June 28th, 2024

Kevin Reidy
State Water Conservation Specialist
Colorado Water Conservation Board
1313 Sherman St., Room 718
Denver, CO 80203

Dear Mr. Reidy,

Resource Central has completed Task 3 of the Landscape Change Program Impact Analysis which concludes the grant project in its entirety. We are very excited to report on our findings and share our final deliverable Story Map. The goal of this project was to evaluate community benefits and quantify the impact of our water conservation program Garden In A Box. Building off the foundational work completed in Tasks 1 and 2, Task 3 was an opportunity to compile and share our findings with our water provider and municipal partners as well as our greater Colorado community. Using ArcGIS Story Maps, Task 3 yields an exciting visual deliverable of the findings from this project in addition to a formal project report. More details of the final deliverables and completion of the study can be found in the following documents.

- Attachment 1: Progress Report & Communications Summary
- Attachment 2: Presentation
- Attachment 3: Story Map Deliverable
- Attachment 4: Internal Project Report
- Attachment 5: Billing Summary
- Attachment 6: Invoice (submitted in June)

Although this project has been completed, the team will continue to share their findings in various conferences throughout the year. Please contact us with any feedback or questions and thank you.

Sincerely,

Kate Larson

Kate Larson
Program Director: Water & Energy
Resource Central
6400 Arapahoe Rd. Suite B.
Boulder, CO 80303

Garden In A Box Impact

PRESENTATION

An evaluation of the Garden In A Box program

RESOURCE central

CONSERVATION MADE EASY

DNR

Katie Butler

Research Fellow
kbutler@resourcecentral.org

With a background in geography and research, Katie joined Resource Central to lead the research efforts for this project.

Melanie Stolp

Senior Program Manager
mstolp@resourcecentral.org

With a background in Human Dimensions of Natural Resources, Melanie manages the Garden In A Box and Waterwise Yard Seminars programs at Resource Central.

Presentation Outline

Program Overview

“I love this program and how easy it makes creating a novice xeriscape garden so that anyone can do it!”

-Garden In A Box Participant

Benefits Beyond Water

- Instant curb appeal
- Professional design without the cost
- Attract pollinators

By The Numbers

"We wanted to xeriscape our yard but the price tag and knowledge of plants were out of our range. This [program] made it possible and our front yard is gorgeous now!"

-Garden In A Box Participant

Water Conservation Partnerships

43 Water Provider/Municipal Partners

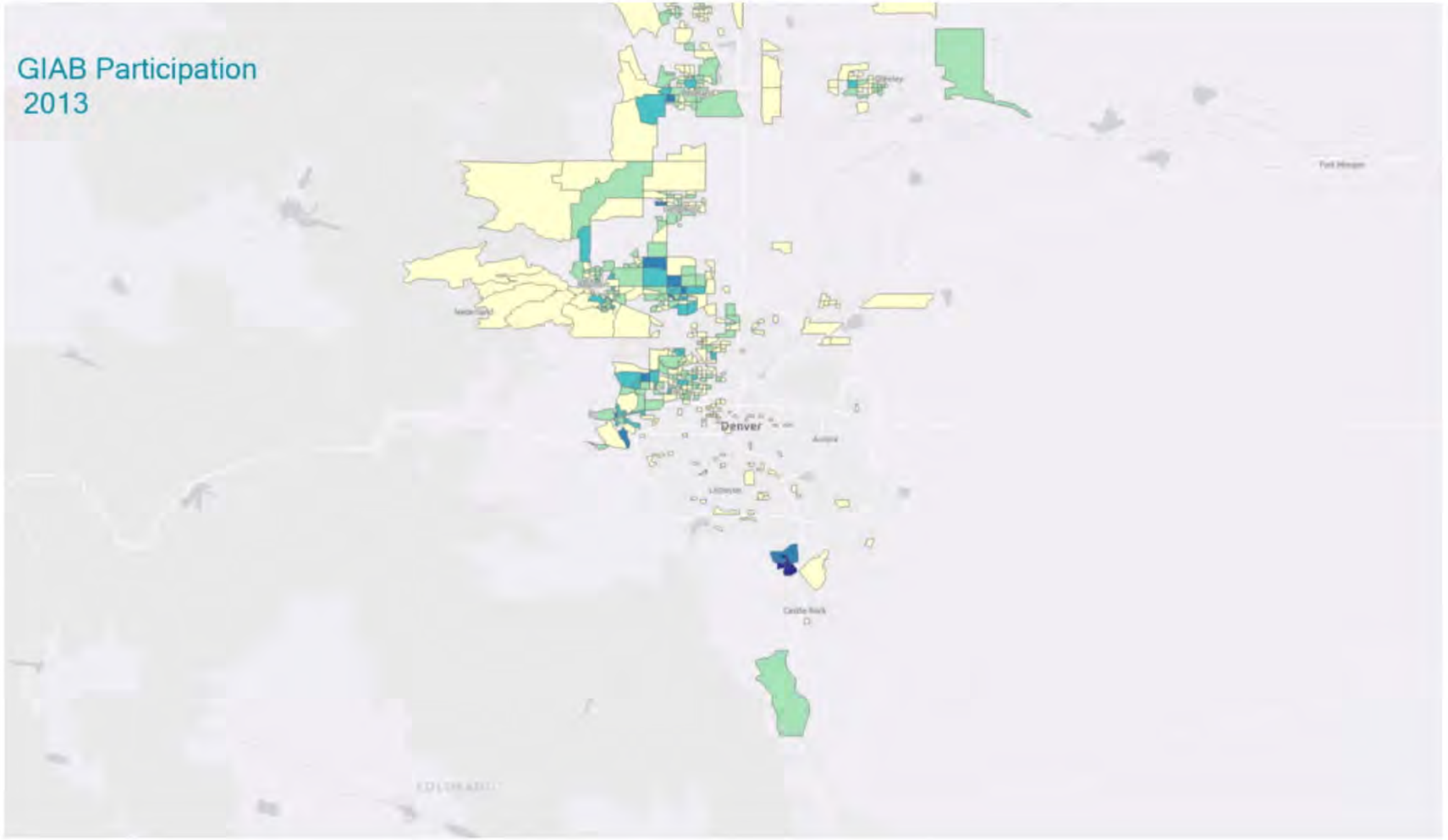
Community marketing

Community pickup event

Garden In A Box is Growing

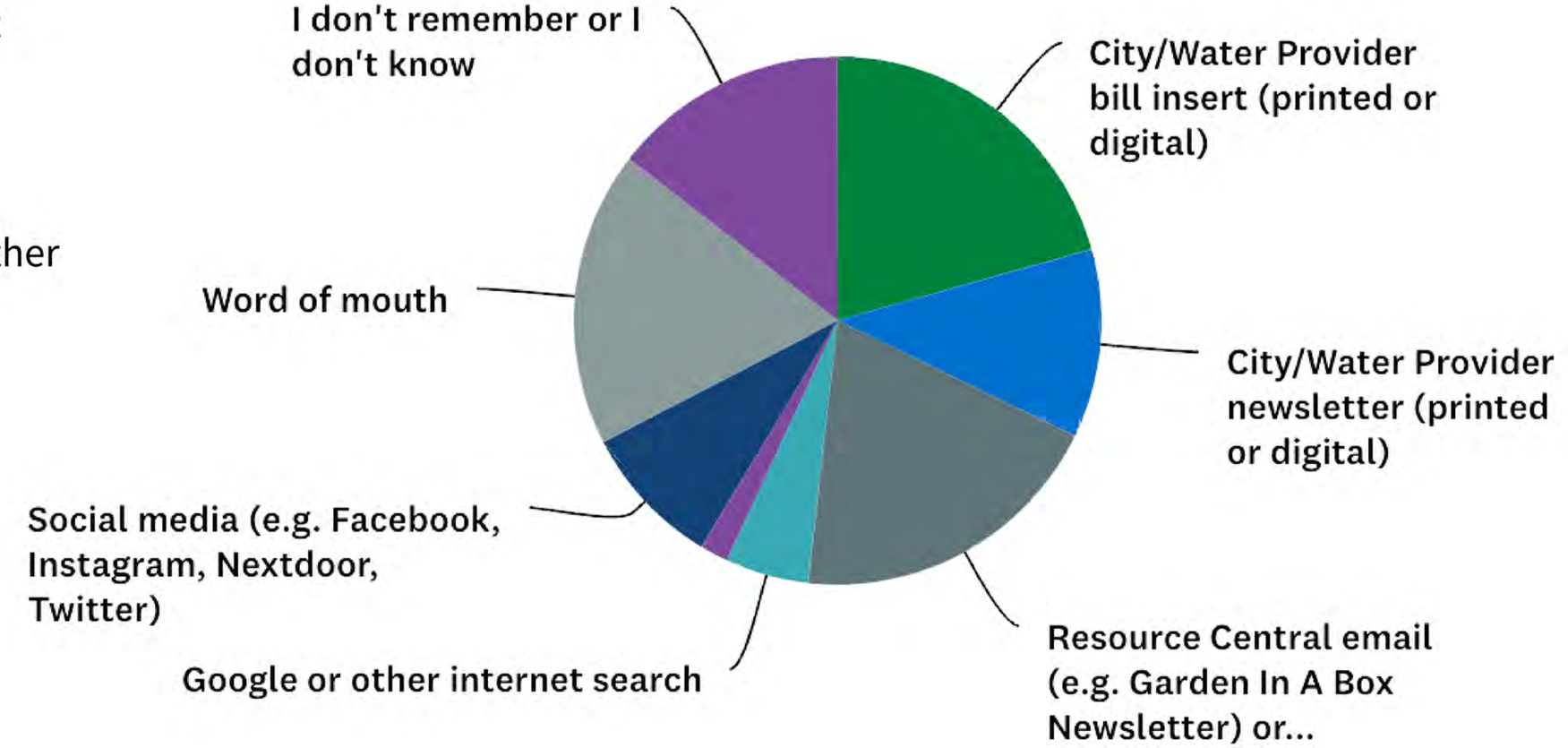
- Significant program reach in the past 20 years
- 2003: **39** participants
  2023: **7,746** participants
- **450%** Growth in late summer season since 2020

Participation Rate by Census Block Group from 2003, 2013, and 2023

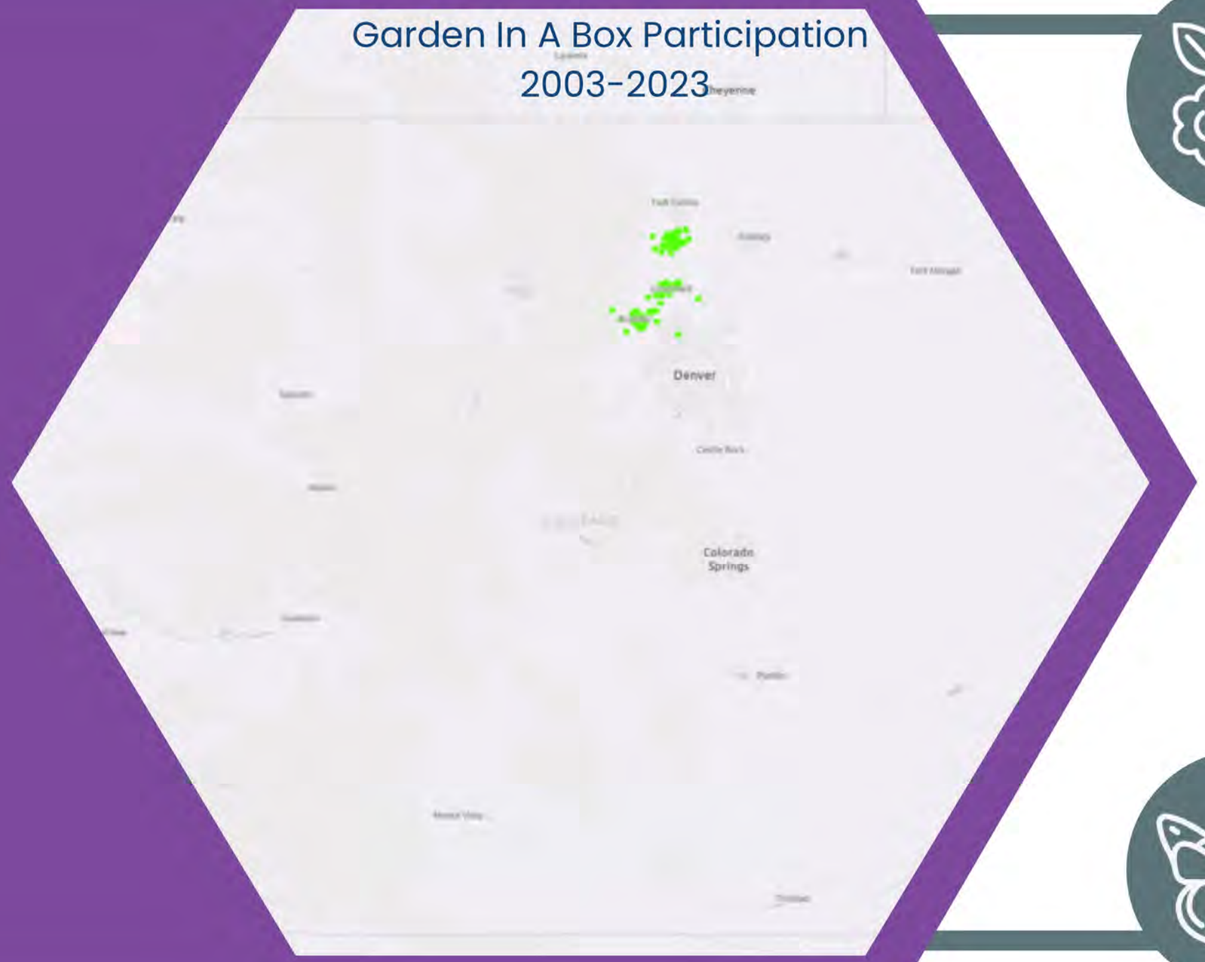


How Do People Hear About Garden In A Box

- City/water provider bill insert **21%**
- Resource Central emails or other program communication **20%**
- Word of mouth **18%**



Research Overview



Impact Analysis

- Quantitative analysis of water savings for program participants

Community Survey

- Qualitative analysis of program benefits, motivators, and barriers

Story Map & GIS

- Visual deliverable

Impact Analysis

"It's a win-win type of agreement. I get to help conserve water, plant Colorado native plants, and help the pollinators!"
-Garden In A Box Participant

RESOURCE central

CONSERVATION MADE EASY

Impact Analysis

Peer-Reviewed Methodology

- Adapted from Slow the Flow study (Shimbaku et.al. , 2016)
- Weather adjusted
- Worked with two expert consultants

Water Records 2017 - 2022

- 2018 - Year of Garden In A Box Purchase
- Includes 2020: pandemic; very hot, dry weather

Additional Factors

- Multiple garden purchases
- Repeat customers

Water Use Records 2017 - 2022

Data Request

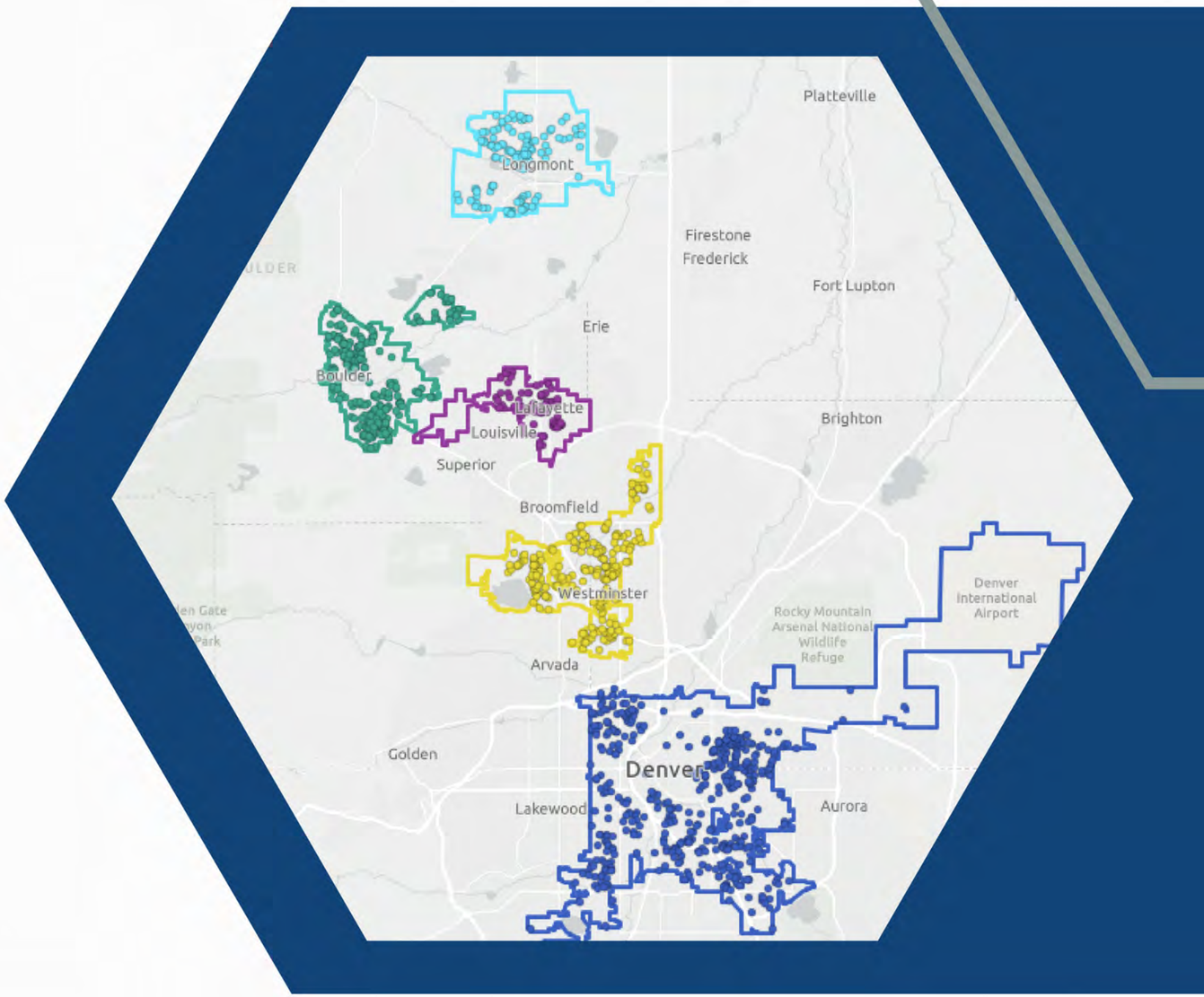
- **1,689** Participants in **6** cities

