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Utility Customer Profile Guide for Water Conservation Planning

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Texas A&M AgriLife Extension Service

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Introduction

Conservation coordinators and managers often seek recommendations for best management practices (BMPs) that produce the greatest amount of water savings at the least cost. In practice, it is difficult to create a hierarchy of BMPs based on cost and water-savings effectiveness because numerous factors may affect those results, including available conservation funding, how conservation affects revenue generation, differences in customer classifications, conservation goals set by the utility or provider, staff availability and training, economic and social values of water, and customers' attitudes regarding conservation. Therefore, performing a customer profile in each utility service area is necessary for determining the BMPs that may help achieve water conservation goals.

Box 1. Definition – Customer Profile

The characterization of customer accounts, categorized by levels of billed water consumption, that is indicative of the nature of their individual consumption trends.

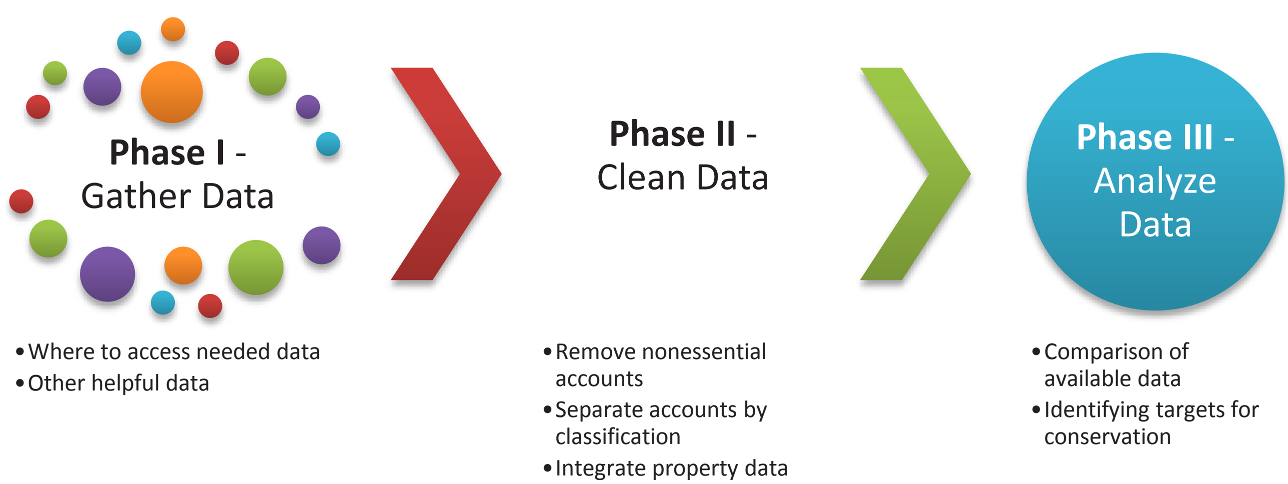
The goal of water conservation planning is not to influence as many water users as possible but to realize the greatest amount of water savings for the least cost. Customer profiling is a very important practice to ensure that resources are used and conservation goals are met in an effective and efficient manner. Completing a customer profile can allow a utility the opportunity to learn how water is used within the service area and what "normal" consumption trends look like for each customer classification, identify high consumptive accounts, and establish mechanisms to educate and encourage high consumptive account holders on implementing more efficient practices for water use that are in-line with the conservation goals of the utility.

While not intended to recommend specific BMPs, this guide will assist utilities with understanding the nature of their customers' usage so the utilities will be better equipped to select the most appropriate conservation BMPs for their service area.

Customer profile process using existing utility sample data set

Customer profiling consists of three phases outlined in Figure 1: I) gather data, II) clean data, and III) analyze data, although implementation of this process will vary among utilities based on available information, time, and expertise. To illustrate a completed customer profile, an anonymous, existing utility consumption data set was processed using the three phases explained in this guide and outlined in Appendix A. Due to data availability and time constraints, only the single-family residential data set was thoroughly analyzed to identify the appropriate audience for targeted conservation efforts. The step-by-step process completed for the sample data set outlines a single method to complete

Figure 1. Phases in the utility customer profiling process



a customer profile, but it is not the only method. This process is meant to stimulate discussion and creative thinking that will benefit a utility and its customers by targeting water conservation BMPs.

1. Phase I – Gather Data

The quantity of available data is an important consideration in Phase I. Three to five years of complete consumption data will be the most beneficial when analyzing trends over time (Brehe and Coll, 2012). As with any analysis, the more data collected, the better informed decisions will be. However, a realistically manageable data set is also important. Therefore, monthly consumption data is best for customer profiling because seasonal trends and unusual high or low consumption periods are still evident and daily consumption may be estimated if desired.

The types of available information must be considered. It is desirable to gather information that will help the utility understand how water is used within the service area. Available demographic and property information integrated with billed consumption data can be strongly indicative of trends and provide a predictive tool for future use among specific customer classifications. Box 2 discusses the importance of the data described below and provides examples of how the data may be analyzed.

Box 2. Importance of Gathered Data

Billed Consumption: Historical consumption data allows the utility to identify trends of water use within its service area.

Property Data: Property characteristics are often indicative of different levels of water consumption, and the information is easily accessible.

> ***Example*** *– Accounts with a high winter average (consumption data) combined with a home built prior to 1992 (property data) may indicate older, high water using appliances and fixtures inside the home and an opportunity for water savings.*

Spatial Data: While not crucial for the process outlined in this guide, spatial comparisons of consumption levels (or even water waste violations) may provide valuable information for conservation BMP decision making.

> ***Exampl****e - Spatial distributions of consumption data may highlight consistent high consumption within neighborhoods, area codes, or political districts, through which a utility can customize conservation BMPs to target those audiences whether through home water audits, education, enforcement, etc.*

1.1. Where to access data

Monthly consumption data is the easiest to collect for all actively metered, potable connections (open accounts) in the service area. Utility billing departments should be able to provide this information if it is not readily accessible by conservation staff.

Local appraisal districts provide detailed, public information for each residential and non-residential property, if it is not already included in the billing data, and is searchable by address and sometimes downloadable for the entire county. Useful information for each property includes a unique identifier, year built, most recent appraised value, and lot or parcel size. If not already included in billing data, this may be a challenge to integrate with the consumption data set, but it can be useful when looking at the characteristics of those highest users. The steps for integrating data are outlined later in Phase II.

