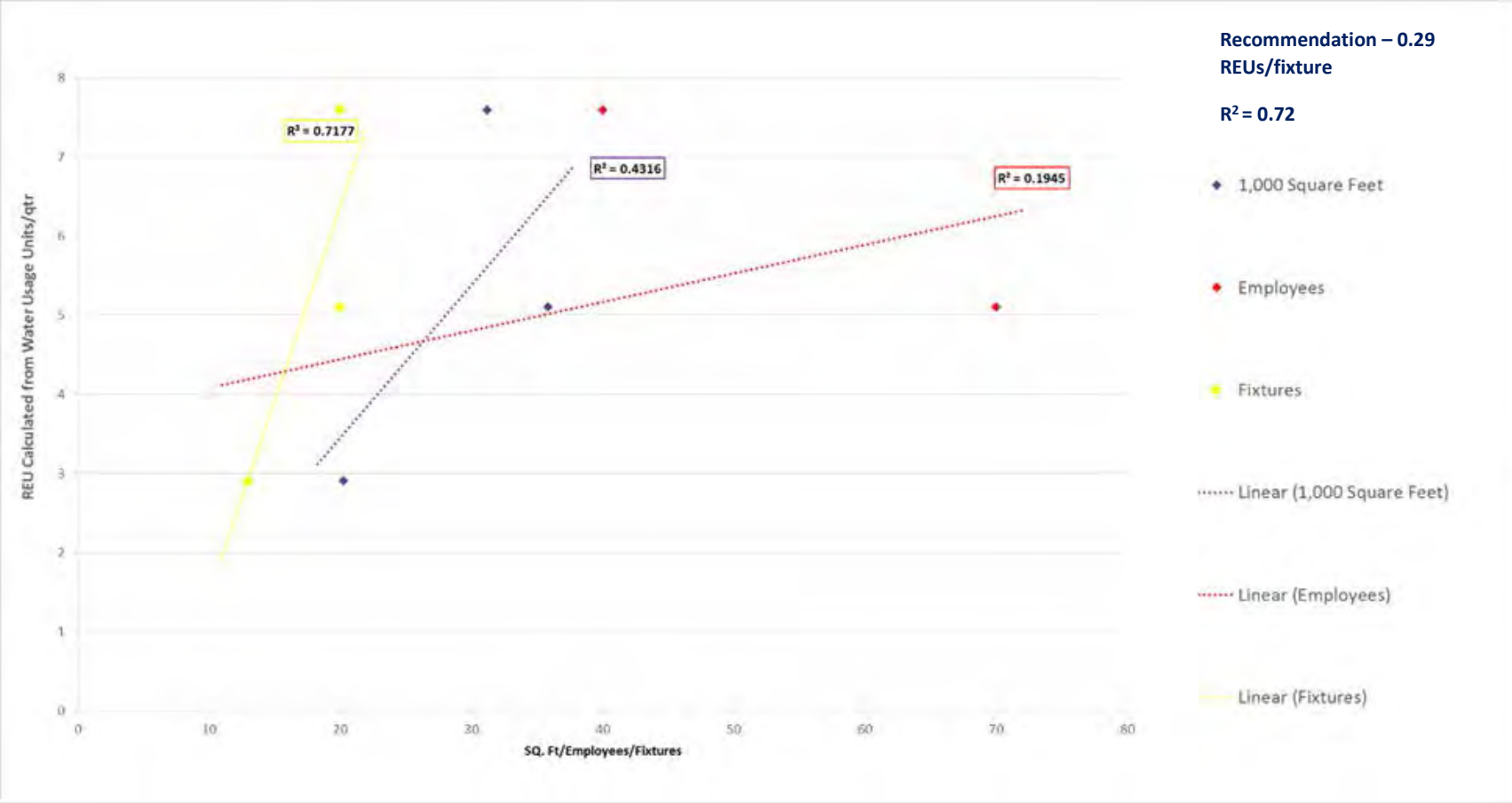
Manufacturing – Dry Process



Recommendation – 1.38 per facility

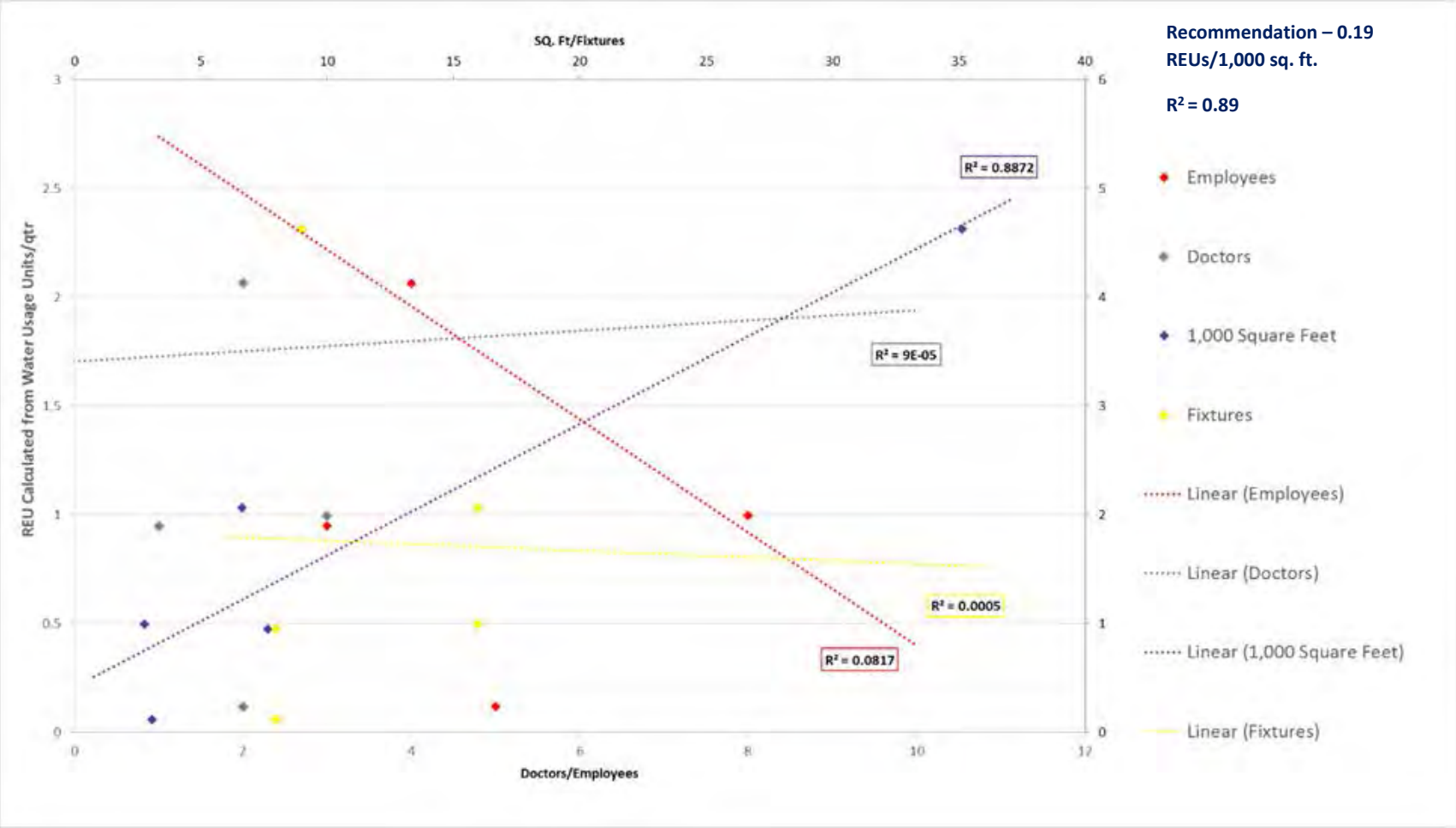
Appendix IX – Non-Residential Classification Regression Analyses

