

High Water Users and Project Goals

With high temperatures and relative aridity, the Phoenix metropolitan area requires careful oversight of residential water use. High residential demand is often indicated by large lots and features, such as turf or pools, but **actual overuse is rarely immediately apparent**.

Gilbert Water Conservation has recently focused on engaging with single family households that use more than 500,000 gallons of water a year. They believe these homes are also overusing for their household and landscape's projected need. This study characterizes landscaping and lot features of **homes using more than 500,000 gallons of water** a year to **determine how high use correlates with overuse** based on a home's calculated need. Figure 1 displays an area of high use.

This research serves as a first step for targeting overusing households. It motivates the development of home water reports (HWRs), which inform homes of their projected water need versus actual water use and their potential for monetary savings. **By identifying features and evaluating common patterns, this study works towards piloting a new demand-side program for Gilbert Water Conservation.**

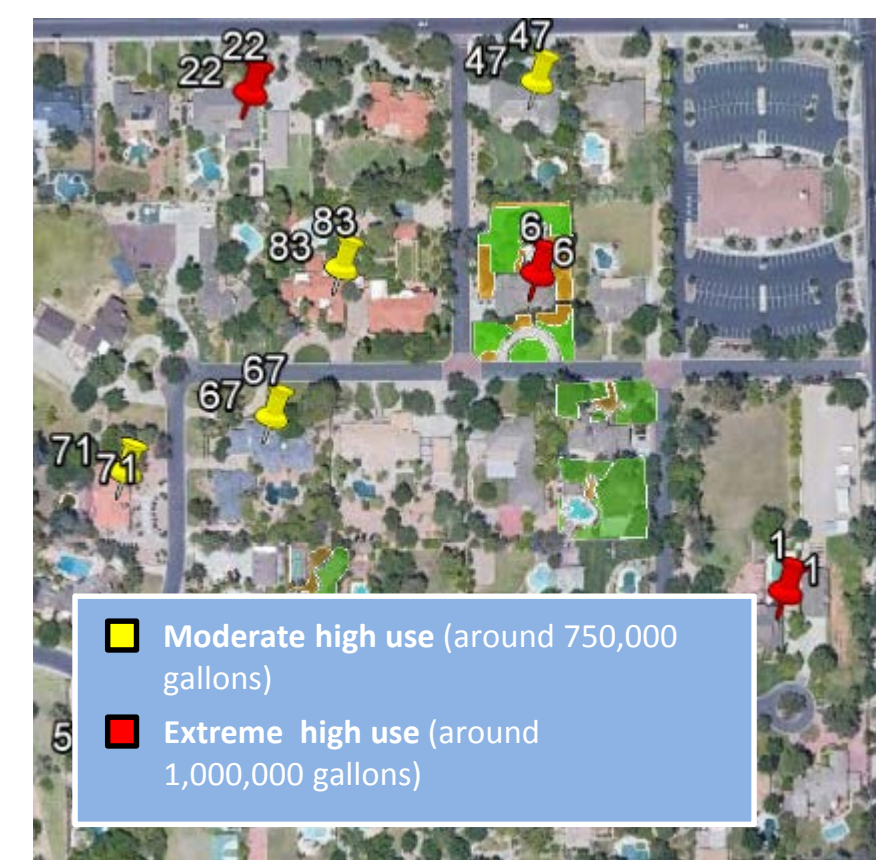


Fig. 1: Cluster of high water use homes in Gilbert

What property features characterize high water use homes in Gilbert? To what extent do these features signal overuse?

Aerial Measurements, Landscape Coding, and Evaluation

Data was obtained through Eden, Gilbert's utility billing service, Google Earth Pro, Excel, and web page-based tools. A top consumption population was generated in Eden for homes that used more than 500,000 gallons in 2017. **A 150 home sample was taken.** Each home's landscaping features were mapped with polygons in Google Earth Pro (figure 2). Green polygons represent turf, orange polygons represent decomposed gravel, and blue polygons represent pools.

Home landscapes were sorted as **desert adapted, drought tolerant, and high water use with density levels sparse, medium, or dense** (figure 3). These categories draw from research done by the Phoenix Water Services Department and follow the protocol defined by their 2016 Aerial Coding Guide.