1.2. Other helpful data

The "American FactFinder" database (U.S. Census Bureau, 2010), maintained by the U.S. Census Bureau, is a good resource for *general* demographic data such as estimates of people per household (pphh), income and poverty levels, and the distribution of residential structures built by decade (if individual property build-dates are not available from an appraisal district as mentioned above). The Bureau maintains a "QuickFacts Beta" database containing general demographics about people, businesses and the geography of a city, and allows for the comparison of individual cities to each other and the United States as a whole (U.S. Census Bureau, 2015). The most recent census was conducted in 2010, but updated information from community surveys between years 2008 and 2013 is sometimes available. Although general, the demographic data in the database can still provide good indications for the types of users that are present in a particular city.

Most cities and appraisal districts will have spatial data available either on their website, or upon request. Geographical information system (GIS) data sets may include address points, city limits, extraterritorial jurisdiction (ETJ) limits, school districts, watershed areas, land use, municipal utility district (MUD) jurisdictions, streams, roads, railroads, subdivisions, reservoirs, and buildings. Demographic and billed water consumption data may be integrated with available GIS data to analyze spatial trends in use. Spatial distributions of income or appraised property value may reflect consistent usage trends across multiple customer classifications. For example, lower income customers tend to be more efficient with their consumption in order to maintain a low bill. However, those low-income customers with leaks that are difficult or costly to repair may not tend to the issue, so unusually high consumption records in concentrated locations of low-income in a service area may be investigated to identify such problems. Household income is not usually included in utility billing data, so the service area can be separated by average income within different spatial distributions and then compared to locations of any high consumptive users. Appraised property values, typically included in appraisal district data sets, can be used to make assumptions about income levels.

The data gathered in this phase may not be formatted or reported in a way that is useful for comparisons or trend identification. So, the next phase will outline the steps necessary for combining multiple data sets into one data set for analysis.

2. Phase II – Clean Data

The cleaning phase will require the most time, as it is meant to prepare all data for analysis. There are several steps in this phase including removing nonessential accounts, adding calculations to be used for analysis, separating data based on customer classification, and integrating property data into the billed consumption data set. The completely cleaned data set will contain significantly fewer accounts than the original data set but will allow the utility to more accurately analyze a sample of accounts with complete data. Box 3 and Box 4 outline the step-by-step cleaning process, which is explained in more detail in the following sections.

2.1. Identify types of information contained in data set

The amount and type of data present in the billed consumption is important to identify before any cleaning or analysis takes place. As stated in Phase I, three to five years of monthly billed consumption data is ideal for the customer profiling process. In order to accurately calculate the metrics discussed later in this phase, a "complete year" of data should include December of one year to December of the next year (see metric calculation in Box 3, Step 6b).

It is common to have data listed in units of thousand gallons, but it can be listed in units of hundred gallons, gallons, or hundred cubic feet as well. Identifying the unit in which the billed consumption data is listed is very important so the data analysis is accurate.

2.2. Remove closed accounts

Removing nonessential data from the data set will improve manageability and result in a clean data set that is more representative of the current utility service area. Closed billing accounts may give information about historic usage trends, but from a conservation perspective, their consumption is no longer influenced by the implementation of conservation programming. In addition, the effectiveness of conservation programming on closed-account holders can’t be evaluated because the account is no longer associated with a meter that will report consumption data. It is more desirable for a utility to influence account holders that will use water in the future and contribute to an aggregate reduction in water consumption. The removal of any closed accounts (a status designated by the utility) included in the consumption data set will allow the utility to focus its resources on account holders that may participate in water conservation efforts.

2.3. Calculate metrics from existing consumption data

The following calculations may be compared in Phase III, so it is helpful to add columns for each to the existing billed consumption data set if it is not already reported: annual total consumption, annual winter (indoor) average, annual seasonal (outdoor) average and annual assumed indoor and outdoor use. Box 3, Step 6 outlines how to calculate each metric from existing data and how each was applied to the sample data set.

2.4. Separate by customer classification

To compare data, the complete data set must be separated into similar customer use classifications. A residential customer should not be compared to a non-residential customer on any scale, as the characteristics of these customer classifications and the nature of their consumption are inherently different.

Box 3. Sample Utility Data Set: Step-by-Step Cleaning Process

Starting with original billed consumption data set in a spreadsheet program:
[33,885 accounts in the sample data set]:

1. Save a separate spreadsheet with all data, before any changes are made, in case it is needed for reference, or information needs to be recovered.
2. Optional - Format data into a table (*‘Format as Table’* function in Excel) for easier sorting and management.
    a. If a formula is entered in the first cell of a column, then the entire column will auto-generate the same formula for all cells in the same column.
3. Identify all columns of monthly consumption data for *complete* years.
    a. Remove columns of monthly consumption data that were not included in the desired year range.
    b. Sample Data Set: for 2009 to 2013 complete data, monthly consumption from December 2008 to December 2013 was needed.
4. Identify units of monthly billed consumption.
    a. Common units are gallons or thousand gallons.
    b. Sample Data Set: monthly consumption is in hundred gallons.
5. Identify a column for service status that indicates whether the account is open or closed.
    a. This status will be designated by the utility, it is not assumed.
    b. It is possible that the data set already contains only open accounts.
        i. If not apparent, confirm whether all accounts are open.
    c. Sample Data Set: removed all accounts designated closed. **[31,548 open accounts remain]**
6. Create columns for each year for the following metrics:
    a. Annual Total [Jan-Dec Summation]
    b. Annual Winter (Indoor) Average [Dec-Feb Average]
    c. Annual Seasonal Average [Jun-Aug Average minus Winter Average]
        i. Negative results in this column should be replaced by a zero (0) value
    d. Annual Assumed Outdoor Use [Annual Use minus (Winter Average x 12)]
        i. Negative results in this column should be replaced by a zero (0) value
7. Identify column containing customer classifications.
    a. Sample Data Set: split residential and non-residential customer classification data into separate spreadsheets for manageability. **[29,118 open residential accounts remain]**

2.4.1. Residential classification

The residential classification should contain only single-family residential accounts. Winter average (representing monthly indoor use) and seasonal average (representing monthly outdoor use) may be estimated and analyzed individually for single-family accounts. Multi-family properties like apartments and duplexes sometimes contain one billed water account for multiple residences, so they can be considered non-residential in classification since the nature of their use is more difficult to estimate.