Manufacturing – Wet Process



Appendix IX – Non-Residential Classification Regression Analyses

Medical/Wellness – Medical Clinics

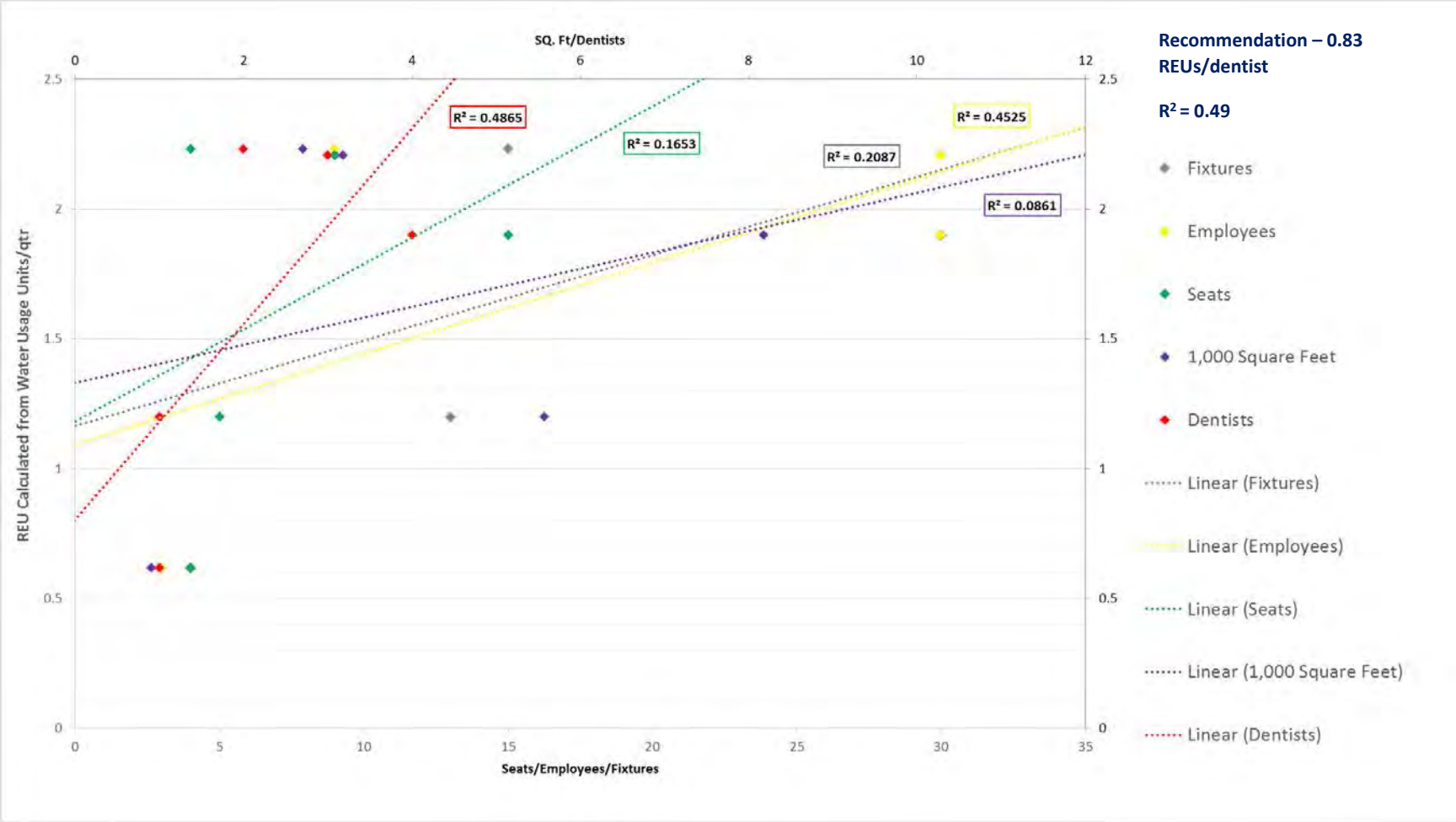


Recommendation – 0.19 REUs/1,000 sq. ft.