Data Received

- **1,275** Participants in **5** cities

Participating Cities

- Longmont
- Boulder
- Lafayette
- Westminster
- Denver



Impact: 5,000 Gallons/Year Water Savings

Sample Size

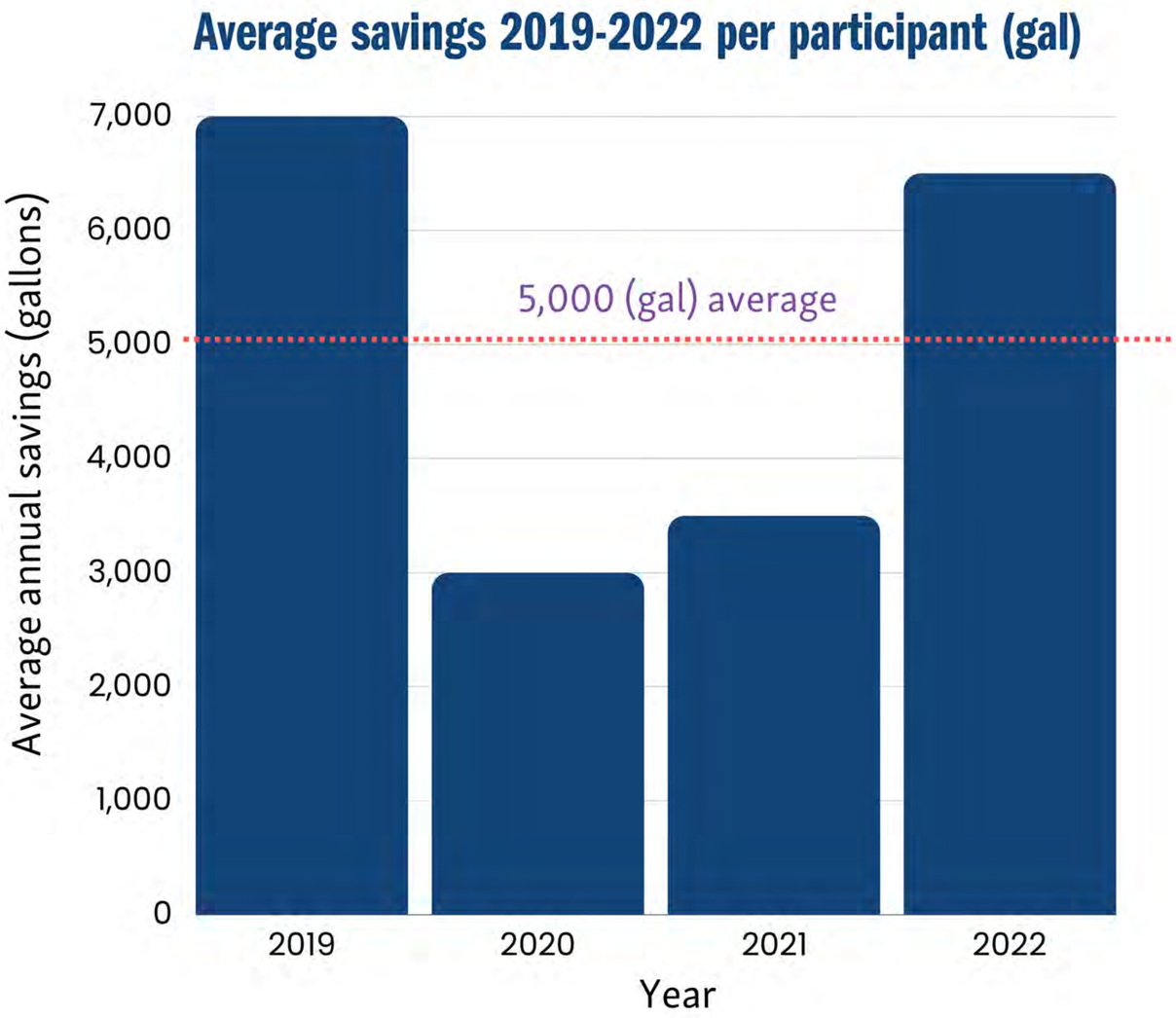
- **1,031** number of participants

Annual average savings

- **5,000** gallons per year

Considerations

- 2020 was an exceptionally hot and dry year
- COVID pandemic



Impact Analysis: Weather Data

Sample Size

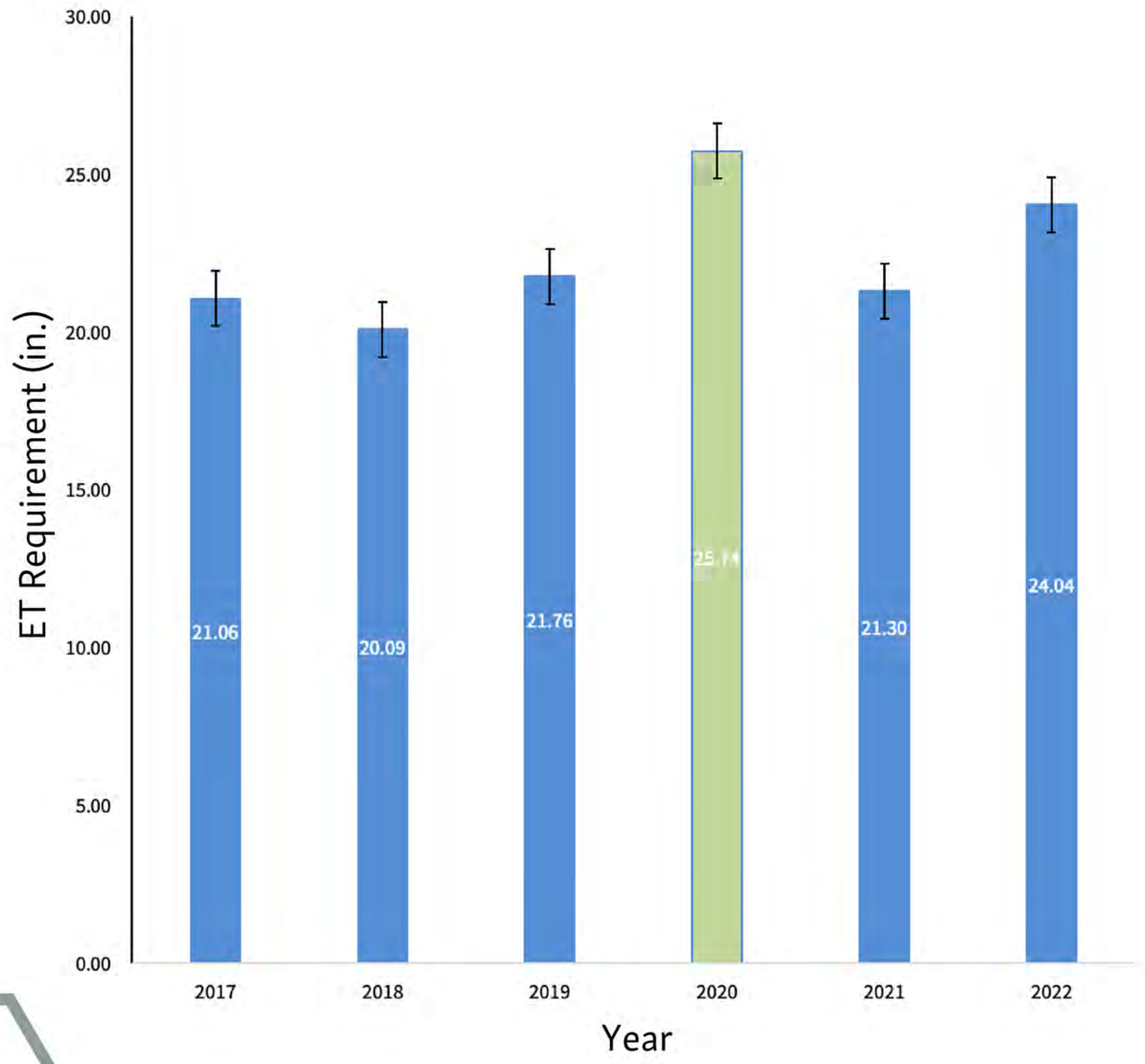
- **1,031** participants

Annual average savings

- **5,000** gallons per year

Considerations

- 2020 was an exceptionally hot and dry year
- COVID pandemic



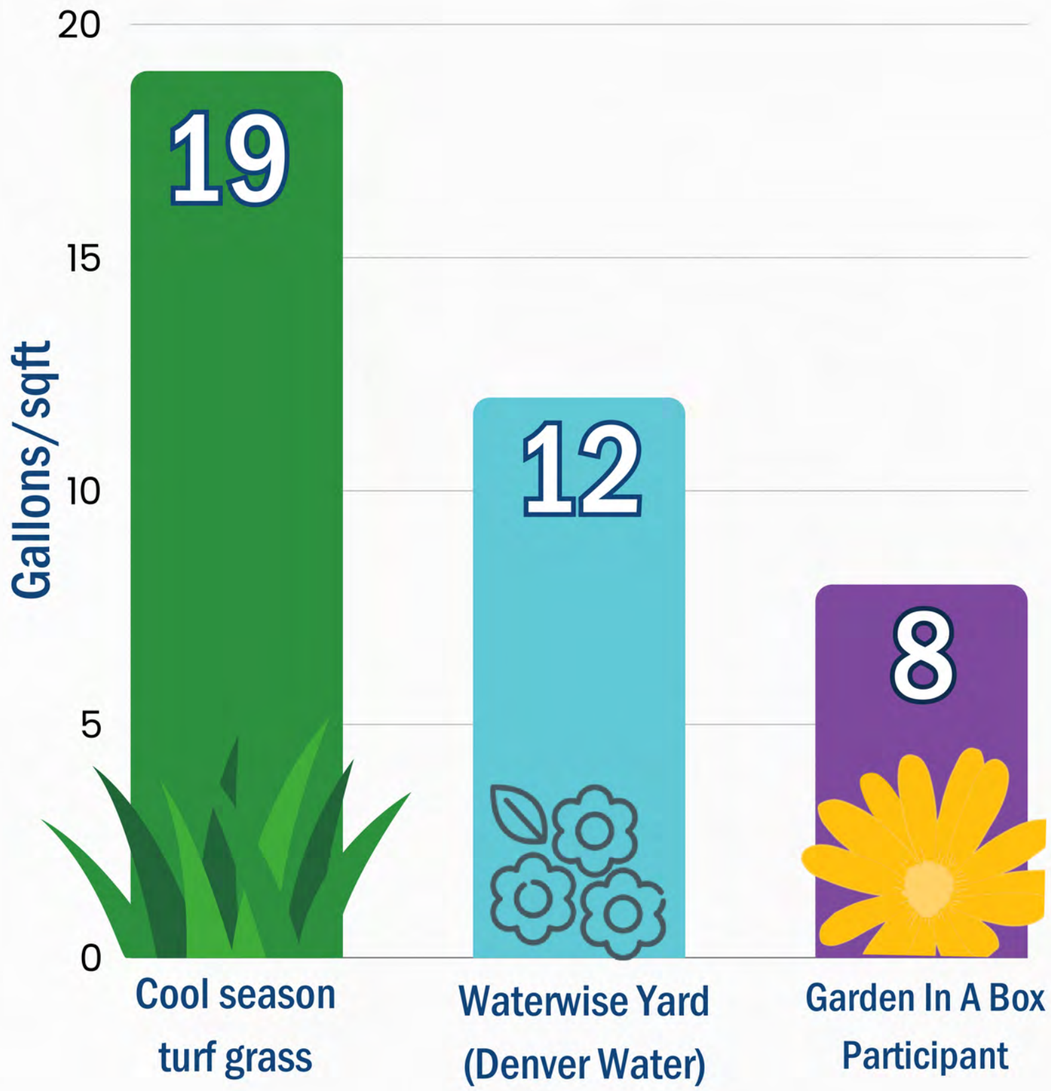
Garden In A Box is Leading the Way

Garden In A Box participants use:

- **8 gallons** per square foot per year

Estimated Savings

- **11 gallons/sqft** compared to turf grass



Multi-Year Participation

Multi-Year Participation

- Purchased a Garden In A Box in 2018 and more than one year during study period

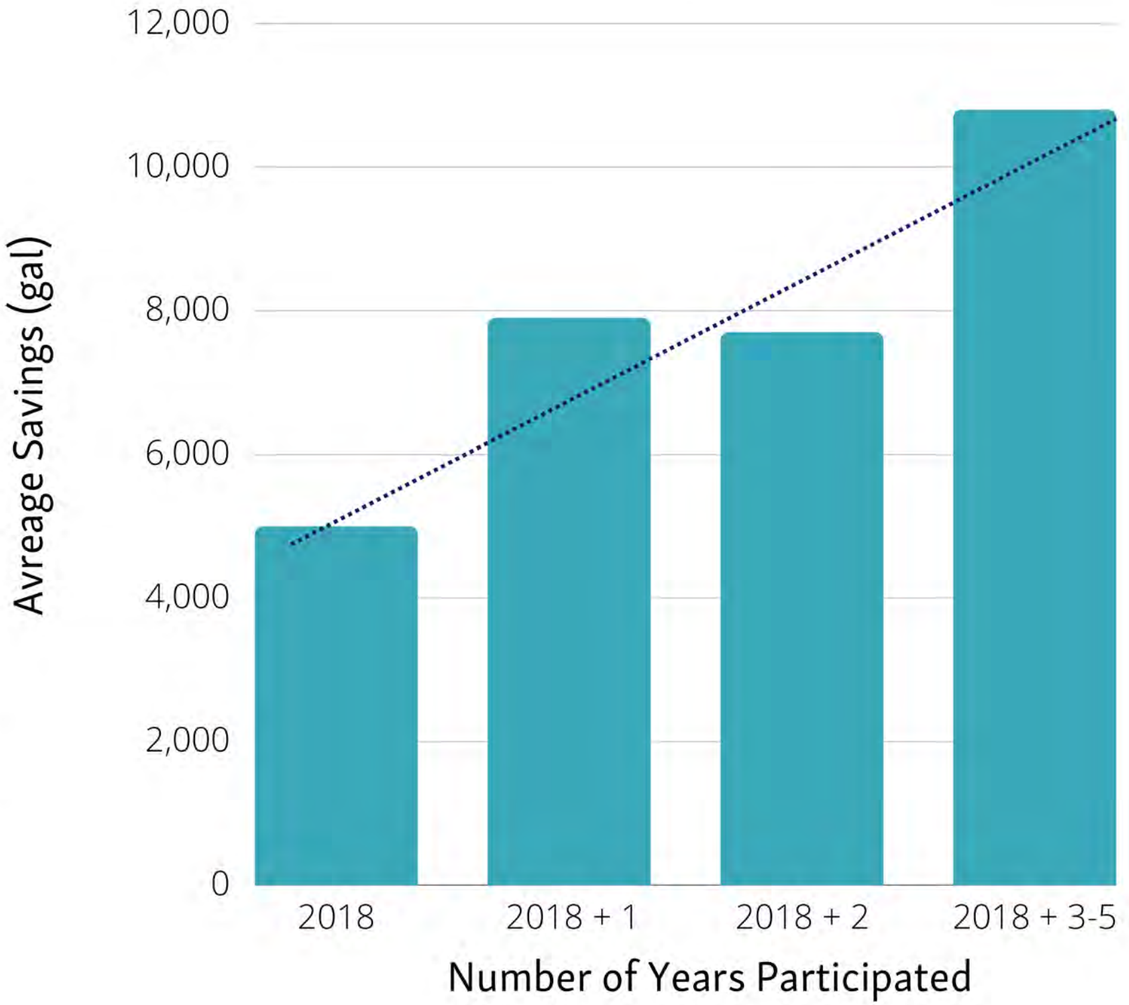
Sample Size

- **856** participants
- Excludes Boulder

Findings

- Trend shows higher water savings for multi-year participants
- Higher confidence in 2018 + 1 results, due to larger sample size (n=137)

Average Savings Per Participant (gal): Multi-Year Participation



Multi Garden Participation

Multi Garden Participation

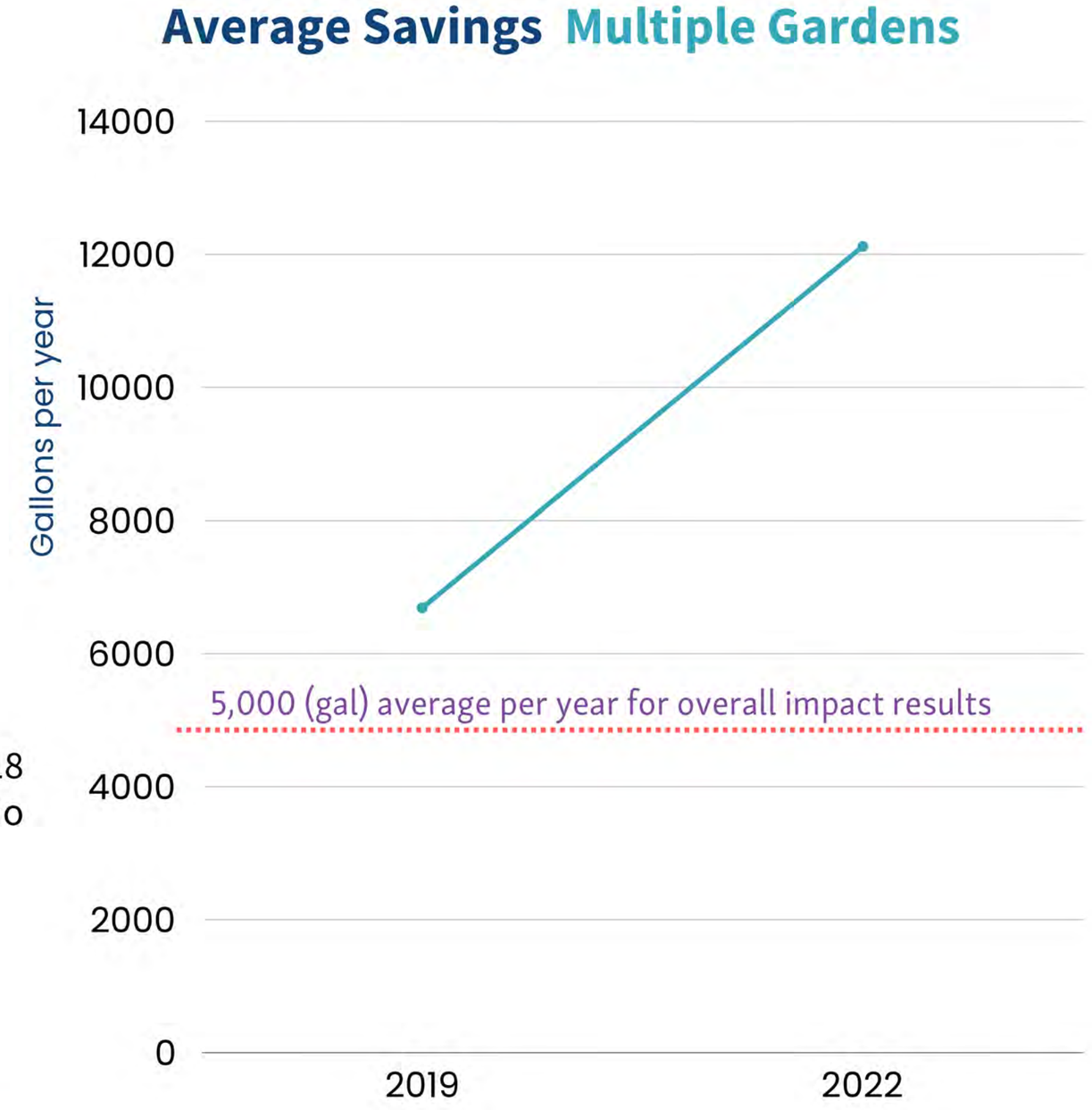
- Compared to those who purchased one Garden In A Box in 2018