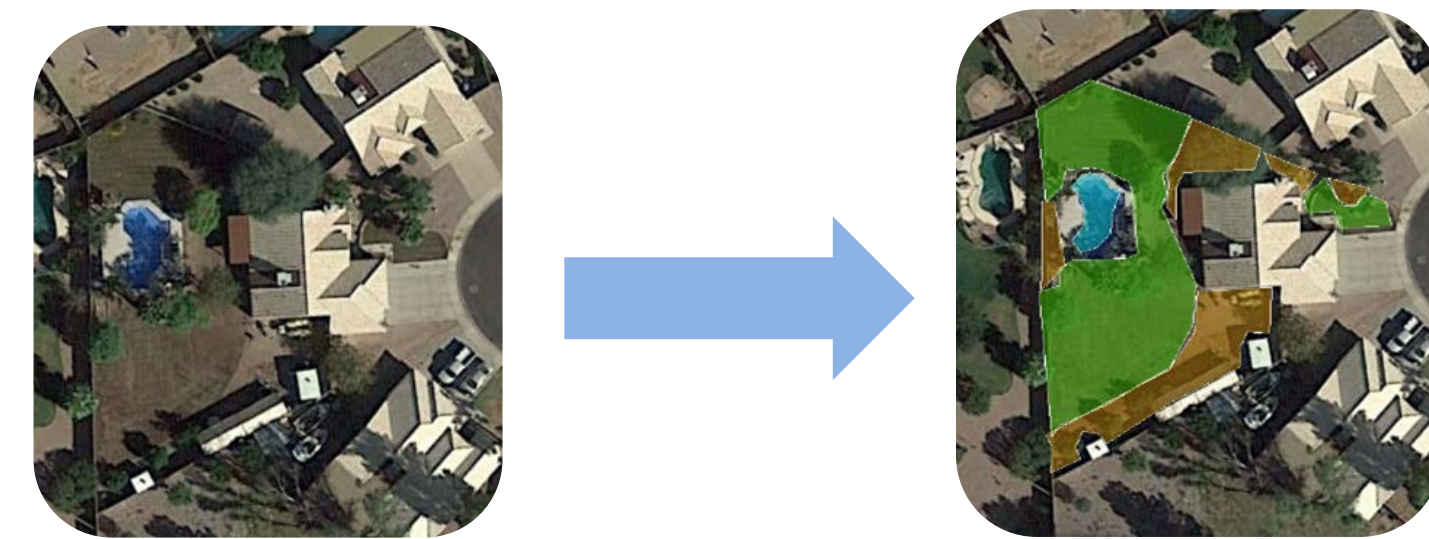


Fig. 2: Mapping of landscape features

Home specific file information was entered into Gilbert's Home Water Calculator spreadsheets, which use outdoor measurements along with baseline assumptions of indoor use to calculate projected water need. **Projected need was then compared to the home's actual 2017 use to determine monthly and annual overuse.** The difference between projected need and actual use for each home was added to the original sample spreadsheet. Homes were grouped by landscape type and evaluated with frequency statistics and hypothesis testing in Excel.



Fig. 3: Comparison of high water use landscaping feature and a low water use (drought tolerant) feature. Desert adapted homes may have a mix of both.

Regardless of Landscape Type, Overuse is Endemic

Tabulation of landscaping type frequency revealed a distribution of 18 drought tolerant homes, 81 desert adapted homes, and 51 high water use homes (figure 4).

A 2-tailed t-test was performed for each landscaping type. The null hypothesis for each type states that there is no expected overuse, **H0: $\mu = 0$ gallons**. The alternative hypothesis is defined as **H1: $\mu > 0$ gallons**. The results of the t-test are reported in figure 5. Drought tolerant, desert adapted, and high water use homes reported 9.35, 16.83, and 10.8 t-statistics respectively. Their p-values are all reported as < 0.01 . Therefore, **the null hypothesis is rejected at the 1% level for all landscaping types.**