$R^2 = 0.89$

Appendix IX – Non-Residential Classification Regression Analyses

Medical/Wellness – Dental Clinics

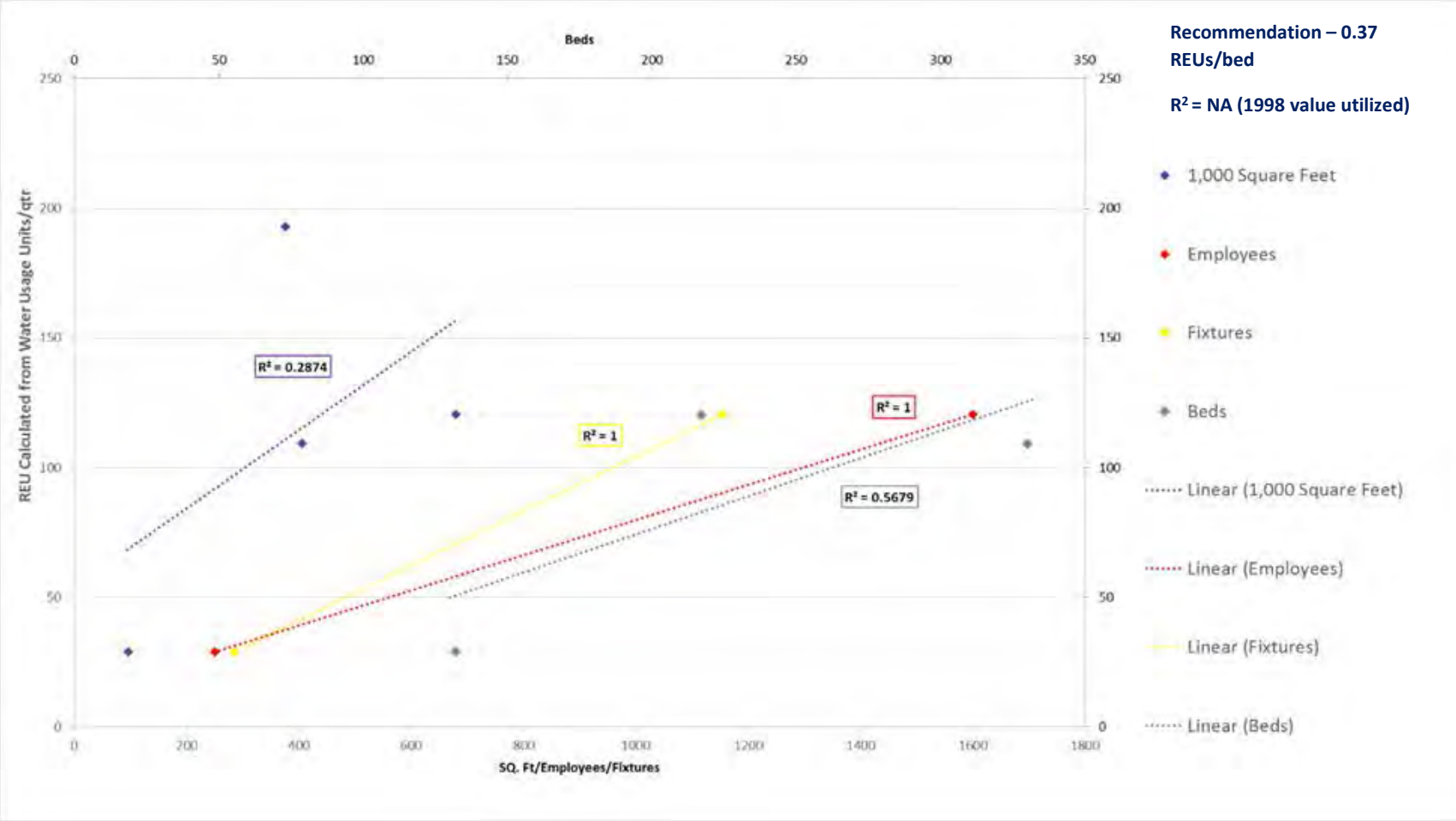


Recommendation – 0.83 REUs/dentist

R^2 = 0.49

Appendix IX – Non-Residential Classification Regression Analyses

Medical/Wellness – Hospitals

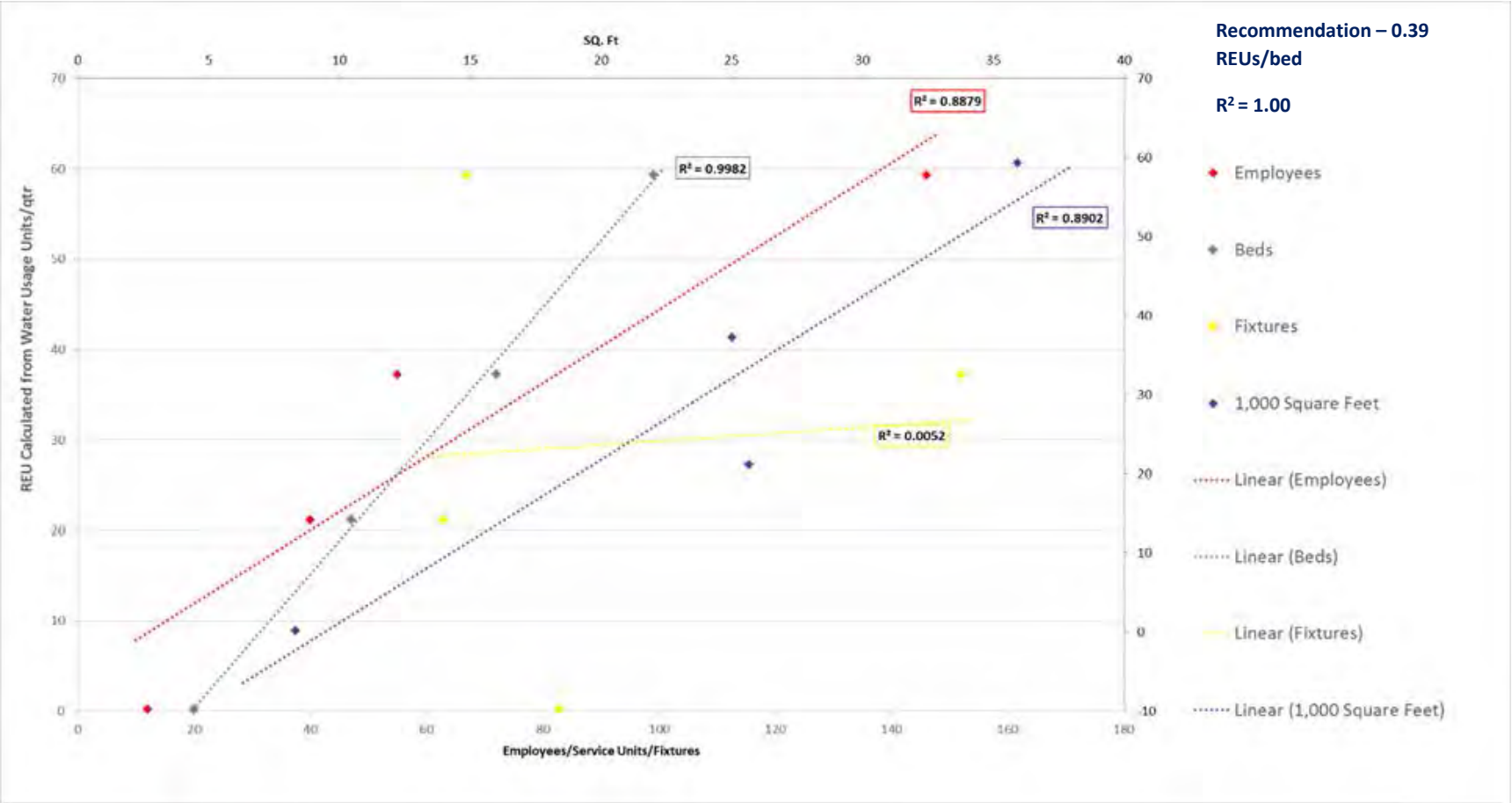


Recommendation – 0.37 REUs/bed

R^2 = NA (1998 value utilized)

