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Adoption, Spatial Patterns, and Behavioral Mechanisms in California Turf Removal Rebate Programs

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Approval of the Dissertation Committee

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of John Shideler as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy in Economics.

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Abstract

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In January of 2014 the Metropolitan Water District of Southern California implemented a $450 million-dollar regional turf removal rebate program which provided homeowners with a cash rebate for every square foot of natural turf removed from their yard and replaced with a program approved alternative. This dissertation is divided into three distinct papers that analyze the role that non-price mechanisms such as peer effects, social norms, personal norms, and household characteristics play in the household decision to participate in this program.

The first paper uses a multilevel survival model framework to explore spatial patterns, drivers of participation, and the presence of peer effects. Results show that home ownership, length of time in home, and peer effects all influence the time to participation in the program. The second paper uses a survey tool and a structural equation model to test the applicability of the Theory of Planned Behavior and Value Belief Norm Theory in program participation. The survey was deployed in April of 2018 and had 108 respondents. Results suggest that environmental beliefs and attitudes did not influence participation in the program, while opinions of drought tolerant versus natural turf lawns do. The final paper applies survey methodology and a contingent valuation framework to analyze sensitivity in the household willingness to accept a rebate to participate in the program. Water conservation beliefs and homeowner views over a drought tolerant lawn were both shown reduce the rebate amount required for participation in the program.

Dedication

Charlye I can never thank you enough, hopefully now we can go back to "life". While I am not sure exactly what it means, I am dedicating this to you, Brinley, Soco, and Diesel. To you because I could never have done it without you, and I am hopeful that it will help us with the life we want to build with Brinley. I suppose you deserve a dedication at the very least and maybe a plaque for all that you had to endure through this process. To Soco and Diesel for always being there through the best of times and the worst!!! I love you all!

Acknowledgements

I would like to thank my committee for their continued mentorship, patience, and support. This has been an extremely difficult journey for me, and I feel fortunate to have worked with a committee that cared so much about my professional development. I would also like to thank the Metropolitan Water District for their willingness to share data, and for the provision of the World Water Forum College Grant Program. Shout out to Texas A&M geoservices for their help in early phases of this project, and all of the people who responded to my survey. Most importantly I want to thank some friends and family who provided emotional support during this process. Charlye, Mom, Dan, Tess, Mary, Fu, Trixie, Sanval, Mingming, Eric, Ana, Josh V., Ally, Josh N., Tony, Derrick, and Joseph I appreciate all the support, jokes, adventures, conversations, and venting sessions. I definitely would not have stayed sane without your help and humor. Now we finally do not have to talk about this any more!

Table of Contents

1 Neighborhood Effects or Just Homophily: Using Survival Analysis to Analyze Turf Rebate Patterns in Los Angeles County

Abstract

The effectiveness of lawn conversion rebate programs is being scrutinized and reassessed as water agencies search for ways to cut down unnecessary water consumption associated with increasing populations and uncertainty in future water supply. This work utilizes household level analysis of spatial patterns and drivers of participation in a regional turf removal rebate program in Los Angeles County. A multilevel survival model is used to model program participation which exhibits low participation rates in a one-time-event. Results indicate that when each additional neighbor that lives within 2000 feet participates in the program, a resident's time to participate in the program is decreased by between one and two percent. Home ownership and longer home tenure also decrease the time to participation. Increases in the rebate amount above the standard program amount was not found to decrease the time to participation. Policy implications from this study indicate that when a turf rebate program is constrained by time, peer effects may have a more significant effect on program participation than modest increases in rebate level. Furthermore, targeted marketing based on household characteristics may provide increased participation rates and improved cost-effectiveness than blanket increases in rebate level.

1.1 Introduction

Water agencies are eager to evaluate program effectiveness of recent massive investments in turf removal rebate programs to curb household water consumption as recurring drought and increasing populations threaten the reality of long-term sustainability in California. These programs paid residence a per square foot rebate amount for removing natural turf and replacing it with less water-intensive alternatives. Furthermore, turf removal rebate programs continue to play an important role in the portfolio of policy instruments that water agencies use to cut down residential water consumption. Nearly half of all urban water use in California between 1998 and 2010 was dedicated to landscape irrigation (Mitchell, et al., 2017). When coupled with the thought that conversion to a "climate-appropriate landscape" could reduce a California homeowners' outdoor water use by 50 – 70%, it is easy to see why California water agencies are eager understand what drives participation in turf removal rebate programs ("Turf Removal Program", 2020). While it is obvious that the rebate plays a key role in the household decision to participate in these programs, policy makers and academics are increasingly interested in the role that non-price behavioral mechanisms play in the decision over participation.

Household psychology related to participation in utility level rebate programs designed to incentivize pro-environmental behavior is a growing research domain. A better understanding of the household decision making process is not only beneficial for better estimation of program effectiveness, but also provides additional policy tools in the context of "nudges" and targeted marketing strategies. A key piece of this puzzle is better understanding how individuals are affected by neighbors' participation, or lack of participation, in these programs. This work focuses on the regional turf removal rebate program in Los Angeles County California funded by The Metropolitan Water District of Southern California (MWD). Specifically, this research focuses on the identification of peer and spatial effects in that program along with other household level drivers of participation.

A survival (a.k.a. time-to-event or hazard) analysis modelling framework is employed due to the advantages over the standard fixed or random effects panel framework modelling a program in which participation is a one-time-event, relatively low in aggregate, and exhibits a non-linear increasing relationship with respect to time. A novel data set was created which provides critical variation in household characteristics, neighborhoods, water agencies, average water price, and rebate levels to test for the presence of peer effects and better understand the role of household heterogeneity in program participation.

In the next section I will discuss related literature and how this work will add to that literature. Section three will give background information specific to the regional turf removal rebate program in Los Angeles County. In section four I will discuss the methodology, the data in section five, and follow with some descriptive statistics in section six. In section seven I will discuss further model specifications and follow with results in section eight and policy implications in section nine followed by the conclusion.

1.2   Literature Review

A key component that was not included in the classical economic framework related to incentive-based policy levers was the role that social norms and peers might play in influencing consumption. Recent studies have shown that peer comparisons can affect water and energy consumption (e.g. see Alcott, 2011; Brent, Cook, & Olsen, 2015; Ferraro & Price, 2013). Ferraro and Price (2013) also find evidence that information related to the positive environmental and societal impacts of water conservation can reduce water consumption. Nolan, Schultz, Cialdini, Goldstein, & Griskevicius (2008) find that messaging comparing customer conservation behavior to that of neighbors had a stronger effect on conservation behavior than messaging related to environmental protection, social responsibility, or saving money.

Recent work related to solar photovoltaic panels (Bollinger & Gillingham, 2012; Graziano & Gillingham, 2015; Baranzini, Carattini, & Péclat, 2017) and landscape changes (Bollinger, Burkhardt, & Gillingham, 2018; Brelsford & De Bacco, 2018; Torpey, 2017; Pincetil, et al., 2017) have focused on the role of peer and spatial effects in the household decision to make infrastructure changes which relate to natural resource consumption through utility provision. This strand of recent literature is an extension of earlier work related to the diffusion of technology (Hagerstrand, 1952; Rogers, 2003), diffusion of new products (Bass, 1969), and neighborhood effects (Glaeser, Kallal, Scheinkman, & Shleifer, 1992; Conley & Udry, 2010).

The visibility of solar installations and landscape changes is what allows for an attempt to establish causality in relation to some form of peer effects. This work attempts to establish causality in peer effects where one home in a neighborhood[1] participates in a turf removal rebate program, and then a neighbor views this turf removal project and their choice over participation in that same program is influenced. Moving forward this paper will use terminology used in Brelsford and De Bacco (2018) in the sense that we will call this effect the "neighborhood peer effect". In other work this has also been referred to as spatial spillover, peer effect, or neighborhood effect.   A neighborhood spatial effect will be defined by changes in the magnitude or significance of the neighborhood peer effect with changes in distance from the initial house. Following Graziano and Gillingham (2015) this work uses Geographic Information System (GIS) analytics to create an installed base variable which counts the number of homes within two separate concentric circles that have previously participated in the regional turf removal rebate program. It is this variable that will be used to seek out the presence of neighborhood peer and neighborhood spatial effects.

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[1] The definition of neighborhood is relative, and neighborhood along with spatial definitions of a peer or neighborhood group vary in this realm of research. The installed base metric will be introduced later in this paper and define the spatial bounds considered for establishing a neighborhood effect.

Turf removal and landscape conversions are highly salient to neighboring homes which allows for a similar modelling framework as that set out in Bollinger and Gillingham (2012) and Graziano and Gillingham (2015). While it is difficult to ascertain information related to the level of communication that neighbors may have about a policy, or a potential program, the visibility of landscape changes allows neighbors to infer, if nothing else, that a home that makes a change is in favor of this type of change. This allows us to test whether the increased presence of participation in the turf removal rebate program in a neighborhood will have a related effect on the participation of neighboring homes.

The unbiased identification of neighborhood peer effects relies on the ability to adopt a modelling strategy that addresses three primary issues that have been identified in previous work. The "Big Three" as I have learned to lovingly call them are ***simultaneity*** *(a.k.a. reflection),* ***correlated unobservables****,* and ***homophily*** *(a.k.a. endogenous group formation)* (Hartmann, et al., 2008; Manski C. , 1993; Brock & Durlauf, 2001; Moffit, 2001)*.*

In the context of this research, simultaneity bias would occur when two neighbors participate in the program within a relatively close time frame and the first neighbor to participate is assumed to influence the other; when the truth is that they both influenced each other, or they both made nearly simultaneous decisions unaware of the others' decision to participate. In either case, it would be a mistake to assert that the first home to participate influenced the second. Similar to Bollinger and Gillingham (2012) and Graziano and Gillingham (2015), the issue of simultaneity is avoided in this work by using a lagged installed base. This ensures that a neighbor will not show up in a household's installed base count unless that neighbor completed their turf removal rebate program project before the household decided to apply for the program.

The second issue, homophily, is related to the idea that individuals may self-select into neighborhoods based on homogeneous preferences, and therefore sequential participation in the

5

program might be more of a signal of similar preferences than neighborhood peer effects. For instance political ideology (Costa & Kahn, 2010) and culture (Schultz, 2002; Samarasinghe, 2012) have both been shown to affect environmental behavior and are also cited as influencing homophilic neighborhood formation (McPherson, Smith-Lovin, & Cook, 2001). With panel data homophily can be controlled using fixed effects or by including "a rich specification for heterogeneity", while "both fixed effects and random effects serve the role of picking up common aspects of group tastes" (Hartmann, et al., 2008).

 Finally, other correlated unobservables may influence households within a certain proximity to make similar infrastructure changes. Differences in marketing between water agencies, neighborhood restrictions, or even differences in communication networks between neighborhoods are all examples of correlated unobservables that could influence differences in participation across groups. The inclusion of random or fixed effects is also helpful in eliminating at least part of the problem related to correlated unobservables (Hartmann, et al., 2008).

In this work the issues of correlated unobservables and homophily are addressed using a combination of time invariant covariates providing heterogeneity at the household level and shared frailty modelled at the zipcode level. In the survival analysis framework, a shared frailty is used to represent the potential for different pre-defined groups to share a coefficient which is different from other groups and effects the way that covariates affect the baseline hazard function. "This is most similar to a random effects framework in panel data analysis" (Cleves, Gould, Gutierrez, & Marchenko, 2010).

This work is intended to improve upon the modelling framework designed in Bollinger and Gillingham (2012) and Graziano and Gillingham (2015) to better isolate neighborhood spatial and neighborhood peer effects from the presence of the three forms of bias discussed in the previous paragraphs. Additionally, this work will extend that framework to analyze the choice to participate in

MWD's regional turf removal rebate program at the household level. The first contribution of this paper will be to add to a growing literature where additional empirical work is needed to compare results across various program designs, time intervals, populations, and geographic areas. This will help assess the generalizability of theoretical implications related to the role of neighborhood peer and spatial effects related to natural resource consumption and participation in related programs.   While this is not the first paper to focus on turf removal rebate programs in Los Angeles County (e.g., see Torpey 2017; Pincetil, et al., 2017; Marx, et al., 2018), this is the first study of the regional program across Los Angeles County which employs a modelling framework explicitly focused on isolating neighborhood peer effects from the three forms of bias discussed above. Further contributions of this work will come in the form of the chosen methodology and household-level analysis.

The use of a hazard model framework is not completely new with respect to the study of recent turf removal rebate programs. Brelsford and De Bacco (2018) map an epidemic model into a hazard model in pursuit of the identification of neighborhood peer effects in a turf removal rebate program in Las Vegas Nevada. This work is similar to that of Brelsford and De Bacco (2018) in the assertion that a hazard model framework is better equipped to handle the various challenges related to modelling turf removal rebate program participation but differs in the specific application of the hazard model framework. The geographic region, rebate program structure, creation of the variable intended to capture neighborhood peer effects, and handling of potential bias related to unobserved group level effects are also different from that study. Not only does the Los Angeles county region provide greater variation in neighborhood and demographic characteristics than most urban areas in the United States, the complicated structure of water agencies within Los Angeles County allows for variation in rebate levels over time and across regions. This provides a more robust environment to test the effect of changes in the rebate level on program participation.

In addition, this heterogeneity between households and neighborhoods within Los Angeles County allows for a rich set of control variables at the household level and further independent variables to test proposed theoretical drivers of participation. Political affiliation has been cited as a factor which influences choice over decisions which may be deemed "pro-environmental" as some political parties are theorized as more likely to pursue an agenda which is supportive of the protection of the environment (Costa & Kahn, 2010). The classic tenant-landlord market failure provides support for the idea that the presence of the owner living in home will significantly increases the probability of any infrastructure change which would cost money and affect utility consumption and bills (e.g. see Brown, 2001; Davis, 2012). Recent work by Bollinger et al. (2018) suggests that households are more likely to pursue landscape changes when they first move into a new home. This is consistent with work from real estate economics that suggests that there is a negative relationship between the length of time that an owner lives in a home and the probability that they will undertake a home improvement project (Baker & Kaul, 2002). Both results are based primarily in the idea that the owner will have more flexibility and a stronger desire to take on home improvement projects when they first move into the home. This suggests that there may be a positive relationship between the time in home and the time to participation in this program.

The theoretical relationships discussed above will be tested in this work using the following hypotheses:

H_1: When a close neighbor participates in the turf removal rebate program, it will decrease the time it takes for a home to participate in the program (neighborhood peer effect).

H_2: The significance and magnitude of this effect will decrease with distance (neighborhood spatial effect).

H_3: Home ownership will decrease the time it takes for a home to participate in the turf removal rebate program.

H_4: Increases in home tenure will increase the time it takes to participate in the turf removal rebate program.

H₅: Presence of a pool on the property will decrease the amount of time it takes to participate in the turf removal rebate program.

H₆: Political ideology will have a significant effect on the time it takes to participate in the turf removal rebate program.

H₇: Increases in the per square foot rebate level will decrease the time to participate in the turf removal rebate program.

Results from this work will add to the growing empirical literature related to neighborhood peer effects and help better inform future policy related to landscape conversions and utility level rebate programs.

1.3   Case description

The Metropolitan Water District of Southern California (MWD) is a water wholesaler which serves cities, member agencies, and retail agencies in six counties in Southern California. This includes "over 10 million residents and more than 100 sizeable water agencies" (Pincetil, et al., 2017). In response to growing drought concerns and a desire to decrease water usage related to ornamental turf coverage, some member agencies administered a rebate of $0.30 per square foot in 2008, which was increased to $1 in 2011. In January of 2014, MWD launched a regional turf removal rebate program which started with the same $1 per square foot rebate amount, but was increased to $2 per square foot in May of 2014 (McDonnell, Michelon, & Sovocool, 2015). By the middle of 2015 MWD had gone through the budgeted 350 million dollars devoted to the program, receiving over 85,000 applications and removing over 165 million square feet of turf (Pincetil, et al., 2017). Prior to the dispersion of the dedicated funds, some cities, retail, and member agencies decided to add on to the level of the MWD amount of $2 per square foot and after the funds ran out some agencies and cities continued to provide rebates from their own source of funding. The variation in rebate amounts, water providers, and neighborhoods along with a very heterogeneous population in the greater Los Angeles County region provide additional opportunities, but also additional challenges in data collection and modelling.

1.4 Data and Spatial Patterns of Participation

A basic kernel density of program participation in figure 1 below confirms the hypothesis that there was

spatial correlation in program participation with the Metropolitan Water Districts service area in Los

Angeles County. The role of time

was another critical component of

this program. Learning, increased

communication opportunities,

market transformation through

social norms, and the presence of

peer effects would all provide

theoretical support for a non-linear

trend in program participation with
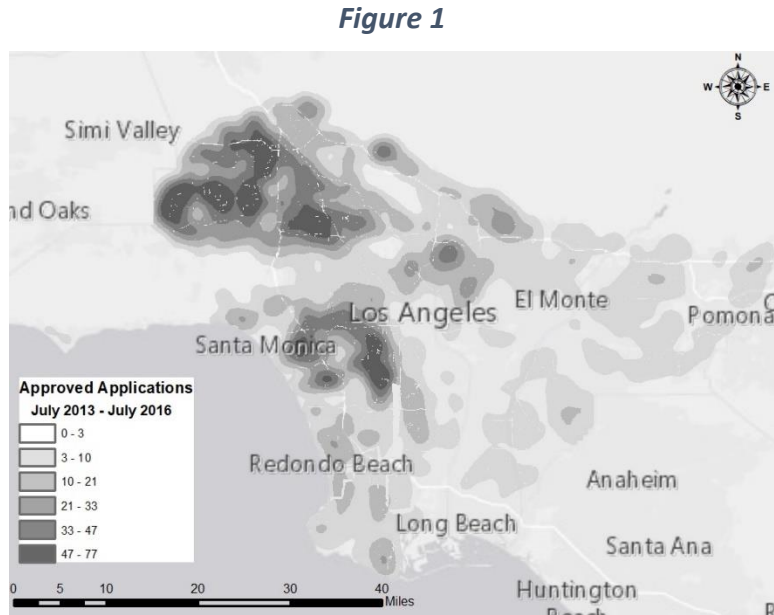
Figure 1

respect to time. Analysis of approved applications in figure 2 does exhibit a non-linear increasing trend

through the study period.

Figure 2
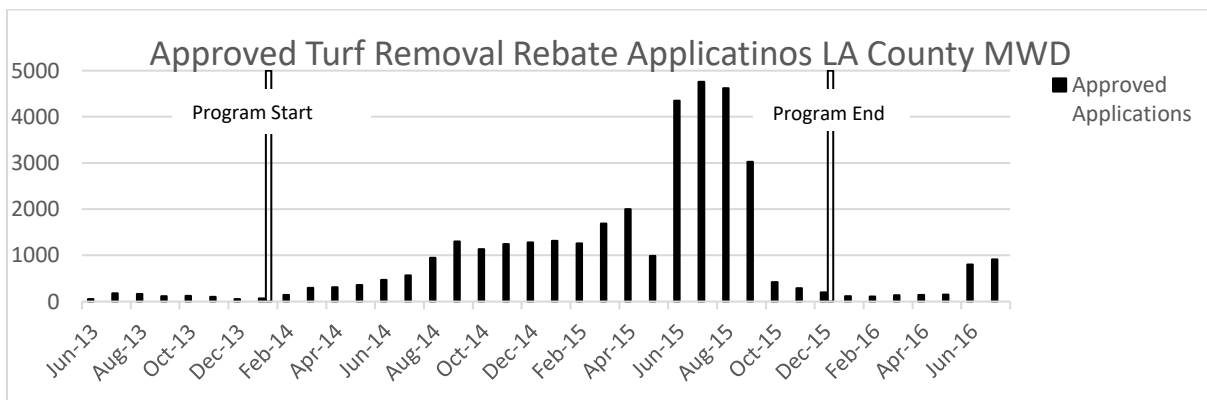
The size of the data set containing all of Los Angeles County provided challenges in creating the

quarterly installed base variables for every home in this population. Therefore, a random sample of

15,000 was used to proceed with the empirical modelling. Descriptive statistics for the random sample

10

are listed in Table 1 below. Home ownership and presence of a pool both seem to be household

characteristics that may affect participation in the program due to the large differences between

applicants and non-applicants.

Table 1: Descriptive statics for sample		
	Applicants	**Non-Applicants**
Observations	397	14,603
Percent of sample	2.64%	97.36%
Average home age	57	55
Percent who own home	75%	67%
Average home square feet	1,964	1,908
Average yard area	6,579	6,220
Average value	471,759	444,046
Average bedrooms	3.4	3.4
Average bathrooms	2.4	2.4
Percent with pool	30%	21%
Number of retail agencies	46	77
Total observations 15,000		

Significance of the pool and home ownership variables were further tested using log rank tests to test

the equality of survivor functions between groups. The log rank test was used to test for differences

between groups in three different cases :

A. The equality of survivor functions between homes with a pool and homes without a pool

B. The equality of survivor functions between homes where the owner lives at the address and

homes where the owner does not live at the address

C. The equality of survivor functions between homes with a pool and the owner living at the

address, and homes that do not have a pool and the owner living at the address.

The results of the three log rank tests are provided in Table 2.

Table 2

Log rank Test Between		Observed Participation	Expected Participation	Chi square test of equality
Owner vs. Non Owner				
	Yes	96	131	
	No	297	262	13.96***
Pool vs. Non Pool				
	Yes	274	308	
	No	119	85	17.87***
Pool and Owner vs. Not (Pool and Owner)				
	Yes	297	334	
	No	96	59	27.49***

. * denotes *P< 0.10, **P<.05, and ***P<0.010*,

Results indicate that there is a significant difference in participation between the groups in question in all cases.

1.4.1   Data

This research compiles data from several sources to create a unique quarterly panel data set which includes time varying and time invariant data points for a random sample of 15,000 single family homes, with at least one registered voter, between October 2013 and October 2015[2]. Condo buildings and single-family homes with no estimated yard area were not considered for the random sample.   Table 3 below shows the data and sources used in this paper.

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[2] The regional program started in January of 2014 and funds were exhausted by the third quarter of 2015. The start date of October 2013 represents the "Year 0" baseline in the survival analysis but analysis of participation is not considered until January 2014. The last quarter in the study period is the third quarter of 2015 since homes could no longer be considered "at risk" once the funds were exhausted.

Table 3: Data and Sources		
Data set	**Description and Source**	**Key variables**
Property data	2015 tax assessor's data set for Los Angeles County	Pool, yard area, home age, owner living in residence, tax assessor home value, time living in home
Voter data	2012 voter roll for Los Angeles County from the Los Angeles County Registrar	Registered voters and political affiliation in residence
UCLA Luskin Center Data	Data compiled in Community Water Systems Atlas and Policy Guide	Drought messaging, estimated annual cost of water by retail agency
Turf removal rebate data set #1	Household level application data provided by MWD	Applications, member agency, retail agency, name, address, approved/denied, project approval date
Turf removal rebate data set #2	Anonymous household level rebate records provided by MWD	Anonymous participants, city, zip, member agency, retail agency, total rebate amount, total square feet removed
Precipitation data	Monthly precipitation data for downtown Los Angeles downloaded from Los Angeles Almanac website at laalmanac.com	Monthly rainfall totals used to create average monthly rainfall by quarter
Climate Zone data	California building climate zone data downloaded from the California Energy Commission website at ww2.energy.ca	Building climate zone by zipcode

1.4.1.1 Water agency data

The Metropolitan water district collected data on turf removal rebate program applications that were

processed under their regional program. The primary variables of interest for this study were the

installation address, the Member and Retail Agency for the home, the actual rebate amount that was

paid out for the home per square foot, and the reservation date. The reservation date was the date that

the project was approved, and the applicant was allowed to begin removing natural turf from their yard.

Program application data was matched to LA County property assessor data then mapped using Arcgis.

Variation in potential rebate amount through time and across households allows for better

analysis of the effect of rebate amount. However, collecting the level of the additional rebate amount

for every single agency could prove to be challenging as noted in Pincetl et al. (2017). This research uses

an estimated quarter-retail agency rebate amount per square foot paid. Quarter-retail agency rebates

were estimated by taking the actual per square foot rebate amount for all participating homes in the

program and averaging over retail agency and quarter, and then rounding to the nearest $0.25

threshold. This step was required because information was not available on the advertised total rebate

amount per square foot available for every retail agency by quarter, and actual reported rebate amount

per square foot was not always equal within retail agency and quarter.

The reservation date will be the source of the dependent binary variable which indicates

participation in the program during a certain time interval. Having application date and project

completion date would allow for a straightforward interpretation of when the household decided to act

and when their project became visible to neighbors. Unfortunately, the data set used for this research

did not have a consistent record of the application date or the project completion date. There are two

points related to the program that will help support the use of the reservation date as a substitute for

both of these critical time points. First, it was noted on the MWD website that the typical time between

application and approval was two weeks. Second, the maximum allowable time between the

reservation date and project completion was 120 days. The relatively short turn-around time supports

the reservation data as a reasonable estimation for the time when the resident formally applied to the

program. The requirement on the completion interval allows for the creation of a specified time lag

between reservation date and the time when we can guarantee that the finalized project was visible to neighbors.

There are two other critical data points at the retail agency level that were downloaded from the UCLA Luskin Center Community Water Systems Atlas and Policy Guide. Both data points are time invariant and represent the 2015 calendar year. The first data point is the drought messaging data point which is a binary variable indicating the presence of drought messaging on the retail agency website. The second variable is an estimate of the annual cost of water within that retail agency given their pricing system and an assumed average usage of 18 hundred cubic feet of water per month (Deshazo, Pierce, McCann, & Zarate, 2015). While the drought messaging variable would not fully capture the level of communication and marketing from a retail agency it still provides an opportunity to isolate water agencies that did not have any messaging related to drought conditions. The water price estimation is also a critical control variable when considering that a primary motivation for participation in the turf removal rebate program may be to save money on water consumption. Theoretically, a home with a lower water cost would be less willing to participate in the program all else constant.

1.4.1.2   Property Data

Property data from the 2015 tax assessor's data set for Los Angeles County provided time invariant household data related to building and yard characteristics, geographic location, and tax assessed home value. Variation in household location and characteristics provide additional heterogeneity which will help isolate the effects of the variables of interest from bias related to homophily and correlated unobservables. Furthermore, estimations of yard area and home age along with presence of a pool compliment water price estimates in consideration of attempting to control for differences in household cost of water.

There are also three critical variables created from the property data set that will be used in testing hypotheses three, four, and five. The presence of a pool, presence of the owner living in home, and the length of time in home are all hypothesized to influence the time to participation in the program. Theoretically, the presence of pool would signal a higher monthly water bill and therefore a greater desire for the household to find other ways to cut down water use and monthly bills. The importance of the owner not being in home follows the idea that an owner may not be as strongly incentivized to make changes to a property that he/she does not live in to cut down on a bill that they do not pay. In addition, coordination of the project and maintenance of the finished product is typically more difficult for a rental property. Finally, the length of time that an owner lives in a home has been shown to be negatively related to the probability of undertaking landscape changes (e.g. see Bollinger, Burkhardt, & Gillingham, 2018) and home improvement projects (e.g. see Baker and Kaul, 2002)

1.4.1.3   Voting Data

Time invariant household level data related to the number, age, and political affiliation of registered voters as of 2012 is included in this data set to add an additional layer of household heterogeneity and information related to ideology. In order to aggregate the household voting preference an index was created which ranges from 0-2. If all registered voters in the home were either registered to the Republican or Libertarian party, then the home is assigned a score of zero. If all registered voters in the home were registered either as Democratic or Green Party, the home was given a score of two. Any other combination of registered voters in the home is assigned a value of one. While registered voters are not a perfect measure of household population, number of adults which reside in a dwelling is related to the demand for water in that dwelling and average age within the household may also affect environmental views or attachment to a natural turf lawn.

1.4.1.4   Environmental Variables

Two key variables are included to control for environmental conditions which might affect the willingness to participate through the requirement for supplied water to keep a lawn green versus relying on nature. The first variable is a time varying average monthly precipitation amount for the city of Los Angeles. The second variable is a numeric categorical variable designating the different building climate zones downloaded from the California Energy Commission website. The California Energy Commission has developed 16 building climate zones based on energy use, temperature, weather, and other factors to help inform builders of weather patterns and constraints in the referenced area. There are five building climate zones that are used in reference to Los Angeles County. This data is included to control for regional differences in weather patterns which may influence a homeowner's demand for water, or ability to sustain a healthy natural-turf lawn. Theoretically, homes that receive a large amount of precipitation would have to depend on sprinkler systems less than a home that receives very little precipitation. The costs of water along with the installation and maintenance of the irrigation system should provide a greater incentive to participate in the regional turf removal rebate program. The combination of these two variables is intended to control for differences in general climate and seasonal precipitation.

1.4.1.5   Primary Variables of Interest

The primary variable of interest in this work is the installed base which will count the number of homes that have already participated in the program within a predetermined distance of the home. The installed base is then counted for every quarter of the panel data set so that changes in the installed base across homes and through time can be analyzed.

Consistent with previous work in solar and turf rebates (e.g., see Bollinger, et al., 2018; Bollinger and Gillingham, 2012; Graziano and Gillingham, 2015; Brelsford and De Bacco, 2018), this work also uses the lag between application and project completion to ensure that potential simultaneity bias is avoided

in testing for neighborhood peer or spatial effects. Specifically, this work uses the reservation date and the 120-day project completion requirement to create a lagged entry into another household's potential installed base. This means that if home A was approved for the turf removal program on January 1, 2013, it will not show up in neighbor B's installed base measure until May 1, 2013. The fact that many of the homes may have completed their turf removal project much earlier than the allotted 120 days, adds strength to the idea that this is a conservative measure of the installed base, and therefore the neighborhood peer effect measure in this work, is likely more of a lower bound.

The creation of the installed base follows Graziano and Gillingham (2015) in creating two concentric circles around each individual home and counting the amount of homes within these two circles that have participated in the regional turf removal rebate program and were approved at least 120 days prior as specified above. Other studies in this realm have used counts at the zip code, census block, or city block level as a measure for the installed base (Bollinger & Gillingham, 2012; Torpey, 2017), street-zip counts (Bollinger & Gillingham, 2012), on-street distance measures (Brelsford & De Bacco, 2018), and even "line of sight" analysis through a street imagery platform (Matlock, 2018). As a general rule for this study it was felt that the concentric circles were the best method for capturing potential visibility or likelihood of being in the same neighborhood.