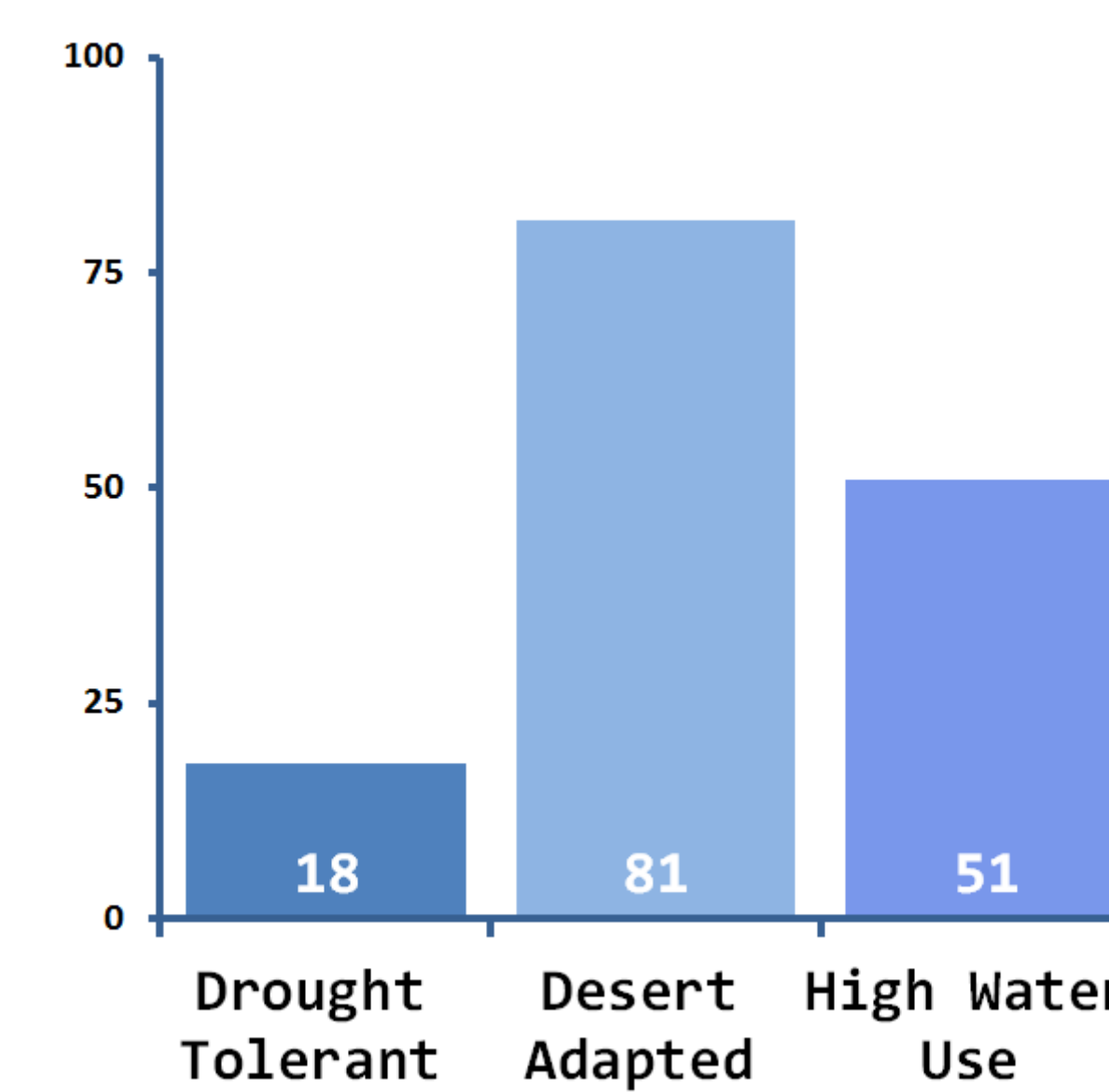
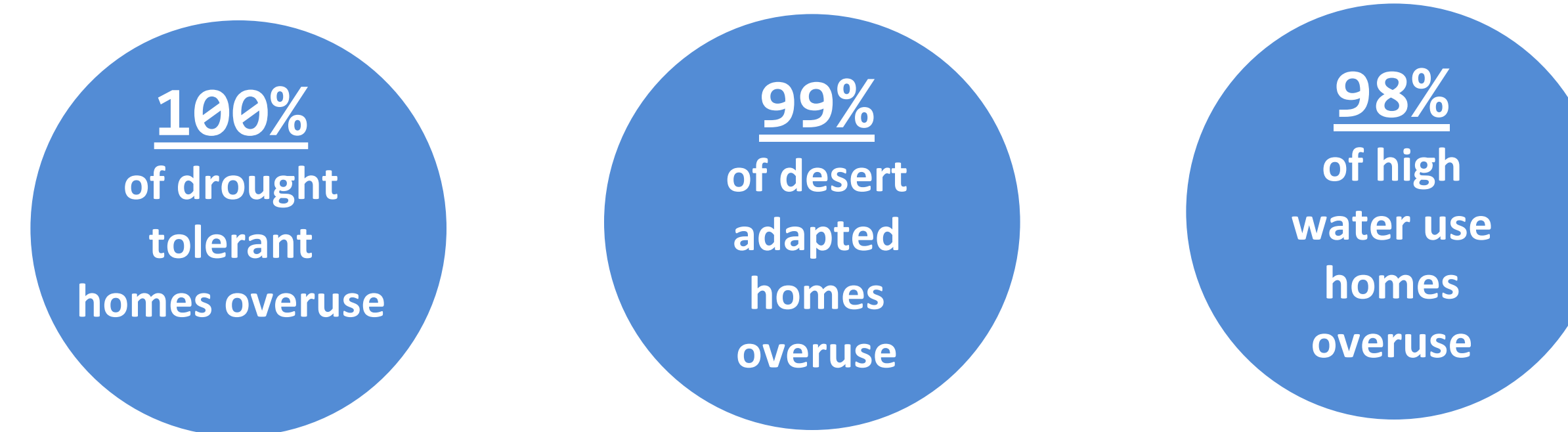