Appendix IX – Non-Residential Classification Regression Analyses

Medical/Wellness – Retirement Homes/Assisted Living

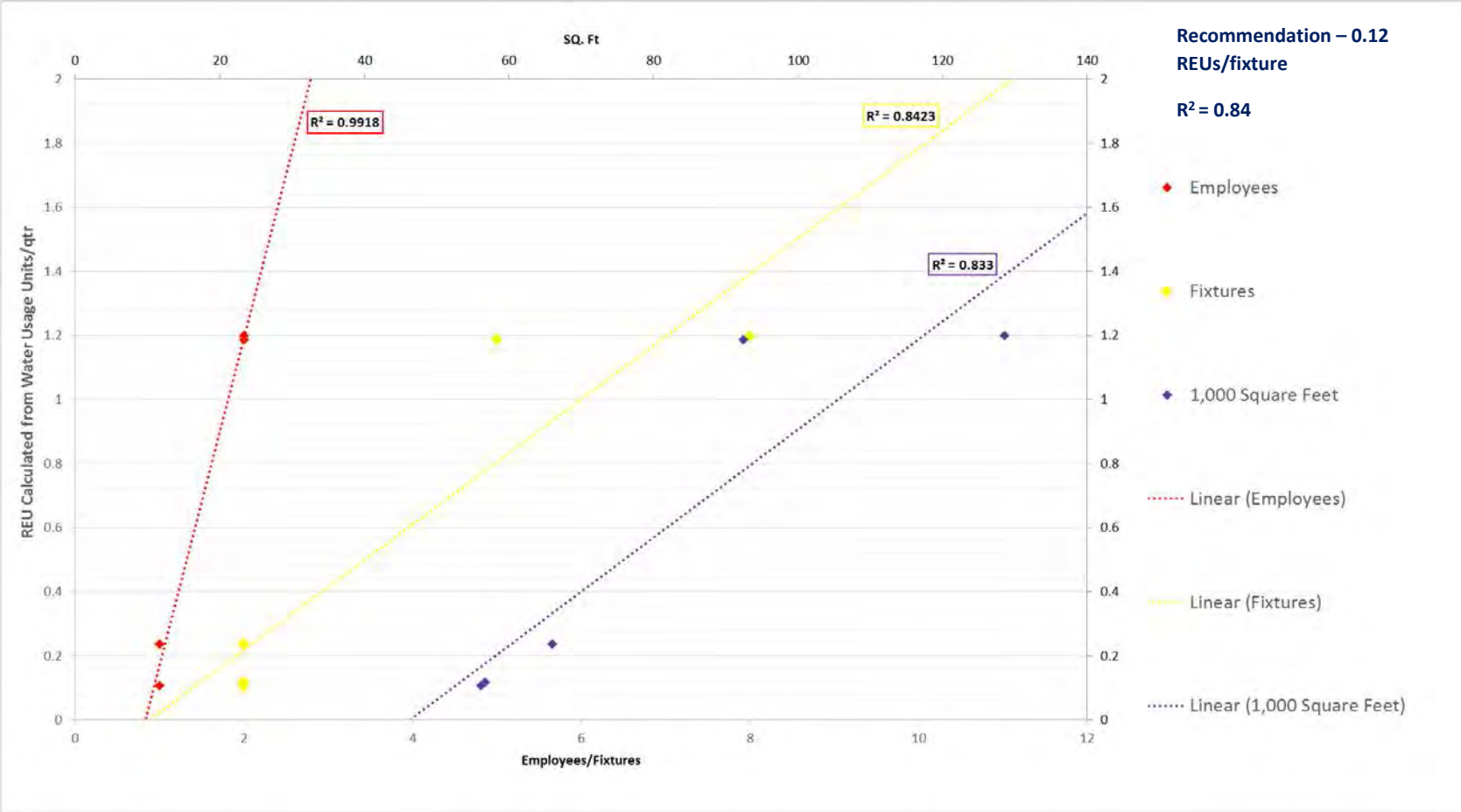


Recommendation – 0.39 REUs/bed

$R^2 = 1.00$

Appendix IX – Non-Residential Classification Regression Analyses

Office/General/Assembly – Warehouses & Storage

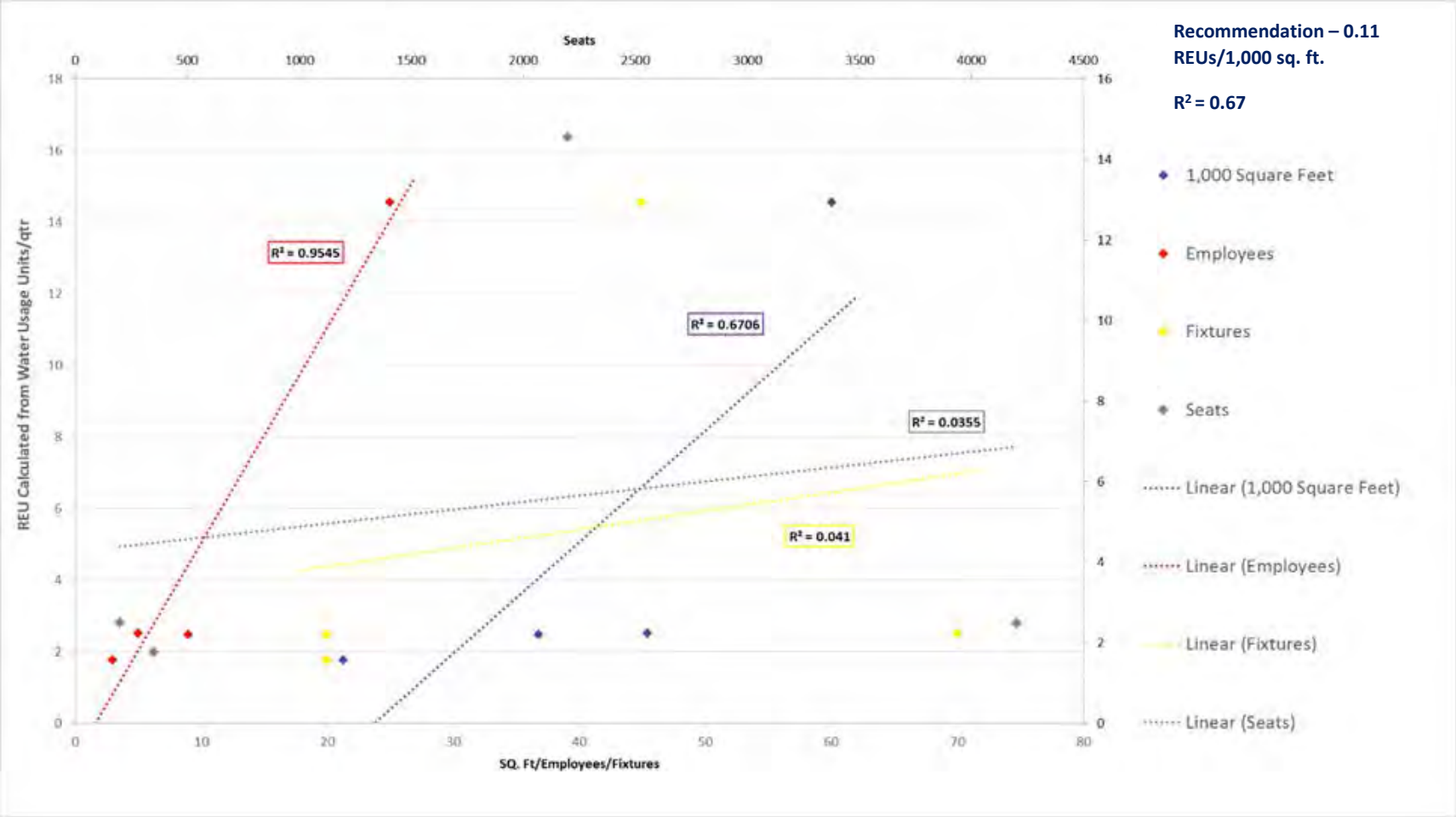


Recommendation – 0.12 REUs/fixture

$R^2 = 0.84$

Appendix IX – Non-Residential Classification Regression Analyses

Office/General/Assembly – Churches

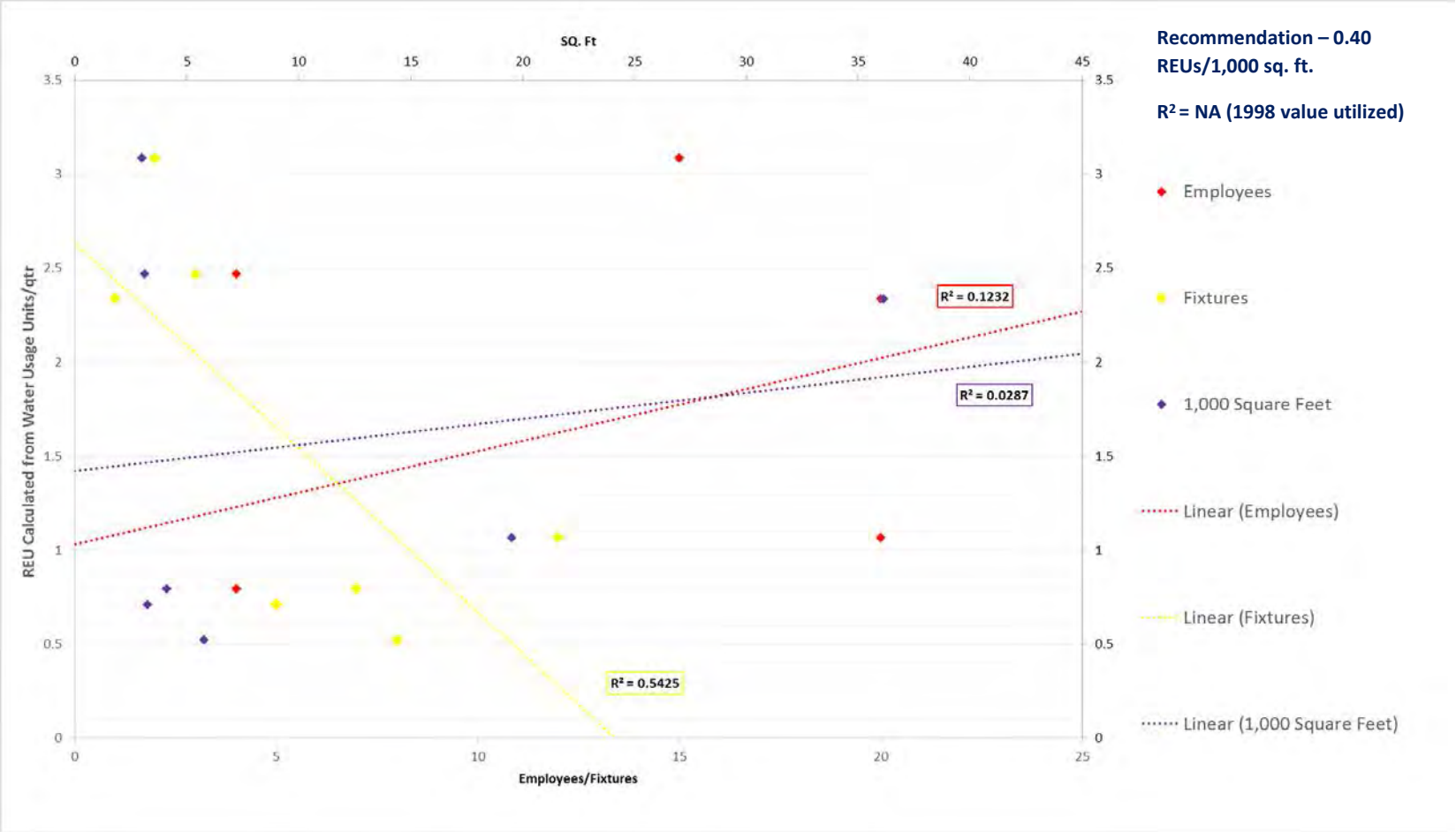


Recommendation – 0.11 REUs/1,000 sq. ft.