This work differs from Graziano and Gillingham (2015) in the choice of distance to use for the concentric circles around the home, and the number of concentric circles. While it is not stated in their work why the specific distances were chosen for the concentric circles, this work started by taking the average Euclidean distance to a neighboring program participant for every single-family home in Los Angeles County served by Metropolitan Water District in the final period (652 feet), and then added the standard deviation to create the first concentric circle (1,942 feet). The second circle is then the mean plus two standard deviations (3,232 feet). This methodology asserts an installed base area that uses observed data and focuses on relative frequency within the population.

18

Only the outer portion of the circle that has not already been counted in the interior circles is used for the count of the second installed base measure. This is done specifically so that the different levels of distance can be used to analyze whether the magnitude or significance of a potential neighborhood peer effect increases or decreases with distance. This point is critical for a distinction which will be made between what is being referred to as neighborhood peer effects and neighborhood spatial effects. The distinction, and the use of the concentric circle method in general, can be made clear when referring to Figure 3 below.

Figure 3   Installed Base Measures

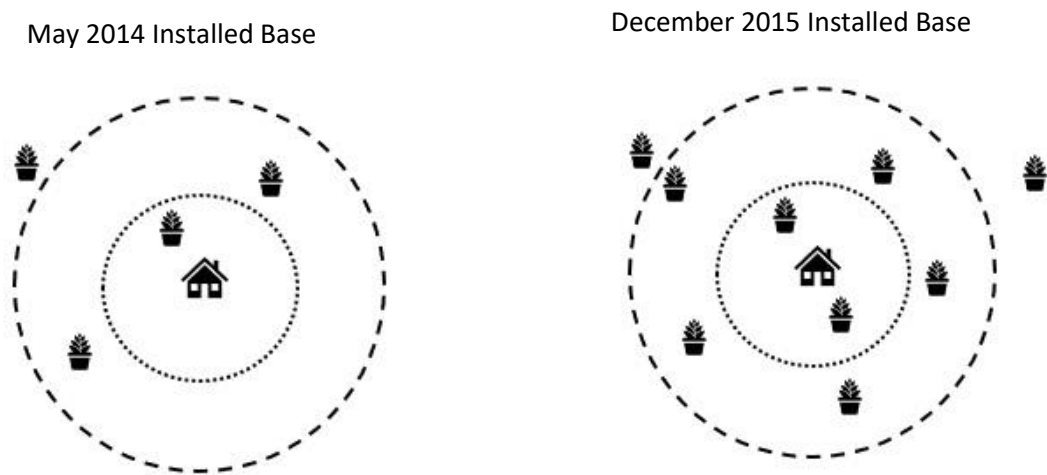May 2014 Installed Base   December 2015 Installed Base

Figure three shows the same house for two different periods in time. Two concentric circles are drawn around the house and the number of homes that have previously participated in the turf removal rebate program are counted (these show up as small potted plants) within the two areas as specified above.

A neighborhood peer effect refers to the extent to which the presence of previous program participation by neighbors effects an individual's decision to participate, while a neighborhood spatial

effect will focus more on how that effect changes as you move further away from the house i.e. from one concentric circle to the next. Theoretically the assumption is that closer landscape changes would be visible on a more consistent basis, and therefore have a more salient effect than from changes in homes that are farther away. In addition, it may be that you care more about what your close neighbors do than neighbors that are further away. Therefore, they would have a stronger influence on your own decisions.

1.5   Methodology

This work implements a survival (time-to-event or duration) analysis modelling framework to better address the role of time in program participation, the low participation rate, and issues that arise in a standard panel data set with a one-time event. Survival modelling maintains much of the flexibility of a standard panel data framework, including the ability to implement a multilevel modelling approach to model group level effects. The sample of 15,000 homes allows a hazard ratio of 1.02 or larger, to be detected in the Cox proportional hazard model at the 5 percent level of significance and a power of 0.8.

1.5.1   The survival analysis framework

Two popular parameterizations of the survival analysis framework which were considered in this work are the proportional hazards (PH) framework, which is generalized to $h_j(t) = h_0(t)\exp(\beta_0 + x_j\beta_x)$ and assumes that changes in covariates have a multiplicative effect on the baseline hazard function; and the accelerated failure time (AFT) framework which is generalized to $\ln(t_j) = x_j\beta_x + \ln(\tau_j)$ and assumes that changes in covariates have a multiplicative effect on the time to failure. In the context of this work a "failure" would be taken as the event happening, i.e. participation in the regional turf removal rebate program.

Using the survival analysis framework, we start with a specification for the time to event t_i as follows:

$$t_j = \beta_0 + \beta_1 X_j + \beta_2 \omega_j + \beta_3 \gamma + \beta_4 \delta_r + \epsilon_j$$

where X_j is a vector of time invariant household level structural and sociodemographic variables, ω_j is a vector of time varying installed base measures at the two different specified distances, γ represents rainfall and climate zone variables, δ_r represents time varying water agency-quarter average rebate amounts per square foot of turf removed where j represents an individual household and r represents retail water agency.

1.5.2 Group Effects

The concept of frailty is used in the Survival analysis literature to describe elements, which may be unobserved, that can make certain observations (households) more susceptible to failure than others. Frailty can be asserted either at the observation level (unshared) or at a group level (shared). This work employs shared frailty at the zipcode level in order to better isolate *neighborhood peer effects* from the effect of *homophily* and other potential *correlated unobservables*. Given a general form for the parametric survival model $h(t|x_j) = g(h_0(t), x_j \beta_x)$, the extension to include the shared frailty is $h(t_{ij}|x_{ij}, \alpha_j) = \alpha_i h(t_{ij}|x_{ij})$ where i represents the higher level (zipcode), and j represents the lower level units (household) observation within the group. Group level effects were tested at the zipcode, census block, and census block group level. Zipcode was the only level which showed significant group effects across all models tested.

1.5.3   Model Specification

The first consideration in moving forward with a survival analysis framework is the choice over level of

parameterization. The Nelson-Aalen cumulative hazard estimates provide insight into the rate of

"failure" (participation in this study) and functional choices for parameterization. Figure 4 gives the

Nelson-Aalen cumulative hazard estimate related to the sample data set. The time to event does not

seem to be normally distributed, and overall program participation displays an increasing rate of growth
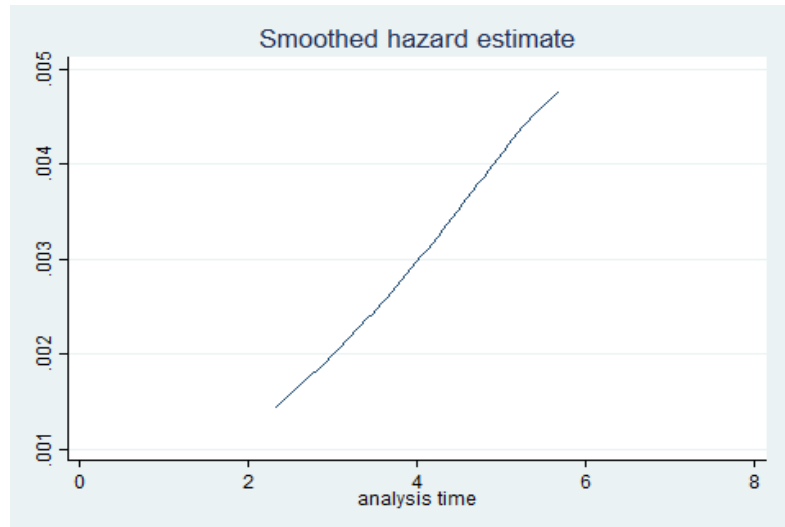
Figure 4

during this period.
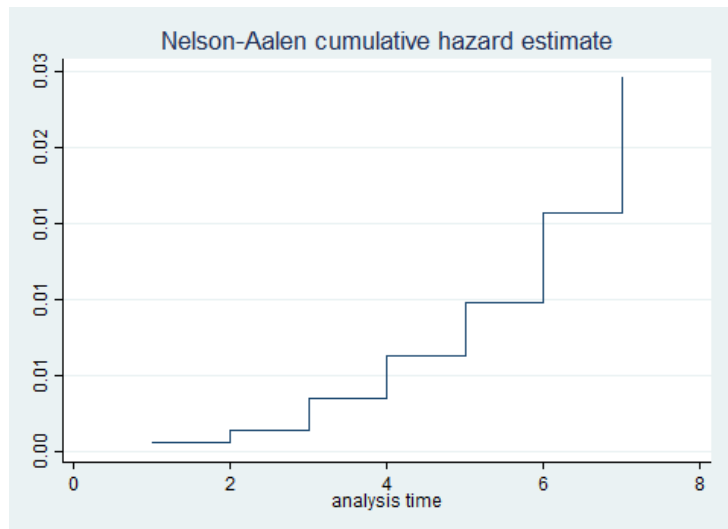
Given this shape, the Weibull,

Goempertz, and Lognormal

parameterizations are good distributions

to start with. The Weibull allows for

flexibility for a constant, linear, or

exponential shape, while the Goempertz

allows for an increasing, decreasing, or

constant shape, and the Lognormal exhibits a decreasing rate of increase in later periods. Consistency

with the stages of adoption as noted in Rogers (2003) also provides some theoretical support for the

flexibility provided by these distributions.

A smoothed estimate of the actual hazard in Figure 5 shows a monotone increasing hazard function. According to Rogers (2003) the participation rate of between 2% and 3% would put adoption somewhere between "adopters" and "early innovators[3]". This would support the application of a local increasing monotone hazard and cumulative hazard function, as we see here. A monotone hazard function is supported by both a Weibull and Goempertz distribution. The Lognormal parameterization was still considered as this may be a better representation of the long-term global hazard function. The Weibull distribution was chosen to move forward due to its flexibility in shape and applicability towards

Figure 5

either a Proportional Hazards (PH) or Accelerated Failure Time (AFT) parameterization. Alternative parameterizations were used as robustness checks and results are provided in appendix A.

1.5.4   The proportional hazards assumption

The proportional hazard assumption was tested via the Schoenfield residuals, by interacting covariates with time, with graphical analysis, and by use of the auxiliary option for the Weibull parameterization. In all cases the proportional hazard assumption was rejected. With lack of support for the proportional hazards assumption, parameterization in the Accelerated Failure Time (AFT) framework was chosen to move forward. Parameter estimates will be a representation of the effect of the covariate on the time

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[3] Again, assuming participation in the program, which does not include homes that pursue landscape conversions on their own as in (Bollinger & Gillingham, 2012). In the context of this article even if conversions outside of the program were included it is not likely that LA county would be past the early adopter stage in terms of percentage of overall lawn conversions.

to event, as opposed to the increase or decrease in the instantaneous probability of the event happening.

1.6   Results

Model results are listed in Table 4. Model two is the preferred specification, a fully parameterized Weibull distribution model in the AFT framework with a shared frailty effect at the zipcode level. Model one is a fully parameterized Weibull distribution model in the AFT framework without the shared frailty at the zipcode level. Other models and specifications were considered and are discussed in Appendix A.

Parameter estimates are given in the time ratio output, which shows the factor to which a one-unit increase in the specified covariate accelerates or deccelerates the time to event. For example in model one, we could say that all else equal the presence of the owner living in home signals that it will take that home 0.848 times the amount of time it will take a home without the owner living in home to participate. For non-binary variables, like the installed base, the interpretation is similar. For instance staying with model one, a one unit increase in the installed base in the first concentric circle will multiply the time to event by 0.987. This interpretation is informative for policy makers and utility agencies who want to understand how program duration may influence household level and aggregate participation. Furthermore, parameter estimates give insight into the likelihood that different types of households will participate within a given program window. This

Both models show significant evidence of neighborhood peer and spatial effects, along with the importance of the cost of water, presence of the owner living in the home, amount of time the current resident has lived in home, and the building climate zone with respect to the time to participation. Surprisingly there was no evidence that an increase in the rebate amount above the program-wide level, having a pool on property, or that the presense of democratic or green party voters in home decreased the time to participation.

Table 4		N = 119,378
	(1) Weibull No Frailty	(2) Weibull Zip level Frailty
Installed Base 1	0.987***	0.989**
	(0.005)	(0.004)
Installed Base 2	0.995	0.997
	(0.003)	(0.003)
Rebate Amount	0.997	1.022
	(0.035)	(0.036)
Water Cost	0.999***	0.999***
	(0.000)	(0.000)
Drought Mssg	0.650	0.679
	(0.235)	(0.242)
Average Rainfall	0.981	0.995
	(0.040)	(0.038)
Bldg. Climate Zn	0.973**	0.965**
	(0.012)	(0.015)
Pool	0.931*	0.961
	(0.038)	(0.041)
Home Age	0.999	0.999
	(0.000)	(0.000)
Owner	0.848***	0.849***
	(0.038)	(0.035)
Home Tenure	0.993***	0.993***
	(0.001)	(0.002)
Yard Area	0.999	1
	(0.0000)	(0.0000)
House Vote	0.969	0.968
	(0.025)	(0.024)
Home Value	1	1
(Tax Assessor)	(0.0000)	(0.0000)
Constant	130.13***	115.256***
	(55.88)	(46.816)
LR test		7.19***
Wald test	263.74***	88.33***

Notes: The dependent variable is a binary representing participant application to the program during that quarter. All the models in this table are modelled in the Accelerate Failure Time (AFT) framework. * denotes *P< 0.10, **P<.05, and ***P<0.010*, standard errors are in ().

1.6.1   Peer and spatial effects

In model two the parameter estimate for the first installed base measure signals that the presence of an additional home within 1,942 feet of a home decreases the time to participation by 1 percent. The inclusion of an additional participant in the second installed base measuring between 1,942 and 3,232 feet reduces the time to participation by less than one percent but is not statistically significant at the ten percent level. These results confirm hypotheses one and two from the introduction of this paper

and show that there is a neighborhood peer effect related to the time to participation in the program, and that this effect dimishes with distance from the home.   A participating neighbor within 1,942 square feet of a home has a significant effect on the time to participation, but once you move beyond this distance neighbors in this sample did not have a significant effect on time to participation.

This information can give policy makers a better understanding of how far the influence from one participating home, cluster of homes, or neighborhood may stretch into adjoining neighborhoods. Not only does this help policy makers estimate the potential spread of participation in the program, but can also provide vital information for marketing campaigns. For neighborhoods where there is a significant amount of homes that are within 1,942 square feet of a home that has already participated, there is a much higher liklihood that non-participating homes are aware of the program and are in some way influenced by the participation of neighboring homes. These neighborhoods would not be strong candidates for relatively stronger marketing campaigns, while neighborhoods with a more limited number of homes that fall within a distance of 1,942 square feet of a participating home would be better candidates for relatively stronger marketing campaigns.

The effect of the first installed base metric is easier to understand when analyzed in the context of the average home. Over the whole program the average number of homes within the first installed base measure for all homes in the sample was approximately two. There were some homes that did not have any homes in their first installed base over the whole period and the maximum amount that any home in this sample had in their first installed base measure was 46. The predicted time to participation for the average home in the sample was approximately six years, with a 95% confidence interval between approximately 5 and 7 years, while the regional turf removal rebate program was funded for approximately 2 years. Implimenting a program of this magnitude is extremely expensive even outside of the money set aside for rebates. Reductions in time to participation would save significant budgetary dollars even if there is a predetermined outlay for rebates or goal for number of homes to participate.

This further enforces the importance of understanding the power of peer and spatial effects in future programs.

To better understand how the installed base affects the time to participation the average of the estimated, and marginal change in, time to participation depent upon six separate hypothetical values for the first installed base measure are given in Table 5 below.

Table 5				
Neighbors that have participated within 1,942 sqft	Average time to participatoin	Upper bound of 95% confidence interval	Lower bound of 95% confidence interval	Marginal Change
0	73.5 months	60.3 months	86.4 months	.7 months less
1	72.6 months	59.7 months	85.5 months	.66 months less
5	69.9 months	57.6 months	82.5 months	.66 months less
10	66.9 months	54 months	79.5 months	.6 months less
20	60.9 months	45.9 months	75.6 months	.57 months less
30	55.2 months	38.1 months	72.6 months	.51 months less

The estimated average time to participation for a home with 5 neighbors who have already participated within 1,942 square feet of their home is approximately 4 months less than a home with no neighbors who have already participated within 1,942 square feet of their home. While this effect may seem small in magnitude, the policy implications need to be weighed in aggregate. With approximately 1.3 million single family residences in Los Angeles County the budgetary effects of a potentially large amount of homes reducing their time to participation by even one month could effect marketing and program budgets significantly, not to mention water savings.

The final column in Table 5 shows the marginal change in the estimated time to participation from an additional home within 1,942 square feet participating in the program. The marginal effect is decreasing with the number of homes in the first installed base. The maximum marginal effect from an increase within the first intalled base was .8 months while the minimum marginal effect from an increase in the installed base was .25 months. From Table 4, a unit increase in the first installed base

decreases the time to participation by approximately 1 percent. From Table 5 it is shown that the

average estimated time to participation is reduced with increases in the number of homes within 1,942

square feet that have already participated. These two facts result in a diminishing level effect from

increases in the installed base.

These results leave us with three important points which can help inform future policy and

theory:

1. There is evidence of a neighborhood peer effect in this program

2. The significance and magnitude of this effect diminsh with space (spatial effect)

3. The absolute effect on the time to participation has a negative relationship with previous
participation within approximately ¼ of a mile from the home.

Combined these findings can help policy makers better understand the likely effects from increases in

neighborhood participation, and also provide important information for program marketing.

1.6.2   Home ownership and presence of pool

While the primary specification of this work focused on neighborhood peer and spatial effects,

additional tests were considered to better understand the effect that the presense of a pool and home

ownership might have on participation in this program. The binary pool variable is not significant in the

preferred model above, and in only one of the eight models used for robustness checks in the appendix.

However, the log rank tests provided evidence that participation was significantly different between

"pool homes" and "non-pool homes" and also between households with the owner living in home and

rentals. This is further seen visually when comparing smoothed hazard estimates between groups as in
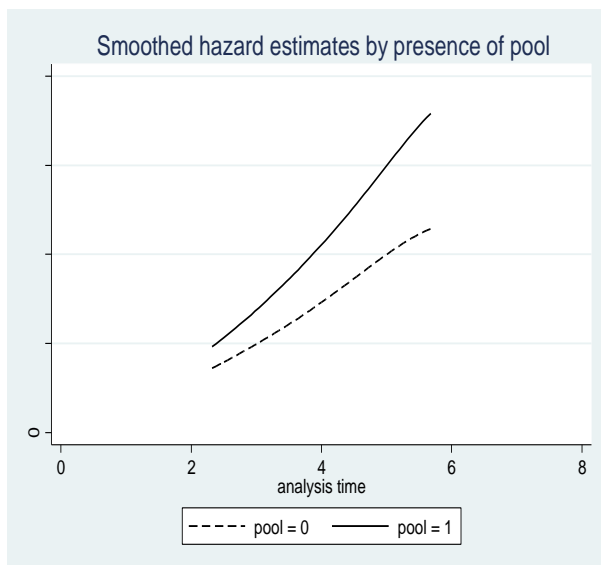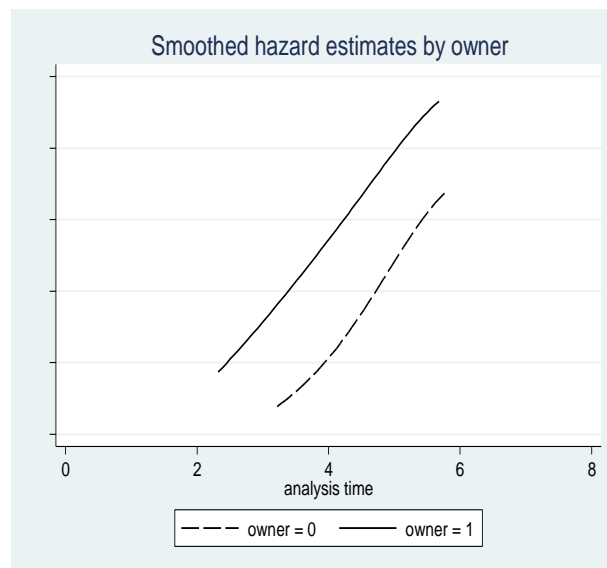
Figures 6 and 7 below.

Figure 7

Figure 6

Smoothed hazard estimates by presence of pool

pool = 0 ---- pool = 1 ——

analysis time

Smoothed hazard estimates by owner

owner = 0 ---- owner = 1 ——

analysis time

To better understand the role that these two variables may play together, a separate stratified sample was created to test for the effect of these two variables occuring simultaneously. This stratified sample was chosen to test for a significant difference in the survival between the experimental group (homes with pool and owner present) and the control group (homes with either no pool or owner not present) with a power of .9 and 5% level of significance. Specifics related to the sample sizes and within group participation required for the power and significance level are included in Appendix B.

The proportional hazard assumption was once again tested and in this case there was no evidence against the proportional hazard assumption being used. A fully parameterized Weibull model is used once again, with the shared frailty at the zip code level. Table 6 shows results of the model under the PH and AFT model specification to test for significant differences between participation in this comparison group and experimental group.

	(3) Weibull Zip level Frailty AFT	(4) Weibull Zip level Frailty PH
Table 6		N = 119,378
Installed Base 1	0.993	1.019
	(0.005)	(0.018)
Installed Base 2	0.997	1.009
	(0.003)	(0.012)
Rebate Amount	0.989	1.035
	(0.040)	(0.139)
Water Cost	0.999***	1.002***
	(0.000)	(0.000)
Drought Mssg	0.877	1.522
	(0.284)	(1.54)
Average Rainfall	0.942	1.209
	(0.045)	(0.199)
Bldg. Climate Zn	0.979	1.068
	(0.014)	(0.051)
Pool and Owner	0.801***	2.033***
	(0.041)	(0.261)
Home Age	0.998	1.004
	(0.002)	(0.004)
Home Tenure	0.994***	1.018***
	(0.001)	(0.005)
Yard Area	0.999	1
	(0.000)	(0.000)
House Vote	0.956	1.152
	(0.029)	(0.112)
Home Value (Tax Assessor)	1	1
	(0.000)	(0.000)
Constant	82.06***	0.00***
	(31.65)	(0.00)
LR test	0	0
Wald test	88.5***	88.5***

* P< .10, **P<.05, ***P<.010

In model three the interpretation of parameters is the same as it was in models one and two.

Model four is the preferred model in this case as we are free to rely on the proportional hazards

assumption, and the interpretation is more easily compared to similar probabilistic models. In model

four the interpretation is that the parameter serves as a multiple that a one unit increase in the variable

in question will have on the instantaneous probability of participation. In the example of the pool and

owner variable for model number four, the instantaneous probability of participating in the program is

approximately twice as high for those homes where the owner lives in home and there is a pool present

as compared to homes where either the owner does not live in the home or there is no pool.

In a separate analysis that was not included here, a sample was selected using pool and no pool,

and also one using owner and no owner, as the experimental and comparison groups respectively. In

both cases ownership proved to be a significant component while presence of a pool alone did not. In

addition, the overall effect in the model stratified on pool and owner is stronger than the effect from

ownership alone. This result suggests that on its own the presence of a pool is not enough to

significantly affect participation, but when combined with the owner living in home the presence of a

pool may complement the effect of ownerhsip status on the probability of participating.

1.6.3   Home tenure

While the effect is somewhat small, the length of time living in home proved to be a significant factor in

the time to participation in every model that was run. This result is contradictory to the hypothesis

formed at the beginning of this paper, and with previous work related to home improvements (Baker &

Kaul, 2002) and landscape conversions (Bollinger, Burkhardt, & Gillingham, 2018). The result in this

work could provide evidence that in this type of program residents who have lived in a home longer are

more familiar with their water company and typical water usage, likely have more equity built up in their

home, and may have a better idea of how neighbors might react to such a highly visible exterior change.

In model two the parameter for home tenure captures the total amount of time since the last

resident change at that address according to the 2015 property data. Seperating home tenures into

distinct categories that may signal differences between individuals who are somewhat new to the

neighborhood, versus established, or very established residents provides additional information. By

grouping hometenure into four distinct categories I was able to perform a log rank test to test for a

significant difference in the participation time between the groups. Table 7 shows the results of this log

rank test along with the distinction between the groups studied.

Table 7		
Home tenure	**Observed participation**	**Expected participation**
0-10 years	39	64
10-20 years	88	160
20-30 years	132	111
30 or more years	132	58
Chi squared (3)	145.79***	
	*** P < 0.010*	

Results from the logrank test show that there is a difference in participation between the

groups. Smoothed hazard functions stratified by home tenure category provide another visual

interpretation of the power of home tenure related to the time to participate in this program. Figure 8

shows how distinct the experience was between the different groups within the random sample.

 There is a stark contrast between all of the estimated hazard functions, and also what appears to be a

Figure 8
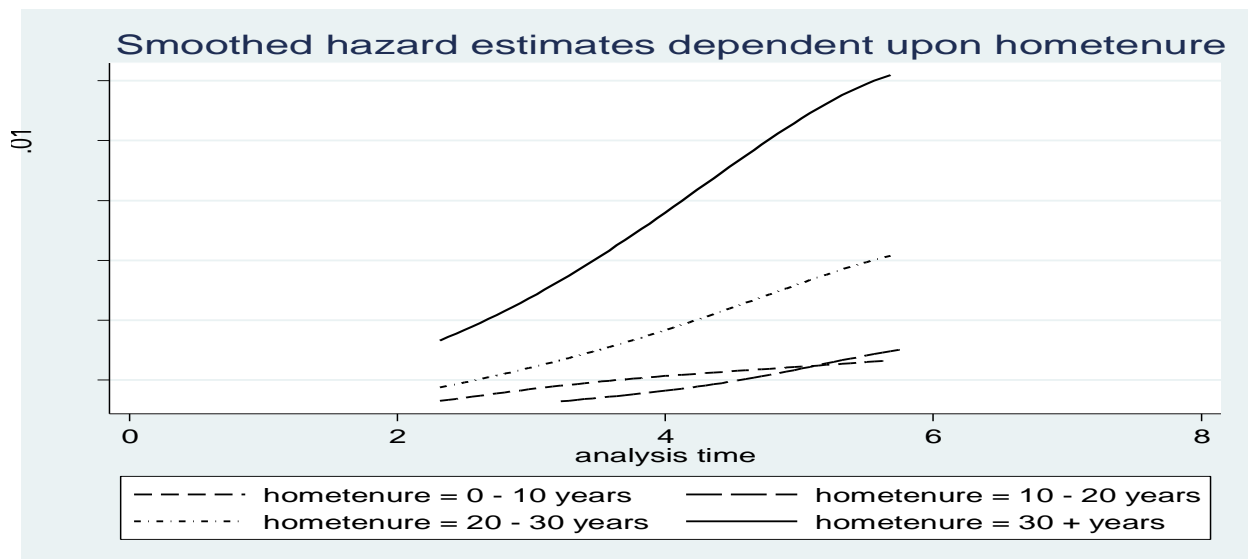
significant difference between a home tenure of less than and greater than 20 years. Finally it seems

that changing home tenure category not only shifts the hazard function, but also changes the slope of

the hazard function signalling that the magnitude of the effect of increases in home tenure also changes as you live in a home longer.

1.6.4   Building climate zone

The environmental variables are meant to provide additional control for heterogeneity between geographic areas and over the time period of this sample. In the preferred specification for this work building climate zone is shown to significantly influence the time to participation in the program. The translation of this parameter estimate is not straightforward as building climate zones is a categorical variable in this model. There are four climate zones that are referenced. Zone 6 is a coastal zone, while zones 8 and 9 are inland from the coast and zone 16 includes elevations above 5,000 feet in elevation. Zone 16 has the highest amount of precipitation, the widest annual variation in temperatures, and the lowest representation in the sample by far. Zone 9 has the highest representation in the sample, and in general there are a higher amount of climate variation in zone 8 and 9 than in the coastal zone. In general the mild coastal temperatures provide less rainfall in the winter, but the fog layer keeps a significant amount of moisture while zones 8 and 9 off the coast see more extreme temperatures and less moisture in the summer. This results in a greater need to use outdoor irrigation to keep a healthy lawn consistently throughout the year. This supports the idea that a higher need for outdoor irrigation is related to a greater desire to move to a more drought tolerant landscape.

1.7   Implications

There are important policy and theoretical implications related to this work. These results can help better inform future policy and provide empirical support for theory related to peer effects and household behavior in related programs.

1.7.1 Policy implications

First, there was no significant evidence that increasing the rebate amount decreased the time to participation in this program. It is more likely that the rebate amount did not go high enough to be significantly effective in attracting households that were not willing to participate at the $2 baseline. This highlights the uncertainty of marginal increases in the rebate amount, and that getting increases in participation through increases in the rebate amount may be very costly in aggregate.

Second, there does seem to be evidence of neighborhood peer effects and neighborhood spatial effects from this work. While water agencies should expect that participation by close neighbors may influence own participation, we should not expect that effect to necessarily overlap neighborhoods. This information is very important for estimating how likely neighbors are to affect other neighbors' participation, and how quickly participation is to spread among a population. A better understanding of these boundaries will allow for better targeted marketing based on space and the installed base measure. Furthermore, the marginal value of the neighborhood peer effect is dependent upon, and negatively related to, the actual level of the installed base. Knowing where additional marketing is most needed, and where the peer effect is likely to be the strongest, would be critical components of maximizing effectiveness of a marketing budget.

The first step in moving forward employing this information would be to separate neighborhoods into three categories based on the average installed base within 1,942 square feet. The first category (A) would include neighborhoods where the average installed base is between 0 to 1 inclusive. The second category (B) would include neighborhoods with an average installed base between 1 and 5, while the third category (C) would include homes with more than 5. Residents in neighborhood C will have the highest likelihood of seeing a program participant on a day to day basis, experience the largest absolute neighborhood peer effect but the lowest marginal neighborhood peer effect. Residents in neighborhood A will have the lowest likelihood of seeing a program participant on a

day to day basis, have the lowest absolute neighborhood peer effect, and have the highest marginal neighborhood peer effect.

Marketing campaigns would then vary in dollars spent and type of information between these three types of neighborhoods. In neighborhood A the focus should be on discovering why there are no participants up to this point and trying to find "leaders" in that neighborhood. The largest per household dollar amount should be spent on marketing campaigns in this neighborhood, but dollars should be spent on trying to find out what is causing low participation as opposed to just providing information. Marketing should be focused on outreach and educational events along with field interviews and phone calls to gain neighborhood trust and find out why residents are not participating. Program information along with visuals representing before and after changes to landscape and potential monthly savings in terms of water and utility bill should be the focus of email or USPS-based marketing outreach. They may be unaware of the program, untrusting of the utility company, unable to afford the high entry cost, susceptible to the tenant-landlord market failure, dislike drought tolerant landscaping, or just not ready for such a heavy infrastructure change. Once you find out more about why they are not participating you can have a better understanding of how to target potential "leaders" in that neighborhood. Marginal neighborhood peer effects are strongest in this neighborhood so establishing the first participants is critical.