Fig. 4: Landscape distribution among 150 sampled homes

	Drought Tolerant	Desert Adapted	High Water Use
Overuse	18	80	50
Underuse	0	1	1
Mean Overuse	382,311	351,711	313,166
T-Stat	9.35	16.83	10.8
P-Value	4.11×10^{-8}	5.256×10^{-28}	1.115×10^{-14}

Fig. 5: Overuse tabulation and t-testing



Of the 150 homes only 2 were calculated as underusing for their landscaping features and indoor needs. Between the 3 categories, homes showed descending mean over use. Drought tolerant homes displayed the most overuse and high water use homes displayed the least overuse. This follows intuition, as high use homes with water intensive plants can better equalize their projected need and actual use. Notably, drought tolerant homes showed no underuse. Following the inverse of the argument above, homes in this category have fewer landscaping features to account for their use and therefore may be more likely to have indoor overuse. As most homes in the sample were desert adapted, the category contained the most variation in overuse amount and suspected variation in turf size. **Pools were not accounted for in this study due to their relatively small impact on outdoor water use compared to other landscaping features.**

The coding of these homes do not necessarily indicate their amount of turf. Thus calculations of overuse cannot be entirely predicted by decomposed gravel/non-turf landscaping. Ideally, a regression would be run on overuse with turf size included as a control variable.

Home Water Reports and Demand Side Program Research

This study is a preliminary inquiry into the set of homes for future study. It confirms that high use homes overuse when accounting for turf, lot size, and landscaping. This indicates that **high use is a useful proxy variable in predicting overuse** and this sample may be representative of the population of overusing households.