$R^2 = 0.67$

Appendix IX – Non-Residential Classification Regression Analyses

Office/General/Assembly – Offices - General

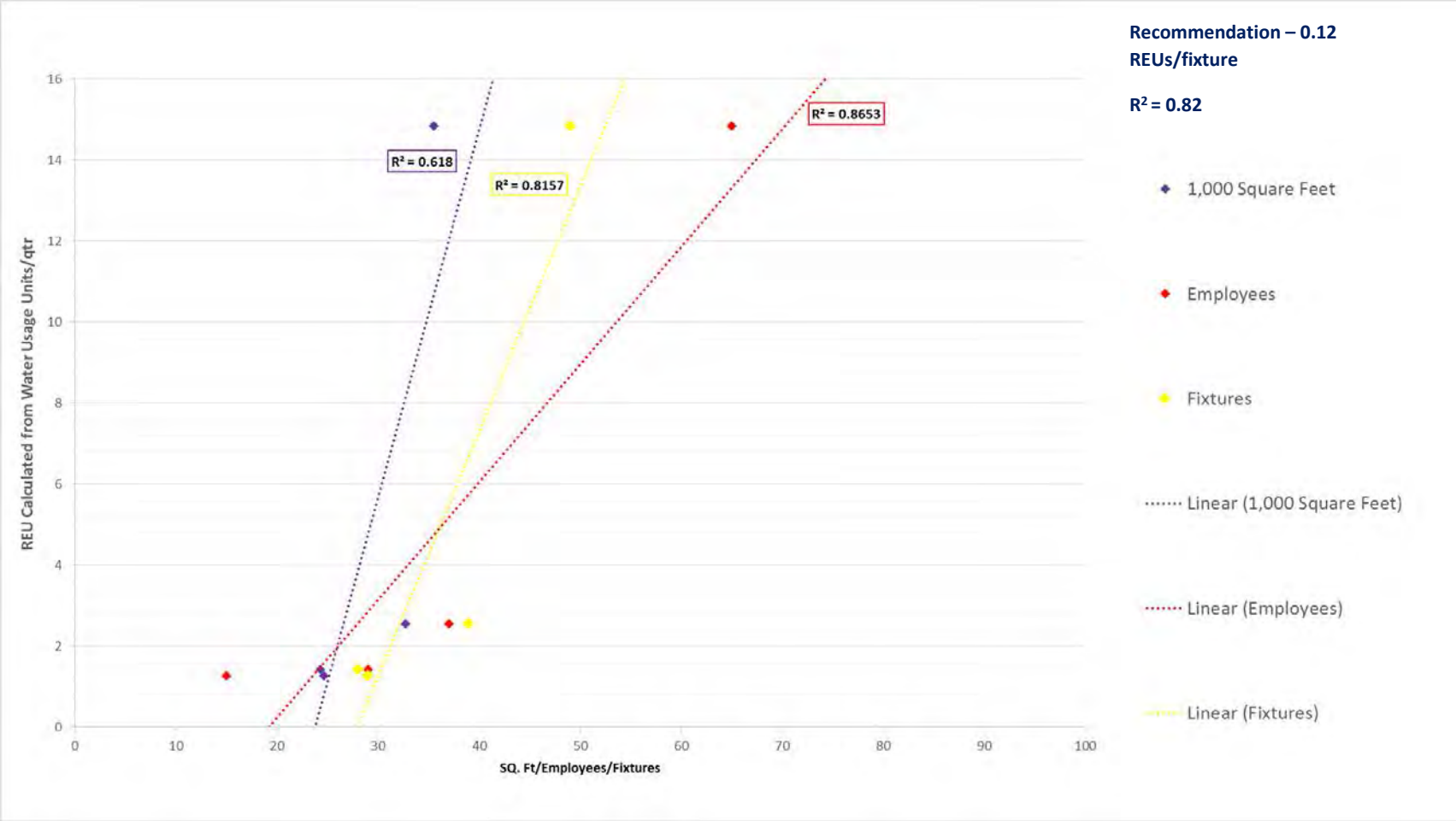


Recommendation – 0.40 REUs/1,000 sq. ft.

R^2 = NA (1998 value utilized)

Appendix IX – Non-Residential Classification Regression Analyses

Office/General/Assembly – Public Institutions (other than hospitals, schools)