In neighborhood C there is already a stronger absolute peer effect and there is a higher likelihood that individual residents are aware of the program and have done some initial research. This neighborhood will merit the lowest amount of per home marketing dollars as there is a higher likelihood that social norms and contagion are able to play a role in conversion without outside assistance. This is because neighborhood "buy in" is strongest in these areas. Budgetary funds in these neighborhoods should instead be focused on email or text messaging to residents asking if they have any questions related to their water service, water usage, or potential savings from taking advantage of the many

programs offered. Social comparisons using average neighborhood per square feet estimated outdoor

water usage and estimates of water savings and utility bill savings from program participation should be

the focus of email or USPS based marketing. Policy makers can assume that that lack of participation in

this neighborhood is less likely due to lack of information, awareness, or fear of neighborhood image.

Establishing trust and providing home specific information will likely add value while generic program

marketing may just annoy residents.

Finally, neighborhood B likely falls somewhere in the middle and so should marketing dollars per

home. Outreach should start like that in neighborhood C, but dollars should be budgeted for smaller

outreach and educational events if residents are very unresponsive to initial outreach used in

neighborhood C or if residents more often respond that they need more information, as opposed to just

being uninterested. Ultimately this information can be combined with information related to household

characteristics which make some homes quicker to participate than others. This will give policy makers a

better idea of which homes might be good candidates for leaders in those lower participation

neighborhoods.

The third policy implication is related to the presence of the owner in home and home tenure.

Each of these were significant factors in reducing the time to participation in all the models that were

run. This work also provides some evidence that homes with a pool face a different hazard rate than

homes without a pool. When the owner is living in home and there is a pool, the probability of

participating is approximately twice as much as those homes either without a pool or without the owner

living in home. This information could help segment the customer base to better understand which

populations are more likely to participate and where marketing efforts should be focused to get the

most "bang for the buck".

The importance of the owner living in home is consistent with the landlord-tenant market failure that is often seen in home energy efficiency infrastructure changes. When combined with the fact that it is often renters who are most in need of a reduction in monthly bills, this is particularly troubling. A program focused on better incentivizing rental property owners to consider conversion to a more drought tolerant landscape could help increase participation in rental properties and reduce monthly bills for some portions of the population that are most in need. Incentive could come in the form of a higher rebate amount for work on rental properties, zero interest financing on approved projects on rental properties, or proportional reductions in owners' home address water bill.

Home tenure provides another key variable for market segmentation. This variable proved to significantly effect time to participation, and segmenting home tenure into groups provided further illustration as to the different hazard rates that residents likely have depending on if they are "new to the neighborhood", "established residents" or "very established residents". With each category the cummulative participation not only shifts upward, but also becomes steeper.

Combining the information related to these three household variables could provide an even more powerful tool for targeted marketing to "jump start" a future program. Creating a marketing strategy which targets homes where the owner is in residence, there is a pool, and they have been living in the neighborhood for twenty years or more will provide a lower time to participation and higher probability of participating, all else equal. This could also be complemented with information related to neighborhood peer effect. By targeting homes that have a higher likelihood of participating, and incentivizing rental property landscape changes, water agencies can have greater success in creating "leaders" in those low participation neighborhoods. In those neighborhoods where there is already high participation, all this information can help inform water agencies as to the more likely reasons they have not yet participated.

Finally, while the program in general is proof that rebates do incentivize participation, this work finds no evidence that increases in rebate amount up to $3.75 per square foot significantly decrease time to participation. Therefore, water agencies would be better served by keeping rebate levels consistent at the $2 level, or potentially lower, and depending on targeted marketing to incentivize "leaders" and "early adopters" and rely on the increasing power of neighborhood peer effects and changing social norms to transition from "leaders" in adoption to "followers" and eventually "hold outs".

1.7.2   Theoretical implications

There are also a number of implications which can help inform theory related to peer effects and household decision making in related programs. The first implication is that this work does show evidence of neighborhood peer and neighborhood spatial effects. This further supports recent work in Behavioral Economics that suggests that there is significant room for behavioral drivers in the household utility function. Additionally, when considering a functional form which would allow neighborhood peer effects to enter that utility function, consideration should be taken for how salience will affect the magnitude of the neighborhood peer effect. This work is consistent with previous work that finds distance from the initial household is an important part of salience and the neighborhood peer effect. (Graziano & Gillingham, 2015)

The next theoretical implication is related to the role of the rebate level in this and potentially other programs. While there is no argument that the laws of supply and demand will hold in related programs, it is likely that the aggregate response to increases in the rebate level are non-linear and could more likely be represented by critical threshold points where significant portions of the population will be willing to participate. The specific thresholds are important to policy makers so they can better understand if marginal increases in the incentive level are likely to cause a significant increase in participation.

Finally, the role of time living in home is not as straightforward in this study as it has been in other studies. While previous work states that there is a negative relationship between the probability of pursuing a home infrastructure change and time living at a home, this work finds the opposite effect. In some ways new homeowners may be more incentivized to pursue said projects, but there are other theoretical reasons to believe that a longer time in residence could make someone more likely to pursue a home infrastructure change. Namely the likelihood that they have equity built up in the home could provide more comfort related to the resulting valuation of the home or easier financing for the project. There is also a higher likelihood that they feel they are due for a change and feel comfortable with the thought of living in that home for a long time to fully benefit from that change. Furthermore, a longer resident may be more familiar with neighbors and local utility agencies. All these reasons could provide theoretical grounds for why someone who has been living in a home longer would be more willing to participate in this type of program. This is not to say that this relationship will always hold, but rather that the role of length of time in home will likely have combatting effects on the willingness to pursue changes in home infrastructure.

1.8 Conclusion and future research

The results of this work provide evidence of a peer effect in the turf removal rebate program in Los Angeles County, but they also reiterate the need to better understand how household, neighborhood, and water agency heterogeneity can influence participation. Evidence of unobserved group level effects could signal the presence of homophily but could also signal the power of differences in marketing campaigns, neighborhood communication, water pricing, and reputation of the water agency.

The lack of evidence for influence from the variation in the rebate level further supports the need to focus on the non-price mechanisms that drive participation in future programs and the importance of social networks in behavioral change and program participation. Combined with the

strong effect from household variables, this work points to the importance of understanding how heterogeneity in home structure and household population can provide better forecasting of participation and help guide targeted marketing to ensure that budget dollars are optimally spent.

While these results are informative, it is also important to point out the limitations of this work. One primary limitation of this work is that it only captures turf conversions that were included in the turf removal rebate program. To better understand the peer effect a more robust study would include those lawns that pursued some form of lawn conversion outside of the turf removal rebate program. This not only provides information for the peer effect, but also allows the researcher to better represent the population which is "at risk". Another limitation of this work was that certain variables are only captured via the registered voter data set and therefore the choice of homes to include in this data set was also constrained to registered voters within Los Angeles County. This limits the external validity of this study. While this allows for use of those variables in analysis, further work should be done with the entire population to analyze the consistency of the effect of structural variables and neighborhood participation.

These limitations also provide opportunity for extensions and further work in this realm. There is recent work that applies lidar data and machine learning to capture lawn conversions via satellite imagery (Bollinger, Burkhardt, & Gillingham, 2018). This methodology could be applied to this study area to capture those who participated in the program and did conversions outside of the program to better understand the effects of lawn conversions in general and the population that is most likely to pursue a conversion outside of this program.

Two additional extension of this work will be to move towards analysis of the entire population and separating the installed base variable into between and within effects to better ensure that the orthogonality condition is not violated in the isolation of group level effects (e.g. see Bell and Jones,

2015). Currently this work analyzes a random sample of homes where at least one registered voter is present. This creates challenges with external validity, and the potential for bias related to any effects that may be present in the population of voters that is not present in homes where there are no registered voters. Both extensions would provide greater validity to this work and a better understanding of the drivers of program participation over the whole county.

Finally, there is clear evidence that there is a group level effect at the zip code level. While this could be from some form of homophily, it is also likely that this is related to differences in marketing strategies, availability and quality of landscape contractors, and the level of agency-customer interaction across different water agency regions. This work attempted to isolate the included variables from those group level effects but understanding how those group level effects increase or decrease participation rates will be critical for a more significant rate of landscape conversion with or without future rebate programs. Future research which focuses on the differences between water agencies, marketing strategies, communication networks, and customer relationships will provide a more detailed picture of what incentivized participation in this program and better inform future policy.

It is likely that some of this future work would come in the form of more detailed data analysis related to water agency behavior, but there is also a need for more in-depth study of behavior at the household level. This would likely come in the form of questionnaires and focus groups intended to better understand the household behavioral mechanisms that are not as easily attained through observational data. There still seems to be much to be gained from better understanding how household views towards the role of a lawn and water conservation affected program participation.

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1.10 Appendix A: Robustness checks

The results in table 6 show four separate parameterizations that are still specified using the AFT framework and include frailty at the zipcode level. The direction and significance of most of the covariates is consistent with the preferred model discussed above.

Table 6

	(4) Loglog	(5) GGamma	(6) Lognormal	(7) Exponential
Installed Base 1	0.989**	0.987**	0.981**	0.964***
	(0.005)	(0.005)	(0.007)	(0.013)
Installed Base 2	0.997	0.997	0.993	0.988
	(0.003)	(0.003)	(0.005)	(0.009)
Rebate Amount	1.02	1.03	1.06	0.526***
	(0.038)	(0.043)	(0.050)	(0.045)
Water Cost	0.999***	0.999***	0.999***	0.998***
	(0.000)	(0.000)	(0.000)	(0.000)
Drought Mssg	0.679	0.683	0.701	0.370
	(0.241)	(0.243)	(0.236)	(0.381)
Average Rainfall	0.999	1.03	1.07	1.154
	(0.041)	(0.043)	(0.046)	(0.118)
Bldg. Climate Zn	0.965**	0.964**	0.962*	0.932*
	(0.015)	(0.043)	(0.019)	(0.035)
Pool	0.959	0.958	0.962	0.893
	(0.042)	(0.046)	(0.053)	(0.109)
Home Age	0.999	0.999	0.999	0.999
	(0.004)	(0.000)	(0.000)	(0.001)
Owner	0.846***	0.831***	0.805***	0.615***
	(0.037)	(0.039)	(0.043)	(0.076)
Home Tenure	0.993***	0.992***	0.992***	0.988***
	(0.002)	(0.001)	(0.002)	(0.004)
Yard Area	1	1	1	1
	(0.000)	(0.000)	(0.000)	(0.000)
House Vote	0.968	0.967	0.969	0.924
	(0.025)	(0.027)	(0.031)	(0.068)
Value	1	1	1	1
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	117.87***	160.30***	222.73***	53501***
	(50.721)	(70.46)	(101.63)	(59033)
LR test	6.87**	6.83**	7.47**	1.41
Wald test	79.81***	84.89***	86.16***	399.38***

Notes: The dependent variable is a binary representing participant application to the program during that quarter. All the models in this table are modelled in the Accelerate Failure Time (AFT) framework. * denotes *P< 0.10, **P<.05, and ***P<0.010*, standard errors are in ().

Table seven shows the results of similar models under the proportional hazards assumption. Consistent with the examples above, and the preferred specifiation, there is significant evidence of peer

effects in the first installed base measure along with home ownership and home tenure. However with

the proportional hazards assumption the significance fo the rebate amount is not as straightforward.

Table 7			
	(9) **StCox** **No Frailty**	**(10)** **Weibull** **Zip Frailty**	**(11)** **Exponential** **Zip Frailty**
Installed Base 1	1.039***	1.03***	1.036***
	(0.014)	(0.014)	(0.004)
Installed Base 2	1.009	1.006	1.011
	(0.009)	(0.009)	(0.009)
Rebate Amount	1.300***	0.937	1.911***
	(.136)	(0.099)	(0.164)
Water Cost	1.001***	1.002***	1.001***
	(0.000)	(0.000)	(0.000)
Drought Mssg		3.126	2.710
		(3.279)	(2.8)
Average Rainfall	2.048	1.014	.864
		(0.117)	(0.088)
Bldg. Climate Zn	1.069**	1.109*	1.073*
	(0.036)	(0.053)	(0.042)
Pool	1.184	1.125	1.115
	(0.138)	(0.140)	(0.137)
Home Age	1	1	1
	(0.001)	(0.001)	(0.001)
Owner	1.601***	1.618***	1.627***
	(0.197)	(0.200)	(0.201)
Home Tenure	1.015***	1.018***	1.011***
	(0.004)	(0.081)	(0.004)
Yard Area	1	.999	1
	(0.000)	(0.000)	(0.000)
House Vote	1.083	1.101	1.082
	(.079)	(0.081)	(0.079)
Value	1	1	1
	(0.000)	(0.000)	(0.000)
Constant		0.00***	0.00***
		(0.00)	(0.00)
LR Test		7.19***	1.65*
Wald test	263.37***	83.33***	288.23***

Notes: The dependent variable is a binary representing participant application to the program
during that quarter. All the models in this table are modelled in the Proportional Hazards (PH)
framework. * denotes *P< 0.10, **P<.05, and ***P<0.010*, standard errors are in ().

Finally a random effects logistic regression was considered with random effects at zipcode level. The

results were not included in this report, but it is noted that the direction and significance of the installed

base measures, rebate amount, home ownership, and home tenure are consistent with the preferred

model discussed above.

1.11 Appendix B: Requirements pool and owner stratified sample

Table						
Case	Control Group	Experimental Group	Required Events	Required homes from control group	Required homes from experimental group	Total required homes
C	Not (Pool and owner)	Pool and owner	206	5214	991	6205

2 THE PSYCHOLOGY BEHIND TURF REMOVAL REBATE PROGRAMS: TESTING THE APPLICATION OF THE THEORY OF PLANNED BEHAVIOR AND VALUE BELIEF NORM THEORY

ABSTRACT

This paper tests the application of *the Theory of Planned Behavior* and *Value Belief Norm Theory* towards the participation in a recent turf removal rebate program in Los Angeles County California. A case control study design was employed due to a low participation rate in the population of single-family residences. Structural equation modelling was used to analyze responses from 85 randomly chosen households across Los Angeles County. Theory of Planned Behavior is found to have greater influence on the decision to participate in the program. Environmental beliefs and attitudes are not found to directly influence the decision to apply to or participate in the turf removal rebate program, while perceived behavioral control is. This suggests that future efforts to increase the spread of turf conversions should be focused more significantly on how turf removal could benefit the household and on influencing social norms about the role of a "yard" as part of packaged good that makes up a home, than on the environmental benefits or social comparison.

2.1 INTRODUCTION

Growing concerns over environmental health and sustainability have placed increasing attention on the

role of non-price mechanisms in the household consumption of natural resources. As such, utility

agencies are interested in what drives household decisions over usage of water and electricity. Massive

rebate programs have been rolled out to incentivize household level changes in infrastructure which will

also lead to a more efficient consumption of water and electricity. The effectiveness of utility level

rebate programs is under great debate and utility managers, government agencies, and academics are

all eager to better understand the household level drivers of participation in these programs. The

purpose of this work was to investigate the applicability of two widely used theories from environmental

psychology, *Theory of Planned Behavior (TPB)* (Ajzen, 1991) and *Value Belief Norm Theory (VBN)* (Stern,

Dietz, Abel, Guagnano, & Kalof, 1999)*,* in explaining household level participation in a recent turf

removal rebate program in Los Angeles County California. A survey was developed to elicit information

related to the components which form the basis of these two underlying theories along with other

information related to demographics, awareness of the program, communication channels, and

willingness to pay.

The Theory of Planned Behavior bases decisions on individual beliefs about consequences over

actions, perceived social pressure, and perceived behavioral control over the action. In conjunction with

this theory decisions over rebates would be influenced not only by the actual rebate but also the

perceived social consequences of participating in that program and the perceived control over that

action. This would be consistent with the idea that opinions of neighbors, how an individual would be

viewed in society, and behavioral constraints outside of environmental or monetary benefits may have

an effect over the decision. Recent work related to a curb-side recycling program in the United Kingdom

has shown that TPB can in fact be used to explain intention and behavior related to recycling. (Nigbur,

Lyons, & Uzzell, 2010). While a study focused on solar electricity adoption in Wisconsin suggested that "environmental values alone are not enough to motivate adoption" (Schelly, 2014).

Value Belief Norm theory places more of an emphasis on personal norms related to beliefs about the environment and how those beliefs drive awareness of consequences and feelings of responsibility over taking action.   A study by Lee et al. (2013) found that the application of VBN could link general environmental beliefs with three different environmentally friendly behaviors related to in home lighting. Poortinga et al. (2012) apply an adjusted version of VBN theory to find that environmental identity and personal norms are associated with supply side technology and demand-side measures related to reduction of carbon emissions. The application of VBN theory to pro-environmental choices seems to be more straightforward, but there remains a focus on both theories in the context of pro-environmental behavior.

Recent work has also focused on testing both theories within the context of the same behavior to see if one theory performs better than the other. This framework is applied to the willingness to pay for a suburban park in Spain and find that the Theory of Planned behavior has a larger influence on willingness to pay, but that environmental values do contribute to the willingness to pay as well. (Lopez-Mosquera & Sanchez, 2012) Kaiser et al. (2005) compared the two theories in the context of general environmental behavior and found that both theories showed explanatory power, but TPB performed better in explanation of variance. (Kaiser, Bogner, & Hubner, 2005).   A recent study on solar photovoltaic systems combined aspects of the Theory of Planned Behavior, Value Belief Norm Theory, and Diffusion of Innovations (Wolske, Stern, & Dietz, 2017). They find that "pro-environmental personal norms only influence interest in solar panels indirectly through perceived personal benefits" (Wolske, Stern, & Dietz, 2017). There remains a large amount of debate over the relevancy of these theories, and variation in the applicability dependent upon the specific type of environmental behavior that is being studied. As noted in the work of Wolske et al. (2017) and Schelly (2016), solar panel adoption provides

additional challenges that other pro-environmental behaviors may not due to the high initial investment, novelty of adoption, uncertainty and trust issues related to installation, and the extent to which this infrastructure change effects the resident's perception of the home. Lawn conversions share these same traits. While the infrastructure change has environmental benefits, and utility companies have placed a considerable focus on the environmental benefits, there is significant attachment to other portions of the homeowner's utility which are not related to the environmental benefit or the spectrum of financial effects. At the time of writing this article, the author is unaware of any other study that applies the TPB and VBN to the decision to participate in a utility funded turf removal rebate program. The intention of this work is to contribute dually to the growing literature related to the application of TPB and VBN towards pro-environmental behavior, and towards the growing literature focused on better understanding the household decision to pursue a turf conversion.

2.2 MATERIALS AND METHODS

To investigate the potential underlying behavioral drivers of participation in the turf removal rebate program, a survey instrument was used to collect data while factor analysis and structural equation modelling were used to examine questionnaire validity and fit of the proposed theoretical models.

2.2.1 Study area and Procedures

The case-control study design provides advantages over cross sectional and cohort studies when the probability of event is low. The target population for this survey were 2,500 Los Angeles County single family homeowners. Half of the sample were randomly selected from the pool of participants in the recent turf rebate program. For each one of these homes a single-family home which did not participate was matched on zipcode, yard area, tax assessor home value, presence of pool, home age, length of time in home, and home ownership Via Mahalanobis distance matching. Propensity score matching was also considered for this study, but has been shown to "increase imbalance, inefficiency, model dependence, research discretion, and statistical bias" (King & Nielsen, 2019). Furthermore, mahalanobis

distance matching "has the ability to achieve lower levels of imbalance, model dependence, and bias

than propensity score matching" (King & Nielsen, 2019). Initial contact mailers were sent in April of

2018 inviting households to participate in an online survey administered via qualtrics and housed at the

webpage www.laturfsurvey.com. Any household which received a mailer was informed of the

opportunity to participate in a random drawing which offered households an estimated 1/10 chance at

winning a $100 visa gift card. While participation in the survey was not required, it was required that

they signal their interest in the random drawing and leave an email at the end of the online survey. In

May of 2018 follow up post card[4] reminders were sent to all the households, and then again in June of

2018.

2.2.2   Response Rate

Out of the 2,500 invitations sent 107 responses were received which is just above a 4% response rate.

Of those respondents 75 applied for, and 58 participated in, the turf removal rebate program. It was

also found that 12 of the respondents were not ever aware of the actual program. Those 12 were

dropped from the sample for the part of this work that focuses on participation in the turf removal

program. Two of those individuals who were not aware of the program replaced a part of their turf

without a rebate, while 5 of the households that were of aware of the program replaced their turf

without a rebate. An additional 10 observations were dropped as their records were very incomplete.

This left a total of 85 records that were aware of the program, 67 which applied, and 54 which

participated. The response rate was below expectations yet still falls within the minimum sample size to

ensure a power of 80 percent with a 90 percent level of confidence in testing the goodness of fit

through the Root mean squared error statistic (RMSE). This test was conducted using the online

calculator at quantpsy.org (Preacher & Coffman, 2006).

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[4] Initial contact mailer and post card mailer are not included in the appendix. You can obtain a copy by contacting
the author.

2.2.3   Environmental Behavior

In this study the "pro-environmental" behavior will be considered participation in the turf removal rebate program. One additional difference that this work points out between the TPB and VBN models is the role that intentions play in the TPB model. In the TPB model, as pictured below in Figure 2, attitudes toward behavior, perceived behavioral control, and subjective norms all influence intentions directly, and then intentions and perceived behavioral influence behavior directly. In this case the application to the program will be taken to be intention, while participation in the program will be the actual behavior. This is different from the VBN model, pictured below in Figure 1, where the sequential move toward behavior flows from environmental beliefs, to awareness of consequences, to ascription of responsibility, to pro-environmental personal norms, to the behavior in question.

2.2.4   Measures

The mental models that form the basis of the components in the questionnaire are shown in Figure 1 for the VBN model, adjusted from Stern et al. (1999), and Figure 2 for the TPB model, adjusted from Ajzen (1991). For most of the latent constructs included in the mental model, a series of questions were asked which measured responses on a seven-point Likert scale ranging from strongly disagree = 0 to strongly agree= 6. In the original survey some questions were worded in a way that showed a more positive environmental response as a higher point on the Likert scale while some where worded in a way that a lower score was a more pro-environmental response. This was done intentionally to respondents who just assumed that all questions were worded one way and answered in the same way before reading the questions thoroughly. Before analysis all scores were coded so that a higher score would represent the more pro-environmental answer. Questions that were reverse coded are denoted with an "RC" in the tables and figures below. Factor extraction and Confirmatory factor analysis were used to test the reliability of the questions designed to provide factors for latent constructs from the theoretical model.

Figure 1. Schematic mental model of the Value-Belief-Norm theory with application to the turf removal rebate program as a form of private sphere behavior. The circles represent latent constructs in this study, while the square represents an observed variable from the survey.
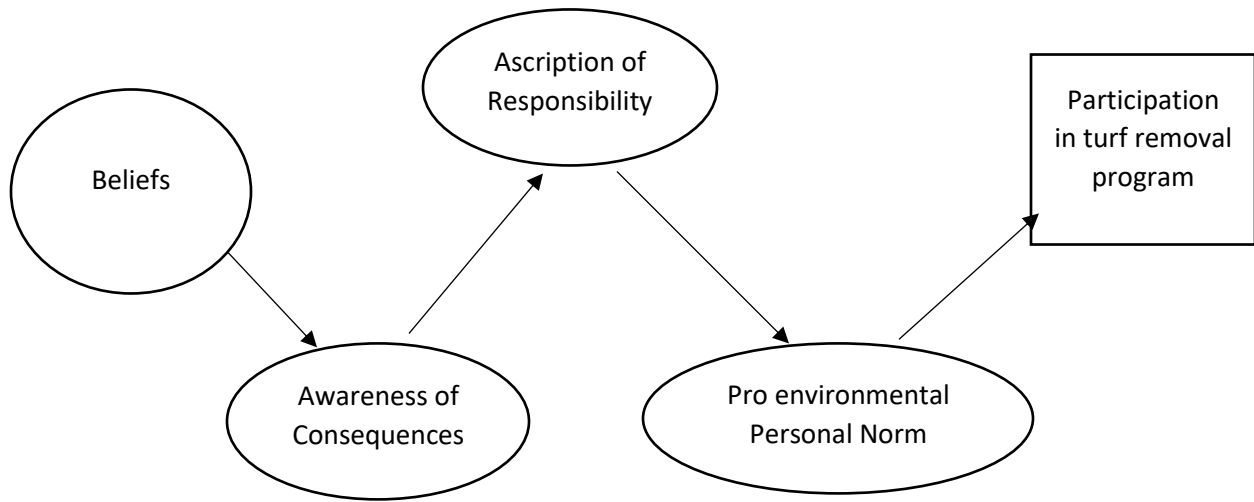
Figure 2. Schematic mental model of the Theory of Planned Behavior with application to the turf removal rebate program. The circles represent latent constructs while the rectangle represents an observed variable.
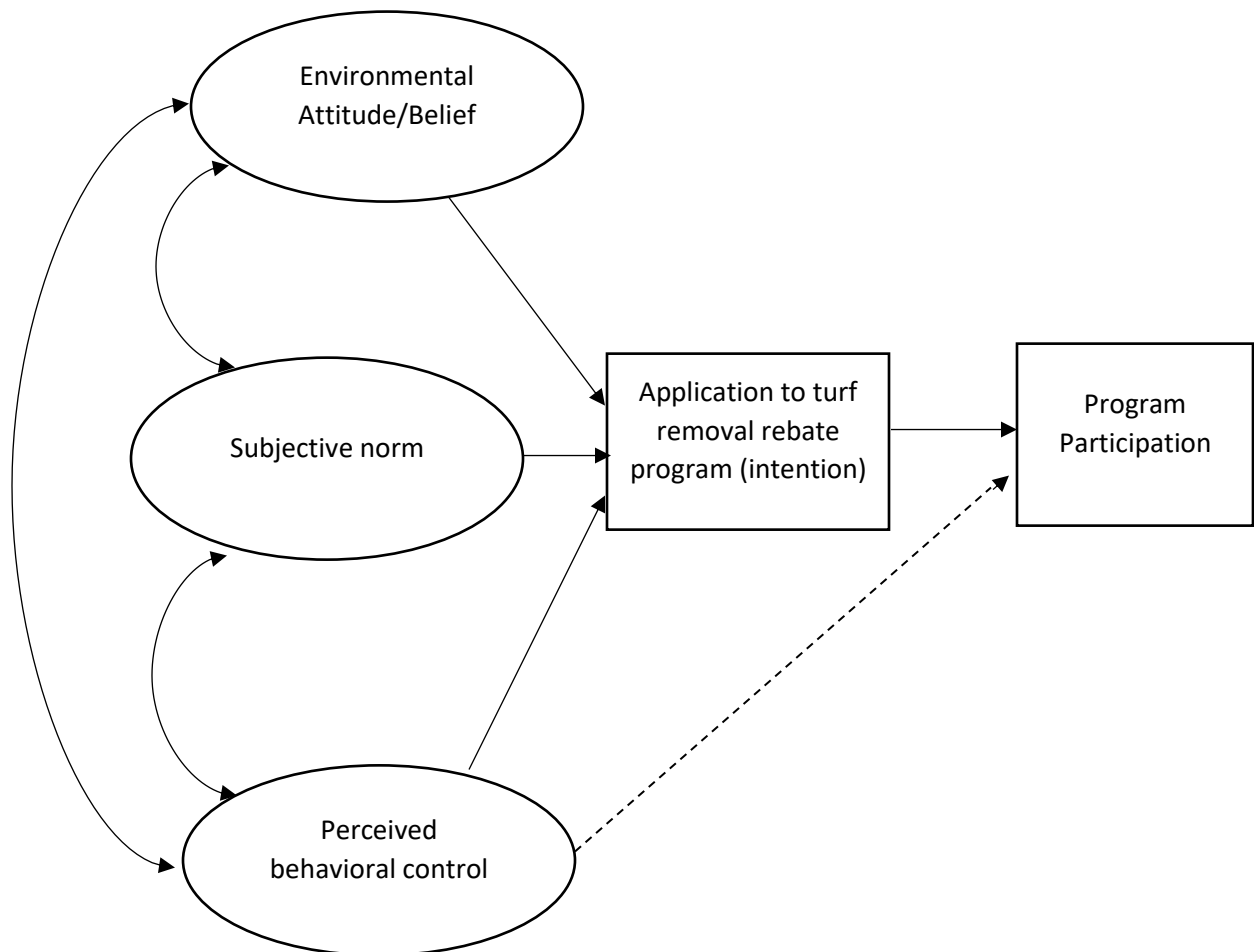
2.2.4.1　VBN measures

In the original VBN model the New Ecological paradigm (Belief) construct is itself driven by 3 latent

constructs: altruistic values, egoistic values, and traditional values. The purpose of this study focused on

the ability of environmental beliefs and values to drive pro-environmental consumer decisions, and not

on where those specific environmental beliefs and values come from. Length of the survey is also a key

constraint in any questionnaire, so this work did not include questions that would give insight to the

level of altruistic values, egoistic values, and traditional values. Instead this model starts with questions

from the New Ecological Paradigm to see how this does or does not provide a basis for the latent

variable "Beliefs", and then see how that in turn influences the path forward in the model. The final

observation point is a Private-sphere behavior in the form of participation in the program. Private-

sphere behaviors are only one of the four measures of pro-environmental behavior in the original model

from Stern et al (1999). The questions related to awareness of consequences were intended to capture

general awareness and concern for the damage that humans are doing to the natural environment.

Questions for ascription of responsibility were focused specifically on the responsibility that

respondents felt towards water conservation, and pro-environmental personal norms were also focused

on water conservation practices that were taken. If turf removal rebate program participation is viewed

at least in part as a water conservation practice, then VBN theory asserts that environmental beliefs and

concerns over water conservation would be a significant driving factor in participation in the turf

removal rebate program.

2.2.4.2　TPB measures

This model is adjusted from the model depicted in Ajzen (1991) in two primary ways. First is that I am

using Environmental Attitude/Belief as a latent construct following the work of López-Mosquera and

Sánchez (2012) as opposed to only attitude specifically towards turf removal. In this model the

Environmental Attitude/Belief construct is designed to capture general environmental beliefs and

attitudes towards water conservation, as opposed to attitude towards participation in the turf removal

rebate program. The question block related to subjective norms was intended to elicit perceptions of

how an individual's social network views water conservation practices. Perceived behavioral control

questions are focused on beliefs about the turf conversion that would potentially restrain a person from

participating in the program. Ajzen (1999) states that "perceived behavioral control refers to people's

perception of the ease or difficulty of performing the behavior of interest". This survey did not attempt

to capture potential financial constraints to participation[5] , rather the intention of this question block

was to focus on perceived constraints outside of the environmental or financial effects of this behavior.