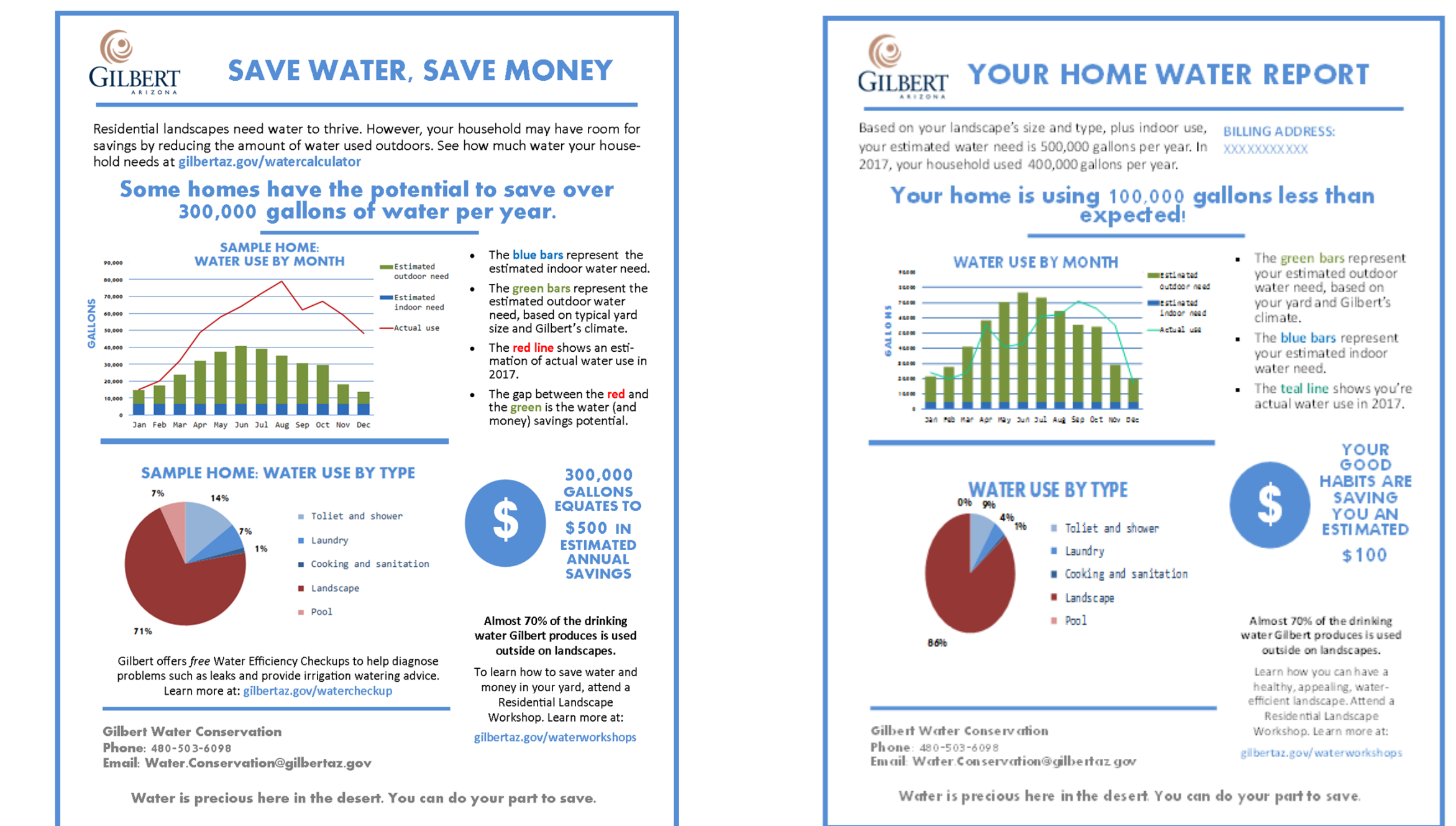


Fig. 6 & 7: Sample home water reports for savings and overuse

Gilbert will attempt to curb overuse through HWRs. **HWRs are mailable documents developed by water utility providers or contracted third parties that when personalized, provide information on a household's use over a period of time.** Alternatively, general home water reports offer less specified statistics. Both personalized and general home water reports will be generated for this study. Figures 6 and 7 show examples of HWRs, with figure 6 targeting an overusing home and figure 7 congratulating a home using under their projected need. Potential monetary savings is also included in each HWR alongside links to conservation resources Gilbert offers. Roughly 2/3 of the homes in the study will receive HWRs, with the remaining 1/3 acting as a control group. **The study will be conducted in the summer of 2018 with HWRs being mailed at the end of April. Mean differences in overuse between the 3 groups will be tracked monthly.**