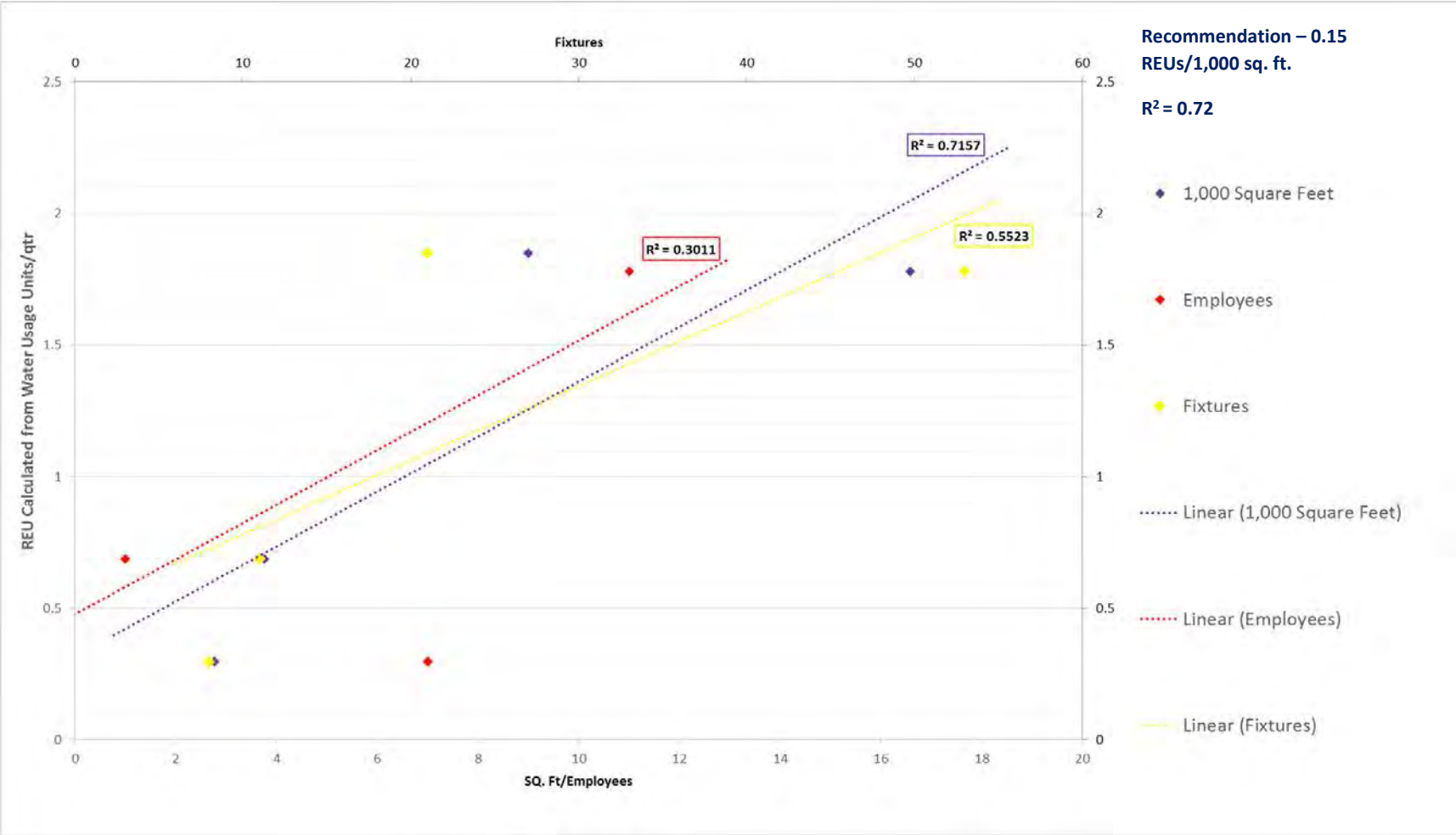


Recommendation – 0.12 REUs/fixture

$R^2 = 0.82$

Appendix IX – Non-Residential Classification Regression Analyses

Service Providers – Funeral Homes

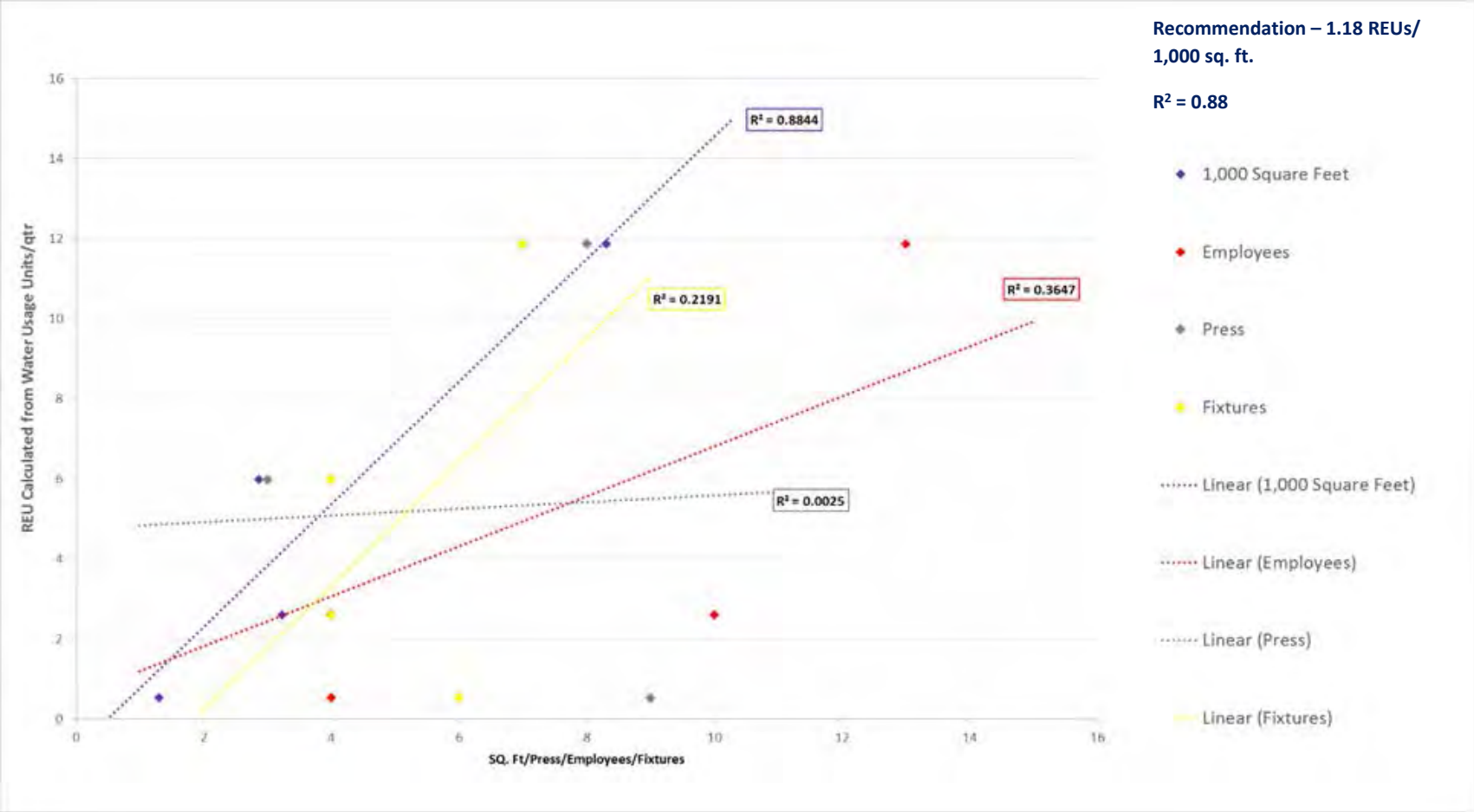


Recommendation – 0.15 REUs/1,000 sq. ft.

$R^2 = 0.72$

Appendix IX – Non-Residential Classification Regression Analyses

Service Providers – Dry Cleaners

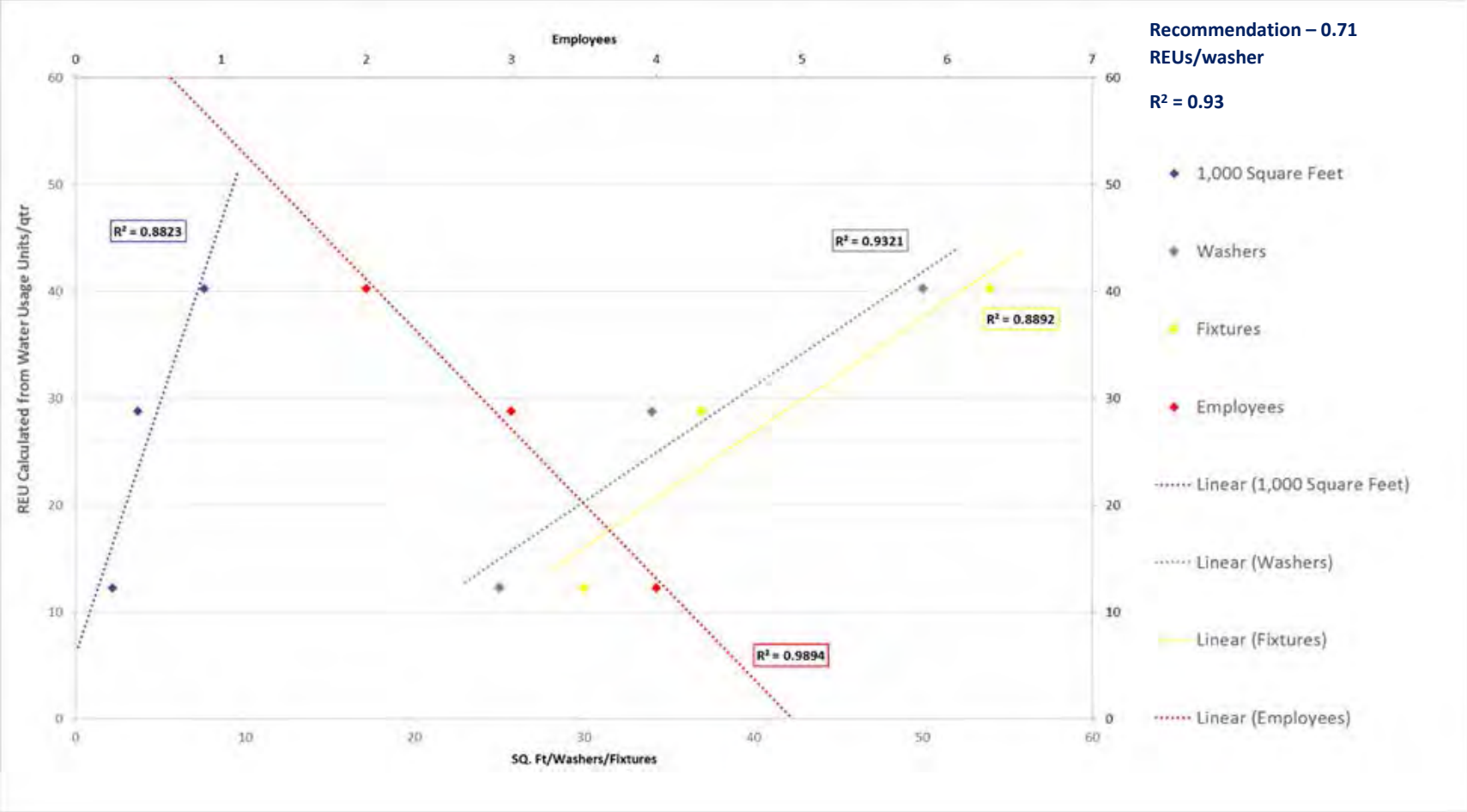


Recommendation – 1.18 REUs/ 1,000 sq. ft.