The scale for subjective norms is a bit different than the other scale questions in this survey.

The subjective norm questions ask how important other groups in an individuals' social circle view water

conservation practices and the answers go from not important at all =0 to Very important =4, and there

is an option for "I do not know" and "N/A". There were four different potential groups to reference

family, friends, coworkers, and neighbors. There was significant variation in the amount of questions

that were answered within this question block. For instance, some people answered "I do not know" for

neighbors or coworkers, while most at least answered what they knew about their family and friends.

The variation in answers limited the cases usable for factor analysis in the structural equation, so an

average factor score of those groups they answered for was used to represent the subjective norm

index, as opposed to using confirmatory factor analysis to see which variables should represent the

latent variable.

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[5] A control variable for categorical income level was added to both models, but did not prove to be significant, or
change the significance of the model structure without that constraint.

2.3 RESULTS

The results[6] of the confirmatory factor analysis for the latent constructs which form the measurement models are given in Table 1 below. Goodness of fit measures for the chi-squared (χ^2), Root mean squared error (RMSE), and Comparative fit index (CFI) as well as the scale reliability (ρ) are all reported. Results and goodness of fit measures for the structural equation models are shown in the next section in figures 3 and 4, with a more detailed table in Appendix A.

2.3.1 Measurement models

All the Cronbach's alpha measures are within an acceptable range, using the "rule of thumb measure" of equal to or above 0.7. All goodness of fit measures for the chi-squared, Root mean squared error, and Comparative fit index are within an acceptable range. Scale reliability measures are all above .7 signaling that variation in an underlying latent variable account for over 70% of the variation in the scale being used in all constructs.

The latent construct for personal norms was saturated due to limited degrees of freedom so the provided statistics are not interpretable for goodness of fit. Only three responses were used for the personal norm latent construct as one of the intended responses was dropped due to a low factor loading and negative influence on the related Cronbach's alpha.   All chi-squared measures are not significant even up to the 10% level of confidence signaling that we fail to reject the null hypothesis that the covariance matrix in this sample is the same as that in the population. This is a positive signal for goodness of fit in comparative factor analysis.

All the factor loadings are significant at the 1% level of confidence, except for the final loading in the VBN model on awareness of consequences which is significant at the 10% level of confidence. The interpretation of the standardized estimate for the factor loading is that a 1 standard deviation increase in the associate latent variable will lead to a (1Xfactor loading) standard deviation increase in the

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[6] A Description of the confirmatory factor analysis process is included in APPENDIX B.

associated response variable. As an example, a one standard deviation increase in the level of Beliefs

will lead to a .691 standard deviation increase in the response to question 3_3 (RC) listed in Table 1

below.

Table 1

Reliability and Confirmatory Factor Analysis for measurement models of latent constructs

Path	Unstandardized value (factor loadings)	Standardized value (factor loadings)
I. The VBN model		
Beliefs (New Environmental Paradigm)		
n = 85; α =.771; ρ = .769; $\chi^2 =. 5$; RMSE = 0.00; CFI = 1.00		
Humans have the right to modify the natural environment to suit their needs (3_3 RC)	1 (constrained)	0.691***
The earth has plenty of natural resources if we just learn how to develop them (3_5 RC)	0.980***	0.620***
Human ingenuity will ensure that we do not make the earth unlivable (3_4 RC)	1.07***	0.750***
People should be able to use water however they want if they pay for it (4_3 RC)	1.03***	0.649***
Awareness of Consequences (AC)		
n = 85; α = .811; ρ = .823; χ^2=.84; RMSE 0.00; CFI = 1.00		
Humans are severely abusing the environment (3_1)	1(constrained)	0.897***
If things continue on their present course, we will soon experience a major ecological catastrophe (3_2)	1.33***	0.987***
The so called "ecological crisis" facing humankind has been greatly exaggerated (3_7 RC)	1.154***	0.779***
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4_4)	0.197*	0.189*
Ascription of Responsibility (AR)		
n = 85; α = .781; ρ = .743; χ^2 = 1.12; RMSE = 0.00; CFI = 1.00		
I feel a sense of personal obligation to ensure that my yard is drought tolerant (4_1)	1(constrained)	0.789***
I feel a personal obligation to do whatever I can to conserve water (4_2)	1.122***	0.907***
I am more concerned with my water bill amount than the amount of water that I use (5_2 RC)	0.604***	0.396***
My neighbors and peers should do whatever they can to conserve water (4_5)	0.821***	0.685***
Personal Norms (PN)		
N = 85; α = .694; ρ = .734; χ^2 = .30; RMSE = 0.00; CFI =1		
I do not let the faucet run when I am brushing my teeth or washing dishes (5_1)	1(constrained)	0.527***
I try to take shorter showers to conserve water (5_3)	2.703***	0.951***
I load my washer efficiently to minimize water consumption for laundry (5_4)	1.277**	0.535***

II. The TPB model		
Environmental Beliefs and Attitudes		
n = 85; α = .692; ρ = .798; χ² = 4.43; RMSE = 0.00; CFI 1.00		
Humans have the right to modify the natural environment to suit their needs (3_3 RC)	1 (constrained)	0.621***
The earth has plenty of natural resources if we just learn how to develop them (3_5 RC)	1.096***	0.624***
Humans were meant to rule over the rest of nature (3_6 RC)	1.109***	0.667***
People should be able to use water however they want if they pay for it (4_3 RC)	1.235***	0.694***
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4_4)	0.261*	0.214*
Perceived Behavioral Control (PBC)		
n = 85; α = .790; ρ= .81; χ² = .23; RMSE = 0.00; CFI =1.00		
Drought tolerant lawns do not look good (6_1 RC)	1(constrained)	0.851***
When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (6_2)	0.500***	0.561***
I like my lawn too much to replace it with a drought tolerant option (6_3 RC)	0.656***	0.657***
Drought tolerant lawns bring down the value of a house (6_4 RC)	.748***	0.722***
Subjective Norms (SN)		
Index average score used		
How do the following groups in your social circle view water conservation practices?		
Friends		
Neighbors		
Family		

*** p<0.01, ** p<0.05, * p<0.10

2.3.2 Structural models

Both structural models, shown below in figures 3 and 4, have acceptable goodness of fit measures.

However, the small sample size prevents the power of this study from being within the normally

acceptable bounds for confidence of parameter estimates. This results in a higher than preferred

possibility of failing to reject a null hypothesis that is not true. While the sample size is smaller than

ideal, results from both models remain informative for policy makers and academics.
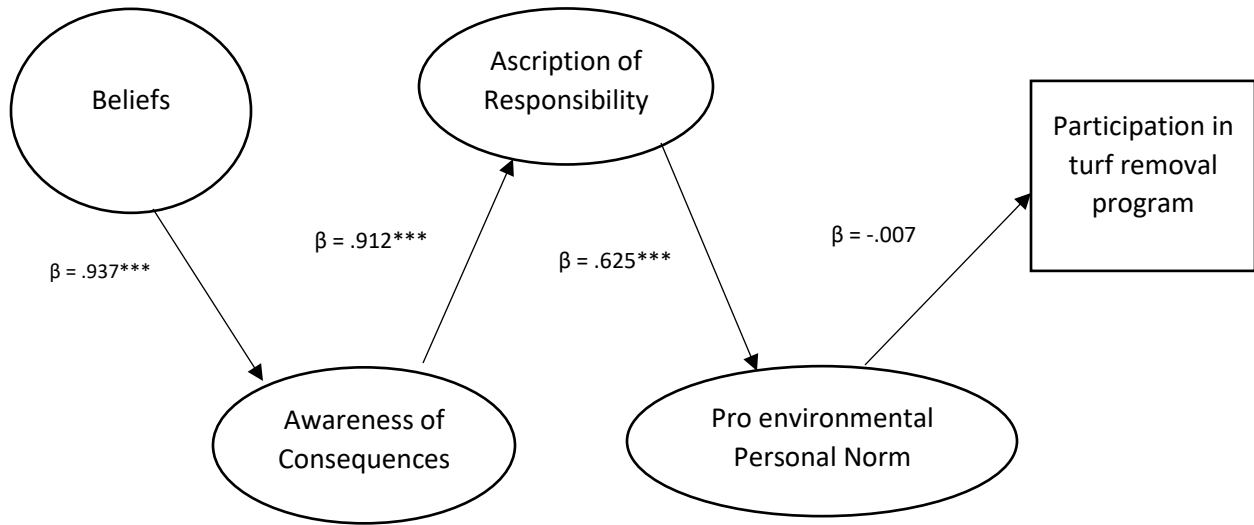
n = 85; χ^2 = 0.108; d.o.f. = 98; RMSE = 0.046; CFI = .973; Overall R^2 = 0.915; P < * = 0.1, ** = 0.05, *** = .01

Figure 3: Structural equation model for the Value Belief Norm theory model standardized results.
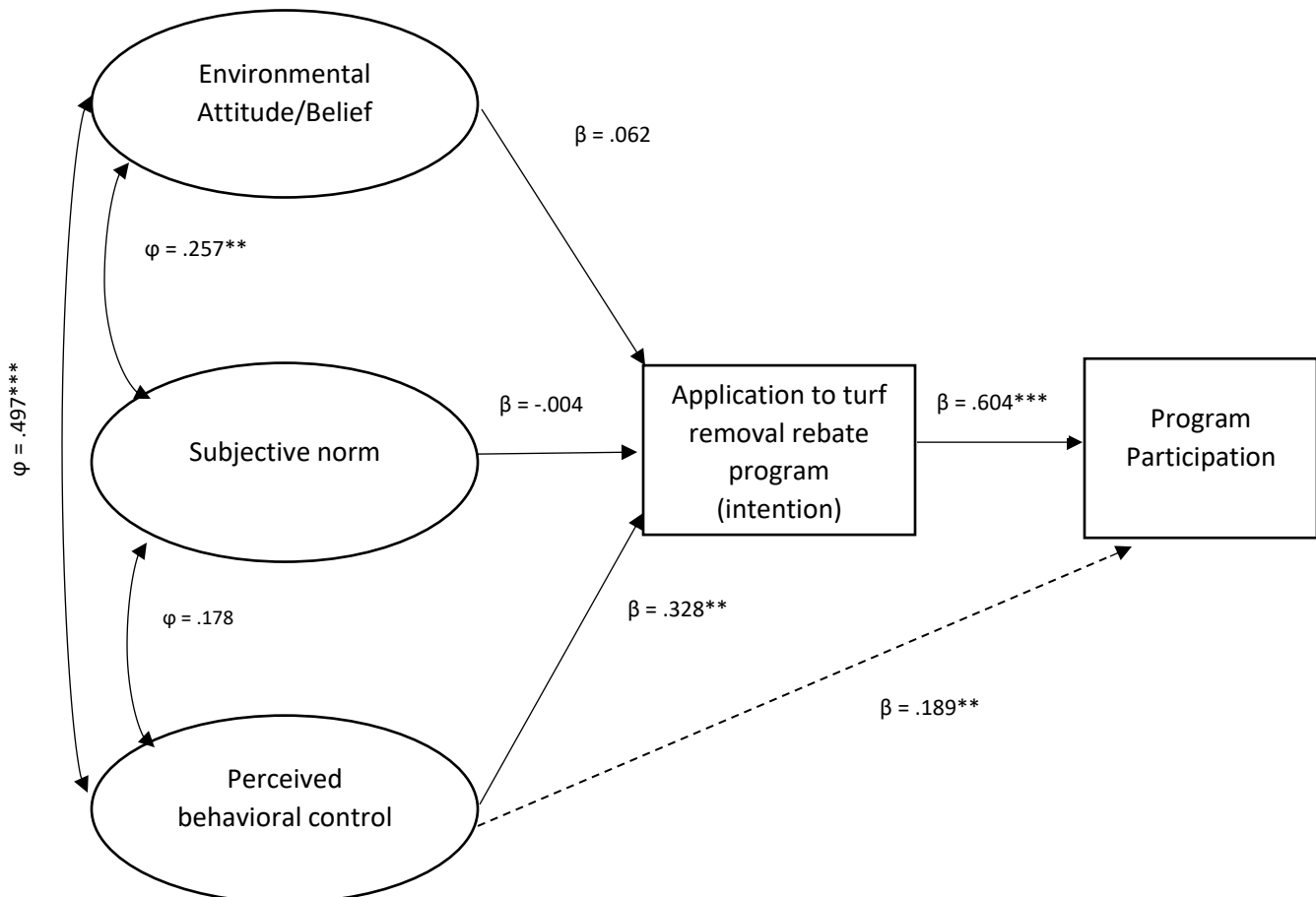
n = 81; X^2 = 60.84; d.o.f. = 46; RMSE = 0.039; CFI = 0.975; overall R^2 = 0.99; P < * = 0.1, ** = 0.05, *** = 0.01

Figure 4: Structural equation model for the Theory of planned behavior construct standardized results.

While the VBN model does show significance in most of the structural components of the model the final step from personal norms to program participation does not prove to be significant. This point leads us to the conclusion that ascription of responsibility may significantly influence pro-environmental personal norms related to household water usage, but these personal norms alone did not significantly influence participation in the turf removal rebate program. A person who changes water consumption habits in their day-to-day routine is not automatically a prime candidate for participation in a turf removal rebate program.

In the TPB model, the coefficients that measure effect on program participation are both significant, however it only seems to be perceived behavioral control which significantly influences application to the program, and therefore program participation. The fact that some of the path coefficients are not significant in the structural models could be interpreted in a couple of different ways. First, while the assigned survey response groups seem to vary reliably with underlying latent variables, the true underlying variables which drive them may not be the same as the latent variables we are assuming here. The second explanation is that both models are lacking in explanation of the drivers behind participation in this program.

The last statement can be further supported by a closer look at Figure 1. Note that all the structural coefficients are significant until the final critical component, the idea that personal norms drive participation in the program. Environmental values do drive awareness of consequences, which in turn drive ascription of responsibility specifically towards water conservation, and those drive personal norms towards water conservation. This information is consistent with the fact that environmental beliefs have driven behavioral changes in other areas of water conservation, i.e. length of shower, efficiently loading washer, and better monitoring of faucet water. However, the data from this survey does not support the idea that these beliefs and the formation of personal norms surrounding water

61

conservation are enough to significantly influence participation in the turf removal program on their

own. Furthermore, environmental beliefs and attitudes do not have a significant structural coefficient in

the TPB model either. Ultimately, the only latent variable that significantly and directly affected

program participation or application in either model was the perceived behavioral control.

2.3.3   Interpretation

The structural, or path, coefficients in Figures 3 and 4 above are standardized results and can be

interpreted as follows. A one standard deviation change in the source variable is correlated with a β X 1

Standard deviation change in the destination variable. For instance, in the TPB model a one standard

deviation change in perceived behavioral control is correlated with a 0.328 standard deviation change in

application to the program. In this case the interpretation takes on the additional challenge of a

resulting binary variable (application) which would take on the same interpretation as the probability of

application. A one-unit standard deviation change in the level of perceived behavioral control would be

correlated with a .328 standard deviation change in the probability of application.

2.3.3.1   TPB Model

In this sample 78 percent of the respondents applied to the program, with a standard deviation

of 0.41. This means that a one standard deviation change in the latent construct of perceived behavioral

control would lead to a (0.41X0.328 =) 13% increase in the probability of application to the program. A

one-unit standard deviation increase in the level of perceived behavioral control would increase the

probability of application by 13%. Continuing with the TPB model, neither subjective norms nor

environmental attitudes/beliefs significantly influenced the decision to apply to the program. Finally,

the decision to participate in the program is directly, and significantly, influenced by application to the

program and perceived behavioral control.

Out of the 78 survey respondents who participated in the program 54 ended up participating in

the program and the standard deviation over the whole sample was .484. Therefore, a one standard

deviation increase in perceived behavioral control would directly increase the probability of participation in the program by (0.484 X 0.189 =) 9%. In addition, a one standard deviation increase in probability of applying (41%) will increase the probability of participating in the program by (0.484 X 0.604 =) 29%. Perceived behavioral control effects participation directly and indirectly through the application for a total effect of 0.387. Therefore, a one standard deviation increase in perceived behavioral control increases the probability of program participation by (0.387 X 0.484 =) 18%.

2.3.3.2   VBN Model

The VBN model did not lead to a significant connection between pro-environmental personal norms and participation in the turf removal rebate program. However, the significant parameter estimates in this model still hold meaning for policy makers. This model does support the idea that environmental beliefs, mediated through awareness of consequences and ascription of responsibility, influence personal norms related to water conservation behavior in the home. The total effect of a one standard deviation increase in the latent beliefs variable will result in an increase in the personal norm latent variable equal to 0.53 multiplied by one standard deviation. While environmental beliefs were not found to be a significant influence on participation in this turf removal rebate program, they are still found to have a positive effect on water conservation behavior.

2.4   CONCLUSION AND IMPLICATIONS

The primary result from this work is that the Theory of Planned Behavior does a better job of explaining application and participation in the turf removal rebate program within this sample than the Value Belief Norm Theory does. In the TPB model the path coefficient from the perceived behavioral control to application is positive and significant. In turn the path coefficients from perceived behavioral control, and application, to participation are also positive and significant. In the VBN model, all path coefficients are positive and significant except for the final path coefficient to participation. This further supports the idea that beliefs may drive awareness of consequences, ascription of responsibility, and personal

norms. However, in the context of participation in the turf removal rebate program survey responses

did not show a connection between beliefs and participation in the program moderated by personal

norms.

A second implication from this work is that subjective norms related to water conservation, personal

norms related to water conservation, and environmental beliefs and attitudes do not seem to have

much of an influence on the actual decision to participate in or apply to this turf removal rebate

program. This is consistent across both models and could be considered as an area of modification for

both models in the context of choices over pro-environmental behavior that involves goods or services

which serve other significant roles in a home or daily routine. At the same time, it should be noted that

the resource limitations of this study related to the length and depth of the survey could have also

affected the significance of these latent constructs. With a more in-depth survey or focus group and

longer set of questions, one of these latent constructs may have proven to be significant. The small

sample size is also a primary limitation of this work and may have also contributed to the lack of

significance in path coefficients.

The model does show that environmental beliefs seem to drive awareness which leads to

acceptance of responsibility and personal norm development with regards to water conservation

practices in general, but this influence is not strong enough to influence participation in the turf removal

rebate program significantly. This contrast to other forms of pro-environmental behavior, where

environmental beliefs have led to personal norms that have significantly influenced eventual behavior,

may be due to the complexity surrounding the decision in general. It is not only a water conservation

choice, like taking a shorter shower, installing a rain barrel, buying more efficient sprinklers, or even just

using less water. There are critical issues surrounding perceived aesthetics of the home, traditional

views of what a yard should be, perceptions of how the value of the home will be affected, durability of

the infrastructure change, and high up-front cost among many other issues. While it may be viewed

partially as a water conservation effort, environmental beliefs or even personal norms related to water

conservation alone do not seem to significantly influence this choice. Ultimately, the yard may be

viewed more as part of a complex package of attributes that forms a home and is not as easily separated

from that package as other consumer goods which signal pro-environmental behavior. Even solar

photovoltaic panels may be more easily separated as it is not as often that people have as much pride in

the way their roof contributes to the home as they seem to have in their yard and its contribution to the

overall home.

This points to a need to better understand the complexities of the role that a yard plays in the

American home. Future work could focus on better understanding this relationship. From a theoretical

perspective, we know that the utility a home landscape provides should come from a variety of sources

including the aesthetics, congruence with social norms, and other amenity values such as recreation,

security, shade, and air quality. In turn, the decision over what to do with a landscape is much more

complex than savings on a utility bill, aesthetics of drought tolerant landscape, and a desire to conserve

water. To better understand the complexities related to the utility that a yard provides researchers can

work to collect more observed and self-reported data. Observed data can come in the form of observed

differences in home sales in conjunction with differences with yard space and type, and household

demographics. Future surveys or focus groups could focus more specifically on what homeowners do

and do not value in a yard, the way it looks, what they use it for, and what they would be willing to pay

to change certain aspects of their yard. This will also help policy makers further segment homeowners

into potential candidates for future participation in turf removal rebate programs, and better

understand how much it would take for them to give up their current yard.

This work shows that issues related to perceived behavioral control seem to have more of a direct

influence on application to and participation in this program. This is important for policy implications as

most of the recent effort towards homeowner "buy in" has been focused on a combination of rebate

potential, savings on utility bills, water conservation and pro environmental behavior, and nudges

related to neighbor comparison. While these all may be a part of the decision, this work suggests that

the way a lawn is viewed as a part of the home is still a much more critical part of that decision. In turn,

more effort should be focused on changing societal norms related to what a lawn "should be" along

with the benefits of the drought tolerant lawn can be in relation to that idea of a home. Part of this

solution will also come from better understanding the different areas that homeowners find utility in a

yard as discussed in the paragraph above, but there should also be an emphasis on helping homeowners

recognize whether they are getting additional utility out of having a natural lawn. In the race to find

ways to make drought tolerant options more popular, this work suggests that the best course is to focus

on how a drought tolerant lawn can better serve a household outside of savings on utility bills or

approval of friends and family.

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2.6 APPENDIX A: Full results from structural models

Table 2
The TPB Model

Path	Coefficient
Structural -> Participation	
Apply (Intention)	0.604***
Perceived Behavioral Control	0.189**
Beliefs (Attitude)	
Subjective Norm	
Structural -> Application	
Perceived Behavioral Control	0.328**
Beliefs (Attitude)	0.062
Subjective Norm	-0.003
Measurement <- PBC	
6_1 (RC)	0.785***
6_2	0.556***
6_3 (RC)	0.716***
6_4 (RC)	0.705***
Measurement <- Beliefs	
3_3 (RC)	0.501***
3_5 (RC)	0.820***
3_6 (RC)	0.525***
4_3 (RC)	0.807***
4_4	0.128

n = 81; X^2 = 60.84; d.o.f. = 46; RMSE = 0.039; CFI = 0.975; overall R^2 = 0.99

P < * = 0.1, ** = 0.05, *** = 0.01

The VBN Model

Path	Coefficient
Structural	
AC<- Beliefs	0.937***
AR <- AC	0.911***
PN<- AR	0.25***
Participate <- PN	-0.007
Measurement <- Beliefs	
3_3 (RC)	0.626***
3_5 (RC)	0.557***
4_3 (RC)	0.735***
3_4 (RC)	0.753***
Measurement <- AC	
3_1	0.763***
3_2	0.808***
4_4	0.283***
3_7 (RC)	0.939***
Measurement <- AR	
4_1	0.646***
4_2	0.799***
4_5	0.761***
5_2 (RC)	0.534***
Measurement <- PN	
5_1	0.536***
5_3	0.902***
5_4	0.576***

n = 85; χ^2 = 0.108; d.o.f. = 98; RMSE = 0.046; CFI = 0.973; Overall R^2 = 0.915

P < * = 0.1, ** = 0.05, *** = 0.01

2.7 APPENDIX B: CONFIRMATOR FACTOR ANALYSIS PROCEDU

Confirmatory Factor Analysis was used to narrow down blocks of questions into latent constructs which function as individual parts of the Structural Equation Model. This appendix describes the procedure used for selecting the questions to be used in each of the specific latent constructs. The work in this appendix uses *Discovering Structural Equation Modeling Using Stata* by Alan Acock as a primary reference (Acock, 2013).

Confirmatory factor analysis assumes that the latent variable accounts for variation in how people respond to a block of associated questions (Acock, 2013). Therefore, all the underlying questions will be indicators of the latent variable which is not observed. The latent variables in this work are those variables which show up in the structural equation models. These are the underlying behavioral components being tested within the Theory of Planned Behavior and Value Belief Norm Theory framework. For each behavioral component that shows up in the structural model, confirmatory factor analysis is used to test the fit of the group of questions which are dependent upon the latent behavioral variable.

2.7.1 Fitting the Confirmatory Factor Analysis Models

Maximum likelihood estimation is used to test the dependence of the associated survey questions on a single latent behavioral variable. As an example, the confirmatory factor analysis for the standardized results for the Beliefs construct from the TPB model described in this paper are included in Table 3 on the next page. The coefficient for each question references how changes in answers to the question (the factor loadings) are a result of changes in the underlying psychological construct under consideration. In this case however, these are standardized results, so interpretation is not as straightforward as the estimated change from one-unit change in beliefs. The standardized coefficient shows you how much the score to a factor loading will change as a result of a one standard deviation increase in the underlying latent variable. For instance, a one standard deviation increase in beliefs

would result in a .691 increase in the score of the first factor loading in Table 3.   At this point we can see

that all the factor loadings are significant at the 1% level of confidence.

Table 3: Confirmatory Factor Analysis for Beliefs Construct

Question, N = 85	Coefficient	Z	P>|z|
Humans have the right to modify the natural environment to suit their needs (3_3_RC)	0.691 (0.079)	8.65	0.00
The earth has plenty of natural resources if we just learn how to develop them (3_5_RC)	0.620 (0.085)	7.24	0.00
Human ingenuity will ensure that we do not make the earth unlivable (3_4_RC)	0.750 (0.075)	10.04	0.00
People should be able to use water however they want if they pay for it (4_3_RC)	0.649 (0.083)	7.84	0.00
LR test of model vs. saturated: Chi2(2) = 0.50, Prob> chi2 = 0.778			

The statistic at the bottom of the table is a likelihood ratio test which compares the given model to a

saturated model with no degrees of freedom. An insignificant result is optimal for this test as it shows

that our model does not fail to reproduce the full covariance matrix. This is not the only test for

goodness of fit for this model, but it is a good start. Table 4 below shows additional goodness of fit

measures associated with this model.

Table 4: Additional fit statistics

Fit statistic	Value
Root mean squared error (RMSE)	0.000
Akaike's information criterion (AIC)	1322.85
Comparative fit index (CFI)	1.000

The RMSE measure considers the amount of error for each degree of freedom. A lower RMSE is take as

a better fit for the model, with below 0.05 being a "good fit" and at or below 0.08 being a "reasonbility

close fit" (Acock, 2013). The AIC criteria is not used for evaluating the fit of a single model but is instead

used to compare models that use the same set variables. A smaller AIC criterion is viewed as a better fit

between models. This statistic came into consideration when comparing alternative choices of factor

loadings for the different latent constructs in this paper. Finally, the CFI measure compares the model in

this paper with a baseline model which assumes there is no relationship among all the factor loadings. A

CFI of one signals that this model does 100% better than the model which assumes no relationship

between these variables. "The recommended cutoff values for CFI should be either 0.90 or 0.95"

(Acock, 2013).

2.7.2   Principle Component factor analysis

The previous section described the use of confirmatory factor analysis in determining the best fitting

underlying model for latent variables that were used in the structural equation models in this paper.

This section will further discuss how I moved from blocks of questions in the survey into comparable

confirmatory factor analysis models.

Originally the survey was designed with the Theory of Planned Behavior and Value Belief Norm

theory in mind. Blocks of questions were created which in some cases were taken from previous work

related to these two theories, and in some cases, they were adjusted to better fit the context of the

regional turf removal rebate program. In this sense, blocks of questions fit naturally into certain latent

constructs for the confirmatory factor analysis, but in some cases, there were questions that could have

fit in more than one underlying construct. In other cases, there were questions that needed to be

eliminated from a block of questions as they did not add explanatory power to the potential variation in

the latent construct.

Principle component factor analysis and alpha reliability scores were used to ensure that the

correct questions were applied to the appropriate latent constructs. Principle component factor

analysis is used to test whether the variance in the factor loadings are explained by an underlying factor,

and if there is more than one underlying factor that is causing variation in the factor loadings. In order

to explain this process more in depth the questions for the beliefs construct from earlier will once again

be used. Table 5 shows the results of a principle component factor analysis test for five questions which

were originally tested in association with the beliefs construct.

Table 5: Factor analysis

Variable	Factor 1	Factor 2
Three_3_rc	0.6396	-0.0950
Three_5_rc	0.6283	-0.0381
Three_6_rc	0.6338	0.1058
Three_4_rc	0.702	-0.0325
Four_3_rc	0.6705	0.0608

The first thing to notice is that there are two underlying factors which explain variation in the group of

questions. It would be preferable if there was only one underlying factor which explained the variation

in these questions. The results in the factor 1 and factor 2 column show how much of the variation in

the variable is explained by that underlying factor. By convention a score of 0.4 or above is viewed as

acceptable (Acock, 2013). The second thing to notice is that most of the scores in the second factor

column are significantly lower, and the third variable has the highest absolute score in that column. The

fact that some of the numbers in the second factor column are negative and some are positive signals

that the effect of the underlying latent variable is in opposite directions for some of the variables. As a

test to see if a different combination of questions would better represent variation in a single underlying

factor, the third question is dropped, and the confirmatory factor analysis is run again. The results of

this second analysis are included in Table 6.

Table 6

Variable	Factor 1
Three_3_rc	0.6688
Three_5_rc	0.6078
Three_4_rc	0.7085
Four_3_rc	0.6306

When this model is run the number of factors drops to one. The relationship between the variables and the second factor is not strong enough now that the third question is dropped. This supports the idea that the dropped question should not be included in the group of questions representing the underlying construct. As a follow up test, the alpha score is calculated to test the reliability (internal consistency) of the questions being used. This is the well-known Cronbach's alpha score. The alpha scores are included for all the latent constructs in Table 1 of this paper. Results from the reliability test for the questions from Table 6 are included below in Table 7.

Table 7: Alpha score reliability

Item	Item-test correlation	Alpha
Three_3_rc	0.7729	0.7046
Three_5_rc	0.7498	0.7375
Three_4_rc	0.7939	0.6861
Four_three_rc	0.7640	0.7277
Test scale		0.7688

The overall alpha score is listed at the bottom in the test scale row. This is the measure of reliability for these questions. A score above 0.70 is viewed as acceptable (Acock, 2013). In this case I decided to proceed with the four remaining questions.

Principle component factor analysis and the alpha score reliability test were applied to all the

underlying latent constructs in order to assess the application of questions to specific latent constructs.

After blocks of questions were narrowed down and allotted to the specific latent constructs,

confirmatory factor analysis was used as described above to further test the applicability of the

remaining questions towards the underlying latent construct.