Sample Size

- **856** number of participants
- Excludes Boulder

Findings

- Participants who purchased multiple gardens in 2018 saved more water on average in 2022 than those who purchased one garden



Impact Analysis Key Takeaways

Water Savings

- Garden In A Box participants save an average of **5,000 gallons per year**

Water Requirement

- Garden In A Box participants use an estimated **8 gallons** per square foot per year compared to **19 gallons** per square foot for cool season turf grass

Increased Savings

- Multi-year participants
- Participants who purchased more than one garden

Community Survey

"A benefit of Garden In A Box is that it gets people in conversation about saving water and planting pollinator habitat and that effect has a positive impact on an ecosystem."
-Andrea Montoya of Pollinator Advocate Program

Survey Methods

Software/Sharing

- SurveyMonkey
- Shared via link and email
- Resource Central community & water conservation partners

Split Respondent Groups

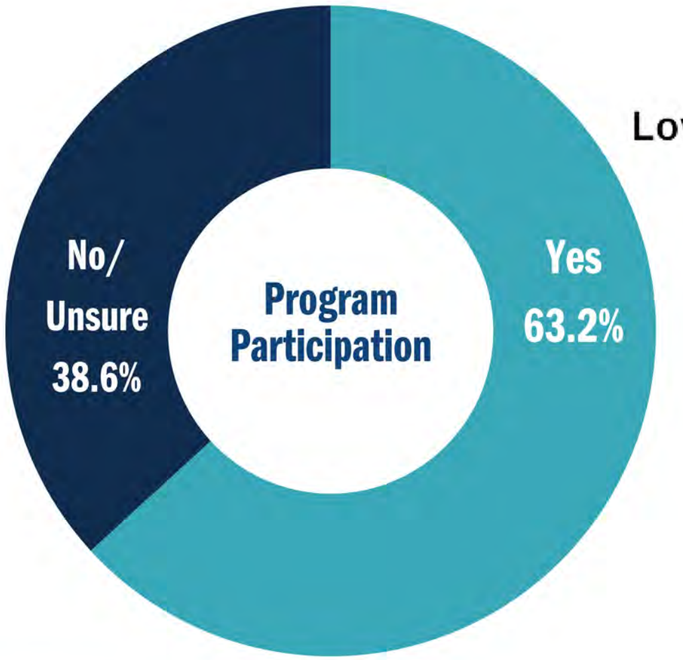
- Program participants
- Non-participants

Purpose

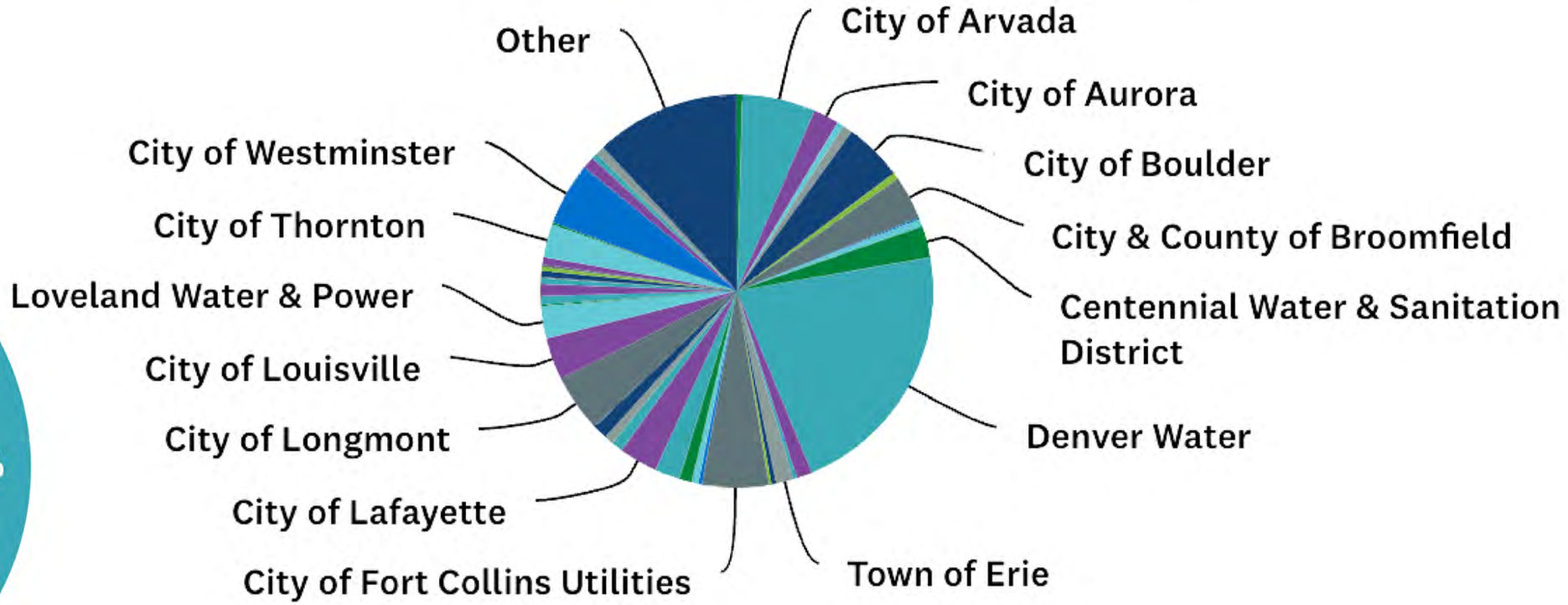
- Attitudes & beliefs on landscapes
- Perceptions & opinions on program

Survey Breakdown

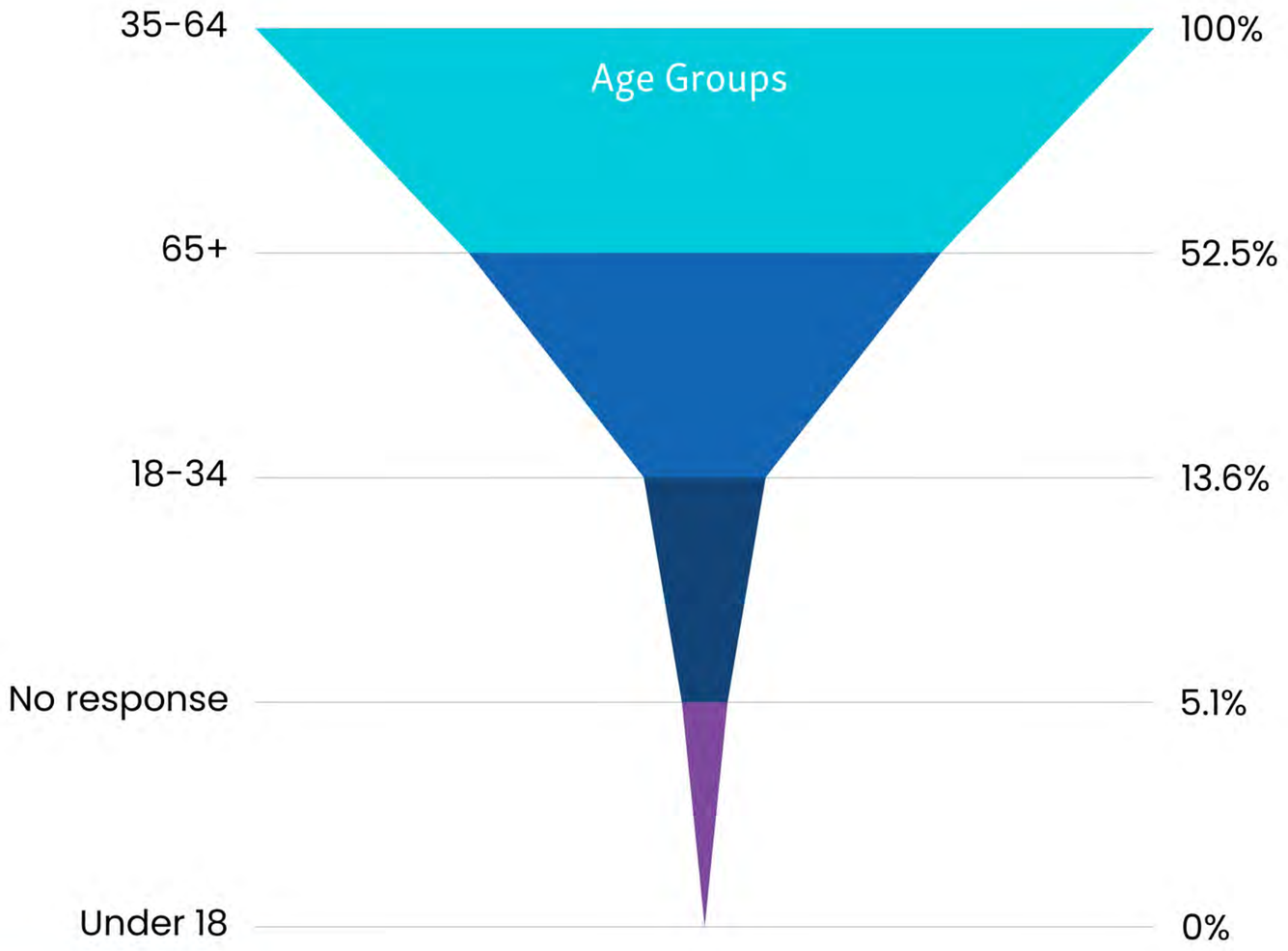
2,938 Responses

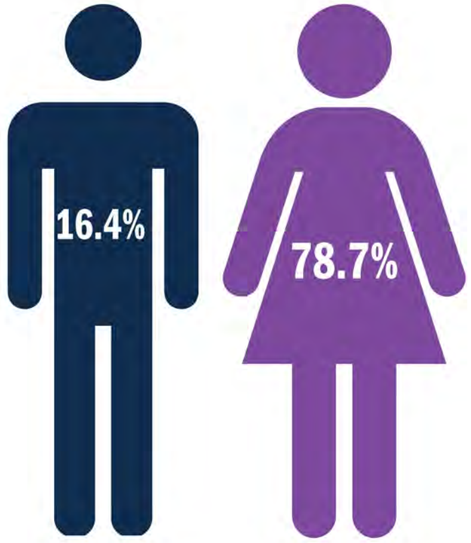


Responses by Water Conservation Partners

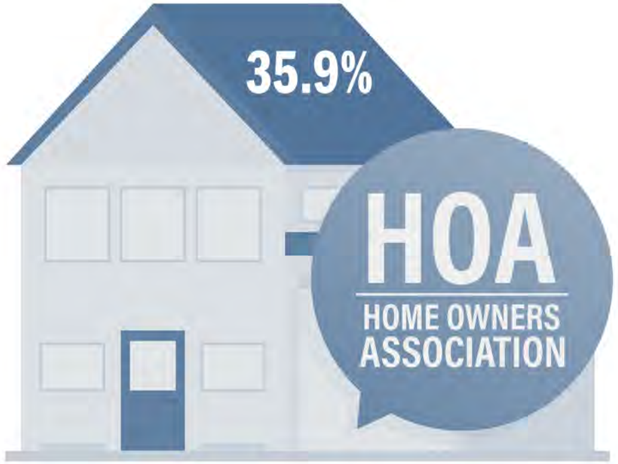


Survey Breakdown - Demographics





4.79%
Non-Binary/ Prefer not to respond



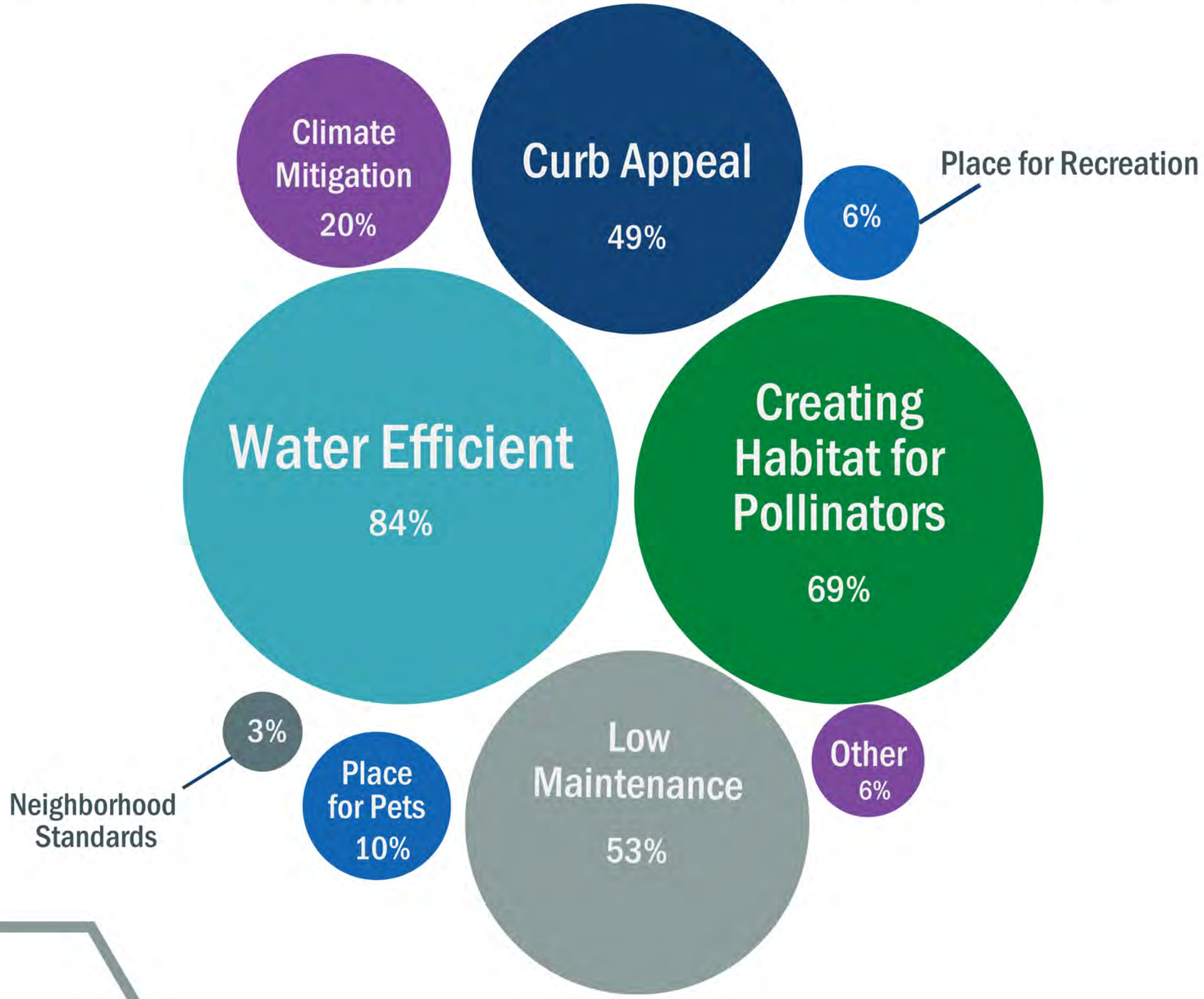
Overall Results - Landscape Values

How important is your landscape to you?