$R^2 = 0.88$

Appendix IX – Non-Residential Classification Regression Analyses

Service Providers – Self Service Laundry Facilities

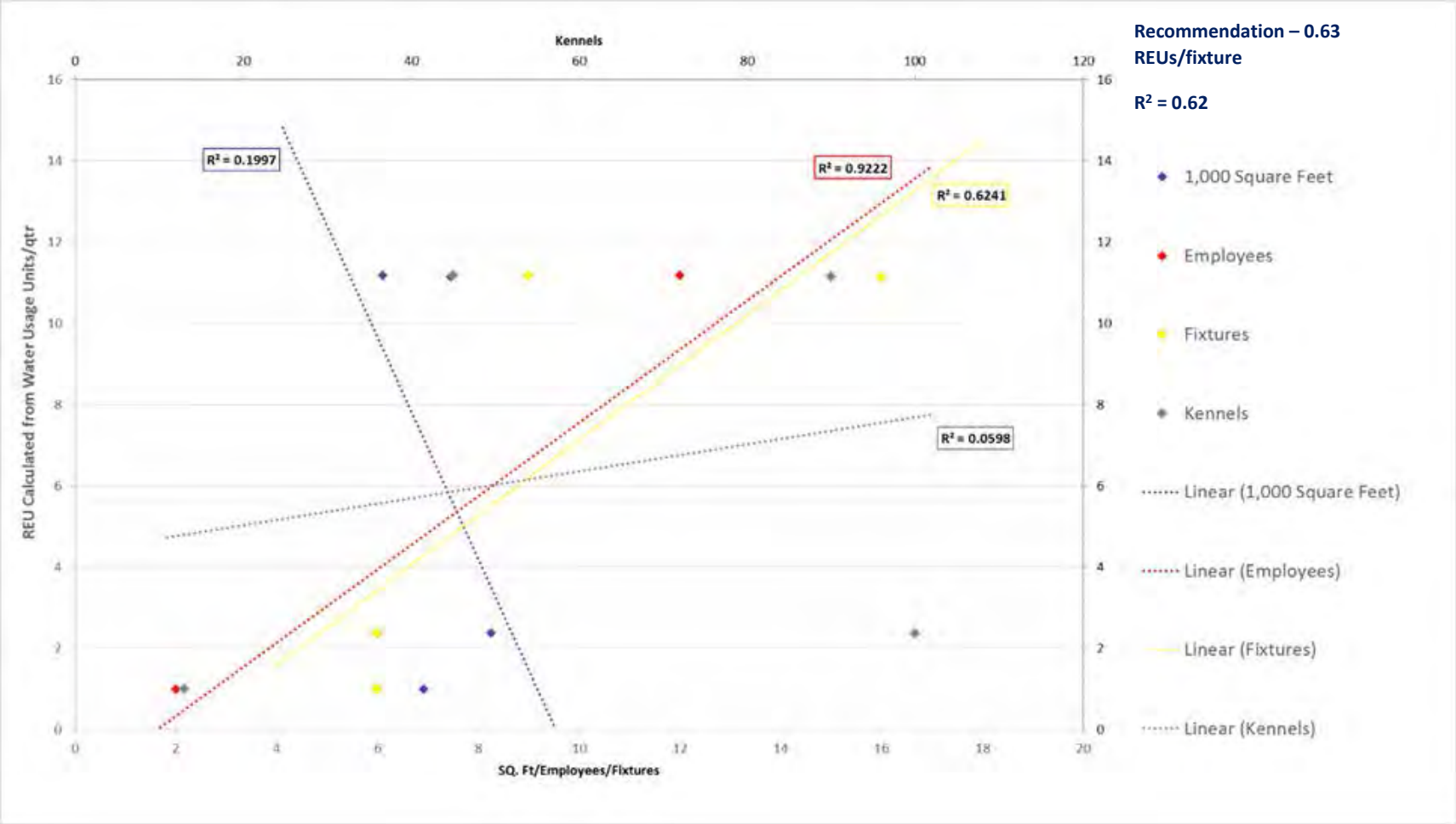


Recommendation – 0.71 REUs/washer

R^2 = 0.93

Appendix IX – Non-Residential Classification Regression Analyses

Service Providers – Pet Care Kennels

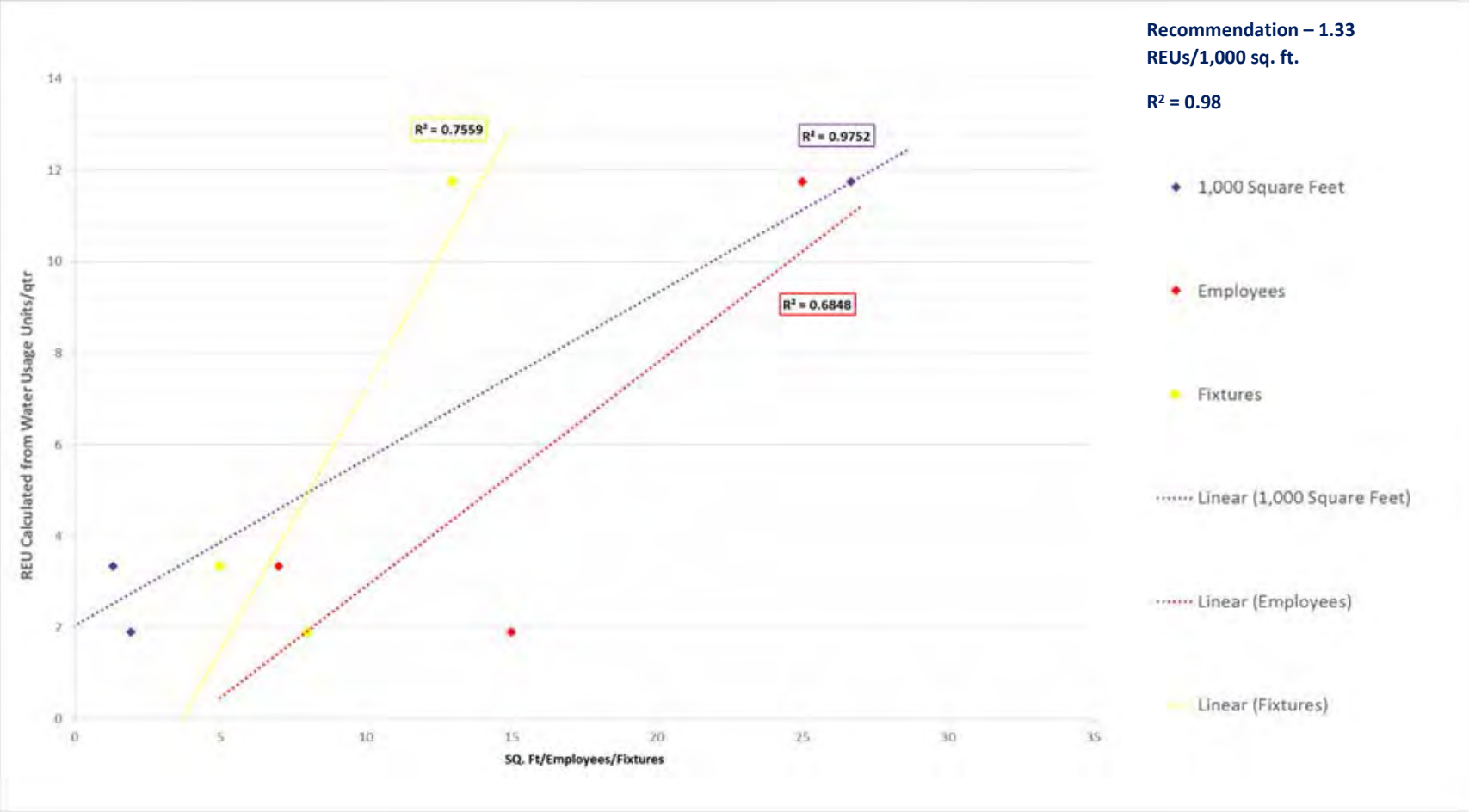


Recommendation – 0.63 REUs/fixture

$R^2 = 0.62$

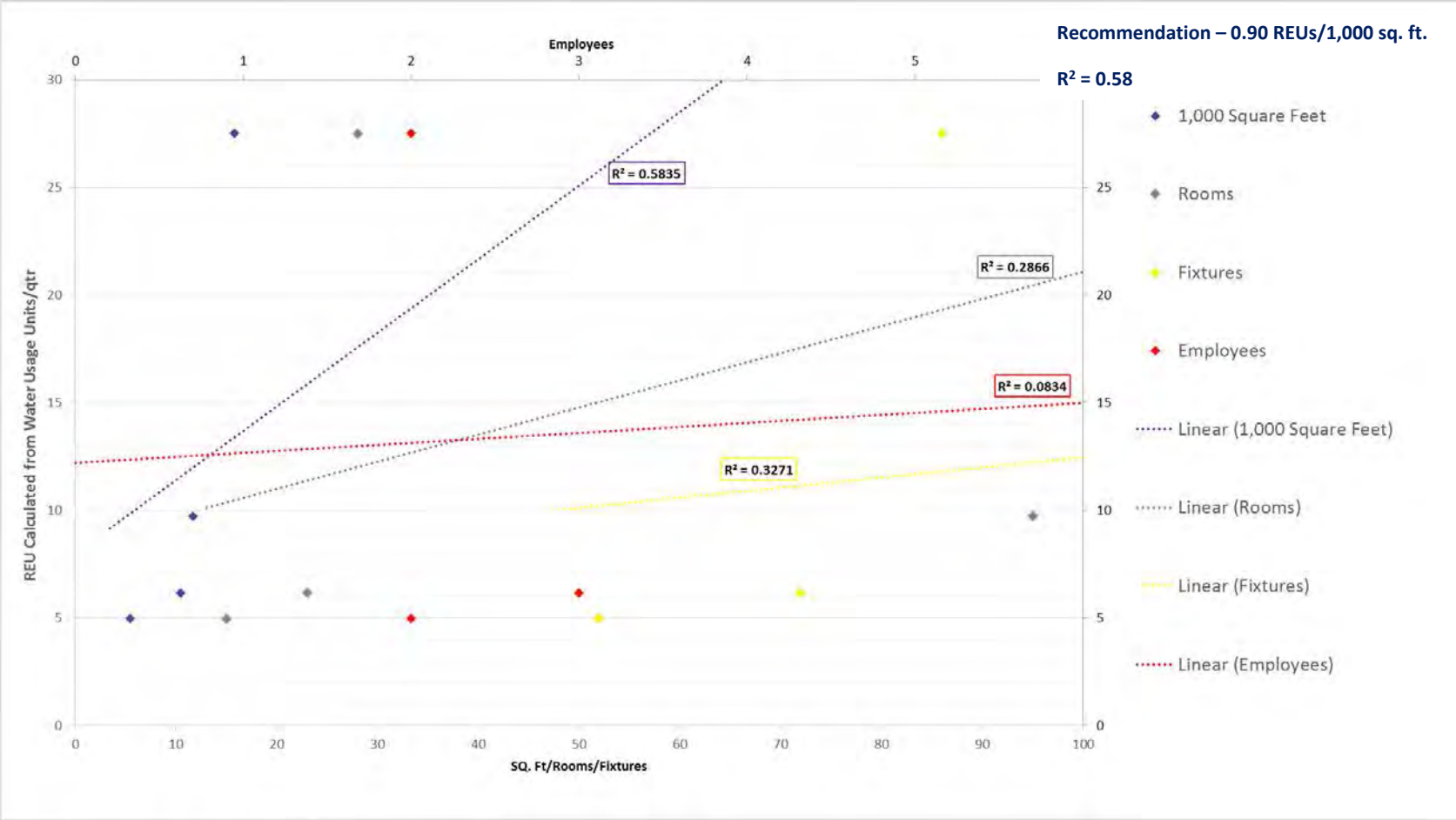
Appendix IX – Non-Residential Classification Regression Analyses

Service Providers – Pet Care Grooming



Appendix IX – Non-Residential Classification Regression Analyses

Service Providers – Motels

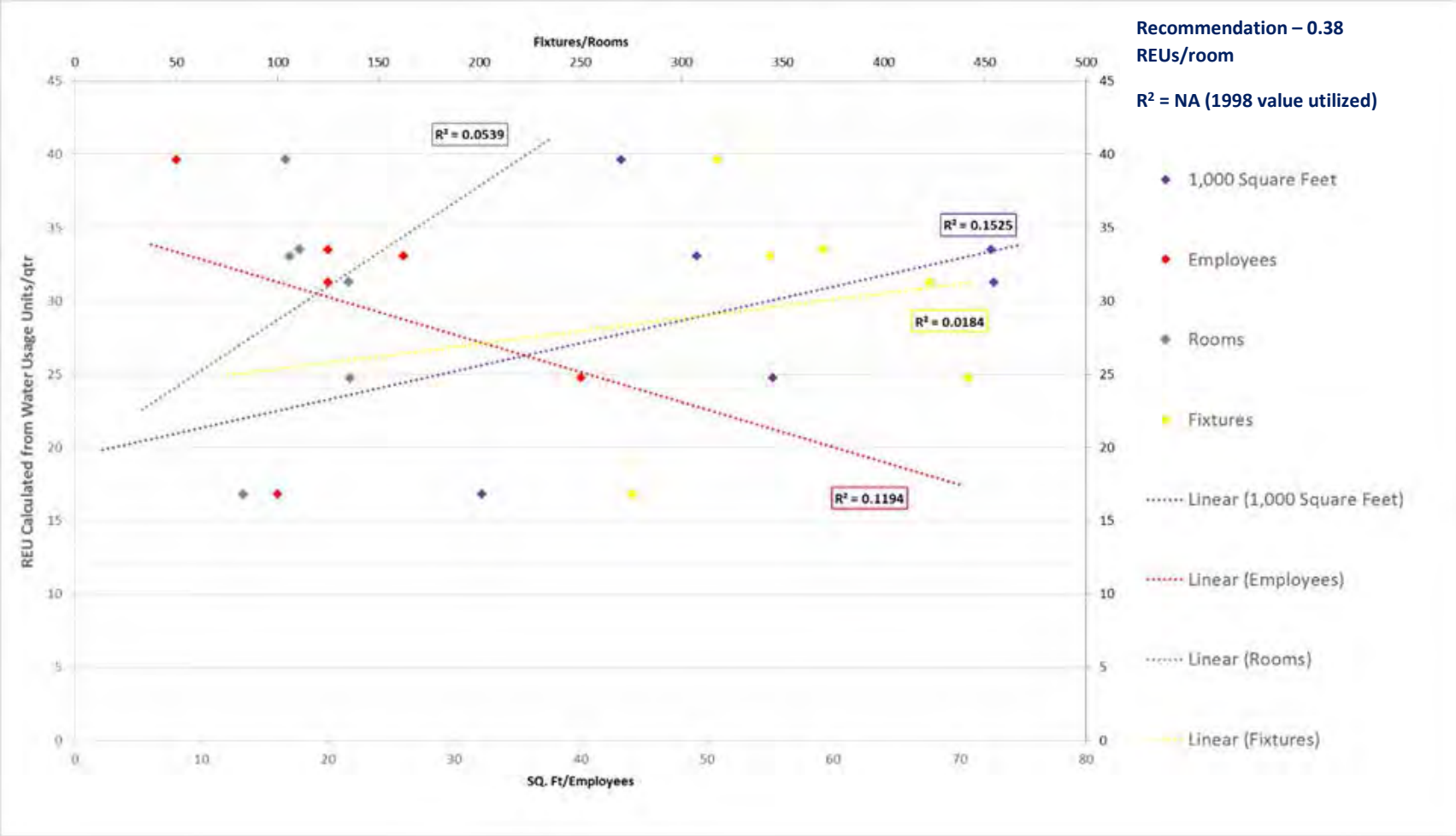


Recommendation – 0.90 REUs/1,000 sq. ft.

R^2 = 0.58

Appendix IX – Non-Residential Classification Regression Analyses

Service Providers – Hotels



Recommendation – 0.38 REUs/room

R^2 = NA (1998 value utilized)

Appendix IX – Non-Residential Classification Regression Analyses

The following non-residential classifications identified by the Steering Committee were eventually eliminated from our suggested/updated Schedule, therefore no regression charts were generated for these properties:

- Automatic Car Washes with recycled water
- Semiautomatic Car Washes (combined with Fully Automatic Car Washes category)
- Bus Maintenance Facilities
- Outdoor Seating
- Hotels/Motels without in-house laundry service
- Cleaners (pick-up only)
- Spa/Massage Parlor (combined with Office/General)
- Indoor Smoking Establishments (combined with Restaurants w/ Liquor)