2.8   APPENDIX C: THE SURVEY INSTRUMENT

This document shows the questions asked on the actual survey in the format and order taken directly
from qualtrics. The questions numbers do not correspond with the order that the questions were asked.
The question numbers correspond with the order that the questions were created in qualtrics. Skip logic
was used in qualtrics to determine the path of questions that respondents were asked depending on
how they answered two key questions.

1. Are you aware of any of the turf removal rebate programs that have been offered through your water
provider over the last 5 years?

2. Have you applied for a turf removal rebate program through your water provider in the last 5 years?

This document is broken up into three sections which represent the questions that respondents would
have seen depending on how they answered these three key questions. Section I shows the questions
that respondents would see if they answered 1 and 2 with a yes. The second section shows the
questions that respondents would see if they answered question one with a yes and question two with a
no. Finally, the third section shows the questions that respondents would see if they answered no for
the first question. Once they answer no for the first question, they were not even shown question
number two.

2.8.1   Questions for respondents who were aware of the program and did apply

Q77 By participating in this survey you are verifying that you have read and understand the information that was mailed to you about this survey. Furthermore, you understand that this survey is completely voluntary. If you agree please mark "Yes I understand" below. If you never received a mailer, or do not want to participate in this research you do not have to.

○ Yes I understand (1)

Q69 Are you aware of any of the turf removal rebate programs that have been offered through your water provider over the last 5 years?

○ Yes (1)

○ No (2)

Q72 Where did you hear or find out about the turf removal rebate program(s)? (mark all that apply)

Neighbors (1)	Coworkers (2)	Friends (3)	Family (4)	Television (5)	Newspaper (6)	Water provider (7)	The internet (8)	Contractors (9)	Not listed here (10)
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q1 Have you applied for a turf removal rebate through your water provider in the last 5 years?

☐ Yes (1)

☐ No (2)

Q81 Did you end up removing some of your turf and participating in the program?

○ Yes (1)

○ No, I was approved but I did not participate in the program (2)

○ No, I was not approved for the program (3)

Q19 Please tell us which of the following did positively influence your decision to apply for a turf removal rebate program. (Select yes if it did positively influence you, no if it did not)

	Yes (1)	No (2)
The rebate amount (1)	○	○
My beliefs about water conservation (2)	○	○
I like the way that artificial grass looks (3)	○	○
Cost savings on my utility bill (4)	○	○
The influence of neighbors (5)	○	○
I want to help make a more sustainable community (6)	○	○
I do not want to mow my grass any more (7)	○	○
It is difficult to keep a healthy lawn in California (8)	○	○
My sprinkler system is frustrating or expensive to fix (9)	○	○
The influence of my friends, family, and peers (10)	○	○
I like the way that a drought tolerant yard looks (11)	○	○
I wanted to reduce potential fire hazard in my landscape (12)	○	○

Q54 This is a brief pause to say thank you for taking the time to complete this survey so far, I really appreciate your participation!! Your opinion and honesty is highly valued in this research. (You do not need to fill out anything in this text box to continue, but feel free to write anything you want)

_____

Q4 For the following questions select the answer that most closely represents the way you feel

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I feel a personal obligation to do whatever I can to conserve water (1)	○	○	○	○	○	○	○
I feel a sense of personal obligation to ensure that my yard is drought tolerant (2)	○	○	○	○	○	○	○
People should be able to use water however they want if they pay for it (3)	○	○	○	○	○	○	○
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4)	○	○	○	○	○	○	○
My neighbors and peers should do whatever they can to conserve water (6)	○	○	○	○	○	○	○

Q5 For the following questions select the answer that most closely represents your daily routine

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I do not let the faucet run when I am brushing my teeth or washing dishes (1)	○	○	○	○	○	○	○
I am more concerned with my water bill amount than the amount of water that I use (2)	○	○	○	○	○	○	○
I try to take shorter showers to conserve water (3)	○	○	○	○	○	○	○
I load my washer efficiently to minimize water consumption for laundry (4)	○	○	○	○	○	○	○

Q6 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Drought tolerant lawns do not look good (1)	○	○	○	○	○	○	○
When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (2)	○	○	○	○	○	○	○
I like my lawn too much to replace it with a drought tolerant option (3)	○	○	○	○	○	○	○
Drought tolerant lawns bring down the value of a house (4)	○	○	○	○	○	○	○

Q7 How do the following groups in your social circle view water conservation practices?

	Not important at all (1)	Not that important (2)	They do not have an opinion about water conservation (3)	Somewhat important (4)	Very important (5)	I do not know (6)	N/A (7)
Friends (1)	○	○	○	○	○	○	○
Family (2)	○	○	○	○	○	○	○
Coworkers (3)	○	○	○	○	○	○	○
Neighbors (4)	○	○	○	○	○	○	○

Q9 The following question mentions IMMEDIATE NEIGHBORS, COMMUNITY MEMBERS, COWORKERS, FRIENDS, AND FAMILY. IMMEDIATE NEIGHBORS should be considered the 10 or so households that live closest to you. COMMUNITY MEMBERS are people who live in your community but are not IMMEDIATE NEIGHBORS.

Did you discuss the turf removal rebate program with any of the following? Please estimate how many times you discussed the turf rebate program with members from each of the following groups

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)	N/A (8)
IMMEDIATE NEIGHBORS (1)	○	○	○	○	○	○	○	○
COMMUNITY MEMBERS (2)	○	○	○	○	○	○	○	○
FRIENDS (3)	○	○	○	○	○	○	○	○
FAMILY (4)	○	○	○	○	○	○	○	○
COWORKERS (5)	○	○	○	○	○	○	○	○

Q56 What kind of information did you discuss with the people you mentioned above?

	Information related to the requirements of the program (1)	Information on potential water bill savings (2)	Information related to landscape design (3)	Information related to water conservation potential (4)
We discussed (2)	☐	☐	☐	☐

Q35 How close are the opinions of the people you have talked to about the Turf Removal Rebate Program?

○ Completely dissimilar (1)

○ Somewhat dissimilar (2)

○ Neutral (3)

○ Somewhat similar (4)

○ Completely similar (5)

○ I did not talk to anyone about the turf removal rebate program (6)

Q48 How many days a week do you do the following?

	Never (1)	Less than once a week (2)	Once a week (3)	A few times a week (4)	Every day (5)
Read a paper copy of the newspaper (1)	○	○	○	○	○
Read news on the internet (2)	○	○	○	○	○
Watch the news on television (3)	○	○	○	○	○

Q12 Did you research the turf removal rebate program

	Answer	
	Yes (1)	No (2)
Online (1)	○	○
Through information received in the mail (2)	○	○
Through a library (3)	○	○
Through communication with the water company (4)	○	○

Q15 What type of information did you gain from the sources you answered yes to above. Select all options that apply.

	Information related to the requirements of the turf replacement program	Information on potential water bill savings	Information related to landscape design	Information related to water conservation potential	No information
	Answer (1)	Answer (1)	Answer (1)	Answer (1)	Answer (1)
Online (1)	☐	☐	☐	☐	○
Received in the mail (2)	☐	☐	☐	☐	○
Through a library (3)	☐	☐	☐	☐	○
Communication with water company (4)	☐	☐	☐	☐	○

Q3 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Humans are severely abusing the environment (1)	○	○	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe (2)	○	○	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs (3)	○	○	○	○	○	○	○
Human ingenuity will insure that we do NOT make the earth unlivable (4)	○	○	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them (5)	○	○	○	○	○	○	○
Humans were meant to rule over the rest of nature (6)	○	○	○	○	○	○	○
The so called "ecological crisis" facing humankind has been greatly exaggerated (7)	○	○	○	○	○	○	○

Q38 In the past 12 months how many times have you done the following?

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)
Had friends over to your house to visit or for dinner? (1)	○	○	○	○	○	○	○
Socialized with coworkers outside of work? (2)	○	○	○	○	○	○	○
Participated in online discussions (Facebook, twitter, blogs, etc) (3)	○	○	○	○	○	○	○

Q59 Almost there! Thank you so much for your continued effort, once again no answer required here just wanted to say thanks again. (If you want to write anything in the text box feel free).

_____

Q56 What is your total household income?

○ $19,999 or less (1)

○ $20,000 - $34,999 (2)

○ $35,000 - $49,999 (3)

○ $50,000-$74,999 (4)

○ $75,000 - $109,999 (5)

○ $110,000 - $149,999 (6)

○ $150,000 - $249,999 (7)

○ $250,000 or more (8)

Q44 Do you consider yourself?

○ White (1)

○ Black or African American (2)

○ American Indian or Alaska Native (3)

○ Asian (4)

○ Native Hawaiian or Pacific Islander (5)

○ Other (6)

○ Decline to State (7)

○ Of Hispanic Origin (8)

Q50 Which gender identity do you most identify with? If you prefer not to answer then leave this blank.

_____

Q71 What zip code do you live in?

_____

Q46 How long have you lived at your current address?

○ Less than 1 year (1)

○ 2 to 3 years (2)

○ 4 to 5 years (3)

○ More than 5 years (4)

Q52 Do you own the home you live in?

○ Yes (5)

○ No (6)

Q47 What political party do you identify with, if any?

○ Democrat (1)

○ Republican (2)

○ Green Party (3)

○ Independent and not Green Party (4)

○ Libertarian (5)

○ Other (6)

○ None-I do not participate in the political process (7)

Q49 What is your age?

○ 18 to 24 (1)

○ 25 to 34 (2)

○ 35 to 49 (3)

○ 50 to 64 (4)

○ 65 or older (5)

Q50 What is your principal occupation?

○ Professional (1)

○ Manager, Administrator, or sales worker (2)

○ Secretary or clerical worker (3)

○ Craftsman or skilled laborer (4)

○ Equipment operator (5)

○ Farmer or farm laborer (6)

○ Service worker (7)

○ Student (8)

○ Retired (9)

○ Unemployed (10)

○ Work at home (including child care) (11)

Q51 What is the highest degree you have attained?

○ Less than High School (1)

○ High School (2)

○ Some college (3)

○ 2 year degree (4)

○ 4 year degree (5)

○ Professional degree (6)

○ Graduate degree (7)

Q52 Are you ...

○ Married or I have a Domestic Partner (1)

○ Unmarried and No Domestic Partner (2)

○ Widowed, divorced, or separated (3)

○ Refuse to answer (4)

Q51 Would you be interested in learning about future turf removal rebate programs offered through your water provider?

○ Yes (1)

○ Maybe (2)

○ No (4)

Q79 Would you like to enter the random prize drawing to have a chance at winning one out of the $100 visa gift cards. If you select yes you will be taken to a separate survey where your email address and home address will be recorded. Remember that your

answers to this survey will remain anonymous since none of the addresses required for the random prize drawing will be connected to this survey.

○ Yes (1)

○ No (2)

2.8.2   Questions for respondents who were aware of the program but did not apply

Q77 By participating in this survey you are verifying that you have read and understand the information that was mailed to you about this survey. Furthermore you understand that this survey is completely voluntary. If you agree please mark "Yes I understand" below. If you never received a mailer, or do not want to participate in this research you do not have to.

○ Yes I understand (1)

Q69 Are you aware of any of the turf removal rebate programs that have been offered through your water provider over the last 5 years?

○ Yes (1)

○ No (2)

Q72 Where did you hear or find out about the turf removal rebate program(s)? (mark all that apply)

Neighbors (1)	Coworkers (2)	Friends (3)	Family (4)	Television (5)	Newspaper (6)	Water provider (7)	The internet (8)	Contractors (9)	Not listed here (10)
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q1 Have you applied for a turf removal rebate through your water provider in the last 5 years?

☐ Yes (1)

☐ No (2)

Q22 Please tell us why you did not apply to a turf removal rebate program.

_____

_____

_____

_____

_____

Q16 Was the reason you did not apply to a turf removal rebate program related to the amount of the rebate?

○ Yes (1)

○ No (2)

Q17 What is the minimum rebate amount per square foot that you would have required to remove a portion of your lawn (turf)? (drag the slider to the appropriate minimum rebate amount)

	0	3	5	8	10	13	15	18	20	23	25
Drag the slider to select your answer ()											

Q2 Did you remove a portion of your lawn (turf) without applying for a turf removal rebate from a water agency?

○ Yes (1)

○ No (2)

Q54 This is a brief pause to say thank you for taking the time to complete this survey so far, I really appreciate your participation!! Your opinion and honesty is highly valued in this research. (You do not need to fill out anything in this text box to continue, but feel free to write anything you want)

_____

Q4 For the following questions select the answer that most closely represents the way you feel

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I feel a personal obligation to do whatever I can to conserve water (1)	○	○	○	○	○	○	○
I feel a sense of personal obligation to ensure that my yard is drought tolerant (2)	○	○	○	○	○	○	○
People should be able to use water however they want if they pay for it (3)	○	○	○	○	○	○	○
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4)	○	○	○	○	○	○	○
My neighbors and peers should do whatever they can to conserve water (6)	○	○	○	○	○	○	○

Q5 For the following questions select the answer that most closely represents your daily routine

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I do not let the faucet run when I am brushing my teeth or washing dishes (1)	◯	◯	◯	◯	◯	◯	◯
I am more concerned with my water bill amount than the amount of water that I use (2)	◯	◯	◯	◯	◯	◯	◯
I try to take shorter showers to conserve water (3)	◯	◯	◯	◯	◯	◯	◯
I load my washer efficiently to minimize water consumption for laundry (4)	◯	◯	◯	◯	◯	◯	◯

Q6 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Drought tolerant lawns do not look good (1)	○	○	○	○	○	○	○
When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (2)	○	○	○	○	○	○	○
I like my lawn too much to replace it with a drought tolerant option (3)	○	○	○	○	○	○	○
Drought tolerant lawns bring down the value of a house (4)	○	○	○	○	○	○	○

Q7 How do the following groups in your social circle view water conservation practices?

	Not important at all (1)	Not that important (2)	They do not have an opinion about water conservation (3)	Somewhat important (4)	Very important (5)	I do not know (6)	N/A (7)
Friends (1)	○	○	○	○	○	○	○
Family (2)	○	○	○	○	○	○	○
Coworkers (3)	○	○	○	○	○	○	○
Neighbors (4)	○	○	○	○	○	○	○

Q9 The following question mentions IMMEDIATE NEIGHBORS, COMMUNITY MEMBERS, COWORKERS, FRIENDS, AND FAMILY. IMMEDIATE NEIGHBORS should be considered the 10 or so households that live closest to you. COMMUNITY MEMBERS are people who live in your community but are not IMMEDIATE NEIGHBORS.

Did you discuss the turf removal rebate program with any of the following? Please estimate how many times you discussed the turf rebate program with members from each of the following groups

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)	N/A (8)
IMMEDIATE NEIGHBORS (1)	○	○	○	○	○	○	○	○
COMMUNITY MEMBERS (2)	○	○	○	○	○	○	○	○
FRIENDS (3)	○	○	○	○	○	○	○	○
FAMILY (4)	○	○	○	○	○	○	○	○
COWORKERS (5)	○	○	○	○	○	○	○	○

Q56 What kind of information did you discuss with the people you mentioned above?

	Information related to the requirements of the program (1)	Information on potential water bill savings (2)	Information related to landscape design (3)	Information related to water conservation potential (4)
We discussed (2)	☐	☐	☐	☐

Q35 How close are the opinions of the people you have talked to about the Turf Removal Rebate Program?

○ Completely dissimilar (1)

○ Somewhat dissimilar (2)

○ Neutral (3)

○ Somewhat similar (4)

○ Completely similar (5)

○ I did not talk to anyone about the turf removal rebate program (6)

Q48 How many days a week do you do the following?

	Never (1)	Less than once a week (2)	Once a week (3)	A few times a week (4)	Every day (5)
Read a paper copy of the newspaper (1)	○	○	○	○	○
Read news on the internet (2)	○	○	○	○	○
Watch the news on television (3)	○	○	○	○	○

Q12 Did you research the turf removal rebate program

	Answer	
	Yes (1)	No (2)
Online (1)	○	○
Through information received in the mail (2)	○	○
Through a library (3)	○	○
Through communication with the water company (4)	○	○

Q15 What type of information did you gain from the sources you answered yes to above. Select all options that apply.

	Information related to the requirements of the turf replacement program	Information on potential water bill savings	Information related to landscape design	Information related to water conservation potential	No information
	Answer (1)	Answer (1)	Answer (1)	Answer (1)	Answer (1)
Online (1)	☐	☐	☐	☐	○
Received in the mail (2)	☐	☐	☐	☐	○
Through a library (3)	☐	☐	☐	☐	○
Communication with water company (4)	☐	☐	☐	☐	○

Q3 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Humans are severely abusing the environment (1)	○	○	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe (2)	○	○	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs (3)	○	○	○	○	○	○	○
Human ingenuity will insure that we do NOT make the earth unlivable (4)	○	○	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them (5)	○	○	○	○	○	○	○
Humans were meant to rule over the rest of nature (6)	○	○	○	○	○	○	○
The so called "ecological crisis" facing humankind has been greatly exaggerated (7)	○	○	○	○	○	○	○

Q38 In the past 12 months how many times have you done the following?

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)
Had friends over to your house to visit or for dinner? (1)	○	○	○	○	○	○	○
Socialized with coworkers outside of work? (2)	○	○	○	○	○	○	○
Participated in online discussions (Facebook, twitter, blogs, etc) (3)	○	○	○	○	○	○	○

Q59 Almost there! Thank you so much for your continued effort, once again no answer required here just wanted to say thanks again. (If you want to write anything in the text box feel free).

_____

Q56 What is your total household income?

○ $19,999 or less (1)

○ $20,000 - $34,999 (2)

○ $35,000 - $49,999 (3)

○ $50,000-$74,999 (4)

○ $75,000 - $109,999 (5)

○ $110,000 - $149,999 (6)

○ $150,000 - $249,999 (7)

○ $250,000 or more (8)

Q44 Do you consider yourself?

○ White (1)

○ Black or African American (2)

○ American Indian or Alaska Native (3)

○ Asian (4)

○ Native Hawaiian or Pacific Islander (5)

○ Other (6)

○ Decline to State (7)

○ Of Hispanic Origin (8)

Q50 Which gender identity do you most identify with? If you prefer not to answer then leave this blank.

_____

Q71 What zip code do you live in?

_____

Q46 How long have you lived at your current address?

○ Less than 1 year (1)

○ 2 to 3 years (2)

○ 4 to 5 years (3)

○ More than 5 years (4)

Q52 Do you own the home you live in?

○ Yes (5)

○ No (6)

Q47 What political party do you identify with, if any?

○ Democrat (1)

○ Republican (2)

○ Green Party (3)

○ Independent and not Green Party (4)

○ Libertarian (5)

○ Other (6)

○ None-I do not participate in the political process (7)

Q49 What is your age?

○ 18 to 24 (1)

○ 25 to 34 (2)

○ 35 to 49 (3)

○ 50 to 64 (4)

○ 65 or older (5)

Q50 What is your principal occupation?

○ Professional (1)

○ Manager, Administrator, or sales worker (2)

○ Secretary or clerical worker (3)

○ Craftsman or skilled laborer (4)

○ Equipment operator (5)

○ Farmer or farm laborer (6)

○ Service worker (7)

○ Student (8)

○ Retired (9)

○ Unemployed (10)

○ Work at home (including child care) (11)

Q51 What is the highest degree you have attained?

○ Less than High School (1)

○ High School (2)

○ Some college (3)

○ 2 year degree (4)

○ 4 year degree (5)

○ Professional degree (6)

○ Graduate degree (7)

Q52 Are you ...

○ Married or I have a Domestic Partner (1)

○ Unmarried and No Domestic Partner (2)

○ Widowed, divorced, or separated (3)

○ Refuse to answer (4)

Q51 Would you be interested in learning about future turf removal rebate programs offered through your water provider?

○ Yes (1)

○ Maybe (2)

○ No (4)

Q79 Would you like to enter the random prize drawing to have a chance at winning one out of the $100 visa gift cards. If you select yes you will be taken to a separate survey where your email address and home address will be recorded. Remember that your

answers to this survey will remain anonymous since none of the addresses required for the random prize drawing will be connected to this survey.

○ Yes (1)

○ No (2)

2.8.3 Questions for respondents that were not aware of any turf removal rebate program

Q77 By participating in this survey you are verifying that you have read and understand the information that was mailed to you about this survey. Furthermore you understand that this survey is completely voluntary. If you agree please mark "Yes I understand" below. If you never received a mailer, or do not want to participate in this research you do not have to.

○ Yes I understand (1)

Q69 Are you aware of any of the turf removal rebate programs that have been offered through your water provider over the last 5 years?

○ Yes (1)

○ No (2)

Q2 Did you remove a portion of your lawn (turf) without applying for a turf removal rebate from a water agency?

○ Yes (1)

○ No (2)

Q54 This is a brief pause to say thank you for taking the time to complete this survey so far, I really appreciate your participation!! Your opinion and honesty is highly valued in this research. (You do not need to fill out anything in this text box to continue, but feel free to write anything you want)

_____

Q4 For the following questions select the answer that most closely represents the way you feel

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I feel a personal obligation to do whatever I can to conserve water (1)	○	○	○	○	○	○	○
I feel a sense of personal obligation to ensure that my yard is drought tolerant (2)	○	○	○	○	○	○	○
People should be able to use water however they want if they pay for it (3)	○	○	○	○	○	○	○
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4)	○	○	○	○	○	○	○
My neighbors and peers should do whatever they can to conserve water (6)	○	○	○	○	○	○	○

Q5 For the following questions select the answer that most closely represents your daily routine

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I do not let the faucet run when I am brushing my teeth or washing dishes (1)	○	○	○	○	○	○	○
I am more concerned with my water bill amount than the amount of water that I use (2)	○	○	○	○	○	○	○
I try to take shorter showers to conserve water (3)	○	○	○	○	○	○	○
I load my washer efficiently to minimize water consumption for laundry (4)	○	○	○	○	○	○	○

Q6 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Drought tolerant lawns do not look good (1)	○	○	○	○	○	○	○
When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (2)	○	○	○	○	○	○	○
I like my lawn too much to replace it with a drought tolerant option (3)	○	○	○	○	○	○	○
Drought tolerant lawns bring down the value of a house (4)	○	○	○	○	○	○	○

Q7 How do the following groups in your social circle view water conservation practices?

	Not important at all (1)	Not that important (2)	They do not have an opinion about water conservation (3)	Somewhat important (4)	Very important (5)	I do not know (6)	N/A (7)
Friends (1)	○	○	○	○	○	○	○
Family (2)	○	○	○	○	○	○	○
Coworkers (3)	○	○	○	○	○	○	○
Neighbors (4)	○	○	○	○	○	○	○

Q3 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Humans are severely abusing the environment (1)	○	○	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe (2)	○	○	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs (3)	○	○	○	○	○	○	○
Human ingenuity will insure that we do NOT make the earth unlivable (4)	○	○	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them (5)	○	○	○	○	○	○	○
Humans were meant to rule over the rest of nature (6)	○	○	○	○	○	○	○
The so called "ecological crisis" facing humankind has been greatly exaggerated (7)	○	○	○	○	○	○	○

Q38 In the past 12 months how many times have you done the following?

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)
Had friends over to your house to visit or for dinner? (1)	○	○	○	○	○	○	○
Socialized with coworkers outside of work? (2)	○	○	○	○	○	○	○
Participated in online discussions (Facebook, twitter, blogs, etc) (3)	○	○	○	○	○	○	○

Q59 Almost there! Thank you so much for your continued effort, once again no answer required here just wanted to say thanks again. (If you want to write anything in the text box feel free).

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answers to this survey will remain anonymous since none of the addresses required for the random prize drawing will be connected to this survey.

○ Yes (1)

○ No (2)

3 Willingness to Accept "Cash for Grass"

Abstract

Residential turf removal rebate programs continue to play a significant role in policy designed to move California towards a more sustainable future. Program efficacy, potential *peer effects* related to neighborhood participation, water savings, and landscape conversion choice have all received significant attention, while homeowner valuation of a natural turf lawn has not been studied as intensively. This work uses survey data and a contingent valuation framework to analyze the household willingness to accept a rebate for the turf removal rebate program in Los Angeles County California between 2013 and 2016. Results indicate that water conservation beliefs and the way that the homeowner views a drought tolerant landscape both affect the minimum rebate a homeowner would be willing to accept. Subjective norms and residential personal norms related to water conservation were not found to influence the minimum rebate amount required for participation. This suggests that having a better understanding of how homeowners value a natural turf lawn will be vital for the success of future programs.

3.1 INDTRODUCTION

After substantial increases in the use of turf removal rebate programs in the Western United States,

policy makers and academics are focused on better understanding participation in these programs.

While the availability of a rebate was the primary driving force behind the marketing of these programs,

work related to the sensitivity of homeowners to changes in the rebate amount is limited. Policy makers

have promoted the bill savings, water savings, and overall sustainability benefits of replacing natural turf

lawn with a drought tolerant option. However, homeowners are likely to view their yard in a variety of

aspects outside of the sustainability factor and contribution to the monthly bills. In order to better

understand participation in these programs, there is a need to focus on the value that homeowners

derive from a natural turf lawn, and their willingness to change from that status quo to a more drought

tolerant option. Having a better understanding of what influences the decision over the minimum

rebate amount required for a homeowner to participate in future programs will allow policy makers to

better estimate participation rates, identify potential household that would remove a portion of their

natural turf without a rebate, and create better targeted marketing plans for "holdouts" or "laggards[7]."

For, the rebate amount is a primary budgetary concern in the context of the net benefits of future

programs.

    This paper will take a contingent valuation approach to study homeowners self-reported

willingness to accept to participate in the regional turf removal rebate program in Los Angeles County

between 2014 and 2016. This approach allows for a focus on the behavioral and environmental factors

that influence the value that a homeowner places on their current landscape as opposed to a program

approved drought tolerant option. The value that homeowners place on their yard is a critical

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[7] These concepts come from Rogers *Diffusion of Innovations Theory* and represent people who are conservative, skeptical of change, and are the hardest population to influence (Rogers, 2003).

component of their willingness to participate in the program, yet it has not been a focus of the related literature that attempts to investigate the drivers of participation in such programs.

The remainder of this paper will proceed as follows. In the next section I will briefly discuss related literature. After that I will introduce the survey instrument used in this work, and then discuss some key findings from that survey. Next, I will summarize the willingness to accept responses in the context of a classic microeconomics framework, and then introduce the methodology and empirical model that will be used to further analyze the variation in willingness to accept. Results from the empirical model of willingness to accept (WTA) will come next, followed by a discussion section related to the results of the empirical model and key findings from the survey in general, and finally a conclusion.

3.2   LITERATURE REVIEW

Much of the recent work related to participation in turf removal rebate programs has applied observational data to statistical models to seek out the presence of *spatial effects* and other drivers of participation (e.g. see Brelsford & De Bacco, 2018; Torpey, 2017; Pincetl et al., 2017; Shideler 2019). Johnson (2017) uses survey data and geographical information systems (GIS) to analyze the conversion of lawns for applicants and non-applicants in a program focused on Irvine Ranch Water District and finds a multiplier effect between participants of the program and non-participants who converted their landscape on their own. Marx, et al. (2018) use GIS analysis to investigate spillover from program participants to non-participants in the Metropolitan Water District Regional Turf Replacement Program.

Observed program level data has served well in recognizing household, geographic, and economic drivers of participation in these programs. However, there is a need to better understand what unobserved behavior, attitudes, and opinions are also driving household decisions. The use of surveys, experiments, and focus groups can complement existing studies by providing information on behavior that is not observable. In a recent survey by the Alliance for Water Efficiency, Chestnut et al.

(2018) find that homeowners are uninformed about outdoor water use and feel they are already using water efficiently. They also find that landscapes are a "source of pride for homeowners", but that they also want to be "smart water users" and are open to making their landscape more sustainable (Chesnutt, et al., 2018). While these results are all informative, there is much work to be done in this area.

The contribution of this paper comes in two forms. The first contribution will come in the form of an original survey instrument related to participation in the regional turf removal rebate program in Los Angeles and a summary of key responses that are not completely consistent with results from previous work in this realm. The second contribution will come in the form of a WTA framework used to calculate self-reported opportunity cost of landscape conversion consistent with program requirements, estimate surplus from specific rebate levels within the survey sample, and model the decision over the minimum rebate amount required.

The willingness-to-accept framework will allow us to investigate what household level beliefs and characteristics influence the minimum rebate required to participate in the program. Furthermore, the willingness to accept measure can serve as a measure of value that a homeowner places on their current natural turf lawn, as opposed to a program-approved alternative. This is a critical component of program participation that could use more attention.

Research related to the household benefits of this program is limited (Jessup, 2016), and the complexity of how a homeowner values their yard is a research strand that needs further attention to better understand participation and increase future conversions. Much of the recent work related to program cost and effectiveness in turf removal rebate programs has focused on program costs, water savings, projected spatial spillover, and utility bill savings (Sovocool, 2005; Atwater, Schmitt, & Tull, 2015; Addink; Chesnutt, et al., 2018; Hodel & Pittenger, 2015; Matlock, 2018; Pincetil, et al., 2017). There has been limited work done related to the value that homeowners place on their yard, as opposed

to a drought tolerant conversion, and the potential surplus they receive from participating in the program. Furthermore, this is the first study to investigate the sensitivity of the required rebate level from a contingent valuation framework, including beliefs and norms related to water conservation.

Contingent valuation has been used extensively in the environmental economics literature as a tool to value resources where there are limitations on the presence or functionality of a market for direct observation. The difference between willingness to accept and willingness to pay measures has also been studied extensively in this literature (e.g. see List & Shogren 2000; Horowitz & McConnell 2002; Amigues et al. 2002; Hatton MacDonald 2010). The presence of property rights (Horowitz & McConnell, 2002) and prospect theory (Kahneman & Tversky, 1979) have been noted as a primary factor in the potential discrepancy between a willingness to pay and willingness to accept measure. The link to property rights is further explained by the endowment effect as discussed in Kahneman et al. (1990). This highlights an important aspect of this study; the intention is not to find out how much individuals are willing to pay in order to change their landscape from a natural turf landscape to a drought tolerant landscape, but to find out what is required for homeowners to give up their natural turf landscape for a program approved alternative. When estimating the value of an item or service that a property owner must give up, a willingness to accept framework better represents the exchange taking place. Recent works related to water resource management (e.g. see Hatton MacDonald, et al. 2010; Feng et al. 2018), ecosystem services (e.g. see Amigues et al. 2002; Vedel et al. 2015; Xiong & Kong 2017; Seroa da Motta 2018), and agricultural waste (He, Zhang, Zeng, & Zhang, 2016) have all relied on a willingness to accept framework in consideration of a property owners willingness to participate in programs or change behavior which affects property or services they have already been granted rights over.