2.4.2. Non-residential classification

Non-residential customers are more difficult to classify since there are many different uses of water in this sector, but doing so will allow for an accurate comparison between users of the same type. A large-scale manufacturing customer or car wash facility will most likely have higher consumption levels than an office park. The most complete list of classifications can be found in the North American Industry Classification System (NAICS), which consists of two- to six-digit classifications that describe the type of use for each account.

If NAICS is not available in the consumption data set or the other data gathered, then non-residential users must be classified manually, which can be a tedious step. It can be helpful to sort users from highest to lowest annual consumption and isolate a specified number of users with the highest annual consumption so that the process of classification can be applied to only those customer accounts that may allow the utility to realize the largest amount of savings, instead of the entire data set.

2.5. Remove low-use accounts

There are multiple reasons, both problematic and legitimate, that accounts have low or even zero water use. To accurately identify the characteristics of water users in the service area, these accounts may be removed or hidden from the usable data set. The low-use metric can differ among utilities. It is possible for a one-person, water-efficient home to use 1,500 gallons per month (50 gpcd) (Vickers, Tiger, and Eskaf, 2013), so any billed consumption less than 1,000 gallons a month is a safe metric to use for removing low-use accounts because the reason for these low bills is difficult to determine.

2.6. Integrate property data

In preparation for Phase III, the final step of Phase II is to integrate the property data set with the consumption data set. The most important part of this step is a unique identifier for each account property that serves to link the two data sets and will allow for the import of additional property data (other than the property data recommended in this guide) for comparison, should the utility see it necessary. Once the correct unique identifiers are determined for each property, the property data imported is assumed accurate since it is linked to the unique identifier.

For the purposes of the process outlined in this guide, the property data imported into the consumption data, using the unique identifiers, include the property year built and the assessed home value. Box 4, Steps 3-4 outline the specific steps taken with the sample utility data set to import the property data and ensure that it is complete and correct. Notice that account properties with duplicate or missing unique identifiers were first researched and then removed from the consumption data set.

3. Phase III – Analyze Data

The most important phase–the analysis phase–of the customer profile process is where the characteristics of customers consuming the largest amount of water are identified. The analysis can be as simple or as in-depth as deemed necessary. There are many characteristics that may be compared to water consumption. For purposes of this guide,

Box 4. Sample Utility Data Set: Continued Step-by-Step Cleaning Process
Starting with complete, open, residential accounts in a separate spreadsheet.
[29,118 accounts remain – following completion of Step 7 in Box 3]:

8. Remove low-use accounts for all monthly consumption data.
    a. Low-use threshold: < 1,000 gallons per month
    b. **Sample Data Set:** filtered each column December 2008 to December 2013 to show only values greater than or equal to 10 (10 hundred gallons = 1,000 gallons).
9. Create columns for property information:
    a. A unique identifier for each account
        i. **Sample Data Set:** Property ID
    b. Year Built
    c. Most recent Assessed Property Value
        i. **Sample Data Set:** 2014 Assessed Value
10. Import property data from downloaded Appraisal District database using a query function.
    a. Import unique identifiers.
        i. **Sample Data Set:** used a *'Lookup'* formula in Excel to compare full address (street number and street name only) in both consumption and property data sets to import Property ID.
            1. Optional – imported a *'Property Type Code'* field to ensure that the property IDs are correct (to confirm all residential properties had a *'RES'* property type code, and not a property type code associated with a non-residential account or land).
    b. Import Years Built.
        i. **Sample Data Set:** used a *'Lookup'* formula in Excel comparing Property ID in both consumption and property data sets to import Year Built.
    c. Import most recent Assessed Home Values.
        i. **Sample Data Set:** used a *'Lookup'* formula in Excel comparing Property ID in both consumption and property data sets to import Assessed Home Value.
11. Examine accounts without individual unique identifiers.
    a. Typos or abbreviations in the full address fields can interfere with the query function in the previous step that imports the property data into the consumption spreadsheet and shows an error instead of the desired unique identifier.
    b. **Sample Data Set:** removed accounts with no Property ID number, or accounts that shared a Property ID number with another property address (may be multi-family residences or duplexes). **[17,774 accounts remain]**

the following comparisons have been made using the existing utility data set and outlined below:

- Use distributions (by classification, year built, assessed value)
- Indoor vs. Outdoor Consumption
- Cross comparison of Indoor vs. Outdoor Percentiles

Some comparisons of water use may not be appropriate for all customer classifications. For example, it would be appropriate to compare water use on a per capita (per person) basis when comparing single-family residential accounts, because the nature of consumption is the same for most single-family residential customers. Residential water consumption includes indoor uses such as cleaning, bathing, drinking, and cooking, while outdoor water use can include irrigation, car washing, and cleaning. However, non-residential customers use water in a different way, even when compared to each other, so methods of normalization are necessary (Morales and Heaney, 2014). Normalization is as simple as comparing water consumption per output. Car washes evaluate their efficiency in terms of gallons per car. Institutional, Commercial, and Industrial (ICI), or non-residential, customers *can* be analyzed based on water consumption per dollar of sales. The idea is to use terms that are comparable to each other without having to further sub-classify customers. Box 5 and Box 6 list all table calculations by table column headings.

3.1. Use Distributions

Use distributions are simple comparisons that serve to familiarize the utility with the service area. Average annual use per account was calculated as a method of normalization to be able to compare individual accounts in each of the categories to each other, instead of attempting to compare aggregate total consumption.

The Total Use distribution for the sample utility in Table 1 includes all open, zero and low-use accounts, with use shown in thousand gallons. The aggregate consumption for all five years in the sample data set is used to compare the characteristics between the different classifications as assigned by the sample utility. Alternatively, this analysis may be compared annually to identify trends and view changes in water use. The percentage of accounts compared to the percentage of use is of particular interest since it illustrates the impact of the highest users of water within the utility service area. It is evident that the residential classification represents the greatest number of accounts and the highest use of water (Table 1), which is why it is important to understand the characteristics of those users so effective BMPs may be identified.