Top 3 landscape considerations:

- Water Efficient
- Creating Habitat for Pollinators
- Low Maintenance

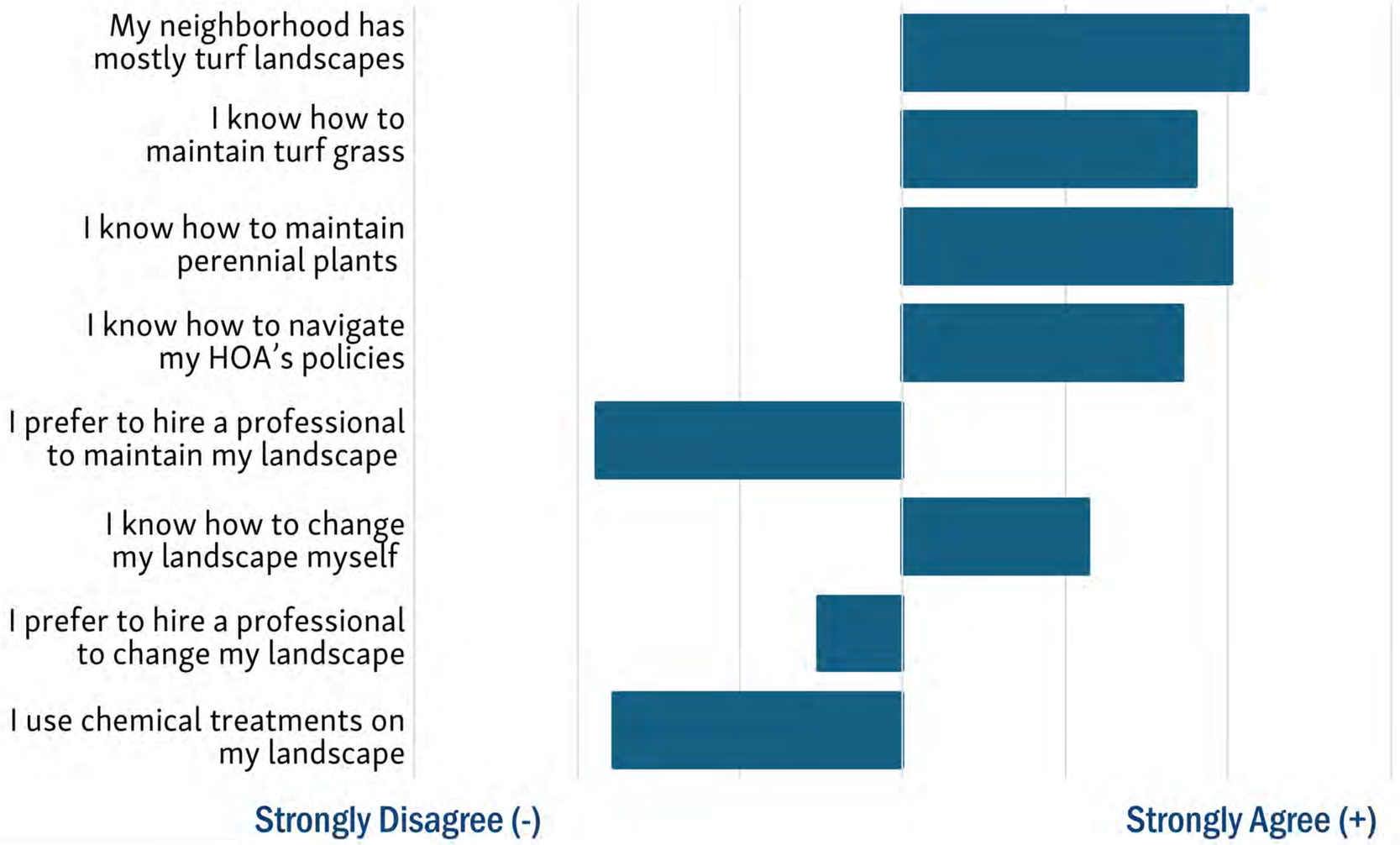
Most important categories when considering your landscape



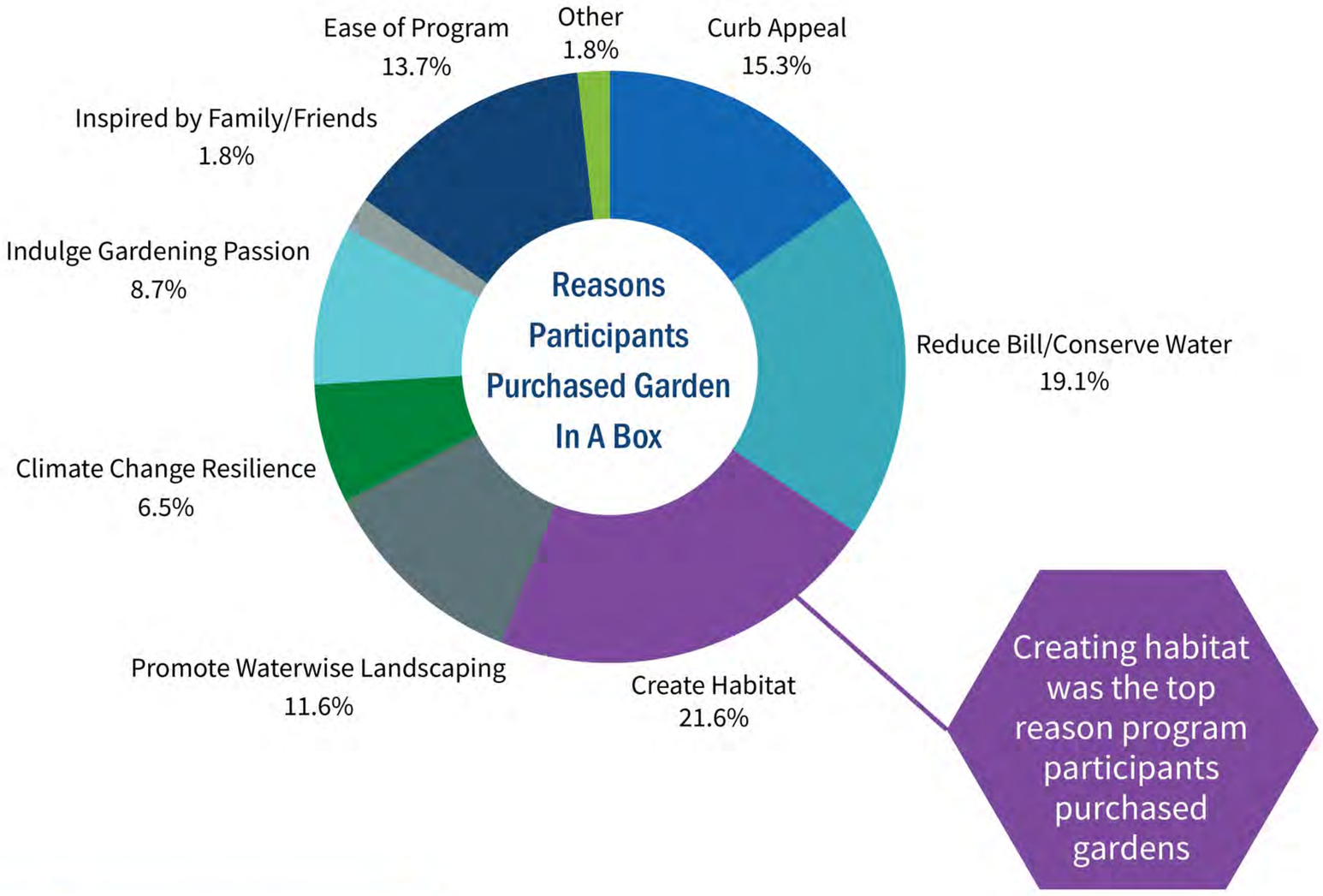
Overall Results - Landscape Opinions

Key Takeaways

- Most respondents do not use chemical treatments on their landscapes
- Most preferred to remove, change, or maintain their landscape themselves



Program Participation Results



Creating habitat was the top reason program participants purchased gardens

99%

Participants likely to recommend Garden In A Box

96%

Non-program participants who would consider participating in the future

RESOURCE central

Participants vs. Non-Participants

1,066 Non-Participant respondents

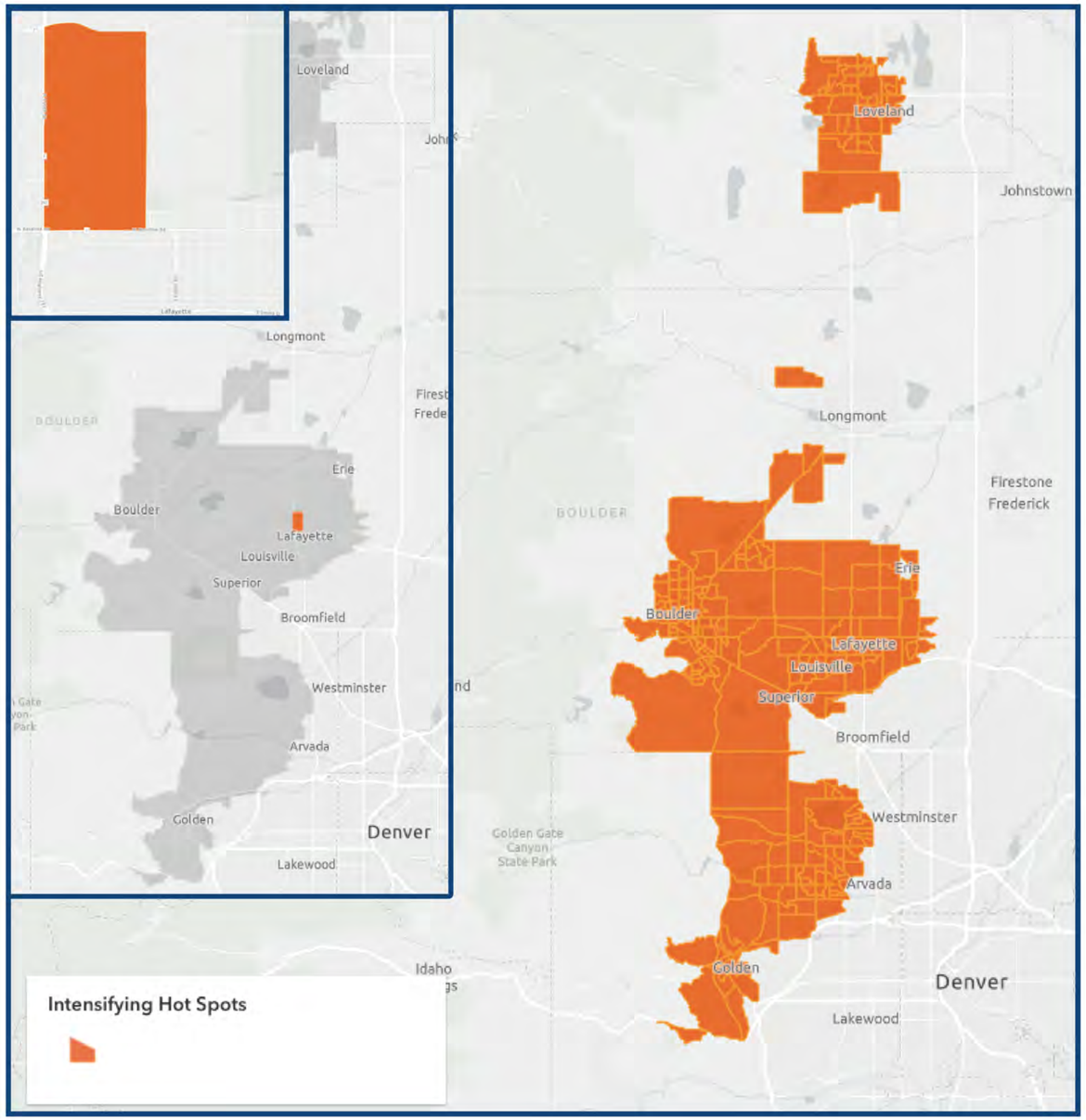
90% of Non-Participants have heard of Garden In A Box

96% would consider participating

Top reasons non-participants would consider participating

Participants of the Future

- Early adopters
- Focus on convenience when shopping
- Young families and rising population

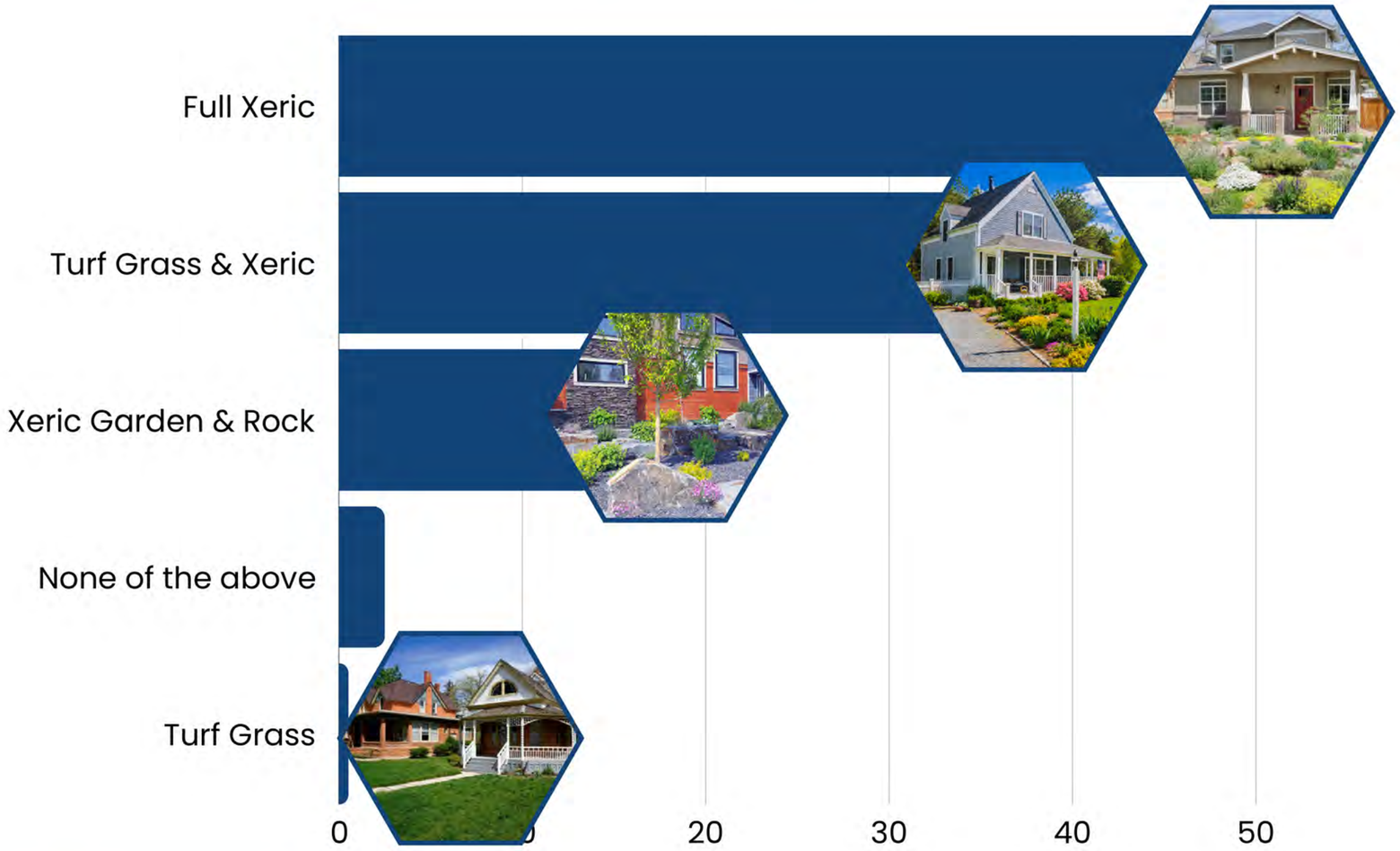


Landscape Preferences

"I am a huge Garden In A Box advocate. The suggested planting maps have been a lifesaver!"

-Garden In A Box Participant

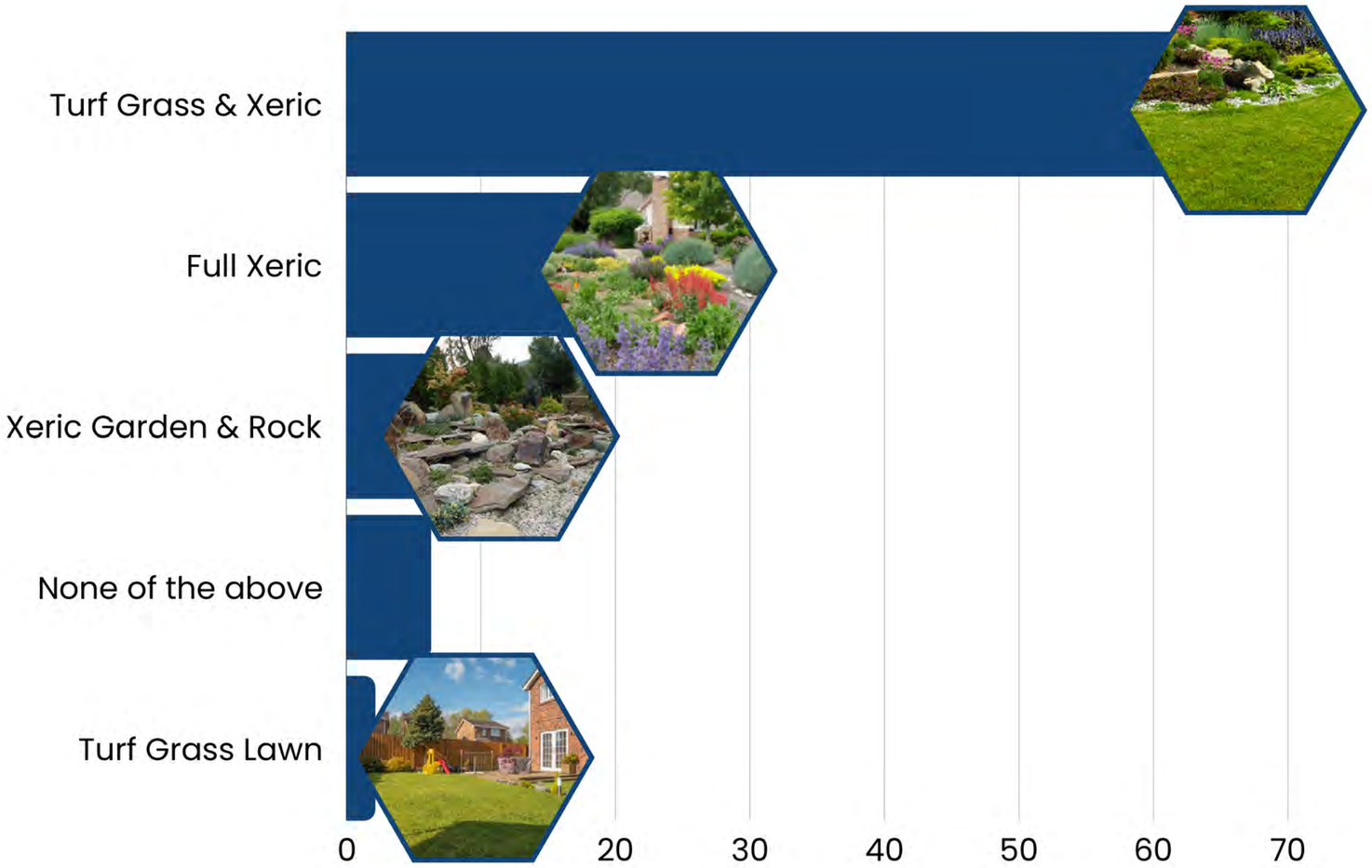
Preferred Front Yard Landscape: All Respondents



Key Takeaways

- Overall, a full xeric plant landscape is preferred for the front yard
- 18 - 34-year-olds prefer a fully xeric plant front yard more than any other age group
- 65+ and HOA survey respondents prefer turf grass & xeric plant combination