The intention of this research is to gain a better idea of what amount it would take for individuals to give up something that they already have ownership over, and that provides additional utility through a variety of avenues (i.e. aesthetics, pride of ownership, recreational purposes,

120

gardening, social status). Given the variety of utility streams, valuation of home landscaping will come

from a variety of sources. It is straightforward to assume that there may be a connection to a potential

savings on the utility bill and the effect on the value of a home, but there are other behavioral

components that will likely factor into this valuation. Nassauer et al. (2009) test homeowner

preferences over landscape design in the context of consistency with cultural norms, neighborhood

norms, and ecological innovation and find that both cultural norms and neighborhood norms influence

preferences, but neighborhood norms have a stronger effect. Research from the Baltimore Ecosystem

study (BES)[8] suggests that three primary categories predict urban vegetation patterns: population

density, social stratification, and lifestyle behavior. Marketing for the regional turf removal rebate

program in Los Angeles County placed a significant focus on the water conservation benefits of

converting a natural lawn to a more drought tolerant option, while communication with and influence of

friends, family, neighbors, and peers have been highlighted as a conduit for increased participation. A

contingent valuation framework combined with survey data will allow us to investigate the influence of

subjective norms, personal norms, and frequency of communication on the minimum rebate amount

required for participation.

In Los Angeles County the turf removal rebate program was designed to incentivize

homeowners who may be reluctant to give up their natural turf lawn due to preferences over landscape

type and the costs related to landscape changes. A willingness-to-accept framework better represents

the research questions being asked than a willingness-to-pay framework due to the clear assignment of

property rights. The decision being analyzed is the minimum amount of the rebate required for a

homeowner to give up the status quo of their natural turf yard and participate in the program by

replacing this with one of the program approved drought tolerant options.

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[8] https://baltimoreecosystemstudy.org/

3.3 DATA AND METHODS

In January of 2014, the Metropolitan Water District of Southern California launched a regional turf removal rebate program paying residents a per-square-foot rebate incentive to dig up their natural turf and replace it with one of the preapproved more drought tolerant landscape options. This program lasted nearly two years before funding ran out but resulted in the removal of over 165 million square feet of turf. To investigate the effects of attitudes and beliefs on program participation a case control study was implemented in the form of an online survey.

3.3.1 The survey instrument

The survey instrument followed a case-control design where 1,250 randomly chosen Los Angeles County single family homeowners that participated in the turf removal rebate program were matched to a single-family home that did not participate in the program. Homes were matched on zipcode, yard area, tax assessor home value, presence of a pool, home age, length of time in home, and home ownership using mahalanobis distance matching. The survey was administered through Qualtrics and invitations were sent via U.S. mail and contained a link to a website where households could participate and enter a random prize drawing. An initial invitation with a brief description of the project was sent to homes in April of 2018, and follow-up post-card mailers were sent in each of the following two months. A copy of the initial mailer and the follow up post card are included in Appendix B. Initial mailers also described an opportunity to enter a random drawing for a gift card worth $200 with an estimated 1 in 10 chance of winning. Completing the survey was not required for entry into the random drawing because this would violate the California law related to lotteries, however households did have to go to the end of the survey and signal that they would like to participate in the random drawing. A total of 107 homes responded to the survey. This included 75 homes that applied for the program and 58 households that ended up participating in the program. Out of the 107 respondents 58 were from the pool of randomly selected program participants and 49 were from the group of matched homes. While this response rate

is too low to ensure external validity there is still much to be gained from the responses. Understanding how this specific population responded to the questions in this survey can still provide insight into the household decision making process for future programs. Furthermore, the results here can be taken as an exploratory analysis which will better inform future research.

Blocks of questions were asked which relate to attitudinal, environmental, and behavioral components that might influence the decision over participation in this program. Additional questions were asked related to the reasons they did or did not participate, the minimum per square foot rebate required to participate, frequency and channels of communication and research, and self-reported socio-demographics. A copy of the full survey is provided in Appendix A.

Primary theoretical support for the questions asked in this survey came from a combination of three well known models in the environmental psychology literature: *The Theory of Planned Behavior* (Ajzen, 1991)*, Value Belief Norm Theory* (Stern, Dietz, Abel, Guagnano, & Kalof, 1999)*, and Diffusion of Innovations Theory* (Rogers, 2003)*. The empirical model estimating the drivers of willingness to accept will also apply components from each of these three theories.

3.4 RESULTS

Basic demographics of the survey respondents are included below in Table 1. The total number of responses for any one question in the survey may vary due to the fact that respondents were not forced to answer any question in the survey.

Table 1: Demographics from survey sample			
Variable	Category	Frequency	Percentage
Age	25 to 34	5	5.4%
	35 to 49	16	17.2%
	50 to 64	36	38.7%
	65 and older	36	38.7%
Sum		93	100.0%
Race	Asian	12	12.6%
	African American	3	3.2%
	Of Hispanic Origin	7	7.4%
	White	61	64.2%
	Other	4	4.2%
	Decline to state	8	8.4%
Sum		95	100.0%
Gender	M	34	45.3%
	F	39	52.0%
	Other or decline to state	2	2.7%
Sum		75	100.0%
Ideology	Democrat	58	61.7%
	Green Party	1	1.1%
	Independent and not Green Party	6	6.4%
	Libertarian	7	7.4%
	Republican	11	11.7%
	Other or do not participate in the political process	11	11.7%
Sum		94	100.0%
Income	$19,999 or less	1	1.1%
	$20,000 - $34,999	5	5.4%
	$35,000 - $49,999	9	9.8%
	$50,000 - $74,999	6	6.5%
	$75,000 - $109,999	24	26.1%
	$110,000 - $149,999	14	15.2%
	$150,000 - $249,999	21	22.8%
	$250,000 or more	12	13.0%
Sum		92	100.0%
Education	High School	5	5.3%
	Some college	8	8.4%
	2-year degree	5	5.3%
	4-year degree	27	28.4%
	Graduate degree	38	40.0%
	Professional degree	12	12.6%
Sum		95	100.0%

There were several exploratory questions in this survey which were designed to provide insight into program participation. On one question respondents who applied to the program were asked to select all items that did or did not positively affect their decision to apply to the program. Results for this question are listed in Table 2. The most consistent answers that were given as positive influences were the rebate amount, beliefs about water conservation, and a positive opinion about the way that a drought tolerant yard looks. Among the options that were least consistently stated as things did influence participation were the appearance of artificial grass, the influence of neighbors, and the influence of friends, family, and peers.

Table 2: Please mark all of the following that did positively influence your decision to apply

	Yes
My beliefs about water conservation	66
The rebate amount	65
Cost savings on my utility bill	64
I like the way that a drought tolerant yard looks	57
I want to help make a more sustainable community	55
It is difficult to keep a healthy lawn in California	51
I do not want to mow my grass any more	37
My sprinkler system is frustrating or expensive to fix	24
I wanted to reduce potential fire hazard in my landscape	11
The influence of neighbors	7
The influence of my friends, family, and peers	7
I like the way that artificial grass looks	5

N = 71, responses do not sum to N because respondents were allowed to mark multiple answers

The responses to this survey are somewhat contradictory to results from other work which highlights the importance of peer effects in program participation (e.g. see Pincetl et al. (2017), Torpey (2017), Marx et al. (2018), Bollinger et al. (2018), Brelsford and De Bacco (2018)). The survey instrument also highlighted the importance of the way that a homeowner views their yard and drought tolerant options, financial incentives, and beliefs about water conservation.

3.4.1 Communication and Information

Two other important aspects of this program were the information sources and communication channels used, and frequency of use. These two aspects of household behavior are important for the spread of innovation or ideas within a population (Rogers, 2003; Nelson, Swanson, & Cain, 2018). Theoretically, households that have more access to information and more communication channels would be quicker, or have a higher probability, to participate all else equal. Furthermore, analyzing the most frequently used communication and information channels can be helpful for future marketing design and policy implementation.

For one question in the survey, respondents were asked to answer, from a given range of frequencies, if they discussed the turf removal program with coworkers, family, friends, community members, or immediate neighbors. Results from that question are given in Table 3 below. The most frequent communication about the program was with family and friends; while coworkers, community members, and immediate neighbors were not communicated with as often about the program. As shown in Figure 1, households initially learned about the program through a variety of sources, but with the water provider as by far the greatest source of information, while research related to the program and requirements was done primarily online, as shown in Table 4. As shown in Table 3 the most popular source for research was the internet, but respondents did still use physical mail and communication with the water company to research potential landscape conversions.

Table 3: Did you discuss the turf removal program with any of the following?

Group	Never	Once a year or less	Several times a year	Once a month	Several times a month	Several times a week	Just about every day
Immediate neighbors	23	32	17	7	7	1	0
Community members	42	24	11	4	3	1	0
Friends	16	34	20	5	8	2	2
Family	25	23	25	9	7	1	2
Coworkers	30	18	10	7	3	2	0

N = 88, there are different totals for each row because respondents did not have to answer every question

Figure 1: Where did you learn about the turf removal rebate program

Neighbors: 18, Coworkers: 2, Friends: 14, Family: 4, Television: 14, Newspaper: 28, Water provider: 57, The internet: 26, Contractors: 6, Not listed here: 4

N = 93, responses do not add to 93 because respondents could select multiple choices
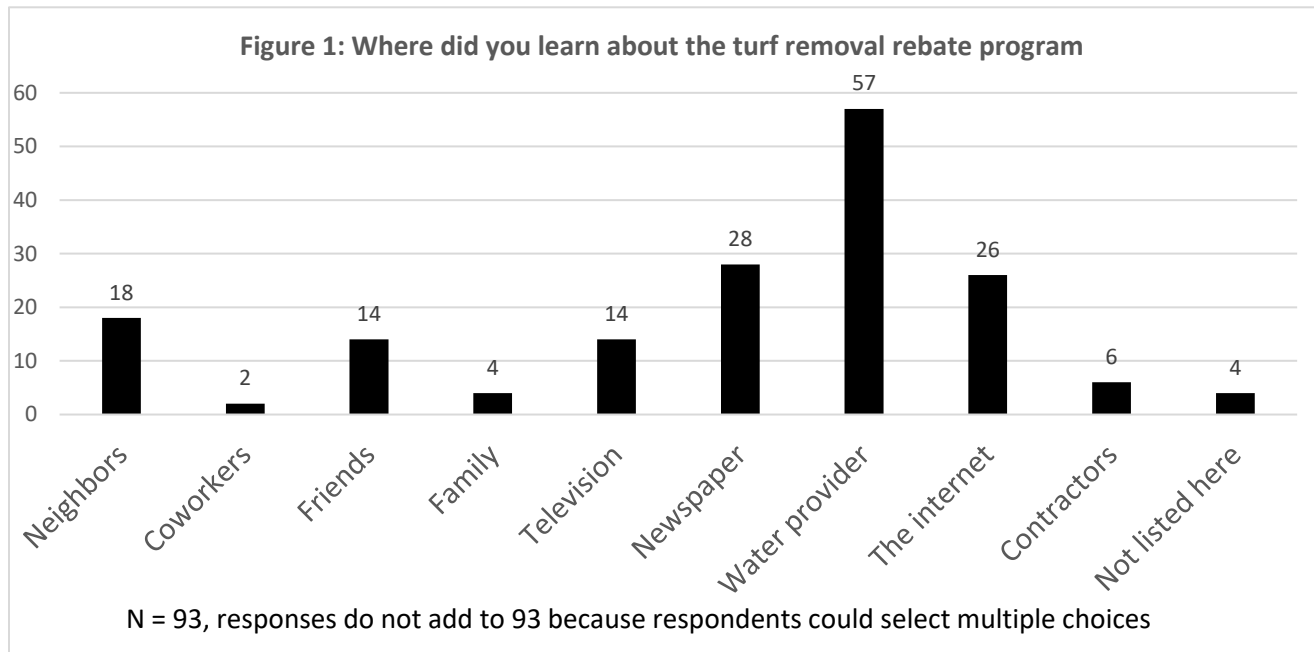
Table 4: Where did you research information related to the following?

	Program requirements	Water conservation potential	Savings	Landscape design
Online	68	48	43	48
Mail	31	19	26	10
Library	1	1	0	1
Water company	38	22	27	13

N = 89, columns do not total to 89 because respondents cold select multiple answers

Combining these results with those from Table 2 in section 4 helps to provide a better idea of how the typical household in this survey was informed about the program along with which modes of communication and information affect their decision. Most respondents signaled that they learned about the program from their water provider or a regular news source. Relatively few respondents learned about the program from neighbors, friends, or coworkers. From that point the most popular research avenue was the internet, but mailers and verbal communication with the water agency also seemed to play an important role. Many of the respondents did also report that they talked with friends, family, and immediate neighbors at least once, but most respondents also signal that these groups did not influence their actual participation.

3.4.2 Willingness to accept

Another interesting question that was included in the survey was related to the minimum rebate amount per square foot that households would be willing to accept to participate in the program and replace a portion of their natural turf with an approved option. Respondents were able to use a continuous slider to provide any answer between $0 and $25 per square foot. A total of 70 out of the 107 respondents answered the question related to the minimum rebate amount required. Of those 70 who responded to the willingness-to-accept question, 58 of them were eventual applicants to the program while 12 of them were not. For those that did not apply to the program, answers ranged from zero dollars to twenty-five dollars. For those that did apply to the program answers ranged from zero dollars to three dollars and fifty cents. A total of seventy responses were recorded with a mean response of $3.4, median response of $2, and a mode of $2. The average response for households that did apply to the program was $2.20 while the average for homes that did not apply to the program was $10. Responses to the survey question are included in Table 5 below.

Table 5: Responses to willingness-to-accept question by rebate amount and application status

Rebate per Square foot	Applicant Responses	Non-Applicant Responses	Combined
0	5	3	8
0.5	1		1
1	4		4
1.1	1		1
1.4	1		1
1.5	2		2
1.6	2		2
2	19		19
2.2	1		1
2.5	2		2
2.6	10		10
3	2	1	3
3.5	8		8
4			0
5		1	1
5.1		1	1
7		1	1
10		1	1
15		1	1
25		3	3
Sum	58	12	70

The mode and median of $2 may be a result of anchoring related to the fact that the base level rebate for the regional program was $2. This anchoring could have biased responses to this question towards $2, or it may have been the case that a $2 baseline was a good estimate of how the largest number of households would value the loss of their natural turf for a landscape conversion inclusive of costs. The large difference between the average response for those that did apply and those that did not suggests that there may be some fundamental differences in the way these two parties value their natural turf. This point will be discussed further in the final paragraph of this section. Willingness to accept will be further analyzed in two ways to help understand the role that the rebate amount played in this program. First the willingness to accept responses are used to create simple surplus measures for this sample that are consistent with welfare measures from classic economic models. Then a statistical

model is created to better understand the variation in the willingness to accept responses at the

household level.

3.4.3   Household Welfare

Individual survey responses were aggregated and a "Willingness to Accept" curve was estimated which

maps the total amount of respondents that would have been willing to participate in the program at

$.50 increments between zero and six dollars. Figure 2 shows the graphical results from the Willingness

to Accept table.

Figure 2: Willingness to Accept
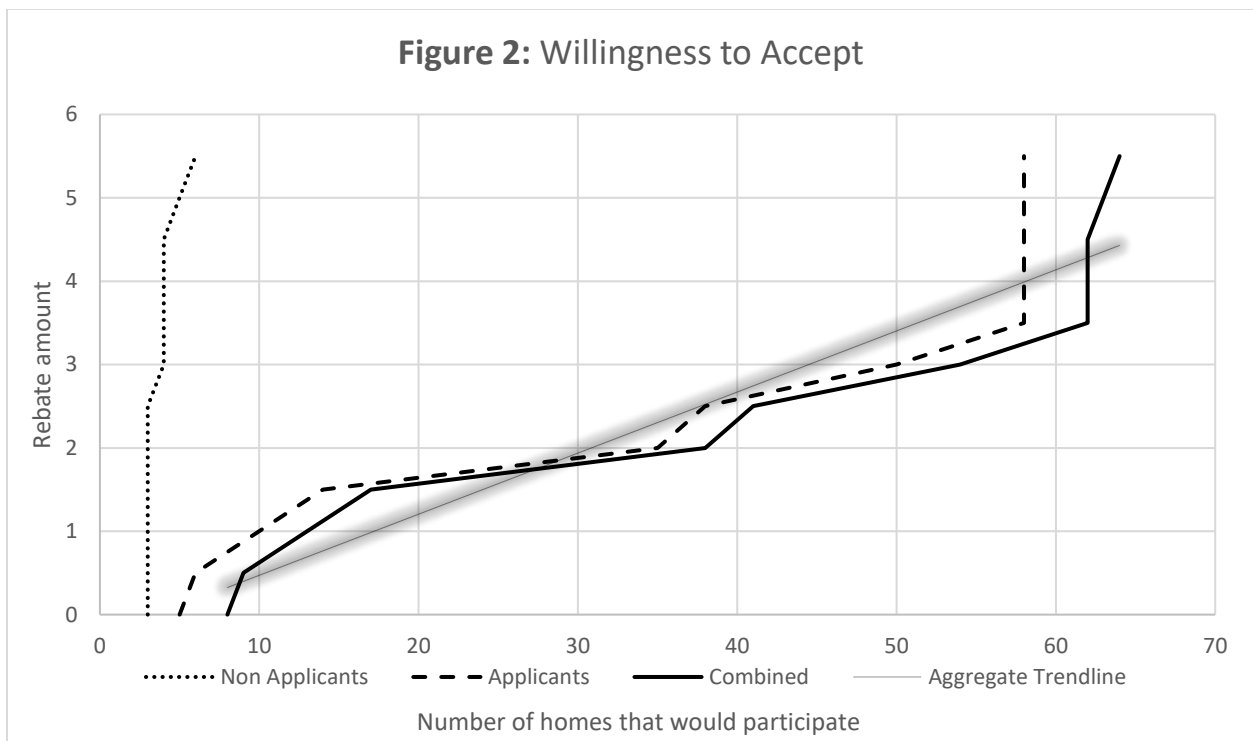
A linear trend was fitted in excel and appears to match the data relatively well between the one dollar

and three dollar and fifty cent rebate thresholds.

The idea of willingness to accept can lead to a better understanding not only of how this sample

would have likely reacted to price changes, but also a better understanding of the household surplus

gained from increases in the rebate level. In addition, we gain information related to the number of

participants that would have required no rebate to remove a portion of their natural turf lawn There is

no way to calculate how much those individuals value the turf replacement without any rebate, but we can capture the surplus they gain from the rebate. Estimation of the household surplus created from the specific rebate level being in place is an important aspect of this study that has not previously been analyzed as extensively as participation rates or peer effects.

Much of the welfare policy analysis surrounding this program has been focused on the water agency side in terms of budgetary spending, participation rates, estimated water reduction, and analysis of the population which participated. A better understanding of the household surplus gained or lost is also a necessary part of policy evaluation and calculation of overall welfare effects.

To move forward, the willingness to accept curve is used in a similar fashion as a classic supply curve, where homes are supplying natural turf to the water company for a per square foot rebate amount contingent upon an approved replacement. This willingness-to-accept curve could also be used for a metric of how much these homes value keeping their lawn in place versus a transition to a more drought tolerant lawn, inclusive of the maintenance and utility costs to keep their lawn or their estimated cost of a replacement project. Staying consistent with the classic economic framework, the surplus from program participation would then be the rebate amount they are paid above and beyond their willingness to accept amount. Household surplus from changes in the rebate amount within this population can be calculated in the same way that changes in producer surplus would be calculated in the classic supply and demand model.

Figure 3 includes the linear trend line within the $0 to $3.5 range in thick bolded black along with the actual aggregated responses in light grey. Additional solid lines and dotted lines are used to help calculate the change in surplus resulting from a hypothetical change in the per square foot rebate amount from $2 to $3.

The estimated aggregate household surplus for survey respondents will encompass approximately areas A and C when the rebate amount per square foot is $2, but will encompass areas A, B, C, and D when the rebate is increased to $3. This includes eight respondents that stated that they would have required a minimum amount of $0 to participate in this program. These individuals are included in household surplus because they are being given a rebate when they would not even require

Figure 3: Linear Trend
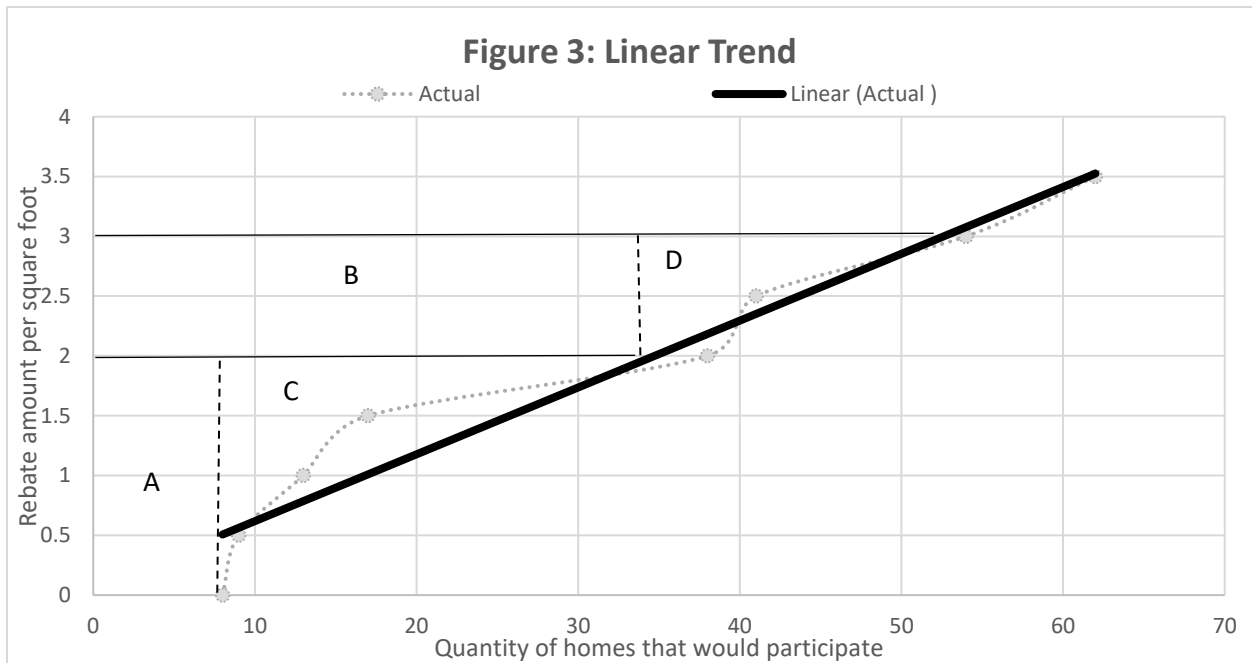
a rebate to remove a portion of their natural turf. Therefore, the whole amount of the rebate should be counted as surplus above and beyond the rebate amount they would require to remove a portion of their natural turf. The household surplus per square foot totals $36.25 when the rebate amount is $2 but goes up to $80.75 when the rebate amount increases to $3.

Calculated from actual turf rebate program data,[9] the actual average square footage removed per single family resident participant in Los Angeles county under this program was 1,898. As an example, an average of 1,898 square feet removed and a change from $2 to $3 per square foot would lead to a difference of $84,461[10] dollars of surplus for the 54 homes that would have participated at $3 and under. In addition, this would mean that in aggregate those 54 homes would value those 102,492 square feet of natural turf at $154,213[11] above the value of a drought tolerant option inclusive of conversion costs. This is taken by aggregating the area under the willingness to accept curve.

3.4.3.1 Extrapolating to the general population

By extrapolating the same thresholds for willingness to accept to actual participants in aggregate, we can gain better insight into the program-level household surplus, yard valuation, and amount of homes that may not have required a rebate to remove part of their natural turf. Between 2013 and 2016 there were 31,593[12] approved residential turf removal rebate applications processed through the metropolitan water district in Los Angeles County for a total amount of approximately 59 million square feet of natural turf removed and 151 million dollars in rebates awarded. Within this population the average per yard natural turf removal was 1,898 square feet while the average total rebate amount was $4,795 and the average rebate amount per square foot was $2.9.

While the random sample survey design in this work is beneficial for external validity, the low response rate of this survey limits generalizability. Sensitivity measures were created to better understand the generalizability of the survey responses to the general population. A 95-percent confidence interval was created around the survey response mean of $2.20 minimum willingness to

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[9] This data is comes from program participation data from the Metropolitan Water District.

[10] This is calculated by multiplying the average square feet removed of 1,898 by the difference in surplus between $2 and $3 for the 54 homes ($80.75 - $36.25). (1,898 X 44.5 = 84,461)

[11] This is calculated by multiplying the 54 homes by an average of 1,898 square feet removed and deducting the surplus of $153,-263 calculated from A+B+C+D above. This leaves the value of the status quo as opposed to conversion under the program.

[12] This is also taken from a data set provided by the Metropolitan Water District

accept for applicants using the Student's t distribution with 57 degrees of freedom. This led to a range

between $1.91 and $2.50 for the population average minimum willingness to accept. The t distribution

was also used to create 95% confidence intervals around population proportions for the minimum

willingness to accept at $.50 increments between $0 and $3.50. In Figure 4 these confidence intervals

are displayed as error bars. Calculations for Figure four are included in Appendix C.

Figure 4: Applicant Population Minimum WTA Estimates with 95% Confidence Intervals
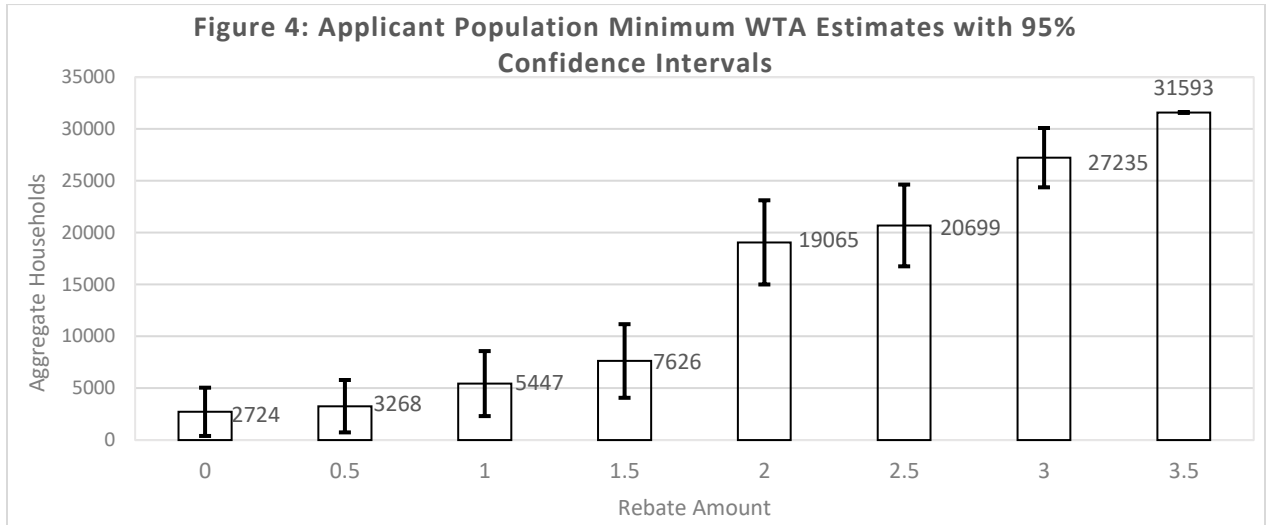
In Figure 5 these confidence intervals were used to create a 95% confidence interval around the

extrapolated aggregate willingness to accept measures for the entire population. This extends the

proportional responses from the survey onto the entire participant population of 31,593.

Figure 5: Applicant Population Estimated Minimum Willingness to Accept
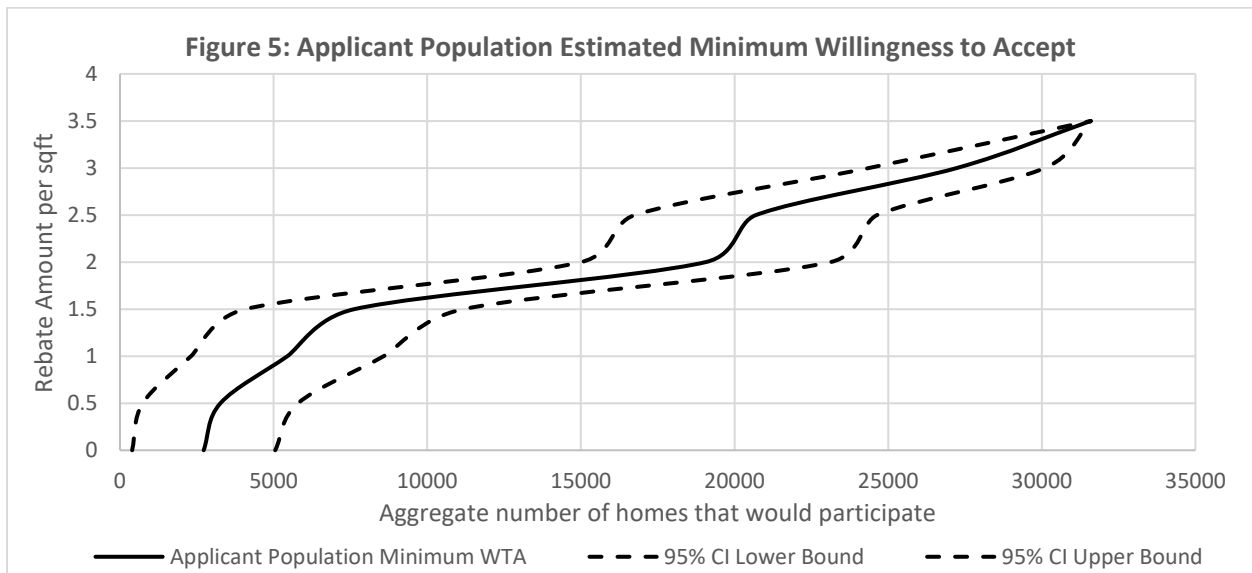
In Figure 6 the extrapolated participant population minimum willingness to pay is replaced with a trend line estimated by P = 0.2137 + 0.0001Q. Marked sections are used to calculate the estimated household surplus per square foot derived from the program assuming the average rebate amount of $2.9.