Table 1. Distribution of customer classification, as assigned by the sample utility, compared to *Total Use*

Classification and Description		# of Accts	% of Accts*	2009-2013 Total Use (1000 gal)	2009-2013 Total Use %*
R	Residential	27,597	87.48%	15,695,281	47.62%
MUD	Municipal Utility District	34	0.11%	5,481,213	16.63%
C	Commercial	1,317	4.17%	4,494,148	13.64%
CIR	Commercial Irrigation	564	1.79%	2,841,524	8.62%
APT	Apartment	215	0.68%	2,261,232	6.86%
CTY	County	169	0.54%	937,189	2.84%
OSC	Outside City	1,521	4.82%	882,865	2.68%
GOV	Government	76	0.24%	300,977	0.91%
FH	Fire Hydrant (Construction)	38	0.12%	11,040	0.03%
I	Industrial	6	0.02%	31,720	0.10%
RIR	Residential Irrigation	11	0.03%	23,079	0.07%
Total		**31,548**		**32,960,268**	

**heat mapping (gradient color scheme) provides a visual image of low (green) to high (red) consumption totals in each classification*

Table 2 shows the distribution of residential property year built compared to total use in terms of average annual use per account. The first two rows of the figure shows properties built before and after 1992. The significance of this date is tied to the Energy Policy Act of 1992 when there were low-use standards set for both residential and non-residential appliances, after which building codes were required to comply with the standards (Alliance for Water Efficiency, Koeller & Co, 2014). Due to this new standard, homes built after 1992 would most likely not show significant water savings from the implementation of toilet replacement and rebate programs because they already have low-flow toilets. For this reason, it is helpful to be aware of the number of properties built after the standards were set to be able to identify whether or not toilet replacement BMPs result in a large amount of savings across the entire service area, or if programs like this can be targeted at certain groups, which would require account holders to qualify for the program based on the year that the property was built.

Table 3 similarly illustrates the comparison of assessed home value to the average annual use per account. In the sample utility data set, it is clear that the average use per account increases when home value increases.

Table 2. Distribution of available property *Year Built* compared to *Total Use* and the *Average Annual Use per Account* both before and after 1992, and in each decade for residential accounts (17,739)

Year Built	Number of Accts	Percentage of Accts	2009-2013 Total Use (gallons)	2009-2013 Total Use Percentage	Average Annual Use per Account (gallons)*
1992 and prior	5,569	33.2%	3,265,906,200	27.62%	103,412
After 1992	12,170	72.5%	8,558,430,100	72.38%	126,830
Total	**17,739**		**11,824,336,300**		
≤1900	3	0.02%	2,281,700	0.02%	152,113
1901-1910	6	0.04%	4,636,900	0.04%	154,563
1911-1920	5	0.03%	2,576,900	0.02%	103,076
1921-1930	11	0.07%	6,013,800	0.05%	109,342
1931-1940	33	0.20%	14,051,000	0.12%	85,158
1941-1950	34	0.20%	14,675,300	0.12%	86,325
1951-1960	27	0.16%	14,623,000	0.12%	108,319
1961-1970	56	0.33%	32,074,400	0.27%	114,551
1971-1980	2,006	11.94%	1,217,849,600	10.30%	121,421
1981-1990	2,810	16.73%	1,559,606,400	13.19%	111,004
1991-2000	6,396	38.08%	4,362,166,200	36.89%	136,403
2001-2010	6,343	37.77%	4,583,876,700	38.77%	144,533
≥2011	9	0.05%	9,904,400	0.08%	220,098
Total	**17,739**		**11,824,336,300**		

**heat mapping (gradient color scheme) provides a visual image of low (green) to high (red) use per account*

Table 3. Distribution of available property *Assessed Value* compared to *Total Use* and the *Average Annual Use per Account* in each home value range for residential accounts (17,768)

2014 Assessed Home Value	Number of Properties	Percentage of Total Properties	2009-2013 Total Use (gallons)	2009-2013 Total Use-Percentage	Average Annual Use per Account (gallons)*
Less than $50,000	13	0.07%	5,536,800	0.05%	85,182
$50,000 to $99,999	202	1.14%	81,023,900	0.68%	80,222
$100,000 to $149,999	5,002	28.15%	2,272,199,800	19.19%	90,852
$150,000 to $199,999	5,485	30.87%	3,017,862,300	25.49%	110,041
$200,000 to $299,999	4,361	24.54%	3,330,586,600	28.13%	152,744
$300,000 to $499,999	2,579	14.51%	2,913,352,300	24.61%	225,929
$500,000 to $999,999	125	0.70%	221,251,800	1.87%	354,003
$1,000,000 or more	1	0.01%	2,673,000	0.02%	534,600
Mean Value	$207,601				

**heat mapping (gradient color scheme) provides a visual image of low (green) to high (red) use per account*

3.2. Indoor Use compared to Outdoor Use

As described in Box 3, the winter average of all residential accounts was calculated to determine indoor use, and indoor use was subtracted from total use to determine the outdoor use for Table 4. The Summer Use table is of particular interest because it fairly compares outdoor and indoor use for residential accounts in months where outdoor use is assumed to occur more frequently (summer months June to August). Although outdoor and indoor Annual Use is useful information for determining maximum use trends, it inaccurately compares the two since outdoor use does not occur year-round, whereas indoor use is assumed year-round so it shows a larger percentage of use. Figure 2 shows the summer outdoor and indoor use in graphical form.

Table 4. Assumed outdoor and indoor use totals for residential accounts (17,774)

Aggregate Assumed Distribution	Annual Use (gallons)		Aggregate Assumed Distribution	Summer Use Jun-Aug (gallons)	Percentage
2009 Outdoor	748,223,700		2009 Outdoor	521,371,700	55.14%
2009 Indoor	1,618,737,000		2009 Indoor	424,111,400	44.86%
2010 Outdoor	911,023,800		2010 Outdoor	408,263,200	55.35%
2010 Indoor	1,267,888,100		2010 Indoor	329,395,600	44.65%
2011 Outdoor	1,328,372,100		2011 Outdoor	679,829,400	63.83%
2011 Indoor	1,500,144,300		2011 Indoor	385,196,300	36.17%
2012 Outdoor	1,049,008,100		2012 Outdoor	505,920,200	60.17%
2012 Indoor	1,300,963,600		2012 Indoor	334,841,900	39.83%
2013 Outdoor	624,016,400		2013 Outdoor	340,739,300	46.36%
2013 Indoor	1,499,686,400		2013 Indoor	394,183,300	53.64%

3.3. Cross-comparison of Indoor and Outdoor Use Levels

To categorize residential accounts into groups of similar use, consumption levels were determined using percentiles of seasonal (outdoor) and winter (indoor) use from residential consumption in 2009. For the sample data set, 2009 was used as the baseline year because it was the first year of consumption data, and it was the first year that the utility participated in conservation programming. The levels of use used for analysis are shown in Table 5.