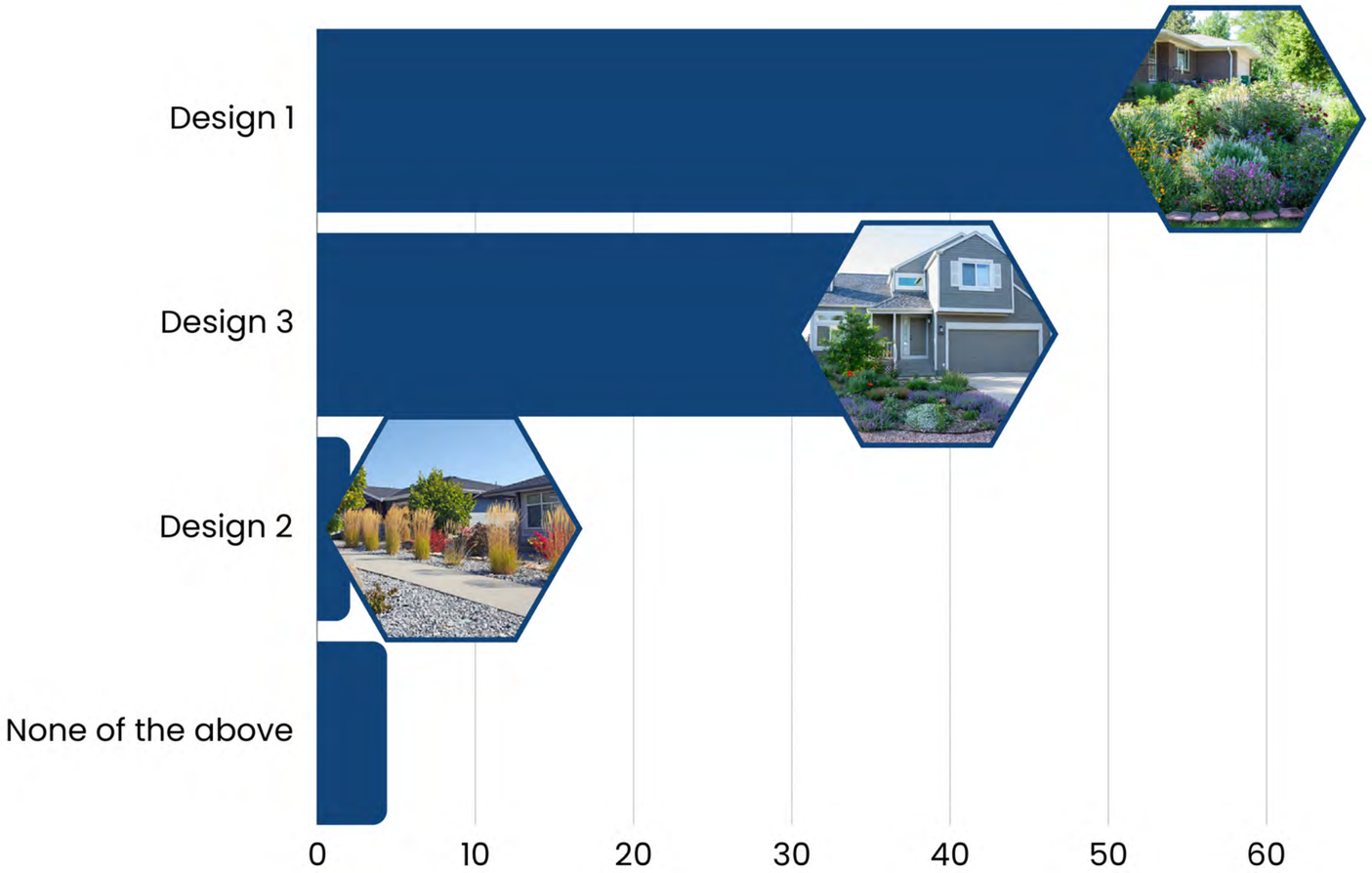
Preferred Back Yard Landscape: All Respondents



Key Takeaways

- Overall turf grass & xeric plant combination landscape is preferred for the back yard by all respondents
- Some turf is still desired for the backyard, but not an entire turf grass lawn

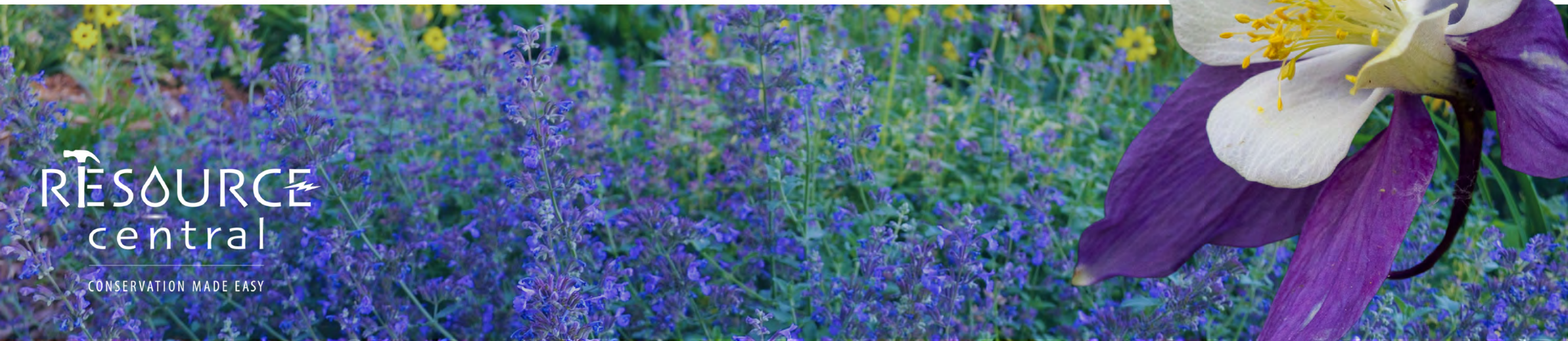
Preferred Xeric Landscape Design: All Respondents



Key Takeaways

- The fully xeric plant landscape design was preferred by all respondents
- Landscape design 3 was significantly preferred by members of HOAs and respondents 65+

Key Takeaways



“This program inspired my gardening passion! It made gardening accessible and gave me a place to start!”

-Garden In A Box Participant

RESOURCE central

CONSERVATION MADE EASY

Key Takeaway: Garden In A Box Participants Save Water

- Average of 5,000 gallons saved per participant per year
- Garden In A Box participants use an average of 8 gallons/sqft per year (versus 19 gallon sqft/year for turf grass)
- Informs water conservation statewide

> Garden In A Box is an invaluable program that teaches homeowners about conservation!
>
> -Garden In A Box Participant

Key Takeaway: Garden In A Box is Good for the Environment

- Reduces outdoor water use
- Creates pollinator pathways
- Contributes to lower chemical use for landscapes

> People come to me not just looking for a pretty garden but they're also looking for an action that they can take to feel empowered about the environment. So I say, start with Garden In A Box. It makes it simple for these folks to be activists in not only their own lives but their broader communities.
>
> -Andrea Montoya of Pollinator Advocates

Key Takeaway: Survey Shows that People Love Garden In A Box

- Aligns with people's values
- Significant program growth over time
- Garden In A Box is the catalyst that starts people on their water conservation journey

"I recommend Garden In A Box at any and every opportunity given!"

-Garden In A Box Participant

Thank you!

Colorado Water Conservation Board

Peter Mayer - Water Demand Management

Austin Troy - University of Colorado Denver

Kate Larson - Director of Water & Energy at Resource Central

Andrea Montoya - Pollinator Advocates

Stay tuned for our story map!

Works Cited

Shimabuku, M., Stellar, D., & Mayer, P. (2016). Impact evaluation of residential irrigation audits on water conservation in Colorado. Journal-American Water Works Association, 108(5), E299-E309.

DeOreo, W. B., Mayer, P. W., Dziegielewski, B., & Kiefer, J. (2016). Residential End Uses of Water, Version 2 : Executive Report. Water Research Foundation .

BBC Research & Consulting. (2024). Updated 2024 Exploratory Analysis of Potential Water Savings, Costs and Benefits of Turf Replacement in Colorado. www.bbcresearch.com

Kirk, Jessica. Tap. (2019). How Much Water Does Your Landscape Actually Need, Summer Water use reports help customers understand how efficient they are with outdoor watering. www.denverwater.org

Attachment 1
Landscape Change Program Impact Analysis: Task 3 Progress Report
June 2024

Project Summary

The objective of the Landscape Change Program Impact Analysis project is to evaluate community benefits and quantify the impact of our water conservation programs, namely the Garden In A Box and Lawn Replacement programs, using established best practices, expert advice, and background research. The results of this analysis will be delivered to our water provider partners and greater community and will allow Resource Central to make informed decisions on how to refine and adapt our programs to meet the goal of making Waterwise Landscapes the new norm in Colorado. The first of its kind, we believe that this study will serve as a resource and example for communities nationwide who are interested in landscape change programs similar to the Garden In A Box and Lawn Replacement Programs.

Task 1 Summary and Findings (January 2023 - April 2023)

Task 1 can be found in Resource Central's June 2023 Update.

Task 2 Summary and Findings (May 2023 - December 2023)

Task 2 can be found in Resource Central's December 2023 Update.

Task 3 Summary and Findings (January 2024 - June 2024)

The goal of Task 3 is to compile the results of the study into a report, StoryMap, and presentation regarding the impacts of Resource Central's landscape change programs. These deliverables will be shared with CWCB, our partners, our wider community, and presented at conferences.

Peter Mayer, P.E., Principal of WaterDM, met regularly with the Resource Central Research Team, Melanie Stolp and Katie Butler, to discuss the analysis of the Garden In A Box program. Peter is the senior technical advisor for the project. In task 3 Peter helped refine the presentation information and key analysis takeaways.Peter has also served as a quality assurance and quality control reviewer for the entire project.

Austin Troy, Ph.D Professor at CU Denver, met with Katie and Melanie regularly to advise on GIS analysis and methods and provide guidance on the story map creation.

From January through June 2024, the team focused on analyzing and organizing our results from the Impact Analysis, survey, and GIS analyses and synthesized them into a presentation, report, and StoryMap. For more information on the StoryMap, please refer to Attachment 3.

The results were then presented to the Resource Central Board of Directors and at a partner appreciation event hosted by Resource Central.

Future Presentations

The team has been accepted to present at the following conferences:

- Water Efficiency & Conservation Symposium, August 6-8, Chicago, IL
- Rocky Mountain Water Conference, August 25-28, Keystone, CO
- WaterSmart Innovations Conference, September 24-26, Las Vegas, NV

Project Completion

Upon concluding Task 3: Reports and Communication, our results have been compiled and presented to internal and external stakeholders. These results will further be communicated through a detailed written report and at various conferences. We have also created a standalone StoryMap that will be hosted by ArcOnline to further engage stakeholders and community members, and which can be updated as needed.

Potential Need for Revisions to SOW and Timelines

The project has been completed within the given timeframe.

Attachment 3 - Story Map

Our primary deliverable for this project was to create an infographic of the results to share with partners and community members to help them better understand the potential impacts that programs such as Garden In A Box can have for them directly, as well as for our community and planet. Upon working with our GIS consultant, the team decided that using an interactive ArcGIS story map would be the best platform to illustrate our findings. A story map is a web map that has been created with context and supporting information making it a stand alone resource. The story map is hosted live on ArcOnline, and will remain an active and up to date resource to share with our community.

Access the digital story map HERE

Research Report

Introduction

Landscape transformation is becoming an increasingly important tool to conserve water in urban environments. In Colorado, communities, decision-makers, and conservation professionals have been looking to landscape transformation as a long-term solution to water shortages. Colorado state policies such as HB22-1151: Turf Replacement Program Bill have increased the need for research focused on landscape transformation programs.

Resource Central, a non-profit organization based in Boulder, Colorado focuses on making conservation easy and is well situated to help make waterwise yards the new norm in Colorado. Resource Central operates the most popular and one of the longest-running water conservation programs in Colorado, Garden In A Box, which has distributed over 69,000 waterwise garden kits over its 21 years in operation. The program makes landscape transformations easy by offering professionally designed, waterwise, perennial garden kits tailor-made for Colorado yards.

It is important to understand the impacts of landscape transformation programs like Garden In A Box, not only in terms of water savings, but also in the other ways these programs can provide benefits to the community. By removing turf grass and replacing it with climate adapted landscapes, communities can save water, and take advantage of the additional benefits these landscapes provide. These benefits include creating habitat for pollinators and other wildlife, reducing the need for chemical treatments, helping with climate and soil mitigation, and providing appealing and unique climate adapted yards that add more interest and variety to the urban landscape.

With grant funding from the Colorado Water Conservation Board, Resource Central has been investigating its flagship Garden In A Box program to answer the questions:

1. Does Garden In A Box save water?
2. What does a typical Garden In A Box customer look like, and what are their opinions, preferences, and values when it comes to landscapes?
3. What other benefits (if any) does Garden In A Box provide?

To answer these questions, Resource Central reviewed literature related to landscape transformation programs and outdoor water usage, and adapted a peer-reviewed methodology (Shimabuku, M., Stellar, D., & Mayer, P., 2016) from their Slow the Flow program to analyze 2018 program participant's water records from five cities for the years 2017-2022. They also developed and conducted a survey to identify program participant's and non-participant's views and values when it comes to their landscapes and landscape preferences, and performed GIS analyses to examine how and where program participation has changed over time.

Literature Review

The articles that were analyzed for this study included a wide variety of sources, from reports to peer-reviewed journal articles. Reports and articles provided solid background on landscape transformation and water research and gave insights on possible avenues for the study and methods to utilize. These studies vary in complexity and methods used, but a few themes stood out.

General Background/Outdoor Water Use

Two studies were helpful guides by providing a broad overview of water consumption in the developed world (Sauri, 2013) and a review of the literature on residential water demand (Arbues et al., 2003). Sauri examined programs and policies that may contribute to decreased water consumption in urban areas. The author found that while no single strategy is better than another, important considerations for decreasing water use include the layout of the urban environment, water prices and taxes (and the equity issues related to pricing), and how conservation behavior may or may not be influenced by beliefs and values. While water consumption in urban areas per capita is declining (pg 228), partly due to conservation strategies, other factors need to be taken into account such as demographic, economic, and environmental changes when developing these strategies.

Sauri also found that “long-term success of conservation campaigns appears to be linked to previously experienced instances of water stress.” (pg. 241) Colorado experiences water stress and watering restrictions/limits on outdoor use are common in much of the state (Kenney, 2004). This highlights the importance of water conservation programs in Colorado and may factor into why programs like Garden In A Box have been successful. Arbues et al. (2003) examined important variables to consider when looking at residential water consumption, such as water price, income, and household composition.

The theme of irrigation efficiency (proper system installation, maintenance, and operation) was particularly prevalent and was often cited when it came to residential water use and savings (Barnett et al., 2020, Endter-Wada et al., 2008, Saher et al., 2022, St Hilaire et al., 2008).

St Hilaire et al., (2008) “Summarized how irrigation and water application technologies; landscape design and management strategies; the relationship among people, plants, and the urban landscape; the reuse of water resources; economic and noneconomic incentives; and policy and ordinances impact the efficient use of water in the urban landscape.” (pg. 2081)

Barnett et al. (2020) assessed the impacts of the agency of individuals and structural factors affecting water use in Northern Utah. They used residential water use records and census data to determine lawn watering systems and structural factors, such as age, homeownership, lot size, and outdoor irrigation infrastructure were important in explaining variation in outdoor water use. They found structural factors “eclipsed individual agency” (pg. 1) in their particular analysis.

Another important factor to consider when it comes to outdoor water use is the weather and its effect on outdoor water use (Breyer & Chang, 2014, Endter-Wada et al., 2008). Breyer & Chang (2014) examined the responses of daily water use to daily weather fluctuations over 29 years in Portland, OR. They found a shift in use due to drought conditions, and changes in building codes/densification (less yard space) were all factors that could contribute to changed outdoor water use.

Other interesting themes that emerged throughout the literature were that high-use consumers have more room for savings and should be the focus of conservation programs (Brent et al., 2015, DeOreo et al., 2016, Endter-Wada et al., 2008, Wang & Chermak, 2021). Additionally, landscape transformation programs can have a spillover effect (Brelsford & De Bacco, 2018, Champine et al., 2022, and Torpey, 2017). The spillover effect is where an individual or household may be more likely to perform a behavior if another household or individual who is influential (important opinion or geospatially close) performs that behavior. In this case transforming their landscape.

These studies give important background on what literature is out there, and the factors that may be important to consider when performing research on residential outdoor water use.

Landscape Transformation

Studies on landscape transformation were particularly relevant to this research (A&N Technical, 2018, Brelsford & Abbott, 2021, Koch et al., 2022, Sovocool, 2005, Tull et al., 2016).

A & N (2018) evaluated 14 landscape transformation programs and found detectable water savings for turf conversion and landscape transformation without incentives, the magnitude of savings was related to pre-participation water use, and that savings slowly increased over time as plants established.

Brelsford & Abbott (2021) analyzed the Southern Nevada Water Authority “Cash for Grass” program to investigate how much water the program conserved overall, if it was cost-effective, and if it produced long-term savings. They found, “that the water savings generated by the WSL program were significant throughout the year, albeit 34% less overall than previous engineering estimates. These effects were long-lasting – with no erosion of conservation benefits up to a decade after the initial landscape change” (pg. 2).

Koch et al. (2022) focused on how, “replacing turf at large scale is a proven water supply, drought, and climate resilience strategy” (pg. 11). The authors identified financing mechanisms from existing programs and found a potential for large saving impacts. They argue that these programs can be viewed as long term water supply investments.

Sovocool's (2005) report covered water savings from the Southern Nevada Water Authority Xeriscape Conversion Program. The authors compared xeriscape, turf, and a control group landscape with data collected during site visits and sub-meter measurements. They found that xeriscape conversions can save water at single family residences. Household consumption drops immediately then stabilizes when converting to xeric (pg. 60), xeric water application remained below evapotranspiration (ET) year- round (compared to turf ET), and those who converted to xeric had lower maintenance time/costs and a decreased water bill.

Tull et al. (2016) analyzed residential turf rebates across three California water utilities to estimate the water savings from 635,713 square feet of converted turf grass. They found "mean predicted savings for single-family residential accounts are estimated at 24.6 gallons per square foot per year for the households used in this study" (pg.1).

These studies demonstrate how a variety of landscape transformation programs save water.

Perceptions/Behaviors/Attitudes

Studies that examine perceptions, behaviors, and attitudes related to landscapes and how that may influence conservation behaviors were of particular interest. Some studies looked at the legacy effects of the built environment and other structural formations and how they can constrain water conserving behaviors (Barnett et al., 2020, Brelsford & Abbott, 2017, Larson et al., 2017, 2020), as well as people's willingness to change behavior. Studies that looked at social norms and network influences on conservation behavior noted the difficulty in determining how humans will behave versus how they intend to behave know as intention-behavior gap (Brent et al., 2015, Champine et al., 2022, Gillis & Swim, 2020, Warner, 2021, Saurí, 2013). An interesting finding pointed to the influence of neighborhood norms and the perception of neighbors are influential in how people conserve and present their landscapes (Andrade et al., 2021, Brelsford & De Bacco, 2018, Gillis & Swim, 2020, Neel et al., 2014, Warner, 2021).

An investigation into how landscape preferences impact satisfaction with the environmental quality of neighborhoods and the decisions people make regarding their landscapes in Phoenix, AZ by Andrade et al. (2021) found a preference for xeric landscaping associated with newer development outside of the city-center, higher incomes, and home ownership. These factors are also associated with more intense landscape management practices. They highlight the importance of education, attitudes, and values to encourage behavior change.