Figure 6: Estimated Willingness to Accept for Los Angeles County Between 2013 and 2016
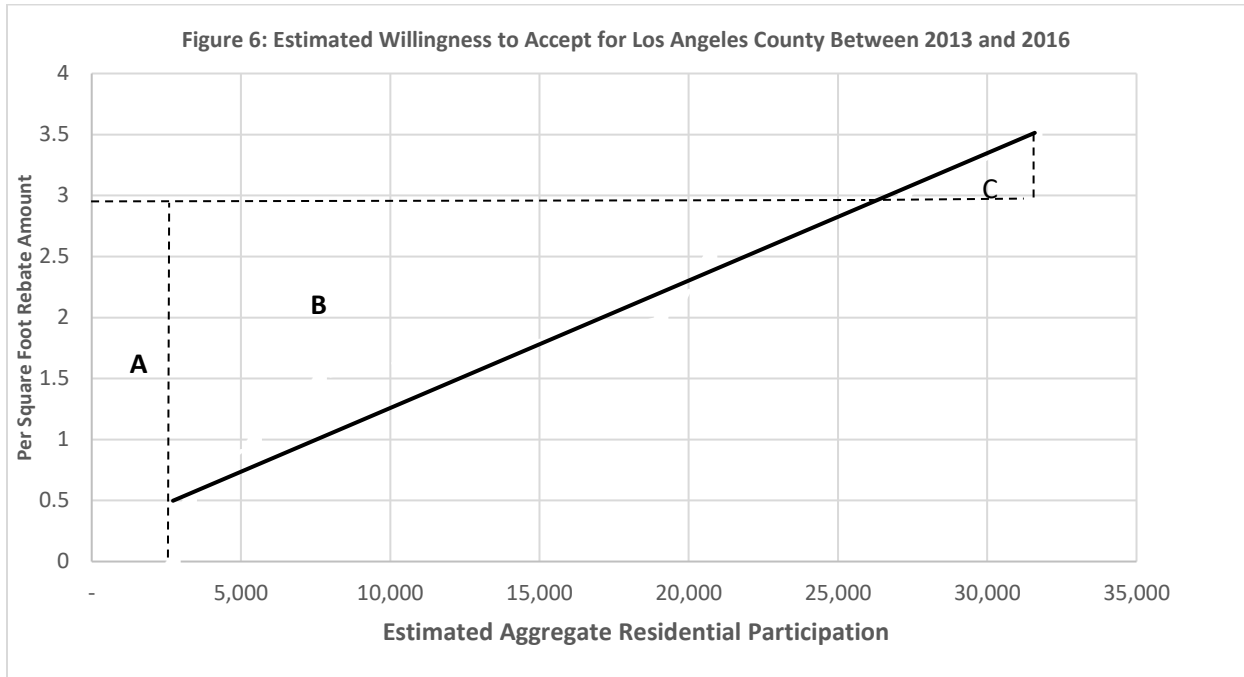
Using this framework, and assuming the same proportion of willingness to accept responses, for the entire population of residential participants in the study area the household welfare per square foot of turf removed at an average rebate level of $2.9 is taken as the sum of areas A and B in Figure 6. Area A consists of 2,724 participants that would have removed a portion of their lawn without the rebate and gain $2.9 per square foot for total surplus of $7,899 per square foot. As noted previously, these individuals recognize the whole rebate amount as a surplus above and beyond what they would have required to remove a portion of their natural turf. Area B consists of the remaining participants who received an average of $2.9 per square foot but would have accepted less and aggregates to approximately $28,966 per square foot[13].

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[13] Area B is calculated by taking ((26,863 − 2724) households X (2.9 -.5))/2.

Once again using the average actual square footage replaced of 1,898, this would result in an estimated total surplus of $69,969,770 for the 31,593 residential participants in this program assuming the average square footage removed and the willingness to pay measures from the survey responders.

This extrapolation will also allow for a calculation of the status quo yard value for the 31,593 participants, as opposed to replacing their natural turf with a program-approved option at average removal amount of 1,898 square feet. This measure is estimated by taking the area under the curve in Figure 6 for all those who had a required rebate amount above zero. Consistent with the classic supply and demand model, this could also be considered as the net aggregated opportunity cost of replacing their natural turf with a program approved option for all 31,593 households without receiving any rebate, including their estimated natural turf replacement costs. This results in a total value of $57,738[14] per square foot of natural turf lawn for the 31,593 residents who participated in the program. If you multiplied this by the average amount of turf replaced in the program (1,898 sqft) this would result in an estimated value of $109,586,724 for the natural turf replaced in this program.

Alternatively, the welfare surplus gained by households as a result of the rebate levels in this program may be considered by water agencies as unnecessary spending in a sensitive budget. In Figure 7 below the cumulative willingness to accept estimates from Figure 5 are compared to the cumulative actual rebate amounts paid per square foot from the turf removal rebate program.

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[14] Calculated by taking the area under the curve between 2,724 and 31,593 in Figure 7.

Figure 7 Cumulative Homes Willing to Accept and Participation

A line chart with y-axis "Rebate Per Square Foot" ranging from 0 to 4.5, and x-axis "Cumulative Number of Homes" ranging from 0 to 35000. Two series shown: dashed line "Program Participants" and solid line "WTA Estimates".
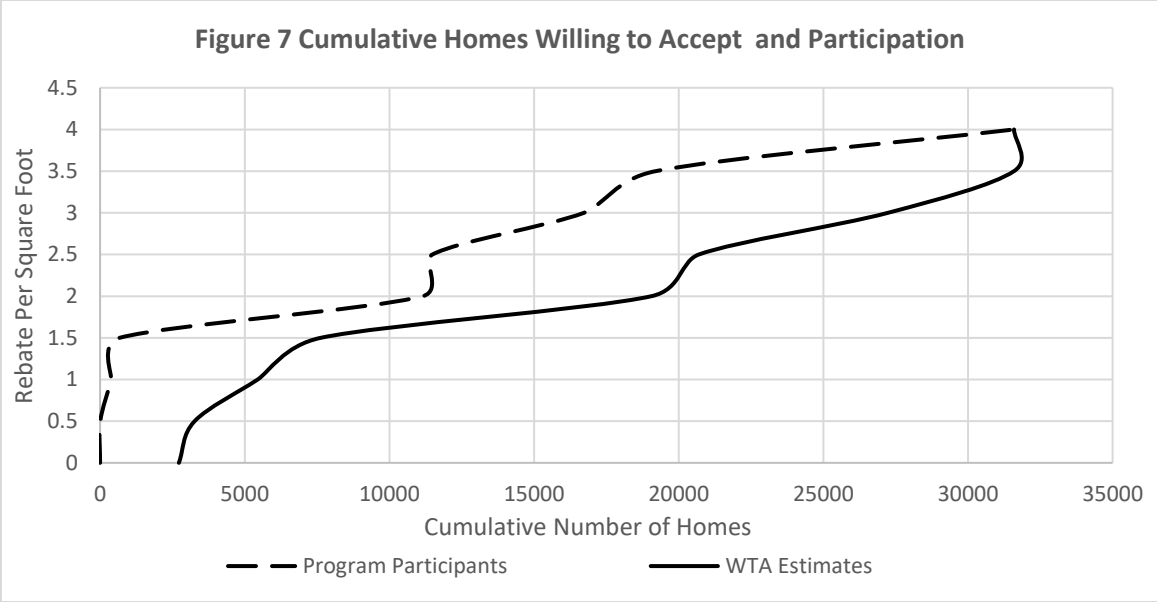
Comparison between the cumulative measures tells a similar story to the estimated surplus measures discussed above. There was significant room for lower rebate thresholds during this program. Figure 8 below takes the same information but compares the extrapolated willingness to pay estimates to the actual number of homes which participated at the $.50 thresholds used in the previous section.

Figure 8: Estimated Population Willingness to Accept and Actual Rebates Processed

A bar chart with y-axis "Number of Homes" ranging from 0 to 14000, and x-axis "Rebate Per Square Foot" with categories $0.00 - $.50, $.51 - $1.00, $1.01 - $1.50, $1.51 - $2.00, $2.01 - $2.50, $2.51 - $3.00, $3.01 - $3.50, $3.51 - $4.00. Two series: "Actual Rebates" (white) and "Estimated WTA" (black).
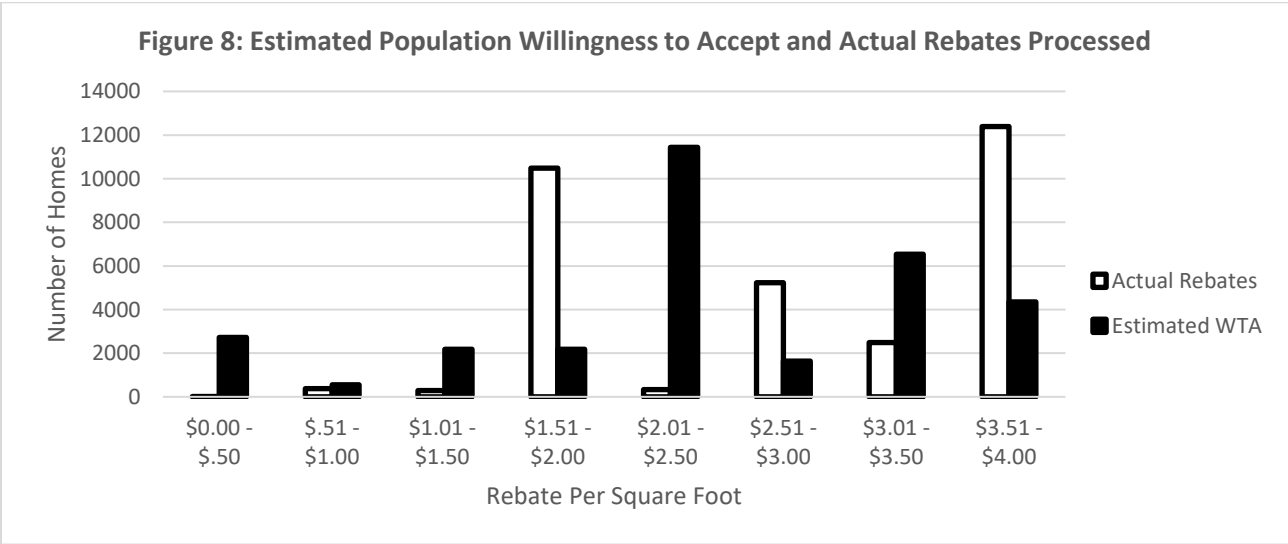
Figure 8 provides more insight into the individual rebate levels where there was an imbalance between extrapolated willingness to accept and actual rebate amount. What is most apparent from this chart is the significant imbalance between willingness to accept numbers and actual rebates paid in the

final threshold level. What is also noteworthy is the imbalance at the $1.51 - $2.00 interval and the $2.01 - $2.50 interval. The participation at the $1.51 - $2.00 threshold most likely accommodated homeowners who would have accepted significantly less, while a large group of individuals who would have required one threshold higher than the $2.00 point did not have many alternatives between $2.01 and $2.50 but took advantage of rebates offered in the next three interval ranges.

The large spike in participation in the actual rebates in the final threshold is due to the large additional incentive offered by the Los Angeles Department of Water and Power. Over a significant range of the program they offered an add on of $1.75 to the regional baseline of $2.00 which put the per square foot amount up to $3.75. According to the survey results the program may have been more cost effective if there were more opportunities between the $2.00 and $3.50 thresholds and fewer at the $3.50 - $4.00 threshold.

3.4.4   Differences between applicants and non-applicants

The dramatic difference in responses between homes that did and did not apply warrants further investigation and may be critical for policy moving forward. There seems to be a sizeable difference in the elasticity of supply between households that did apply and households that did not. According to the survey results, households that did apply, in aggregate, are much more sensitive to changes in the rebate level while households that did not apply, in aggregate, are much less sensitive to changes in the rebate level. This result suggests that there may be differences in the way that non-applicants and applicants value their natural turf lawn. Having a better understanding of what drives this difference in the way these two parties value their natural turf will be critical for the success of future programs and state-wide long-term sustainability goals.

3.4.5   Household willingness-to-accept model

To better understand the variation in willingness-to-accept responses, two regression models were constructed. A combination of behavioral, demographic, and geographic variables were used as control

and explanatory variables in an effort to further explain variation in self-reported responses to the minimum rebate required. Principle component analysis was used to narrow down blocks of questions from the survey, and factor scores and indices were created to serve as variables of interest.

Survey question blocks were used which encompassed aspects of three widely used theories in the Environmental Psychology literature; the *Value Belief Norm Theory (VBN)* (Stern, Dietz, Abel, Guagnano, & Kalof, 1999), *Theory of Planned Behavior (TPB)* (Ajzen, 1991)*, and *Diffusion of Innovations Theory (DOI)* (Rogers, 2003). From the Theory of Planned Behavior, the emphasis of subjective norms is included along with the value of a drought tolerant lawn which relates to Azjen's idea of perceived behavioral control in this context (Ajzen, 1991). If subjective norms are more in favor of water conservation, then a household might be willing to accept a lower rebate amount to convert some of their natural turf to a drought tolerant option. If a homeowner places a higher value on his natural turf, or a low value on drought-tolerant options, then it is likely that they would require a higher rebate amount. From the Value-Belief-Norm Theory the importance of water conservation beliefs and personal norms related to water use are included. The intention is to test if higher values for these behavioral components would lead to a lower rebate amount required. This is important because water agencies base much of their marketing on awareness and nudges related to water conservation. From the Diffusion of innovations theory frequency of communication is considered. This variable is included to test the idea that a higher frequency of communication could make an idea or norm spread more quickly and therefore reduce the minimum rebate amount required for a household to participate in the program.

A categorical income variable is included to control for income differences among the sample of survey respondents. This is important since an outlay of money would typically be required to pursue a turf removal and replacement project even if the rebate dollars were given immediately. The potential for a project cost to be above the rebate amount, and the fact that the rebate is not received

immediately, both create potential financial barriers for a homeowner. On the other hand, a higher income could be correlated with a higher property value and this may also influence a home-owners willingness to change any features of the current landscape. A higher income also means that the water bill, and rebate amount per square foot, will likely equate to a smaller portion of the household disposable income. Therefore, savings on the monthly water bill, and total rebate dollars per square foot, may not be as strong of an incentive for higher income households. In either case it is important to control for the variation of income among households in this sample as it can affect the minimum rebate amount required in many ways.

Results from the principle component analysis along with the included questions, Cronbach's alpha and chi-squared for each construct are included in Table 6 below. A factor score was created for water conservation beliefs, personal norms related to water use, value of a drought-tolerant lawn, and communication frequency. An index score was created for the subjective norm variable due to the lack of available responses to create a factor score. A minimum of three questions is needed to create a factor score. The referenced survey question asked about the water conservation beliefs of friends, family, and neighbors but the response rate related to the views of neighbors was below a reasonable threshold, so an index was created which takes the average score of beliefs of friends and family. Finally, a binary variable is used to indicate that the information source for awareness of the program was from the internet, tv, or a newspaper. This variable is used test whether people respond differently to information gained through a news source versus being told by some other person or agency. Out of the 70 original responses to the willingness to accept question, four observations were dropped due to incomplete answers.

Table 6: Behavioral question blocks and corresponding principle component analysis

Water Conservation Questions

Likert scale from 0 (strongly disagree) to 6(strongly agree)

I feel a personal obligation to do whatever I can to conserve water

I feel a sense of personal obligation to ensure that my yard is drought tolerant

My neighbors and peer should do whatever they can to conserve water

Number of responses: 85, Retained Factors: 1

LR test: independent vs. saturated : chi-squared(3): 102.91

Cronbach's Alpha Score : .835

Personal Norm Questions

Likert scale from 0 (strongly disagree) to 6 (strongly agree)

I try to take shorter showers to conserve water

I do not let the faucet run when I am brushing my teeth or washing dishes

I load my washer efficiently to minimize water consumption for laundry

Number of responses: 85, Retained Factors: 1

LR test: independent vs. saturated : chi-squared(3): 49.00

Cronbach's Alpha Score : .6919

Yard Value Questions

Likert scale from 0 (strongly disagree) to 6 (strongly agree)

I like my lawn too much to replace it with a drought tolerant option

When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (Reverse Coded)

Drought tolerant lawns do not look good

Drought tolerant lawns bring down the value of a house

Number of responses: 85, Retained Factors: 1

LR test: independent vs. saturated : chi-squared(6): 98.71

Cronbach's Alpha Score : .7917

Subjective Norm Questions

Likert scale from 0 (Not important at all) to 5 (Very important)

How do the following groups in your social circle view water conservation practices?

Friends

Family

Number of responses: 77, the variable in this section is an index average score

Communication Questions

Likert scale from 0 (never) to 6 (just about every day)

Immediate Neighbors

Friends

Family

Number of responses: 83, Retained Factors: 1

LR test: independent vs. saturated : chi-squared(3): 110.82

Cronbach's Alpha Score : .8366

The actual questions for the information source and the Income are included in Table 7 below.

Respondents were asked to choose among 10 different answers for the original information source for

the turf removal rebate program, and one of 8 categories for their total household income level.

Table 7: Information source and household income
Information Source Question
Mark all that apply
Where did you hear or find out about the turf removal rebate program(s)?
Neighbors   Coworkers   Friends   Family   Television
Newspaper   Water Provider   The Internet   Contractors   Not listed here
The variable in this section is a binary which takes a value 1 if Newspaper, Television, or The internet were among the answers marked.
Household Income Question
Mark the category which applies
What is your total household income?
__ $19,999 or less
__ $20,000 - $34,999
__ $35,000 - $49,999
__$50,000 - $74,999
__$75,000 - $109,999
__$110,000 - $149,999
__$150,000 - $249,999
__$250,000 or more

In both models the minimum rebate amount required to participate in the regional turf removal

program (WTA) is taken as the dependent variable. Responses to this question in the survey came in the

form of a continuous response variable between the values of $0.00 and $25.00 per square foot of

natural turf removed. In the survey respondents used a slider which allowed them to easily select any

value within this range (but no value outside this range).

The first model estimated was a simple linear regression model, while the second model estimated is a Tobit model. The Tobit model is the preferred estimation since responses are censored at $0 and $25. This can lead to potential bias in the linear model. The Tobit model uses an upper limit of $25 and a lower limit of $0 in estimation. The basic model is as follows:

$$WTA_i = \beta_0 + \beta_1\ Conservation_i + \beta_2 Personal\ Norm_i + \beta_3 Yard\ Value_i + \beta_4 Subjective\ Norm_i + \beta_5 Communication_i + \beta_6 Information\ Source_i + \beta_7 Income_i + \epsilon_i$$

Table 8 includes results from the two models discussed. The parameter estimates from the Tobit model can be interpreted the same way as the parameter estimates from the linear model. For a one-unit increase in the associated predictor the WTA measure is expected to increase by the parameter estimate value in dollars. For the variables where a factor score, or index, was used interpretation takes additional consideration. A one unit increase in the variable of interest means that the Likert score answers among the associated questions would need to increase enough to increase the weighted factor score or index. This is meant to signal an increase in the underlying behavioral component being measured. However, a factor score of 2 does not signal twice as much of that behavior as a factor score of 1.

In both model one and two the parameter estimates for water conservation beliefs, yard value, and income are all significant at the 10% level or better. In the Tobit model a one-unit increase in the factor score for water conservation beliefs is estimated to lead to a $1.75 decrease in the minimum willingness to accept, while a one-unit increase in the yard value factor score is estimated to increase the minimum willingness to accept by $2.65. Personal norms related to other forms of water conservation efforts in home and subjective norms related to the water conservation options of friends

and family were not shown to have a significant effect on the minimum rebate amount required for

participation.

Table 8		
Variables	(1) Linear Model	(2) Tobit Model
Conservation	-1.468* (0.872)	-1.756* (0.931)
Personal Norm	-0.395 (0.652)	-0.614 (0.702)
Yard Value	2.489*** (0.671)	2.657*** (0.717)
Subjective Norm	0.243 (0.705)	0.324 (0.774)
Communication Freq	0.220 (0.510)	0.381 (0.549)
Information Source	-0.306 (1.046)	-0.525 (1.131)
Income	0.690** (0.2917)	0.716*** (0.316)
Constant	0.395 (2.450)	-0.068 (22.711)
Observations	65	65
R-squared	0.470	
Pseudo R-squared		.1041
P < * = 0.1, ** = 0.05, *** = 0.01		

3.5   DISCUSSION

One of the primary goals of this work was to inform future policy related to incentive-based utility

programs. Some of the results of the survey, and the willingness-to-accept analysis, are consistent with

previous work related to the drivers of participation in turf removal rebate programs. However, the

apparent focus on the importance of the yard value in relation to the minimum rebate amount is an

area that merits further exploration. Furthermore, this point suggests that more of the program marketing effort should be focused on changing the way that homeowners view the value of a natural turf yard versus a drought-tolerant yard, as opposed to focusing so strongly on the influence of peers and subjective norms.

3.5.1 Yard Value

The way that a homeowner gains value from their yard should play a critical role in the decision to change that yard, and it has in fact shown up as a significant factor in similar turf removal rebate programs in the past. Early responses to turf removal rebate programs in Las Vegas were consistent with the desire to keep the green lawn envisioned in the "American Dream", while years of community engagement and turf removal rebate programs have changed the way residents think of their lawn (Glionna, 2015). Bronson Mack, spokesman for the Southern Nevada Water Authority stated that "In the long run many homeowners realized they weren't using their grass until they pushed a lawnmower across it" (Glionna, 2015). While these sources cite evidence that changes in social norms are taking hold, it seems they move slowly and at a large budgetary cost. In addition, both Las Vegas and Phoenix have also relied on changes in building codes which disallow or limit natural grass in new residential construction. This leaves homeowners with no option for a natural grass lawn or the attachment to an "ideal" yard that might come along with it. This is also consistent with the idea that homeowners may be reluctant to give up something that they feel they deserve, and that policy makers need to better understand how homeowners value their existing natural turf lawn if they are going to expect them to willingly change to drought-tolerant alternatives.

Results from this work show that the value that a homeowner places on their natural turf lawn and drought tolerant alternatives significantly effects the minimum rebate amount that would be required to take out their natural turf lawn. Furthermore, the value of the yard is likely connected to the role that the yard plays in their "home". Much of the focus of marketing, peer effects, nudges, and

communication networks has been based on the role that sustainability, water conservation, and being

a "responsible" citizen plays in our society. However, this work suggests that a long-term behavioral

nudge strategy should also be based on changing the way that homeowners relate to the role that a

natural turf yard plays in their life and in their home, i.e. how highly they value natural turf in their yard.

Green grass and a beautiful yard have been viewed as a part of the "American dream" for over a century

in the United States (D'Costa, 2017) and it is possible that this norm is causing a significant barrier to

landscape conversion, not only the social norms related to water conservation. They are not the same

thing, but it seems as if many policy makers and researchers have been treating them as if they are. This

calls for a stronger focus on understanding the different reasons that homeowners value their natural

turf lawn, and to what extent these uses are viewed as more important than monetary savings on utility

bills and water conservation.

3.5.2   Water Conservation beliefs

Water conservation beliefs were also found to significantly influence the minimum amount required to

remove natural turf as a part of this program. This further supports the idea that personal beliefs

related to sustainability and water conservation increase the probability that a household will

participate in this type of program. What this work does not investigate, and yet is likely a very

important part of this puzzle, is if those marketing strategies and nudges can in fact change the way that

someone views water conservation. It may seem obvious that someone who has strong water

conservation beliefs might require a lower incentive to participate in this type of program, but what is

far less obvious is how to create stronger water conservation beliefs. In addition, this work does not

find any evidence that the influence from friends or family who have strong water conservation beliefs

can influence an individuals' minimum rebate required to remove natural turf, or even participate in this

type of program. These results further highlight the importance of water conservation beliefs in future

policy surrounding incentivized household changes, but also support the need for more work which

investigates how these beliefs might be influenced. This is critically important for evaluating the role

that education, marketing, and nudges may have in future programs.

3.5.3   Peer effects

Prior work in this realm has focused on *peer effects* through the application of observed participation

data and established the peer effect as the result of increased salience through participation of nearby

neighbors. The survey methodology allows us to ask respondents directly if they had any verbal

communication with those neighbors, and then ask if those conversations influenced their decision over

participation in the program, but we must rely on self-reported responses. This leads to the potential

for respondents to misreport, but it also leads to the potential for respondents to interpret the question

differently than the researcher.

Survey results show that a significant number of respondents did communicate with peers

about the program but were not influenced to participate by those peers. The statistical model also

suggests that the decision over the minimum rebate to accept is not influenced by communication

frequency with friends and family or the way they view water conservation practices. However, an

individual may not consciously realize that they are being influenced by their neighbors. This is often

the way that changes in social norms work, and this is part of the challenge with self-reported data

points. There is the possibility that an increase in program participation in a neighborhood provides a

signal to a homeowner that landscape conversion is accepted in that neighborhood, but there is nothing

that any individual neighbor tells him or her that convinces them to participate in the program and

therefore he or she may answer that they were not influenced by neighbors. This idea would provide a

potential theoretical response to the inconsistency between the significance of peer effects in related

work depending on observed data, and the survey responses in this work.

Considering the last point as a possibility merits consideration for a better understanding of the

different forms that a peer effect might take in program participation, and future work to test this

theory. A peer effect could take the form of increased salience, and potentially increased level of

perceived acceptance, and residents could be influenced unknowingly. This would be more consistent

with what An (2016) labels the *passive peer effect.* Under this scenario the peer effect may not be

recognized by homeowners, and policy makers should continue to focus on specialized marketing

strategies which relate more to household characteristics and heterogeneity than social comparison. On

the other hand, the peer effect may influence through actual communication, or one person being

aware that they are being influenced by another. This is more consistent with what An (2016) calls the

active peer effect. Under this scenario the policy maker can continue to focus on how variation in

household characteristics drives participation, but there will also be more room to use social

comparisons, neighborhood advocacy, or helping to facilitate neighborhood communication through in-

person or virtual events.

    This distinction between the form that a peer effect takes can also be considered in the context of

Rogers (2003) *Diffusion of Innovations Theory.* In this theory innovators and laggards are not *actively* or

passively affected by peers. With early adopters there is limited opportunity for active peer effect*,* and

little traction for a *passive* effect to take hold. More importantly the early adopters often seek to

provide information and foster active peer effects with members of the early majority who are

susceptible to both *active* and *passive* peer effects. The late majority is harder to convince and likely

need active and passive peer effects to influence the adoption of an idea or technology.

    In the context of this work, the failure to establish self-reported peer influence may also be related

to the category of adopters that respondents likely fall into. In terms of overall participation at the time

of this survey, the residential population would be categorized as in the early stages of the early

adoption phase in Rogers' (2003) stages of innovation. Therefore, the applicants in this survey would be

considered either innovators or early adopters. Neither of these stages are listed as being influenced

heavily by active peer effects*.* This leaves room for the argument that the early phase of this program

dictates a smaller influence in the form of an active peer effect. As new rounds of turf removal rebate

programs ensue there may be more room for an active peer effect to play a role in the household

decision over participation. Ultimately, this work highlights the need for increased focus on the different

forms the peer effect may take, which methodology may be better suited to recognize different forms of

peer effect, and what different channels mean for policy implementation.

3.5.4   The rebate amount

When asked which items positively affected the household decision to participate, the rebate amount

was selected by over 90 percent of people who answered that question. In addition, the variation in the

minimum rebate required to participate suggests that there is an increasing relationship between the

rebate amount and the number of people that will participate in the program. The self-reported

answers also show that there is a large difference in the minimum amount required for most of those

that participated and those that did not. This shows up not only in the aggregate calculation but in the

distinct change in slope in the willingness to accept curve in Figure 1. This suggests that some

households would require a very significant increase in the rebate amount in order to get them to

participate in the program. Furthermore, the minimum rebate amount required seems to be influenced

significantly by the way that homeowners value a drought-tolerant option, their information source, and

their conservation beliefs, but not subjective norms or the frequency of communication about the

program.

While there is evidence from the survey, and general customer reaction, that the rebate level

was important, it remains uncertain how much marginal changes in the rebate level influence program

participation once a base level is established. Furthermore, this work suggests that in many instances

the rebate amount was well above what these early adopters would have required to participate in the

program. This work further supports the notion that dramatically increasing program participation

through increases in the rebate level is likely more costly than agency budgets would allow due to the

149

significant difference between the minimum willingness to accept between those that applied and those that did not. There is a need to further investigate what the reasons are that homeowners do not want to participate in turf removal rebate programs and what, if any, rebate amount would incentivize them. If subjective norms about conservation and communication frequency do not influence participation and required rebate amount, then we need to further investigate what is driving the valuation of a landscape.

3.6   CONCLUSION

This work provided an initial step for evaluating the extent to which homeowners value their natural turf in comparison to a program-approved drought tolerant option by using a simplified contingent valuation framework. The limitation of this framework is in the size of the sample and the upper bound of allowable survey responses at $25. However, a larger sample would result in better external validity in estimation of aggregate neighborhood or water-district-area household valuation of natural turf versus program alternatives. Furthermore, this provides avenues for estimating the number of participants who would not have required a rebate and calculating estimates of the homeowner surplus gained from program participation. To this point, a monetary estimation of homeowner surplus outside of water bill and yard maintenance savings has been left out of other studies focusing on program effectiveness and efficiency. The way that homeowners view and value their yard is a critical component of participation in turf removal programs.

This work also highlighted the point of discovery, extent of communication, and avenues of research for a small sample of households for the regional turf removal rebate program. While limited by sample size, the results are informative and can help water agencies and academics better understand the spread of related information through a community. Verbal and USPS-based communication with the water agency still plays a significant role in discovery and research related to this program. Households seem to discuss the program with neighbors, friends, and family to a

moderate extent but respond that they are not significantly influenced by those discussions. While it is not surprising, online research plays the most significant role in research which supports the notion that an increased online presence and accessibility can only help water agencies and related vendors in future programs.

The primary challenge related to this work was the limited sample size. A survey with a better response rate and more extensive in-person focus groups could provide additional qualitative and quantitative data which will help decipher the role of direct communication in peer effects and provide more robust answers to the effectiveness of the rebate amount along with how homeowners value their yard. These two areas will be important if water agencies want the impetus of program participation to continue once the rounds of rebate programs finally end. Ultimately, social norms surrounding the yard will need to change if Southern California wants to meet their residential water goals and contribute to a sustainable future.

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3.8   APPENDIX A

This document shows the questions asked on the actual survey in the format and order taken directly from qualtrics. The questions numbers do not correspond with the order that the questions were asked. The question numbers correspond with the order that the questions were created in qualtrics. Skip logic was used in qualtrics to determine the path of questions that respondents were asked depending on how they answered two key questions.

1. Are you aware of any of the turf removal rebate programs that have been offered through your water provider over the last 5 years?