Table 6 was determined by a cross-comparison of the use levels from ranges of use in Table 5. The first column in the figure shows the number of accounts in each group, and the second column illustrates the cumulative five-year change in number of accounts, as well as the one-year changes between each of the five years in the data set. It is desirable to see a positive change in the direction of Level 1 for both Seasonal and Winter Use, which indicates that accounts are reporting lower water consumption.

Figure 2. Graphical representation of the data in Table 4; Summer Use section only

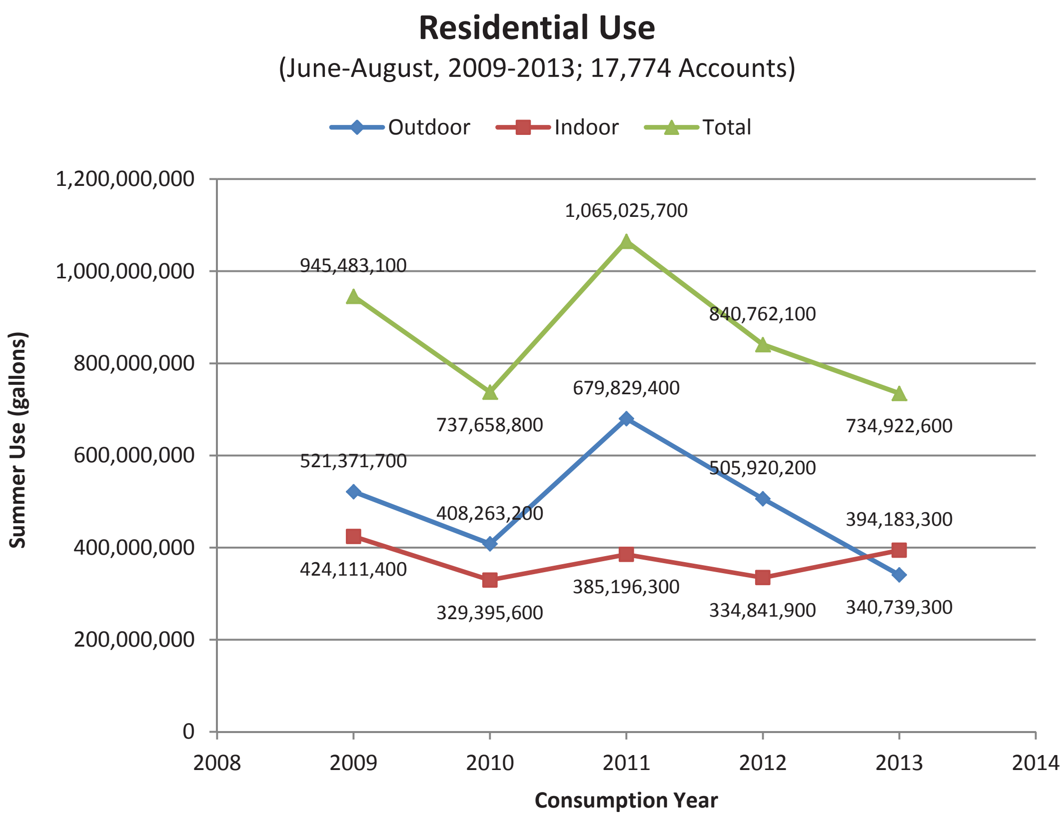


Table 5. Residential levels of use, in gallons, calculated from seasonal and winter percentiles for all accounts in 2009; seasonal and winter use is assumed to represent outdoor and indoor use, respectively.

Monthly Consumption Levels (gallons)

Levels	Seasonal Min	Seasonal Max	Winter Min	Winter Max	Data Set Percentile
1	0	300	1,101	3,267	**10th**
2	301	2,742	3,268	4,542	**25th**
3	2,743	7,367	4,543	6,400	**50th**
4	7,368	13,933	6,401	9,367	**75th**
5	13,934	22,633	9,368	14,100	**90th**
6	22,634	183,467	14,101	98,333	**MAX**

Table 6. *Number of Accounts*, and *Change in Number of Accounts* categorized by cross-comparison of Seasonal and Winter Use Levels

2009 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	149	224	348	383	280	401
2	478	514	739	558	233	137
3	549	840	1257	1062	506	244
4	366	616	1203	1223	708	316
5	161	315	582	763	540	303
6	83	148	334	457	381	372

5-Year Change 2009-2013 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	335	370	413	366	166	14
2	283	377	340	268	113	2
3	-6	-54	-79	24	42	-8
4	-88	-126	-402	-347	-127	-74
5	-29	-112	-174	-271	-169	-111
6	-58	-63	-173	-250	-202	-190

2010 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	365	461	681	704	399	255
2	779	929	1072	723	225	66
3	662	985	1299	948	294	82
4	496	737	1096	828	262	79
5	260	378	687	494	174	66
6	135	221	355	333	167	76

1-Year Change 2010-2011 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	216	237	333	321	119	-146
2	301	415	333	165	-8	-71
3	113	145	42	-114	-212	-162
4	130	121	-107	-395	-446	-237
5	99	63	105	-269	-366	-237
6	52	73	21	-124	-214	-296

2011 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	188	247	350	342	232	222
2	424	475	597	446	170	68
3	553	694	1006	761	350	144
4	457	739	1136	1055	488	198
5	283	548	902	909	529	189
6	170	341	690	871	574	424

1-Year Change 2011-2012 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	-177	-214	-331	-362	-167	-33
2	-355	-454	-475	-277	-55	2
3	-109	-291	-293	-187	56	62
4	-39	2	40	227	226	119
5	23	170	215	415	355	123
6	35	120	335	538	407	348

2012 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	321	357	515	450	237	206
2	676	757	846	509	169	51
3	735	960	1216	864	331	104
4	564	810	1230	934	428	114
5	347	515	765	641	286	111
6	150	282	478	436	233	146

1-Year Change 2012-2013 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	133	110	165	108	5	-16
2	252	282	249	63	-1	-17
3	182	266	210	103	-19	-40
4	107	71	94	-121	-60	-84
5	64	-33	-137	-268	-243	-78
6	-20	-59	-212	-435	-341	-278

2013 — Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	484	594	761	749	446	415
2	761	891	1079	826	346	139
3	543	786	1178	1086	548	236
4	278	490	801	876	581	242
5	132	203	408	492	371	192
6	25	85	161	207	179	182

Seasonal (rows) by *Winter* (columns)

Levels	1	2	3	4	5	6
1	163	237	246	299	209	209
2	85	134	233	317	177	88
3	-192	-174	-38	222	217	132
4	-286	-320	-429	-58	153	128
5	-215	-312	-357	-149	85	81
6	-125	-197	-317	-229	-54	36