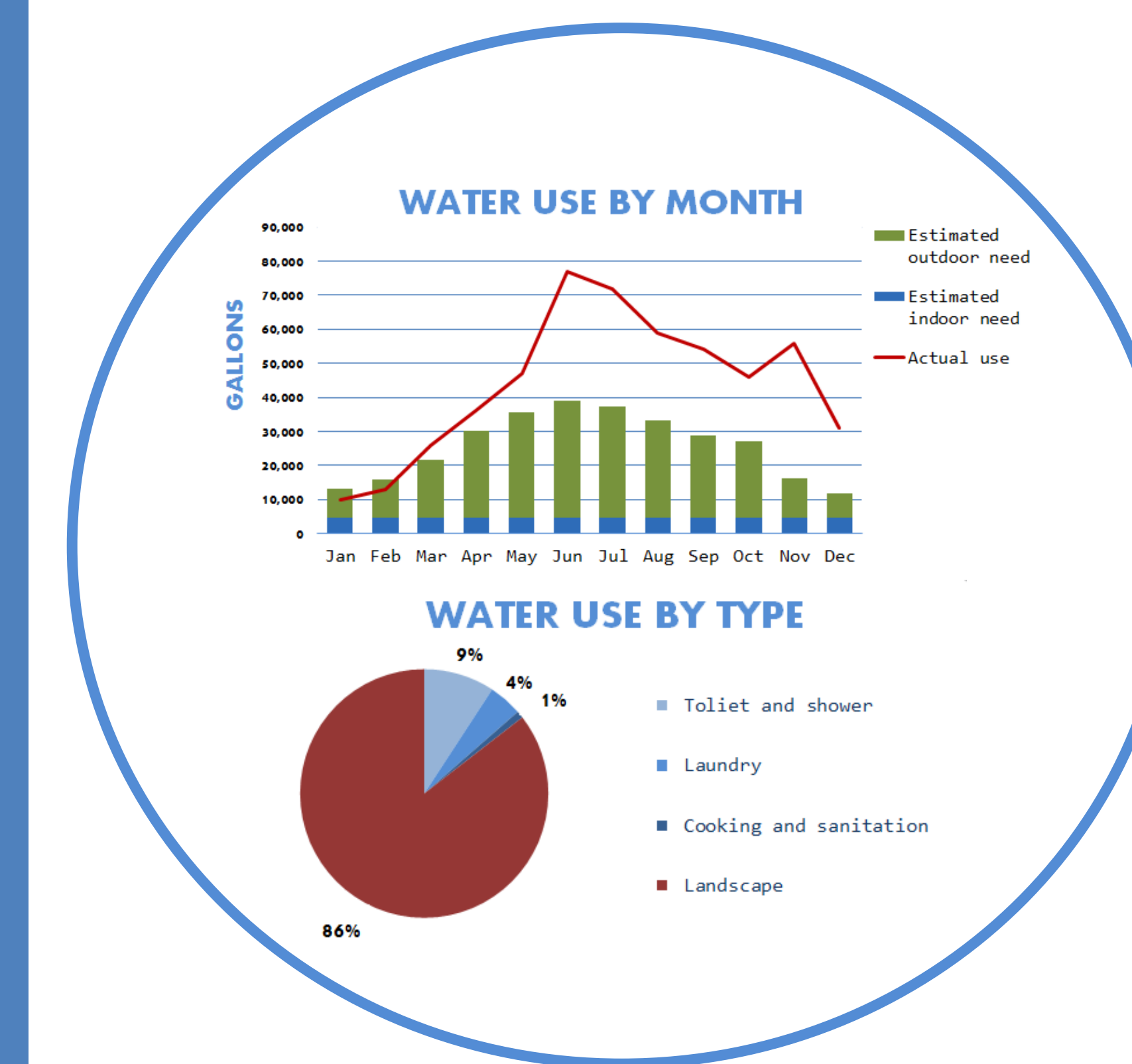


Fig. 8: Larger HWR graphs

Figure 8 shows 2 enlarged HWR graphs, detailing water use by month and by type. The water use by month graph highlights the trend of summer overuse due to landscaping needs and affirms the need for landscape focused messaging. The pie chart reflects the divide between landscaping and indoor use, again establishing landscaping as the primary determinant of water use.

With the results from this investigation, Gilbert can begin to reach overusing households with tailored messages to potentially curb their overall use.