2. Have you applied for a turf removal rebate program through your water provider in the last 5 years?

This document is broken up into three sections which represent the questions that respondents would have seen depending on how they answered these three key questions. Section I shows the questions that respondents would see if they answered 1 and 2 with a yes. The second section shows the questions that respondents would see if they answered question one with a yes and question two with a no. Finally, the third section shows the questions that respondents would see if they answered no for the first question. Once they answer no for the first question, they were not even shown question number two.

3.8.1   Questions for respondents who were aware of the program and did apply

Q77 By participating in this survey you are verifying that you have read and understand the information that was mailed to you about this survey. Furthermore, you understand that this survey is completely voluntary. If you agree please mark "Yes I understand" below. If you never received a mailer, or do not want to participate in this research you do not have to.

○ Yes I understand (1)

Q69 Are you aware of any of the turf removal rebate programs that have been offered through your water provider over the last 5 years?

○ Yes (1)

○ No (2)

Q72 Where did you hear or find out about the turf removal rebate program(s)? (mark all that apply)

Neighbors (1)	Coworkers (2)	Friends (3)	Family (4)	Television (5)	Newspaper (6)	Water provider (7)	The internet (8)	Contractors (9)	Not listed here (10)
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q1 Have you applied for a turf removal rebate through your water provider in the last 5 years?

☐ Yes (1)

☐ No (2)

Q81 Did you end up removing some of your turf and participating in the program?

◯ Yes (1)

◯ No, I was approved but I did not participate in the program (2)

◯ No, I was not approved for the program (3)

Q19 Please tell us which of the following did positively influence your decision to apply for a turf removal rebate program. (Select yes if it did positively influence you, no if it did not)

	Yes (1)	No (2)
The rebate amount (1)	○	○
My beliefs about water conservation (2)	○	○
I like the way that artificial grass looks (3)	○	○
Cost savings on my utility bill (4)	○	○
The influence of neighbors (5)	○	○
I want to help make a more sustainable community (6)	○	○
I do not want to mow my grass any more (7)	○	○
It is difficult to keep a healthy lawn in California (8)	○	○
My sprinkler system is frustrating or expensive to fix (9)	○	○
The influence of my friends, family, and peers (10)	○	○
I like the way that a drought tolerant yard looks (11)	○	○
I wanted to reduce potential fire hazard in my landscape (12)	○	○

Q54 This is a brief pause to say thank you for taking the time to complete this survey so far, I really appreciate your participation!! Your opinion and honesty is highly valued in this research. (You do not need to fill out anything in this text box to continue, but feel free to write anything you want)

_____

Q4 For the following questions select the answer that most closely represents the way you feel

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I feel a personal obligation to do whatever I can to conserve water (1)	○	○	○	○	○	○	○
I feel a sense of personal obligation to ensure that my yard is drought tolerant (2)	○	○	○	○	○	○	○
People should be able to use water however they want if they pay for it (3)	○	○	○	○	○	○	○
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4)	○	○	○	○	○	○	○
My neighbors and peers should do whatever they can to conserve water (6)	○	○	○	○	○	○	○

Q5 For the following questions select the answer that most closely represents your daily routine

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I do not let the faucet run when I am brushing my teeth or washing dishes (1)	○	○	○	○	○	○	○
I am more concerned with my water bill amount than the amount of water that I use (2)	○	○	○	○	○	○	○
I try to take shorter showers to conserve water (3)	○	○	○	○	○	○	○
I load my washer efficiently to minimize water consumption for laundry (4)	○	○	○	○	○	○	○

Q6 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Drought tolerant lawns do not look good (1)	○	○	○	○	○	○	○
When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (2)	○	○	○	○	○	○	○
I like my lawn too much to replace it with a drought tolerant option (3)	○	○	○	○	○	○	○
Drought tolerant lawns bring down the value of a house (4)	○	○	○	○	○	○	○

Q7 How do the following groups in your social circle view water conservation practices?

	Not important at all (1)	Not that important (2)	They do not have an opinion about water conservation (3)	Somewhat important (4)	Very important (5)	I do not know (6)	N/A (7)
Friends (1)	○	○	○	○	○	○	○
Family (2)	○	○	○	○	○	○	○
Coworkers (3)	○	○	○	○	○	○	○
Neighbors (4)	○	○	○	○	○	○	○

Q9 The following question mentions IMMEDIATE NEIGHBORS, COMMUNITY MEMBERS, COWORKERS, FRIENDS, AND FAMILY. IMMEDIATE NEIGHBORS should be considered the 10 or so households that live closest to you. COMMUNITY MEMBERS are people who live in your community but are not IMMEDIATE NEIGHBORS.

Did you discuss the turf removal rebate program with any of the following? Please estimate how many times you discussed the turf rebate program with members from each of the following groups

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)	N/A (8)
IMMEDIATE NEIGHBORS (1)	○	○	○	○	○	○	○	○
COMMUNITY MEMBERS (2)	○	○	○	○	○	○	○	○
FRIENDS (3)	○	○	○	○	○	○	○	○
FAMILY (4)	○	○	○	○	○	○	○	○
COWORKERS (5)	○	○	○	○	○	○	○	○

Q56 What kind of information did you discuss with the people you mentioned above?

	Information related to the requirements of the program (1)	Information on potential water bill savings (2)	Information related to landscape design (3)	Information related to water conservation potential (4)
We discussed (2)	☐	☐	☐	☐

Q35 How close are the opinions of the people you have talked to about the Turf Removal Rebate Program?

○ Completely dissimilar (1)

○ Somewhat dissimilar (2)

○ Neutral (3)

○ Somewhat similar (4)

○ Completely similar (5)

○ I did not talk to anyone about the turf removal rebate program (6)

Q48 How many days a week do you do the following?

	Never (1)	Less than once a week (2)	Once a week (3)	A few times a week (4)	Every day (5)
Read a paper copy of the newspaper (1)	○	○	○	○	○
Read news on the internet (2)	○	○	○	○	○
Watch the news on television (3)	○	○	○	○	○

Q12 Did you research the turf removal rebate program

	Answer	
	Yes (1)	No (2)
Online (1)	○	○
Through information received in the mail (2)	○	○
Through a library (3)	○	○
Through communication with the water company (4)	○	○

Q15 What type of information did you gain from the sources you answered yes to above. Select all options that apply.

	Information related to the requirements of the turf replacement program	Information on potential water bill savings	Information related to landscape design	Information related to water conservation potential	No information
	Answer (1)	Answer (1)	Answer (1)	Answer (1)	Answer (1)
Online (1)	☐	☐	☐	☐	○
Received in the mail (2)	☐	☐	☐	☐	○
Through a library (3)	☐	☐	☐	☐	○
Communication with water company (4)	☐	☐	☐	☐	○

Q3 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Humans are severely abusing the environment (1)	○	○	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe (2)	○	○	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs (3)	○	○	○	○	○	○	○
Human ingenuity will insure that we do NOT make the earth unlivable (4)	○	○	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them (5)	○	○	○	○	○	○	○
Humans were meant to rule over the rest of nature (6)	○	○	○	○	○	○	○
The so called "ecological crisis" facing humankind has been greatly exaggerated (7)	○	○	○	○	○	○	○

Q38 In the past 12 months how many times have you done the following?

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)
Had friends over to your house to visit or for dinner? (1)	○	○	○	○	○	○	○
Socialized with coworkers outside of work? (2)	○	○	○	○	○	○	○
Participated in online discussions (Facebook, twitter, blogs, etc) (3)	○	○	○	○	○	○	○

Q59 Almost there! Thank you so much for your continued effort, once again no answer required here just wanted to say thanks again. (If you want to write anything in the text box feel free).

_____

Q56 What is your total household income?

○ $19,999 or less (1)

○ $20,000 - $34,999 (2)

○ $35,000 - $49,999 (3)

○ $50,000-$74,999 (4)

○ $75,000 - $109,999 (5)

○ $110,000 - $149,999 (6)

○ $150,000 - $249,999 (7)

○ $250,000 or more (8)

Q44 Do you consider yourself?

○ White (1)

○ Black or African American (2)

○ American Indian or Alaska Native (3)

○ Asian (4)

○ Native Hawaiian or Pacific Islander (5)

○ Other (6)

○ Decline to State (7)

○ Of Hispanic Origin (8)

Q50 Which gender identity do you most identify with? If you prefer not to answer then leave this blank.

_____

Q71 What zip code do you live in?

_____

Q46 How long have you lived at your current address?

○ Less than 1 year (1)

○ 2 to 3 years (2)

○ 4 to 5 years (3)

○ More than 5 years (4)

Q52 Do you own the home you live in?

○ Yes (5)

○ No (6)

Q47 What political party do you identify with, if any?

○ Democrat (1)

○ Republican (2)

○ Green Party (3)

○ Independent and not Green Party (4)

○ Libertarian (5)

○ Other (6)

○ None-I do not participate in the political process (7)

Q49 What is your age?

○ 18 to 24 (1)

○ 25 to 34 (2)

○ 35 to 49 (3)

○ 50 to 64 (4)

○ 65 or older (5)

Q50 What is your principal occupation?

○ Professional (1)

○ Manager, Administrator, or sales worker (2)

○ Secretary or clerical worker (3)

○ Craftsman or skilled laborer (4)

○ Equipment operator (5)

○ Farmer or farm laborer (6)

○ Service worker (7)

○ Student (8)

○ Retired (9)

○ Unemployed (10)

○ Work at home (including child care) (11)

Q51 What is the highest degree you have attained?

○ Less than High School (1)

○ High School (2)

○ Some college (3)

○ 2 year degree (4)

○ 4 year degree (5)

○ Professional degree (6)

○ Graduate degree (7)

Q52 Are you ...

○ Married or I have a Domestic Partner (1)

○ Unmarried and No Domestic Partner (2)

○ Widowed, divorced, or separated (3)

○ Refuse to answer (4)

Q51 Would you be interested in learning about future turf removal rebate programs offered through your water provider?

○ Yes (1)

○ Maybe (2)

○ No (4)

Q79 Would you like to enter the random prize drawing to have a chance at winning one out of the $100 visa gift cards. If you select yes you will be taken to a separate survey where your email address and home address will be recorded. Remember that your

answers to this survey will remain anonymous since none of the addresses required for the random prize drawing will be connected to this survey.

○ Yes (1)

○ No (2)

3.8.2 Questions for respondents who were aware of the program but did not apply

Q77 By participating in this survey you are verifying that you have read and understand the information that was mailed to you about this survey. Furthermore you understand that this survey is completely voluntary. If you agree please mark "Yes I understand" below. If you never received a mailer, or do not want to participate in this research you do not have to.

○ Yes I understand (1)

Q69 Are you aware of any of the turf removal rebate programs that have been offered through your water provider over the last 5 years?

○ Yes (1)

○ No (2)

Q72 Where did you hear or find out about the turf removal rebate program(s)? (mark all that apply)

Neighbors (1)	Coworkers (2)	Friends (3)	Family (4)	Television (5)	Newspaper (6)	Water provider (7)	The internet (8)	Contractors (9)	Not listed here (10)
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

Q1 Have you applied for a turf removal rebate through your water provider in the last 5 years?

☐ Yes (1)

☐ No (2)

Q22 Please tell us why you did not apply to a turf removal rebate program.

_____

_____

_____

_____

_____

Q16 Was the reason you did not apply to a turf removal rebate program related to the amount of the rebate?

○ Yes (1)

○ No (2)

Q17 What is the minimum rebate amount per square foot that you would have required to remove a portion of your lawn (turf)? (drag the slider to the appropriate minimum rebate amount)

	0	3	5	8	10	13	15	18	20	23	25
Drag the slider to select your answer ()											

Q2 Did you remove a portion of your lawn (turf) without applying for a turf removal rebate from a water agency?

○ Yes (1)

○ No (2)

Q54 This is a brief pause to say thank you for taking the time to complete this survey so far, I really appreciate your participation!! Your opinion and honesty is highly valued in this research. (You do not need to fill out anything in this text box to continue, but feel free to write anything you want)

_____

Q4 For the following questions select the answer that most closely represents the way you feel

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I feel a personal obligation to do whatever I can to conserve water (1)	○	○	○	○	○	○	○
I feel a sense of personal obligation to ensure that my yard is drought tolerant (2)	○	○	○	○	○	○	○
People should be able to use water however they want if they pay for it (3)	○	○	○	○	○	○	○
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4)	○	○	○	○	○	○	○
My neighbors and peers should do whatever they can to conserve water (6)	○	○	○	○	○	○	○

Q5 For the following questions select the answer that most closely represents your daily routine

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I do not let the faucet run when I am brushing my teeth or washing dishes (1)	○	○	○	○	○	○	○
I am more concerned with my water bill amount than the amount of water that I use (2)	○	○	○	○	○	○	○
I try to take shorter showers to conserve water (3)	○	○	○	○	○	○	○
I load my washer efficiently to minimize water consumption for laundry (4)	○	○	○	○	○	○	○

Q6 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Drought tolerant lawns do not look good (1)	○	○	○	○	○	○	○
When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (2)	○	○	○	○	○	○	○
I like my lawn too much to replace it with a drought tolerant option (3)	○	○	○	○	○	○	○
Drought tolerant lawns bring down the value of a house (4)	○	○	○	○	○	○	○

Q7 How do the following groups in your social circle view water conservation practices?

	Not important at all (1)	Not that important (2)	They do not have an opinion about water conservation (3)	Somewhat important (4)	Very important (5)	I do not know (6)	N/A (7)
Friends (1)	○	○	○	○	○	○	○
Family (2)	○	○	○	○	○	○	○
Coworkers (3)	○	○	○	○	○	○	○
Neighbors (4)	○	○	○	○	○	○	○

Q9 The following question mentions IMMEDIATE NEIGHBORS, COMMUNITY MEMBERS, COWORKERS, FRIENDS, AND FAMILY. IMMEDIATE NEIGHBORS should be considered the 10 or so households that live closest to you. COMMUNITY MEMBERS are people who live in your community but are not IMMEDIATE NEIGHBORS.

Did you discuss the turf removal rebate program with any of the following? Please estimate how many times you discussed the turf rebate program with members from each of the following groups

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)	N/A (8)
IMMEDIATE NEIGHBORS (1)	○	○	○	○	○	○	○	○
COMMUNITY MEMBERS (2)	○	○	○	○	○	○	○	○
FRIENDS (3)	○	○	○	○	○	○	○	○
FAMILY (4)	○	○	○	○	○	○	○	○
COWORKERS (5)	○	○	○	○	○	○	○	○

Q56 What kind of information did you discuss with the people you mentioned above?

	Information related to the requirements of the program (1)	Information on potential water bill savings (2)	Information related to landscape design (3)	Information related to water conservation potential (4)
We discussed (2)	☐	☐	☐	☐

Q35 How close are the opinions of the people you have talked to about the Turf Removal Rebate Program?

○ Completely dissimilar (1)

○ Somewhat dissimilar (2)

○ Neutral (3)

○ Somewhat similar (4)

○ Completely similar (5)

○ I did not talk to anyone about the turf removal rebate program (6)

Q48 How many days a week do you do the following?

	Never (1)	Less than once a week (2)	Once a week (3)	A few times a week (4)	Every day (5)
Read a paper copy of the newspaper (1)	○	○	○	○	○
Read news on the internet (2)	○	○	○	○	○
Watch the news on television (3)	○	○	○	○	○

Q12 Did you research the turf removal rebate program

	Answer	
	Yes (1)	No (2)
Online (1)	○	○
Through information received in the mail (2)	○	○
Through a library (3)	○	○
Through communication with the water company (4)	○	○

Q15 What type of information did you gain from the sources you answered yes to above. Select all options that apply.

	Information related to the requirements of the turf replacement program	Information on potential water bill savings	Information related to landscape design	Information related to water conservation potential	No information
	Answer (1)	Answer (1)	Answer (1)	Answer (1)	Answer (1)
Online (1)	☐	☐	☐	☐	○
Received in the mail (2)	☐	☐	☐	☐	○
Through a library (3)	☐	☐	☐	☐	○
Communication with water company (4)	☐	☐	☐	☐	○

Q3 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Humans are severely abusing the environment (1)	○	○	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe (2)	○	○	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs (3)	○	○	○	○	○	○	○
Human ingenuity will insure that we do NOT make the earth unlivable (4)	○	○	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them (5)	○	○	○	○	○	○	○
Humans were meant to rule over the rest of nature (6)	○	○	○	○	○	○	○
The so called "ecological crisis" facing humankind has been greatly exaggerated (7)	○	○	○	○	○	○	○

Q38 In the past 12 months how many times have you done the following?

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)
Had friends over to your house to visit or for dinner? (1)	○	○	○	○	○	○	○
Socialized with coworkers outside of work? (2)	○	○	○	○	○	○	○
Participated in online discussions (Facebook, twitter, blogs, etc) (3)	○	○	○	○	○	○	○

Q59 Almost there! Thank you so much for your continued effort, once again no answer required here just wanted to say thanks again. (If you want to write anything in the text box feel free).

_____

Q56 What is your total household income?

○ $19,999 or less (1)

○ $20,000 - $34,999 (2)

○ $35,000 - $49,999 (3)

○ $50,000-$74,999 (4)

○ $75,000 - $109,999 (5)

○ $110,000 - $149,999 (6)

○ $150,000 - $249,999 (7)

○ $250,000 or more (8)

183

Q44 Do you consider yourself?

○ White (1)

○ Black or African American (2)

○ American Indian or Alaska Native (3)

○ Asian (4)

○ Native Hawaiian or Pacific Islander (5)

○ Other (6)

○ Decline to State (7)

○ Of Hispanic Origin (8)

Q50 Which gender identity do you most identify with? If you prefer not to answer then leave this blank.

_____

Q71 What zip code do you live in?

_____

Q46 How long have you lived at your current address?

○ Less than 1 year (1)

○ 2 to 3 years (2)

○ 4 to 5 years (3)

○ More than 5 years (4)

Q52 Do you own the home you live in?

○ Yes (5)

○ No (6)

Q47 What political party do you identify with, if any?

○ Democrat (1)

○ Republican (2)

○ Green Party (3)

○ Independent and not Green Party (4)

○ Libertarian (5)

○ Other (6)

○ None-I do not participate in the political process (7)

Q49 What is your age?

○ 18 to 24 (1)

○ 25 to 34 (2)

○ 35 to 49 (3)

○ 50 to 64 (4)

○ 65 or older (5)

Q50 What is your principal occupation?

○ Professional (1)

○ Manager, Administrator, or sales worker (2)

○ Secretary or clerical worker (3)

○ Craftsman or skilled laborer (4)

○ Equipment operator (5)

○ Farmer or farm laborer (6)

○ Service worker (7)

○ Student (8)

○ Retired (9)

○ Unemployed (10)

○ Work at home (including child care) (11)

Q51 What is the highest degree you have attained?

○ Less than High School (1)

○ High School (2)

○ Some college (3)

○ 2 year degree (4)

○ 4 year degree (5)

○ Professional degree (6)

○ Graduate degree (7)

Q52 Are you ...

○ Married or I have a Domestic Partner (1)

○ Unmarried and No Domestic Partner (2)

○ Widowed, divorced, or separated (3)

○ Refuse to answer (4)

Q51 Would you be interested in learning about future turf removal rebate programs offered through your water provider?

○ Yes (1)

○ Maybe (2)

○ No (4)

Q79 Would you like to enter the random prize drawing to have a chance at winning one out of the $100 visa gift cards. If you select yes you will be taken to a separate survey where your email address and home address will be recorded. Remember that your

answers to this survey will remain anonymous since none of the addresses required for the random prize drawing will be connected to this survey.

◯ Yes (1)

◯ No (2)

3.8.3 Questions for respondents that were not aware of any turf removal rebate program

Q77 By participating in this survey you are verifying that you have read and understand the information that was mailed to you about this survey. Furthermore you understand that this survey is completely voluntary. If you agree please mark "Yes I understand" below. If you never received a mailer, or do not want to participate in this research you do not have to.

◯ Yes I understand (1)

Q69 Are you aware of any of the turf removal rebate programs that have been offered through your water provider over the last 5 years?

◯ Yes (1)

◯ No (2)

Q2 Did you remove a portion of your lawn (turf) without applying for a turf removal rebate from a water agency?

◯ Yes (1)

◯ No (2)

Q54 This is a brief pause to say thank you for taking the time to complete this survey so far, I really appreciate your participation!! Your opinion and honesty is highly valued in this research. (You do not need to fill out anything in this text box to continue, but feel free to write anything you want)

_____

Q4 For the following questions select the answer that most closely represents the way you feel

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I feel a personal obligation to do whatever I can to conserve water (1)	○	○	○	○	○	○	○
I feel a sense of personal obligation to ensure that my yard is drought tolerant (2)	○	○	○	○	○	○	○
People should be able to use water however they want if they pay for it (3)	○	○	○	○	○	○	○
It bothers me when I see sprinklers that are not designed efficiently or are watering areas that are paved (4)	○	○	○	○	○	○	○
My neighbors and peers should do whatever they can to conserve water (6)	○	○	○	○	○	○	○

Q5 For the following questions select the answer that most closely represents your daily routine

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I do not let the faucet run when I am brushing my teeth or washing dishes (1)	○	○	○	○	○	○	○
I am more concerned with my water bill amount than the amount of water that I use (2)	○	○	○	○	○	○	○
I try to take shorter showers to conserve water (3)	○	○	○	○	○	○	○
I load my washer efficiently to minimize water consumption for laundry (4)	○	○	○	○	○	○	○

Q6 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Drought tolerant lawns do not look good (1)	○	○	○	○	○	○	○
When I see a drought tolerant lawn I have a positive opinion about the homeowner even if I do not know them (2)	○	○	○	○	○	○	○
I like my lawn too much to replace it with a drought tolerant option (3)	○	○	○	○	○	○	○
Drought tolerant lawns bring down the value of a house (4)	○	○	○	○	○	○	○

Q7 How do the following groups in your social circle view water conservation practices?

	Not important at all (1)	Not that important (2)	They do not have an opinion about water conservation (3)	Somewhat important (4)	Very important (5)	I do not know (6)	N/A (7)
Friends (1)	○	○	○	○	○	○	○
Family (2)	○	○	○	○	○	○	○
Coworkers (3)	○	○	○	○	○	○	○
Neighbors (4)	○	○	○	○	○	○	○

Q3 For the following questions select the answer that most closely represents your opinion

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
Humans are severely abusing the environment (1)	○	○	○	○	○	○	○
If things continue on their present course, we will soon experience a major ecological catastrophe (2)	○	○	○	○	○	○	○
Humans have the right to modify the natural environment to suit their needs (3)	○	○	○	○	○	○	○
Human ingenuity will insure that we do NOT make the earth unlivable (4)	○	○	○	○	○	○	○
The earth has plenty of natural resources if we just learn how to develop them (5)	○	○	○	○	○	○	○
Humans were meant to rule over the rest of nature (6)	○	○	○	○	○	○	○
The so called "ecological crisis" facing humankind has been greatly exaggerated (7)	○	○	○	○	○	○	○

Q38 In the past 12 months how many times have you done the following?

	Never (1)	Once a year or less (2)	Several times a year (3)	Once a month (4)	Several times a month (5)	Several times a week (6)	Just about every day (7)
Had friends over to your house to visit or for dinner? (1)	○	○	○	○	○	○	○
Socialized with coworkers outside of work? (2)	○	○	○	○	○	○	○
Participated in online discussions (Facebook, twitter, blogs, etc) (3)	○	○	○	○	○	○	○

Q59 Almost there! Thank you so much for your continued effort, once again no answer required here just wanted to say thanks again. (If you want to write anything in the text box feel free).

_____

Q56 What is your total household income?

○ $19,999 or less (1)

○ $20,000 - $34,999 (2)

○ $35,000 - $49,999 (3)

○ $50,000-$74,999 (4)

○ $75,000 - $109,999 (5)

○ $110,000 - $149,999 (6)

○ $150,000 - $249,999 (7)

○ $250,000 or more (8)

193

Q44 Do you consider yourself?

○ White (1)

○ Black or African American (2)

○ American Indian or Alaska Native (3)

○ Asian (4)

○ Native Hawaiian or Pacific Islander (5)

○ Other (6)

○ Decline to State (7)

○ Of Hispanic Origin (8)

Q50 Which gender identity do you most identify with? If you prefer not to answer then leave this blank.

_____

Q71 What zip code do you live in?

_____

Q46 How long have you lived at your current address?

○ Less than 1 year (1)

○ 2 to 3 years (2)

○ 4 to 5 years (3)

○ More than 5 years (4)

Q52 Do you own the home you live in?

○ Yes (5)

○ No (6)

Q47 What political party do you identify with, if any?

○ Democrat (1)

○ Republican (2)

○ Green Party (3)

○ Independent and not Green Party (4)

○ Libertarian (5)

○ Other (6)

○ None-I do not participate in the political process (7)

Q49 What is your age?

○ 18 to 24 (1)

○ 25 to 34 (2)

○ 35 to 49 (3)

○ 50 to 64 (4)

○ 65 or older (5)

Q50 What is your principal occupation?

○ Professional (1)

○ Manager, Administrator, or sales worker (2)

○ Secretary or clerical worker (3)

○ Craftsman or skilled laborer (4)

○ Equipment operator (5)

○ Farmer or farm laborer (6)

○ Service worker (7)

○ Student (8)

○ Retired (9)

○ Unemployed (10)

○ Work at home (including child care) (11)

Q51 What is the highest degree you have attained?

○ Less than High School (1)

○ High School (2)

○ Some college (3)

○ 2 year degree (4)

○ 4 year degree (5)

○ Professional degree (6)

○ Graduate degree (7)

Q52 Are you ...

○ Married or I have a Domestic Partner (1)

○ Unmarried and No Domestic Partner (2)

○ Widowed, divorced, or separated (3)

○ Refuse to answer (4)

Q51 Would you be interested in learning about future turf removal rebate programs offered through your water provider?

○ Yes (1)

○ Maybe (2)

○ No (4)

Q79 Would you like to enter the random prize drawing to have a chance at winning one out of the $100 visa gift cards. If you select yes you will be taken to a separate survey where your email address and home address will be recorded. Remember that your

answers to this survey will remain anonymous since none of the addresses required for the random prize drawing will be connected to this survey.

○ Yes (1)

○ No (2)

3.9 APPENDIX B

1.1. *Initial mailer*

Claremont Graduate University
A MEMBER OF THE CLAREMONT COLLEGES

School of Social Science,
Policy & Evaluation
150 E. 10th Street
Claremont, CA 91711
cgu.edu

Hello! You are being asked to participate in a research project conducted by John Shideler and Dr. Hal Nelson from the School of Social Science, Policy, and Evaluation at Claremont Graduate University (CGU). The research has been funded by an educational grant from the Metropolitan Water District of Southern California. You are being asked to participate in our research because you are a resident of Los Angeles County and we value your opinion. To participate in the survey discussed in this letter please go www.laturfsurvey.com.

PURPOSE: The purpose of this study is to better understand citizen awareness of, support for, and opposition to the recent turf removal rebate program that was offered through the Metropolitan Water District of Southern California and/or your local water provider. If you think the program was a good idea, a bad idea, or you never even heard of it feel free to let us know. The findings from the research may be published in peer reviewed journals and publicly available white papers hosted on laturfsurvey.com.

PARTICIPATION: You will be asked to respond to about 25 questions related to the turf removal rebate program, your political views, your social network, your opinion on the use of natural resources, as well as your socio-economic conditions. We expect your participation to take only about 10-15 minutes of your time.

RISKS & BENEFITS: We see no risks to you from taking part in this survey as your responses will be anonymous. We expect this research to benefit society and science by better understanding how people view incentive based rebate programs from their utility provider, how information about these programs is spread, and how people feel about the turf removal rebate program specifically. We feel that this information will likely positively impact the design and implementation of similar programs in the future.

COMPENSATION: As compensation you can choose to be entered into a random drawing for a $100 gift card. The final question of the survey will ask if you would like to participate in the random drawing, and if so you will be asked for an email and physical address to claim entry into the random drawing. This will allow us to contact you in case you do win. We estimate that entrants will have a 1 in 10 chance of winning a $100 gift card. If you do not wish to participate in the survey research you can still enter into the drawing as directed above.

VOLUNTARY PARTICIPATION: Please understand that participation is completely voluntary. You have the right to withdraw from the survey at any time without penalty. You also have the right to refuse to answer any question(s) for any reason, without penalty.

CONFIDENTIALITY: Your responses will be completely anonymous. As discussed above, an email and physical address will be required to claim your entry to the random drawing. The section which allows you to input your email and physical address for entry into the random drawing is a separate survey, and therefore any responses to the questions in the actual survey will not be connected to your physical or email address if you choose to enter the random drawing. Once the prizes for the random drawing have been claimed, all addresses used to send the surveys, or claim prizes, will be discarded. If you have any questions or would like additional information about this research, you can contact John Shideler through the contact link at the website www.laturfsurvey.com. The CGU Institutional Review Board, which is administered through the Office of Research and Sponsored Programs (ORSP), has approved this project. You may also contact ORSP at (909) 607-9406 with any questions. This Board is responsible for ensuring the protection of research participants. A copy of this consent form may be printed out as part of the survey. Thank you for your participation in this important research!

3.9.1 Follow up postcard

Hello,

This is a quick reminder that you have been asked to participate in a research project conducted by John Shideler and Dr. Hal Nelson at Claremont Graduate University. We are asking you to share your opinion and thoughts in a survey which John will use to help analyze the success, or failures, of the recent turf removal rebate program as part of his PhD dissertation research

If you have already completed the survey, thank you so much for participating we appreciate your input! As a refresher, you can participate in the survey, or claim your entry into the random drawing by going to www.laturfsurvey.com.

Thanks again!

3.10 APPENDIX C

Two calculations are included in this appendix. First is the calculation of the 95% confidence interval around average minimum rebate amount required for the sample population. The sample average was $2.2068. The lower bound for this confidence interval was $1.91 and the upper bound was $2.50. The bounds around the sample average were calculated by multiplying the standard error for the sample which was $0.147498977 and multiplying by a tvalue of 2. This created a bound of $0.294937953 to add and subtract to the sample average to create the 95% confidence interval upper and lower bounds.

The second calculation included in this appendix is related to the proportions of the actual participant population which would fall within the respective minimum rebate amount thresholds, with a 95% level of confidence. For this metric bounds were created around the sample portion. For each sample proportion a t value (2 in this case) is multiplied by the corresponding standard error ($\sqrt{(\frac{p(1-p)}{n})}$)
. This provided the amount to which the sample proportion should be increased and decreased to ensure the 95% level of confidence.