**heat mapping (gradient color schemes) provide a visual image of low (green) to high (red) number of accounts in each category, and an increase (red) and decrease (blue) in number of accounts between each year*

Box 5. Table Calculations: Tables 1-6

Listed by table column headings
Time periods for each calculation matter – annual measures unless specifically designated by:
*can be annual measure or aggregate measure of all years in the data set (as seen in the table)

Table 1 – Use Distribution: Customer Classification	
Number of Accts	*Number of accounts in the designated classification*
Percentage of Accts	*(Number of accounts in classification ÷ Total number of accounts) x 100*
Total Use*	*Sum of annual use for all accounts in classification*
Total Use Percentage	*(Sum of annual use in classification ÷ Total use for all accounts) x 100*
Table 2 – Use Distribution: Year Built	
Number of Accts	*Number of accounts in the designated range of years built*
Percentage of Accts	*(Number of accounts in year range ÷ Total number of accounts) x 100*
Total Use*	*Sum of annual use for all accounts in year range*
Total Use Percentage	*(Sum of annual use in year range ÷ Total use for all accounts) x 100*
Avg Annual Use per Acct	*(Sum of annual use in year range ÷ Number of years of data ÷ 'Number of Accts')*
Table 3 – Use Distribution: Assessed Home Value	
Number of Properties	*Number of accounts in the designated range of home values*
Percentage of Total Properties	*(Number of accounts in home value range ÷ Total number of accounts) x 100*
Total Use*	*Sum of annual use for all accounts in home value range*
Avg Annual Use per Acct	*Sum of annual use in home value range ÷ Number of years of data ÷ 'Number of Properties'*
Table 4 – Outdoor and Indoor Use	
Annual Indoor Use	*Annual winter average for all accounts x 12* [months in a year]
Annual Outdoor Use	*Total annual use – 'Annual Indoor Use'*
Seasonal Indoor Use	*Annual winter average for all accounts x 3* [months during summer season]
Seasonal Outdoor Use	*Sum of use for all accounts from June to August – 'Seasonal Indoor Use'*
Percentages	*(Annual Indoor Use ÷ Total Annual Use) x 100* *(Annual Outdoor Use ÷ Total Annual Use) x 100*
Table 5 – Consumption Level Designations (use only one year of data to determine levels)	
Seasonal Max	*Percentiles of seasonal average consumption (10th, 25th, 50th, 75th, 90th and Maximum value)*
Seasonal Min	*Level 1: Minimum seasonal average; Level 2+: 'Seasonal Max' in Level above + 1*
Winter Max	*Percentiles of winter average consumption (10th, 25th, 50th, 75th, 90th and Maximum value)*
Winter Min	*Level 1: Minimum winter average; Level 2+: 'Winter Max' in Level above + 1*
Table 6 – Cross-comparison of Consumption Levels	
Number of Accounts	*Number of accounts in a given seasonal AND winter consumption level*
Change*	*Change in number of accounts*

Table 7, Table 8, and Table 9 report the final analysis in this phase and will help the utility determine which audience to target conservation BMPs. For all account groups that were categorized in Table 6, these tables show annual use and annual use per account for each year in the data set, and average annual use per account in the five-year period. It is evident that the account group in level 4 of both seasonal and winter use tends to show the largest total use in Table 7 and Table 9. This group represents the largest user of water within the residential classification, and the characteristics of this group can be evaluated from the integrated consumption and property data set to determine which BMP will best encourage the group to reduce their consumption. There also exists an opportunity to target BMPs toward level 10 of both seasonal and winter use with the largest annual use per account, as seen in Table 8 and Table 9. This group has different characteristics from those in level 10, so conservation programming may be determined to best target those account holders.

In addition, Table 8 and Table 9 show a baseline metric (blue line) that can be considered a defining level of efficient consumption, in the sample utility service area, where it is desirable for a larger number of accounts to stay below. Individual utility baseline metrics are calculated using the number of persons per household, which is determined on an individual service area basis (U.S. Census Bureau, 2015), and the national median indoor use per person, 60 gpcd, determined by a residential water use study funded by the Water Research Foundation (Mayer, et al., 1999). Table 8 also offers an actual annual indoor use metric (red line) in order to compare actual to desired consumption and is calculated using the average of the winter average of each account in the consumption data set.

Recommendations

Frequency of Analysis

It is important for the process of utility customer characterization to occur on a regular basis. Annual customer characterizations within the utility or utility conservation program will produce more accurate and informative trends of water consumption within different customer categories. Managers will become familiar with normal usage trends and be able to better recognize anomalous and consistent high consumption levels. An annual process will also help managers target BMPs accordingly and to be able to recognize the point at which specific BMPs are no longer needed among different groups, when accompanied with program evaluations.

Outliers, or customers with significantly higher annual consumption than other similar users in their category, may be apparent and indicate the need for inquiry. Additionally, if a customer has a significant increase in annual consumption, an examination would benefit both the customer and the utility. If customers have unusually high consumption as a result of inefficient practices, the utility has an opportunity to work with that user to reduce consumption.

Computational Assistance

Where utility and conservation managers benefit from being able to look at data trends, they may also benefit from computational assistance within Information Technology and GIS departments. Those technicians trained in data manipulation and analysis may be able to more efficiently prepare and sort data sets, and present them in a way that is useful to managers for making decisions about conservation programming.

BMP Selection

Once the characteristics of high consumptive users have been identified, BMPs may be chosen. When considering conservation programs for residential customers, indoor and outdoor programs are usually separated, focusing more heavily on indoor programming since making changes to fixtures and appliances inside the home makes it easier for customers to participate, rather than making changes in water use behavior. For example, it is common for utilities to adopt toilet replacement programs early in the planning process because low-flow toilets save a considerable amount of water when replacing older high-flow toilets.