Champine et al. (2022) studied the influence of diffusion behaviors (informal, persuasive engagement with social networks) and how they influence pro-environmental behaviors, in this case native plant gardening. "This finding reveals that participants with a higher sense of self-efficacy, or belief that they can reach out to others about native plants, and participants who feel they have more knowledge about native plants, were more likely to follow through on their diffusion intention and influence someone else to use the coupon they shared." They do note

there may be some bias since the sample was taken from “highly-motivated environmentally active” people in Fort Collins, CO.

Two studies looked at attitudes regarding landscape type and adding native plants with an additional factor of preference for front yard landscape versus backyard landscape. Gillis et al. (2020), examined “how social pressures and personal attitudes influence sustainable land use” (i.e. adding native plants). They found an overall positive attitude toward native plants. Participants seemed more willing to plant natives in their backyards and felt stronger social pressure to conform in how they presented their front yards. The authors noted they used “convenience” samples due to access and as participants had indicated an interest/knowledge in native plants. Larson et al. (2017) explored residents of Phoenix preferred and actual landscapes between mesic, xeric, and oasis and preferences between front and back yards. Looked at legacy factors including residents’ tenure of residency and age of housing. The authors found longer-term residents with older houses preferred, and were more likely to have, mesic landscapes. While newer houses and shorter-term residents have and prefer xeric landscapes.

These studies give background on behavior, values, and perceptions related to landscapes and can provide guidance on what questions to ask and how to structure a community survey.

Methods to Use

Many studies espoused the value of looking at water conservation programs from an interdisciplinary perspective (Andrade et al., 2021, Arbués et al., 2003, Barnett et al., 2020, DeOreo et al., 2016, Diringer & Shimabuku, 2021, Endter-Wada et al., 2008, Saurí, 2013, Western Resource Advocates and Waternow Alliance, 2022).

These studies used a wide variety of data sets and methods. Data used included billing data, weather and climate data, water use records, parcel and census data, landscape square footage, water rates, water budgets, responses from questionnaires/surveys/interviews, GIS, and remote sensing imagery. The samples varied from random to very targeted. There were a variety of longitudinal studies, cross-sectional studies, and panel data sets. The statistical methods varied widely, summary statistics, variety of regression analyses, and t-tests to name a few. Data were analyzed in R, SPSS, SAS and other programs.

Challenges

A few studies challenged the impacts of water conservation programs, particularly turf removal and replacement with low water gardens. Addink, 2005; Andrade et al., 2021; Barnett et al., 2020 found that the presence of low water use plants doesn’t necessarily mean low water use and touted the benefits of irrigation efficiency. Others noted the issues surrounding urban heat

island effects (Saher et al., 2022), and issues with aesthetics and perceptions of mesic yards as more positive (Neel et al., 2014).

While these issues are important to consider, we believe much of the literature shows more benefits to landscape conversion along with irrigation efficiency (A&N Technical Services et al., 2018, Brelsford & De Bacco, 2018, Sovocool, 2005, Tull et al., 2016, Saher et al., 2022).

After reviewing the literature, we decided to look at the Garden In A Box program holistically by examining the impacts of Garden In A Box on water usage, and elucidating community benefits and other positive impacts of the program. Quantitative methods will be adapted from an already peer-reviewed methodology to analyze changes in Garden In A Box program participant outdoor water usage for a specific period. Other quantitative methods include GIS and statistical tests such as ANOVA and linear regression. Qualitative methods include a cross-sectional survey of Garden In A Box program participants and non-participants to gain insights on landscape preferences, values, and beliefs related to how participants in our study perceive landscapes.

Methods

Impact Analysis

Participant Monthly Water Usage Analysis

The first part of this analysis focused on examining if there was a change in water use for Garden In A Box (Garden In A Box) participants from 2017-2022, using participant data from 2018 as the baseline year.

Monthly water usage data was requested for 1,689 Garden In A Box participants from six cities for the years 2017-2022. Usage data was received for 1,275 participants from five cities, Boulder, Denver, Lafayette, Longmont, and Westminster.

The participant data were analyzed using an adjusted version of Resource Central's Slow the Flow Impact Analysis methodology (2016). Slow the Flow looks at usage data from up to two years pre and one year post the analysis year. This methodology was adjusted to include usage data from one year pre and four years post the garden adoption year (2018), adjusting formulas and graphs accordingly. Additional weather data from Denver Water weather stations was also included.

Participants without enough usage data one year pre and one year post 2018, and outliers were removed leaving 1,031 participants for analysis. Not all participants had enough usage data for two to four years post-analysis, but instead of excluding these participants completely, they were only removed from the analysis during the year there was not enough data (less than nine months).

Multi-Year Participants

Data from the 2018 usage analysis were used to examine water savings from participants who purchased gardens over multiple years. The monthly usage data of 1,031 participants from 2017-2022 were filtered down to 856 for this analysis. Participants from the City of Boulder were removed due to not being able to connect monthly water usage with a specific participant address. It could not be determined which Boulder records matched those who had participated in multiple years of the Garden In A Box program.

The 856 participants were then further filtered to determine if they had participated just in 2018, in 2018 and one additional year of the program, 2 additional years, 3 years, 4 years, 5 years and so on. Multi-year participants were identified, and their usage was analyzed using the Slow the Flow methodology. Years 3, 4, and 5 were combined due to low sample size (n = 16). The average savings of each year were then combined to show the trend of savings over four years (2019-2022).

Multi-Garden Purchases

To determine the savings of the participants who purchased one garden in 2018 versus those who purchased more than one garden, the sum of one year post garden adoption monthly savings (2019) was analyzed for those who had purchased one garden, and those who had purchased more than one garden in 2018 and averaged the savings. This process was then repeated for four years post garden adoption (2022) and analyzed the water usage.

Landscape Use per Square Foot

To find the amount of water participants used on their landscapes was found by taking the average outdoor use for the four years post garden adoption (2019-2022) for all participants and divided by the average square footage of landscape from all participants. The landscape square footage was obtained from the service providers or estimated if it could not be found.

Survey

The research team started with a broad list of questions, which were then narrowed down. Once the questions were consolidated, a rough draft of the survey was created in Survey Monkey. Peter Mayer P.E., Principal of WaterDM, was consulted to further reduce and refine question selection, wording, and format. The survey was sent out to Resource Central staff, program participants, friends, and family to test and make final edits. The final survey contained 29 questions which asked respondents about landscape design preferences, landscape importance, and whether they have participated in Garden In A Box or not. The survey then utilized split logic to separate responses by program participation and asked questions about the Garden In A Box program based on their response. Demographic questions were included to get a better idea of respondent characteristics. The final survey was sent to Resource Central customer mailing lists, water provider customers distributed via the water provider, and posted on Resource Central social media to reach a wider audience. The full survey can be viewed in the appendix.

Once all responses were collected SurveyMonkey's analytics feature was used to determine overall responses and segment these answers into different respondent categories. Reports were then run to gauge whether specific respondent's answers to questions were statistically significant (95% confidence interval) versus others.

Question 10 consisted of a series of likert scale questions which were used to determine the extent to which respondents agreed or disagreed to personal values related to their own landscapes. To analyze these data, weights were given to reach response to determine participants' level of agreement with certain statements (see question specifics in appendix) from -2 (Strongly Disagree), -1 (Disagree), 0 (Neutral), 1 (Agree), and -2 (Strongly Agree). The number of responses in each question was multiplied by its weight and divided by total responses to the question to get the rating average. This process was repeated for different categories. The rankings were then compared by taking the difference and any categories with a difference of .40 or above were statistically significant.

Mapping/GIS

Customer data from 2003-2023 were compiled and organized so that records easily conveyed comparable information. Out-of-state addresses (other than WY), P.O. Boxes, and participants who were missing all address data were removed, which left 39,394 records. The records were formatted into CSV files and coded with a unique ID (YEAR-Record No). The records were then geocoded using Geocodio.com to get latitude/longitude and census block codes.

Polygon layers for census blocks and state borders were loaded into ArcPro from Arc Living Atlas. Then the census block codes for CO and WY were isolated and clipped to provide area of interest (AOI).

The CSV files were loaded into ArcPro and converted to point data, then those points were aggregated into census block groups. Choropleth maps were created to show the number of participants per year per census block group and the sum of gardens purchased per census block group from 2003-2023. The census block group scale was chosen because it removes specific customer point data and maintains privacy, while still being small enough to provide meaningful location data.

Participant point data were joined to any census block groups that had participants. Spatial join was performed for each year and normalized by population in each census block group. Outliers, 0s, and any count by pop over 4 were removed. The cleaned spatial join data were then used to perform other analyses and create maps and visualizations.

Density analysis was performed to show where features are concentrated throughout the study area (i.e. the spread of gardens or participants over the state of Colorado). Density outputs were created for garden totals and participant counts. Two types of density analyses were performed. Point density, density of point features around the output cell, to find the number of gardens or participants within a 'neighborhood' divided by area of neighborhood. Kernel density calculates density of features in a 'neighborhood' around those features.

Two other analyses performed include Cluster and Outlier Analysis (Anselin Local Moran's I). Anselin Local Moran's I, which identifies areas of high values, low values, and spatial outliers.

The purpose of this analysis is to categorize data into similar groups. Cluster analysis can show what groups should be, and how they are organized geographically. The other was Hot Spot analysis (Getis-Ord Gi*) using participant counts normalized by population in each census block group. Hot Spot analysis identifies areas of high values (hot spots) and low values (cold spots). Getis-Ord Gi*looks at each feature within the context of the features around it. A Z-score, p-value, and confidence bin are output once these analyses are run.

After performing the cluster and hot spot analysis it was determined that there were no significant groupings of interest for this study. Space Time Cube and Emerging Hot Spot Analyses were then performed to determine if there would be any significant outcomes. The Space Time Cube adds the dimension of time, and can give insights into trends and areas that have become hot or cold spots for program participation. It aggregates points into bins in areas over specified time frames. All garden participants in all Colorado census block groups from 2013-2023 were included, and clipped to each water utility service area. Output areas were created to show statistically significant up or downward trends, 3D scene of the space time cube, and emerging hot spot map.

Demographic, community profile, and tapestry data were pulled from Arc Business Analyst for each service area from the impact analysis (Boulder, Denver, Lafayette, Longmont, and Westminster). These data were used for further mapping and statistical analyses.

Maps were created to display the geographic spread of the impact analysis participants. We mapped each service area polygon from the five participating service providers, added the points for 2018 participants, and removed points outside service areas. Maps were also created to display Resource Central’s water provider partners and pick-up events to demonstrate program reach within the state, and we created animations for visual presentations including a time series of garden participation over the Garden In A Box program’s 20 years.

Statistical Analysis

Service Areas

A one-way ANOVA (difference among group means) and Tukey post-hoc pairwise comparison (which groups are statistically different from one another)analyses were performed in R Studio to examine garden adoption rate as a function of LifeMode Group for 2023. LifeMode Groups are a part of ESRI Tapestry Segmentation. Tapestry Segmentation groups US residential areas by socioeconomic and demographic characteristics into market segments. From the Tapestry Segments there are 14 LifeMode groups that are combined by life stage and lifestyle. See the formula below:

Sample Size = Number of Census Block Groups (CBG) with garden participants
Adoption Rate = (SUM_garden_total (# of gardens purchased in CBG)/ Total Households w/in CBG) * 100

Hot/Cold Spots

A one-way ANOVA and Tukey test were also used to determine participation rate as a function of LifeMode groups and as a function of hot spots and cold spots from the Emerging Hot Spot Analysis. We were interested in persistent cold, diminishing cold, historical cold, new hot, consecutive hot, and intensifying hot spots (see appendix for definitions).

All participants from 2013-2023 were selected. Hot/cold spots were then clipped in ArcPro and joined with census block group (CBG) data to get the full FIPS code (numbers that uniquely identify a certain geographic area) for each block. Participant counts were added from all 10 years. Total households and tapestry data were pulled from Arc BusinessAnlayst. Finally, the participation ratio between participants and CBG population was calculated. Data were merged and run through an ANOVA analysis in R Studio. Hot spots were compared with other hot spots and cold spots with other cold spots. LifeMode Groups and their differences were investigated to determine which are natural fit for the program and which are under represented.

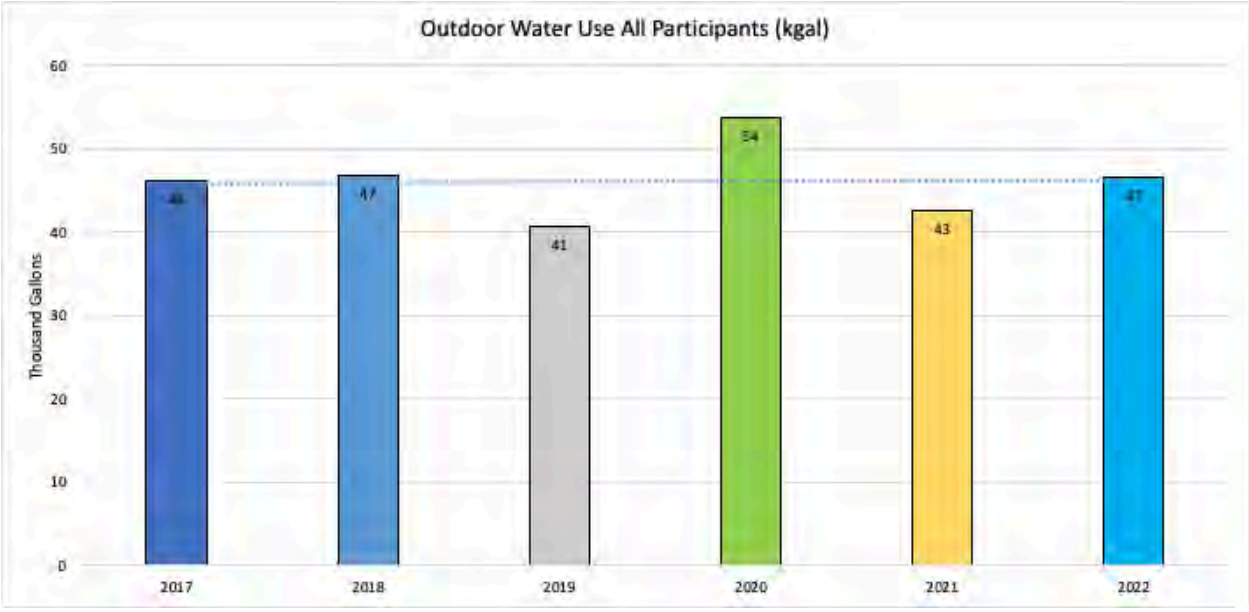
Results

Impact Analysis

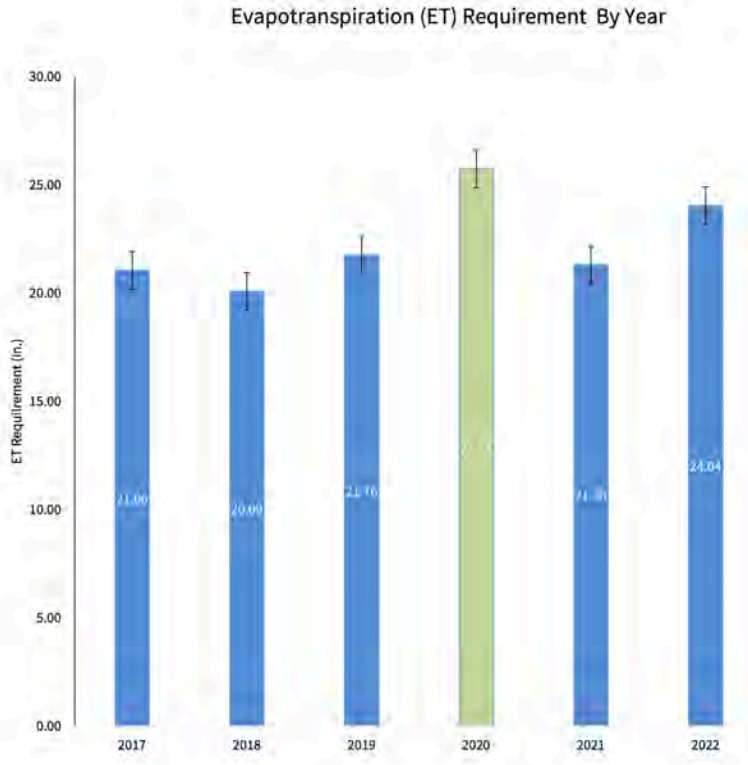
Participant Monthly Water Usage Analysis

Over the study period (2019-2022), Garden In A Box participants saved an average of 5,000 gallons (projected outdoor use minus actual outdoor use). The most savings occurred one year and four years after the assessment year (please see graph below).

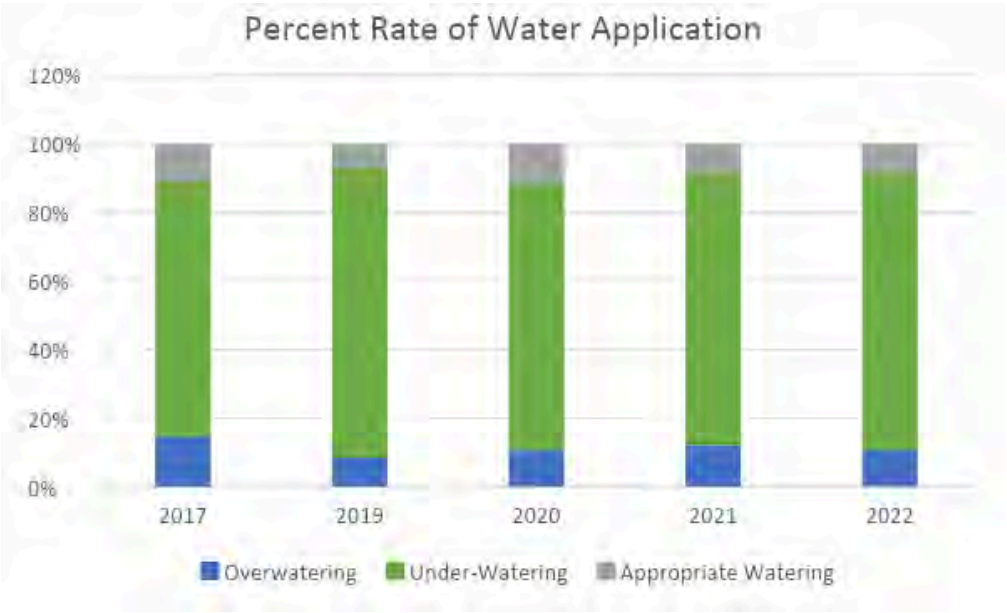
Outdoor water use decreased for all participants from 2018 to 2019 but increased back to 2018 levels by 2022 (see chart below).



The highest outdoor use was noted in 2020, which was an exceptionally hot and dry year (see ET graph below). Outdoor water use can be affected by many factors including, weather, turf removal, COVID lockdowns in 2020, and other behaviors which are not accounted for in this analysis.



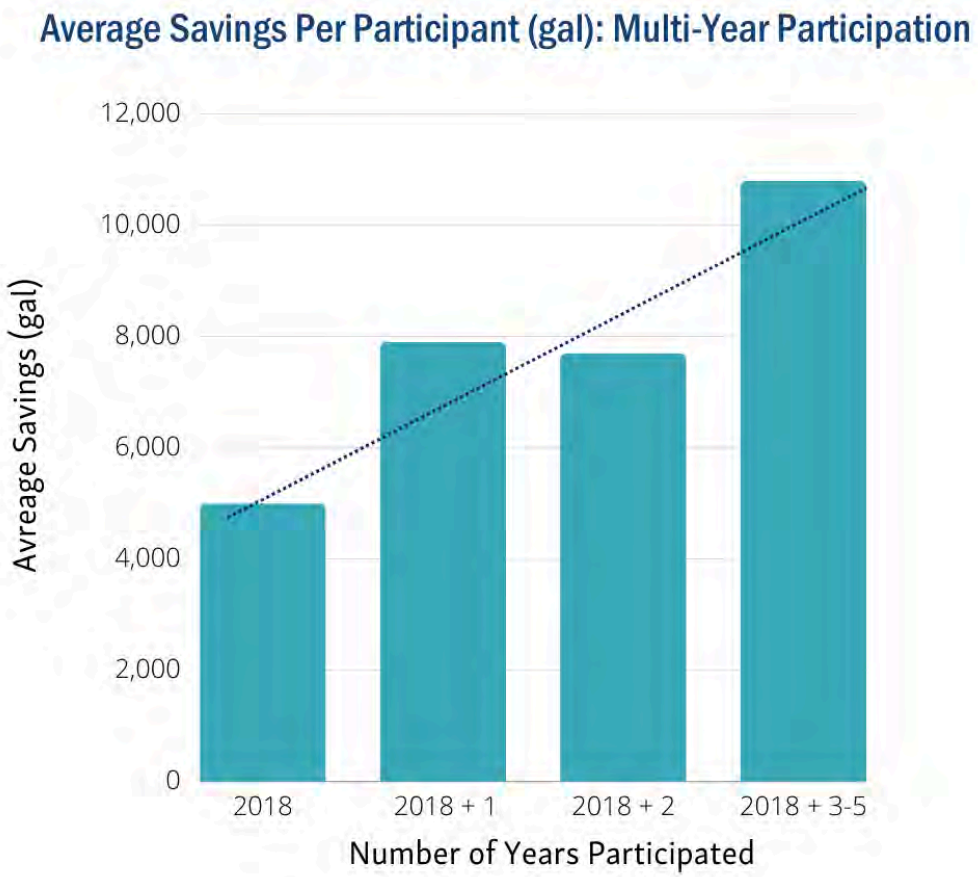
Overall, the percentage of participants who were overwatering went down over the study period, and those who were underwatering increased from the pre-assessment period (see graph below).



Multi-Year Participants

Out of the participants who bought gardens in 2018, 23% bought gardens over multiple years, while 77% purchased gardens in 2018 only. Only participants who purchased in the years when there was water usage data were included in this analysis (2017-2022).

The results of the analysis show that people who purchased gardens multiple years in a row saved more water on average over the 2019-2022 time period than those who only purchased in 2018 (see chart below).



Those who participated 3-5 years saved the most water (10,800 gallons/participant). However, the sample size for participants who participated for 3-5 years was also quite small (n= 16). See table below for sample sizes for all years.

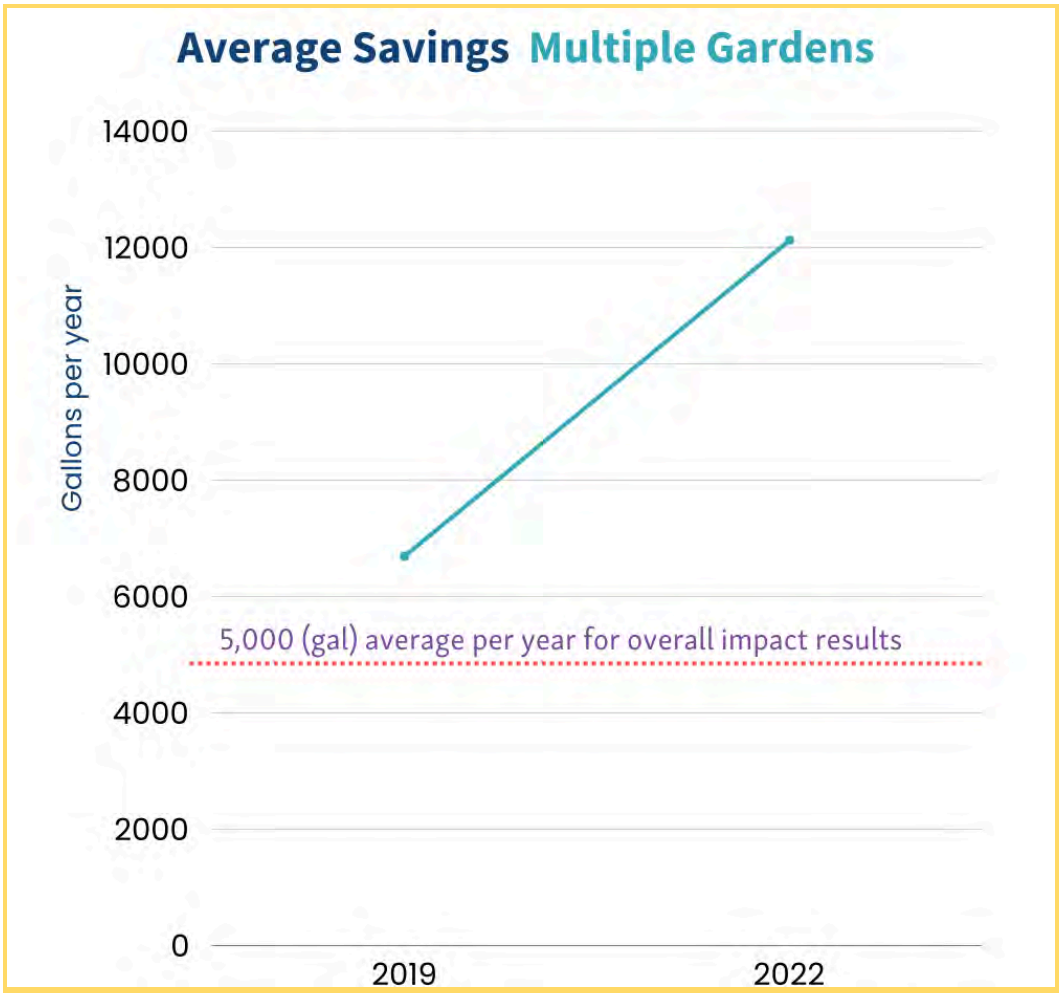
Years Participated	2018 Only	2018 +1	2018 +2	2018 +3-5
Sample Size	661	137	42	16

Due to the larger sample size, the results from 2018 +1 provide the most confidence, however, the trend shows an increase overall with more years of participation. Some participants in the sample may even have increased water use over the study period, which affects the overall savings.

Multiple Garden Purchases

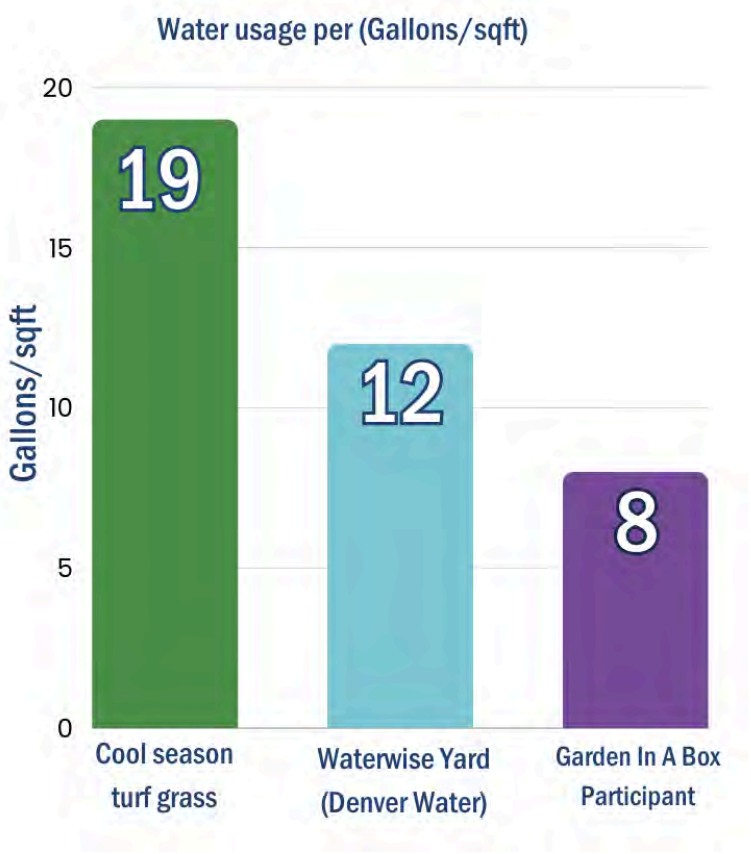
After one year those who had purchased one garden saved an average of 8,400 gallons, while those who purchased more than one garden saved an average of 6,700 gallons. This may be due to the establishment time frame where gardens may require more water. However, after four

years those who purchased multiple gardens saved 12,100 gallons on average, while those who only purchased one garden saved 5,600 gallons.



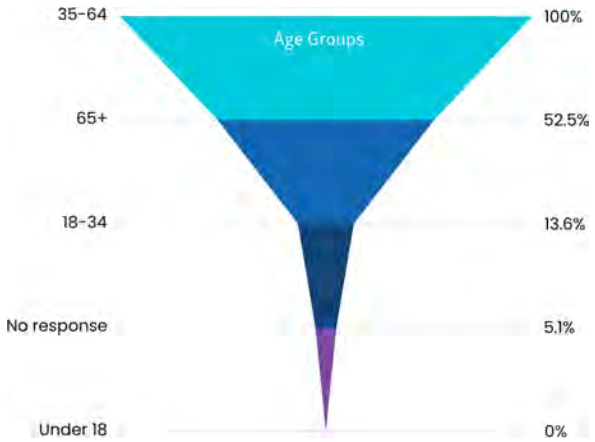
Landscape Use per Square Foot

Garden In A Box participants used an average of 8 gallons per square foot per year on their entire landscape. State estimations (BBC Research and Consulting, 2024) for cool season turf grass are 19 gallons per square foot. Using this estimation, Garden In A Box participants saved about 11 gallons per square foot per year. The benchmark for water use on waterwise yards in Colorado is 12 gallons per square foot (Kirk, 2019). Garden In A Box participants are exceeding the expectations for water use on their landscapes.

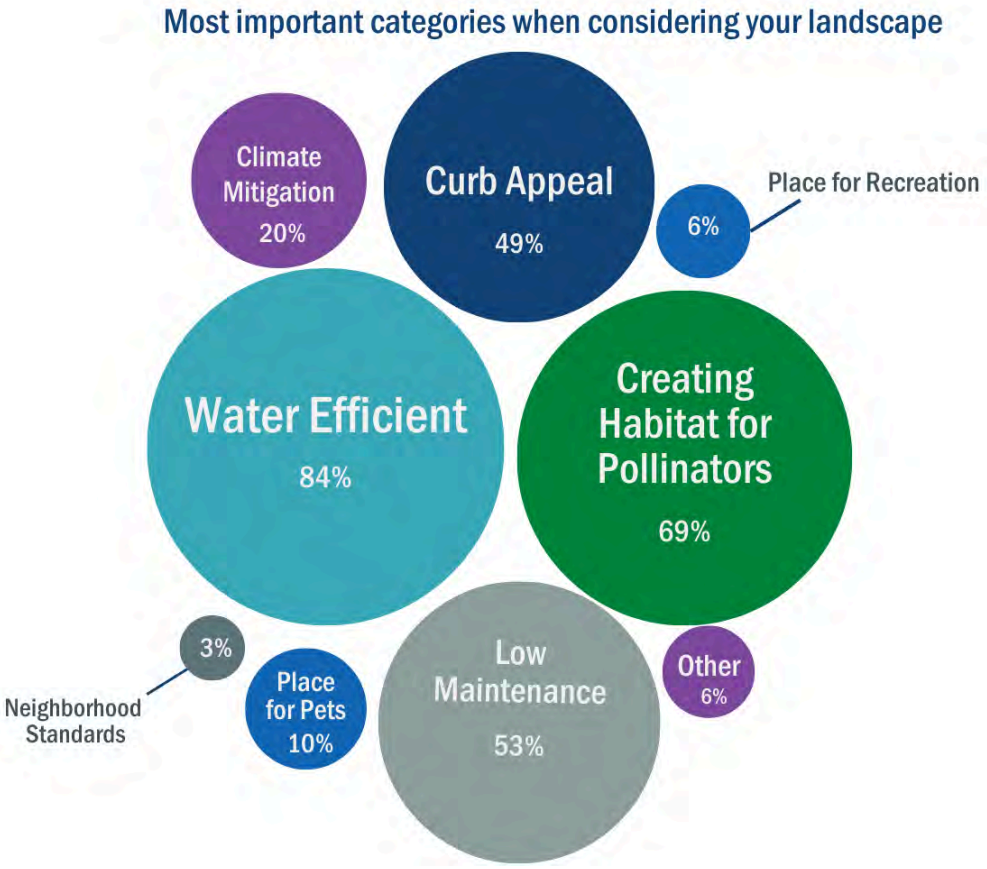


Survey

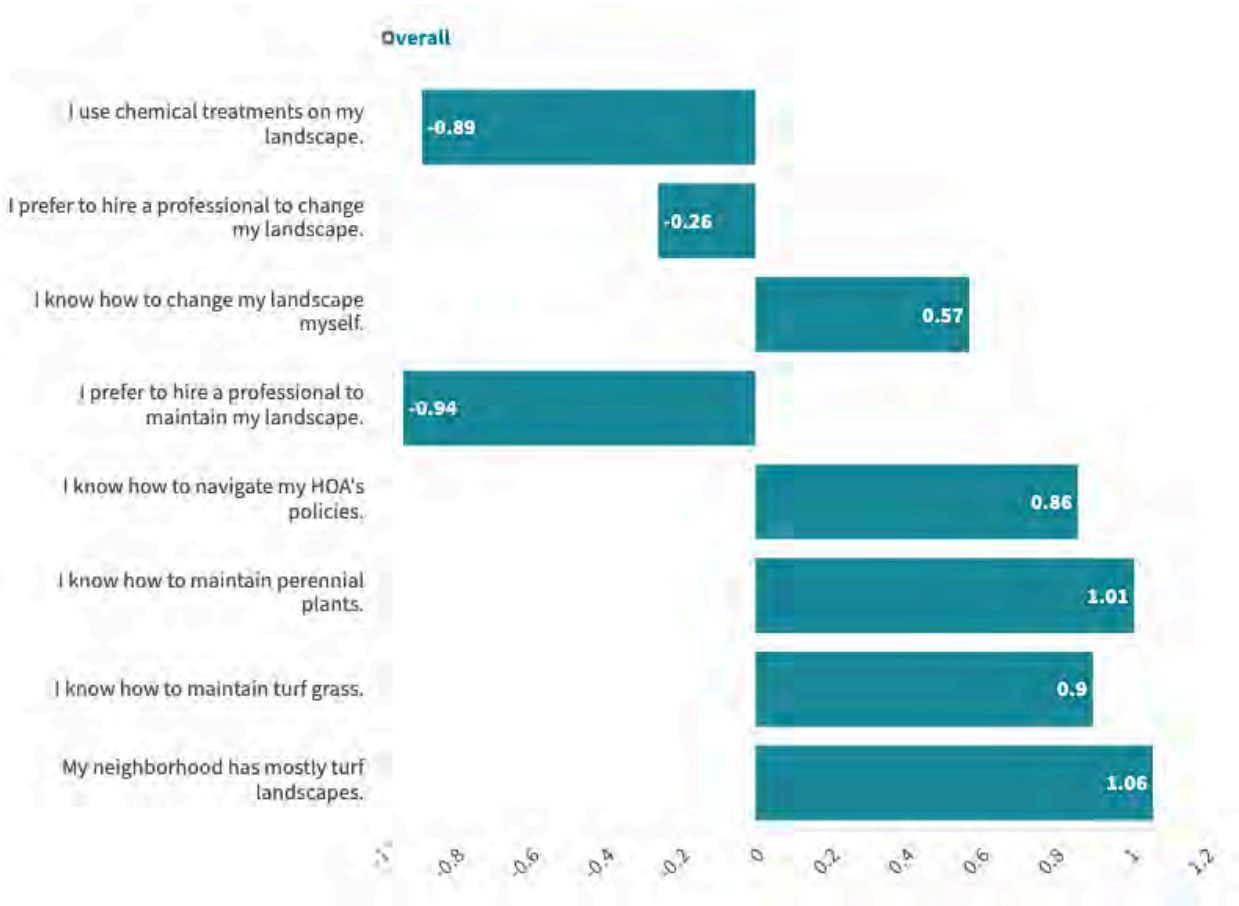
The survey received 2,938 responses. Out of those responses 78.7% were female, 16.4% male, and 4.79% identified as non-binary or did not wish to respond. Out of all of the respondents, 35.9% indicated they lived in a neighborhood with a Homeowner's Association. Most respondents indicated they owned their home as opposed to rent. The largest age group was between 35 and 64 (59.11%). See the graph below for the full age group breakdown. See the full breakdown below.