Table 7. *Annual Use* (gallons) for residential accounts in Table 6

2009 — *Winter* (columns) / *Seasonal* (rows)

Levels	1	2	3	4	5	6
1	4,667,400	9,915,900	21,059,800	30,857,100	31,202,600	78,958,900
2	30,296,300	28,264,100	53,387,500	53,585,800	30,283,400	28,158,900
3	30,047,000	59,356,300	109,990,400	118,632,300	75,135,600	54,706,700
4	29,508,600	58,129,500	134,664,600	166,685,100	120,909,300	78,967,100
5	18,717,200	41,203,800	85,205,600	127,335,600	110,520,300	85,754,700
6	15,906,200	28,612,000	70,197,800	107,982,400	105,258,800	144,429,200

2010 — *Winter* (columns) / *Seasonal* (rows)

Levels	1	2	3	4	5	6
1	11,714,800	21,467,400	41,328,400	59,565,500	44,718,600	45,661,000
2	32,714,000	53,803,700	80,189,400	72,243,200	30,888,200	13,588,400
3	41,996,300	77,457,200	124,883,600	116,394,100	46,845,800	18,196,000
4	49,021,900	84,572,000	144,122,200	130,550,600	51,893,500	21,832,600
5	37,801,900	60,884,600	123,867,300	100,825,900	43,412,000	21,213,100
6	30,725,700	55,113,700	93,419,600	99,802,100	59,656,700	36,464,100

2011 — *Winter* (columns) / *Seasonal* (rows)

Levels	1	2	3	4	5	6
1	6,044,300	11,115,200	21,586,800	27,891,600	25,734,500	41,370,800
2	17,703,800	27,144,800	44,281,200	44,546,800	23,014,100	14,928,100
3	34,826,200	52,834,300	94,666,100	90,739,800	54,683,600	33,948,200
4	43,054,400	79,628,200	143,786,300	159,745,200	93,143,600	54,383,200
5	39,000,600	84,638,900	154,995,100	178,676,600	125,043,700	60,183,300
6	37,530,700	80,107,800	179,913,500	253,485,400	196,470,400	197,493,700

2012 — *Winter* (columns) / *Seasonal* (rows)

Levels	1	2	3	4	5	6
1	9,877,600	16,017,100	31,210,100	37,247,900	25,818,100	37,379,400
2	26,694,100	42,297,000	61,631,500	50,344,600	22,864,400	11,262,900
3	43,797,100	71,894,600	113,267,000	103,251,400	52,901,000	25,108,000
4	53,566,100	90,218,500	158,021,200	145,943,400	83,193,700	31,118,900
5	48,899,600	82,167,000	135,471,000	128,993,700	68,942,000	37,105,600
6	33,059,100	68,129,200	126,606,500	126,310,000	81,294,200	68,068,200

2013 — *Winter* (columns) / *Seasonal* (rows)

Levels	1	2	3	4	5	6
1	14,400,900	26,678,900	45,294,100	60,124,200	47,914,500	82,645,500
2	29,985,900	49,557,600	78,222,400	79,672,800	46,230,300	31,522,800
3	31,871,100	58,116,100	107,236,700	126,380,500	83,996,100	53,928,300
4	24,881,300	50,992,100	97,072,500	130,092,700	107,181,000	64,924,700
5	17,296,800	29,781,600	67,667,200	92,881,600	82,806,100	57,714,500
6	5,050,700	18,129,200	38,515,200	54,879,000	55,328,300	74,695,100

**heat mapping (gradient color scheme) provides a visual image of low (green) to high (red) consumption totals in each category*

Table 8. *Annual Use per Account* (gallons) for residential accounts in Table 6

Baseline (blue line): 2.96 pphh * 60 gpcd * 365 d/yr = 64,824 gal/acct/year

2009 — Seasonal (rows) × Winter (columns)

Levels	1	2	3	4	5	6
1	31,325	44,267	60,517	80,567	111,438	196,905
2	63,381	54,989	72,243	96,032	129,972	205,539
3	54,730	70,662	87,502	111,706	148,489	224,208
4	80,625	94,366	111,941	136,292	170,776	249,896
5	116,256	130,806	146,401	166,888	204,667	283,019
6	191,641	193,324	210,173	236,285	276,270	388,251

Actual Average Indoor Use: 7,954 gal/acct/m * 12 m/yr = 95,445 gal/acct/yr

2010 — Seasonal (rows) × Winter (columns)

Levels	1	2	3	4	5	6
1	32,095	46,567	60,688	84,610	112,077	179,063
2	41,995	57,916	74,804	99,921	137,281	205,885
3	63,439	78,637	96,138	122,779	159,339	221,902
4	98,834	114,752	131,498	157,670	198,067	276,362
5	145,392	161,070	180,302	204,101	249,494	321,411
6	227,598	249,383	263,154	299,706	357,226	479,791

Actual Average Indoor Use: 6,177 gal/acct/m * 12 m/yr = 74,130 gal/acct/yr

2011 — Seasonal (rows) × Winter (columns)

Levels	1	2	3	4	5	6
1	32,151	45,001	61,677	81,554	110,925	186,355
2	41,754	57,147	74,173	99,881	135,377	219,531
3	62,977	76,130	94,101	119,238	156,239	235,751
4	94,211	107,751	126,572	151,417	190,868	274,663
5	137,811	154,451	171,835	196,564	236,378	318,430
6	220,769	234,920	260,744	291,028	342,283	465,787

Actual Average Indoor Use: 7,224 gal/acct/m * 12 m/yr = 86,688 gal/acct/yr

2012 — Seasonal (rows) × Winter (columns)

Levels	1	2	3	4	5	6
1	30,771	44,866	60,602	82,773	108,937	181,453
2	39,488	55,875	72,850	98,909	135,292	220,841
3	59,588	74,890	93,147	119,504	159,822	241,423
4	94,975	111,381	128,473	156,256	194,378	272,973
5	140,921	159,548	177,086	201,238	241,056	334,285
6	220,394	241,593	264,867	289,702	348,902	466,221

Actual Average Indoor Use: 6,280 gal/acct/m * 12 m/yr = 75,355 gal/acct/yr

2013 — Seasonal (rows) × Winter (columns)

Levels	1	2	3	4	5	6
1	29,754	44,914	59,519	80,273	107,432	199,146
2	39,403	55,620	72,495	96,456	133,614	226,783
3	58,694	73,939	91,033	116,372	153,278	228,510
4	89,501	104,066	121,189	148,508	184,477	268,284
5	131,036	146,707	165,851	188,784	223,197	300,596
6	202,028	213,285	239,225	265,116	309,097	410,413

Actual Average Annual Use: 7,393 gal/acct/m * 12 m/yr = 88,710 gal/acct/yr

Table 9. *Aggregate Use* and *Average Annual Use per Account* in five years (gallons) for residential accounts in Table 6

Aggregate 5-Year Use

Seasonal \ Winter Levels	1	2	3	4	5	6
1	46,705,000	85,194,500	160,479,200	215,686,300	175,388,300	286,015,600
2	137,394,100	201,067,200	317,712,000	300,393,200	153,280,400	99,461,100
3	182,537,700	319,658,500	550,043,800	555,398,100	313,562,100	185,887,200
4	200,032,300	363,540,300	677,666,800	733,017,000	456,321,100	251,226,500
5	161,716,100	298,675,900	567,206,200	628,713,400	430,724,100	261,971,200
6	122,272,400	250,091,900	508,652,600	642,458,900	498,008,400	521,150,300

**heat mapping (gradient color scheme) provides a visual image of low (green) to high (red) consumption totals in each category*

Average Annual Use per Account (over 5-year period)

Seasonal \ Winter Levels	1	2	3	4	5	6
1	31,219	45,123	60,600	81,955	110,162	188,584
2	45,204	56,309	73,313	98,240	134,307	215,716
3	59,886	74,852	92,384	117,920	155,433	230,359
4	91,629	106,463	123,935	150,029	187,713	268,435
5	134,283	150,516	168,295	191,515	230,958	311,548
6	212,486	226,501	247,633	276,367	326,755	442,092

Baseline (blue line): 2.96 pphh * 60 gpcd * 365 d/yr = 64,824 gal/acct/year

Box 6. Table Calculations: Tables 7-9	
Table 7 – Annual Use (1-Year Periods)	
Annual Use	*Sum of use for all accounts in a given seasonal AND winter consumption level for the given year*
Table 8 – Annual Use Per Account *(1-Year Periods)*	
Annual Use per Acct	*'Annual Use' in level* [Table 7. ÷ *Number of accounts in level* [Table 6.]
Baseline (blue line)	*Persons per household x 60 gallons/person/day x 365 days/year*
Actual Avg Indoor Use (red line)	*Utility Annual Winter Average x 12 months/year*
Table 9. – Aggregate Use and Average Annual Use Per Account (5-Year Period)	
Aggregate Use	*Sum of 'Annual Use' in level* [Table 7]
Avg. Annual Use per Acct	*Average of the 'Annual Use per Acct' in all years* [Table 8]
Baseline (blue line)	*Persons per household x 60 gallons/person/day x 365 days/year*

However, as mentioned in the Table 2 discussion, the Energy Policy Act of 1992 passed national efficiency standards stating that toilets were not allowed to be installed in new development if they did not meet a 1.6 gallon per flush or less requirement. As a result, manufacturers no longer produce toilets with flow rates higher than 1.6 gallons per flush, and all development is required to meet this standard. Thus, the customer characterization is important in identifying whether or not a toilet replacement program would result in water savings at a reasonable cost to the utility.

National Efficiency Standards and Specifications

Along with standards for water use in toilet fixtures, the Alliance for Water Efficiency publishes an updated matrix, most recently the 2014 National Efficiency Standards and Specifications for Residential and Commercial Water-Using Fixtures and Appliances, which outlines efficient standards for all residential and commercial fixtures and appliances in terms of the Energy Policy Act of 1992, the U.S. Environmental Protection Agency "WaterSense" program, and the Consortium for Energy Efficiency (Alliance for Water Efficiency, Koeller & Co, 2014).

North American Industrial Classification System

As mentioned in Phase II – Preparing Data, the North American Industrial Classification System (NAICS) is a helpful way to standardize the categorization of non-residential customers (U.S. Census Bureau, 2014). The City of Garland, Texas was recently cited in a presentation given by the Texas Water Development Board as identifying an existing, unused field within their billing system that they were able to utilize to input the six-digit NAICS code for each non-residential customer (Kluge, 2015). This standardization will make it easier and faster for the utility to create a consistent customer characterization.

Program Evaluation

The best way to ensure that chosen conservation BMPs are continuing to be successful in reducing consumption and continue to target the correct audience is to conduct BMP evaluations before and after implementation, in addition to an annual customer characterization. Consistent program evaluations will indicate when a BMP is no longer producing a significant amount of water savings, and will give the utility an opportunity to make adjustments.

Maintain Relationships

Successful water conservation planning requires a cooperative culture from all groups of home and business owners in the utility service area. Maintaining positive relationships with local landscape companies, building management companies, and homeowners associations will help establish buy-in for conservation programs and the positive promotion of associated BMPs.

Transient Populations

When engaging in water conservation planning, it is helpful to be aware that customers affiliated with a large military or higher education presence, referred to as transient populations, will make conservation efforts challenging to implement. Transient populations introduce a higher rate of turnover in customers that are sometimes new to the geographic region, and therefore unfamiliar with existing conservation efforts. As a result, transient populations require a higher rate of education and outreach programs.

Conclusion

Adopting the customer characterization process outlined in this document, or a similar process, will make targeted conservation programming easier and quicker to achieve. This familiarity with the customer base will also allow the utility to leverage available resources to their fullest potential, realize the greatest water savings at the least cost.

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Appendix A: Customer Profile Process Chart

Phase I – Gather Data

Data needed for process
- Billed consumption data
- Property data

Other helpful data
- US Census Bureau databases
- Geographical information system (GIS) spatial data

Phase II – Clean Data

Prepare data set
- Save all data in separate spreadsheet for recovery purposes
- Optional - Format data into a table for easier sorting and management ('Format as Table' function in Excel)

Identify all monthly consumption data for complete years
- Retain only data reported for the desired year range (complete year - December of one year to December of the next year)

Identify units of monthly billed consumption
- Common units are gallons or thousand gallons

Remove closed accounts
- Identify a service status that indicates if the account is open or closed (designated by the utility, not assumed)

Create columns for calculating annual metrics
- Annual Total
- Annual Winter (Indoor) Average
- Annual Seasonal Average
- Annual Assumed Outdoor Use

Separate residential and non-residential classification data
- Identify column containing customer classifications (designated by the utility, not assumed)

Remove low-use accounts for all monthly consumption data
- Low-use threshold: < 1,000 gallons per month

Create columns for importing property information
- A unique identifier for each account
- Year Built
- Most recent Assessed Property Value

Import property data from Appraisal District database
- Import unique identifiers
- Import years built
- Import most recent assessed home values ('VLOOKUP' formula in Excel)

Examine accounts without individual unique identifiers
- Typos and abbreviations can interfere with the import of property data

Phase III – Analyze Data

Create use distributions
- Customer Classification
- Property Year Built
- Assessed Home Value

Compare indoor and outdoor Use

Cross-compare indoor and outdoor percentiles
- Categories of similar indoor and outdoor use