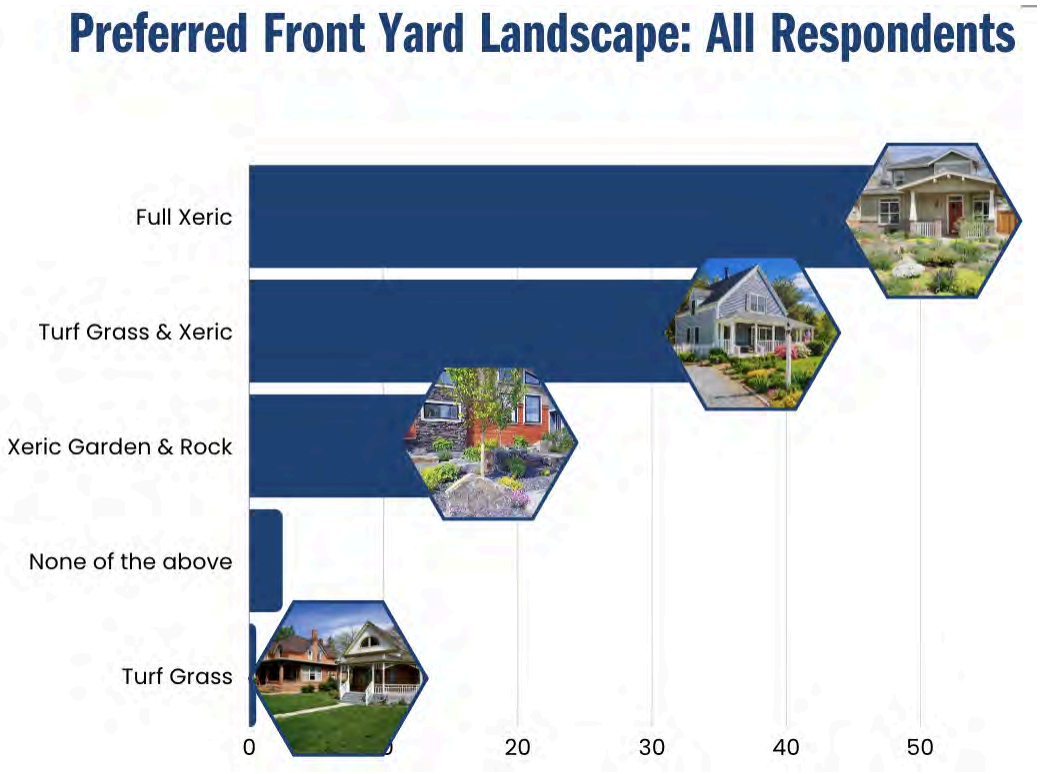
When asked how important their landscape was to them, 79% of the respondents indicated that their landscape was very important to them. The top three considerations when it comes to landscapes were water efficient, creating habitat for pollinators, and low maintenance.



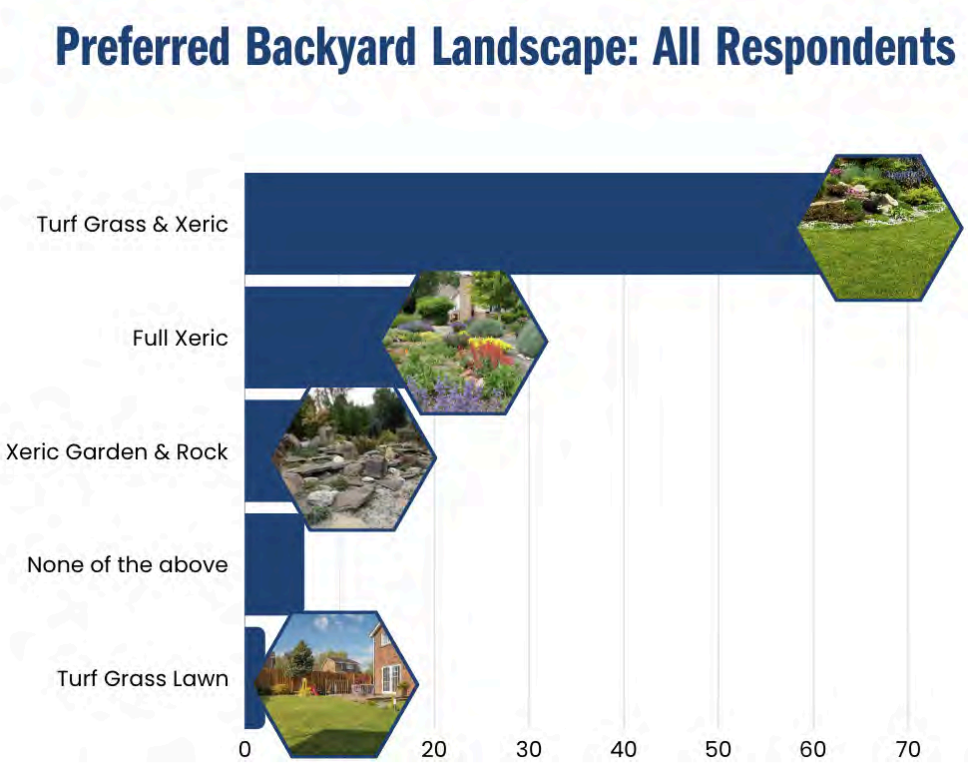
Question 10 asked respondents to indicate their level of agreement or disagreement with different statements regarding their perceptions, knowledge, and values regarding landscapes. Most respondents strongly agreed they know how to plant and maintain perennials (1.01) and the neighborhood they live in has mostly turf landscapes (1.06). Most strongly disagreed that they preferred to hire someone to maintain their landscape (-0.94). The key takeaways from the overall responses to question 10 are that most respondents do not use chemical treatments on their landscapes, and prefer to remove, change or maintain their landscapes themselves.



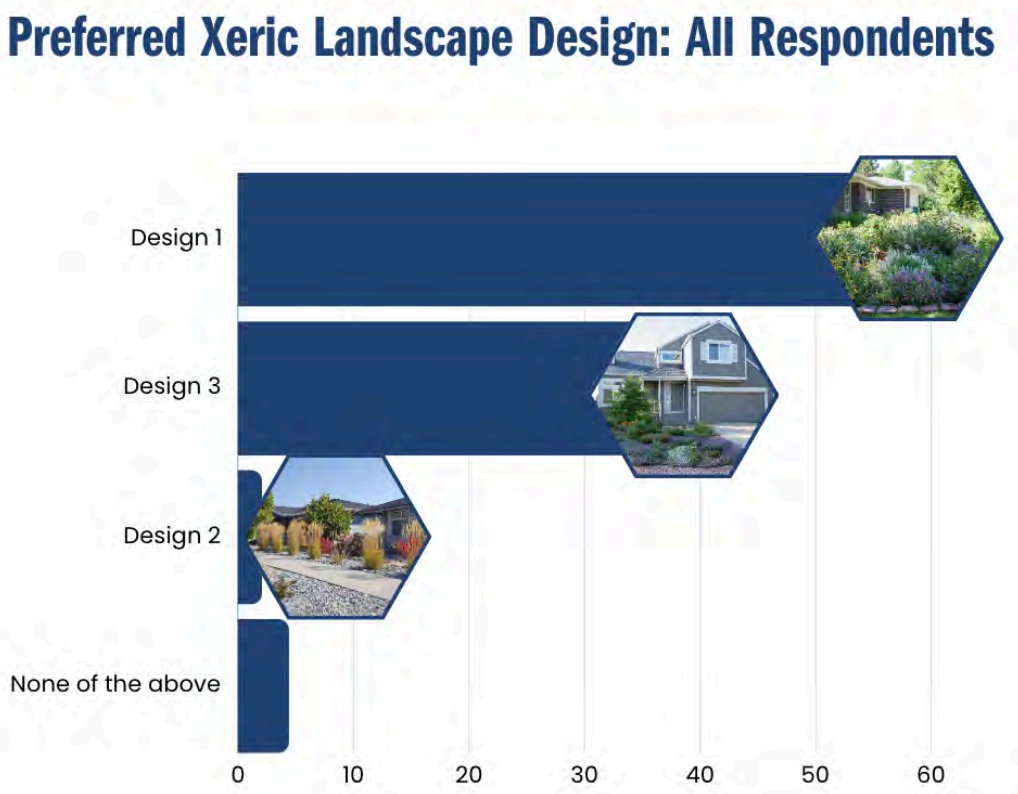
A series of photographic questions were included to gauge landscape preferences. Survey respondents were asked to select which they preferred between photos of different landscapes for front yard, backyard, and overall landscape design.



Overall, respondents preferred a fully xeric garden (48.76%), landscape for the front yard and least preferred a fully turf grass landscape (.52%). Respondents 18-34 years of age preferred a fully xeric garden landscape more than any other age group, while respondents 65+ and members of an HOA preferred a turf grass and xeric plant combination front yard.



Overall respondents preferred a turf grass & xeric plant landscape for the backyard landscape (64.73%). This response is in line with respondents valuing a place for recreation and a place for pets when considering their landscape. A full xeric garden landscape was the second most preferred landscape option (19.57%), and the least preferred landscape for a backyard was a full turf grass lawn (2.16%).



When evaluating the preferred full xeric garden landscape design, respondents preferred a fully plant-based and wild looking design (57.88%) aesthetic as opposed to a more modern, rock and grass based design (2.09%). While the design aesthetic of a combination of plants and rock was the second-most preferred landscape design by all respondents (35.61)=%), it was the most preferred design for respondents 65+ and for members of an HOA.

Participant/Non-Participant

The survey was then split between participants (63.2%) and non-participants (38.6%). Creating pollinator habitat and conserving water/reducing the water bill were the reasons most people participated in the Garden In A Box program. Most non-participants had heard of the program and indicated they would participate in the future, citing the same reasons as participants. Barriers to participation were mostly related to people wanting to design their own landscapes, having mature landscapes already, or the gardens provided by the program not containing enough native plants.

The most significant differences among participants and non-participants responses are shown in the chart below:

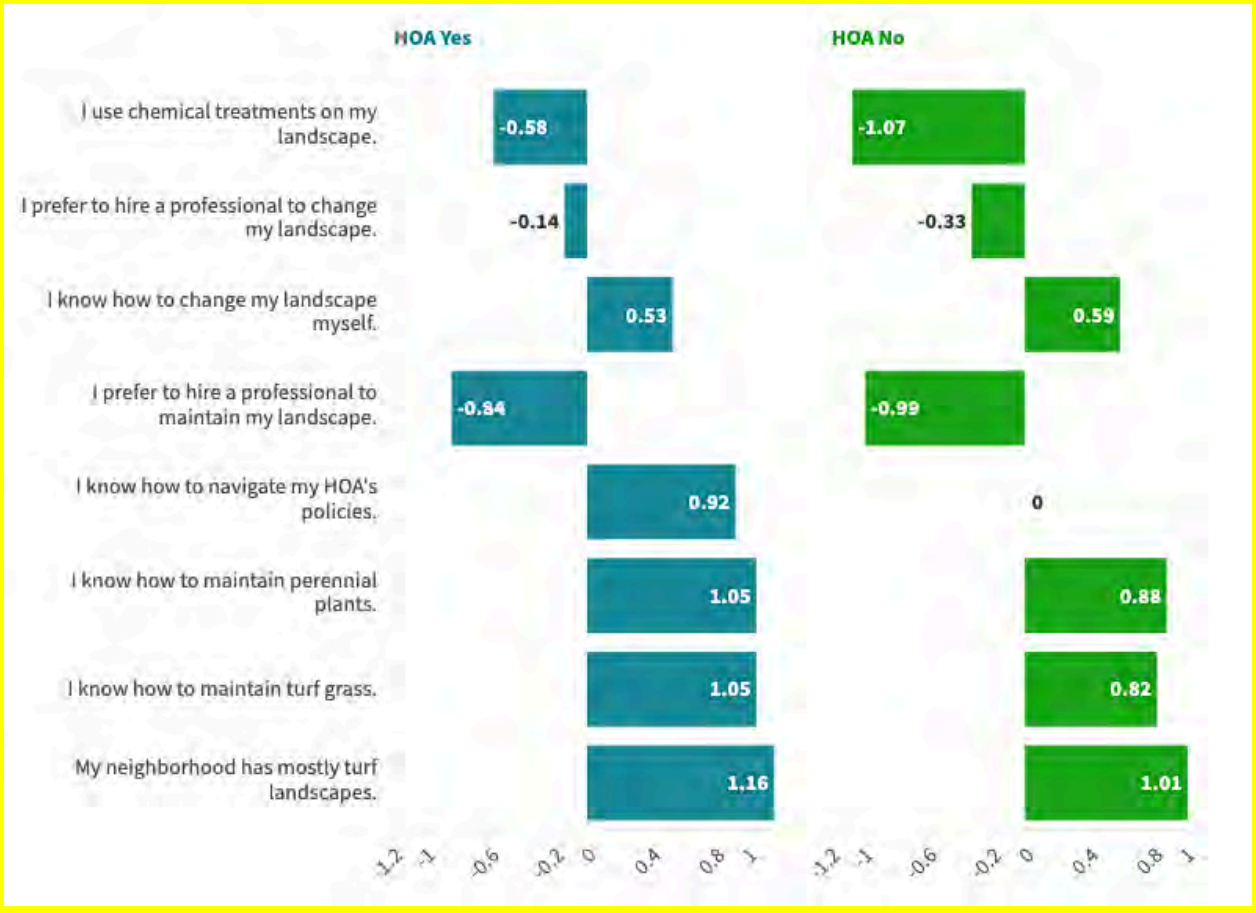
Response	Participants	Percentage	Non-Participants	Percentage
Most Important Factor	Creating Pollinator Habitat	71.49	Creating Pollinator Habitat	63.98
Front Yard	Full Xeric	50.74	Full Xeric	45.34
Backyard	Turf/Xeric Combo	67.05	Turf/Xeric Combo	60.72
Landscape Design	Landscape Design 1	60.03	Landscape Design 1	54.17
HOA	Yes	33.86	Yes	39.36
	No	65.86	No	60.55

On question 10, participants and non-participants differed from one another most significantly on knowing how to remove or change their landscape themselves, participants felt more strongly that they agreed with this statement on average (.72 compared to .33).

HOA

Respondents who do not live in a community with an HOA consider creating pollinator habitat more important when it comes to their landscape. Curb appeal and reducing bill/conserving water rank higher for those who live in an HOA. Aligning with neighborhood standards is also higher.

As far as yard preferences, those in an HOA prefer a turf & xeric landscape for their front yard by 10% , those not in an HOA prefer a full xeric front yard by almost 12%. Landscape design 1 was preferred by those not in an HOA, while landscape design 3 was more preferred by those in an HOA. Respondents in an HOA are more likely to agree that they use chemical treatments on their landscape (-.58 compared to -1.07).



Age

The most interesting differences among survey respondents was observed between age groups. These results may offer an interesting insight into a shift in landscape preferences and a changing culture as younger groups gain access to their own landscapes.

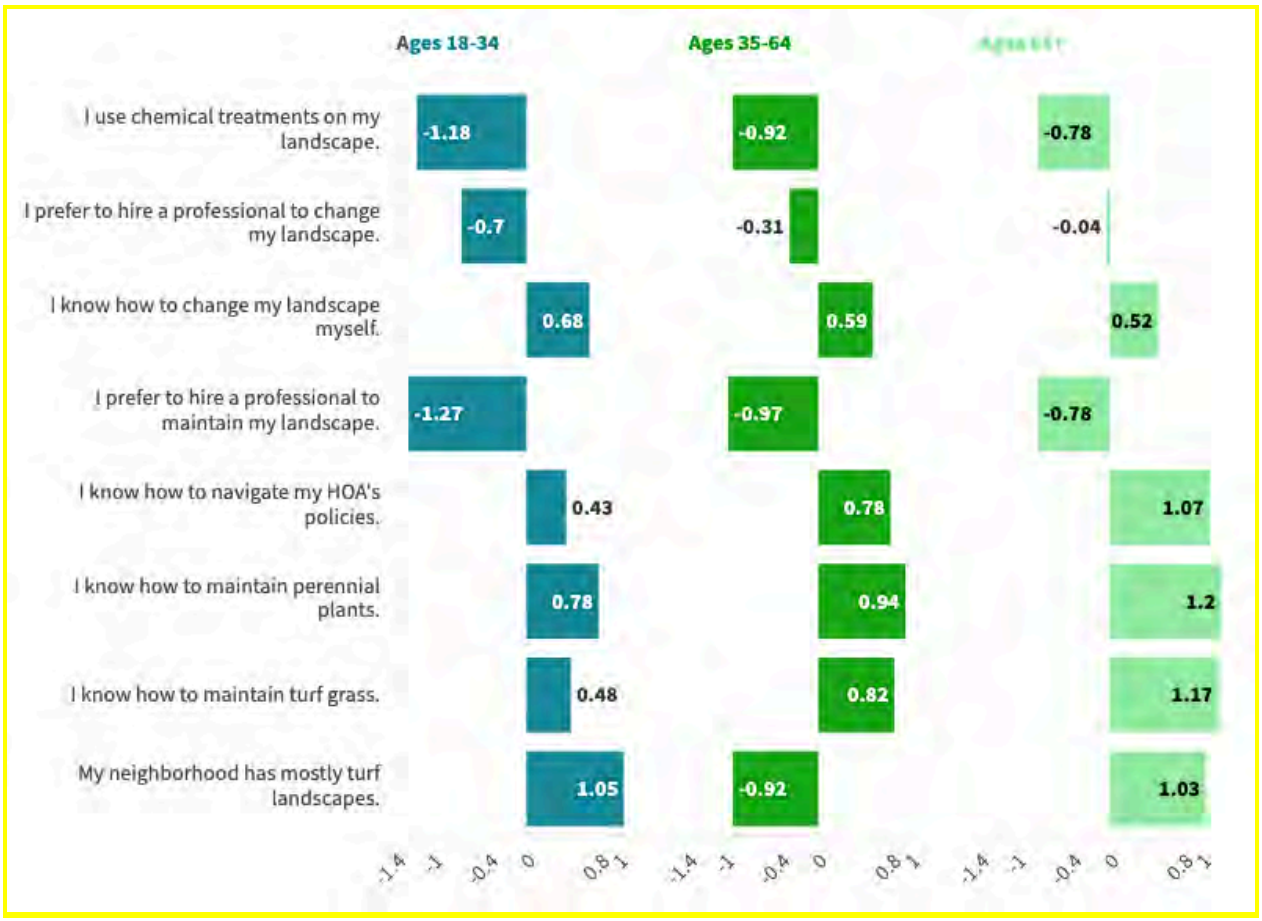
The youngest demographic, 18-34, are statistically more likely to participate in the Garden In A Box program and greatly prefer a full xeric landscape for their front yard. The younger group also prefer turf and xeric for their backyards more so than both other age groups. The youngest group greatly prefer landscape design 1, a full xeric garden, to other options, 14% more than 65+ (who prefer landscape design 3), and 4% higher than the mid-age group.

Younger people who participated in Garden In A Box cited creating pollinator habitat as more important than older groups when it comes to their landscapes. Those who had not participated indicated the ease/convenience of the program as the main reason they would consider participating. Older groups care much more about conserving water/reducing their bill. The 65+ group is more willing to do the project themselves.

The largest difference amongst age groups was 35-64 year olds disagree (-.92) that their neighborhood has turf landscapes as compared to the younger and older groups (1.05 and 1.03

respectively). Older respondents feel more strongly that they know how to maintain turf and perennials than the youngest group, and are more likely to hire someone to maintain their landscape, this may be due to their age and they may be more able to afford to hire someone as opposed to younger age groups. Older respondents are also more likely to use chemical treatments on their landscapes than younger respondents.

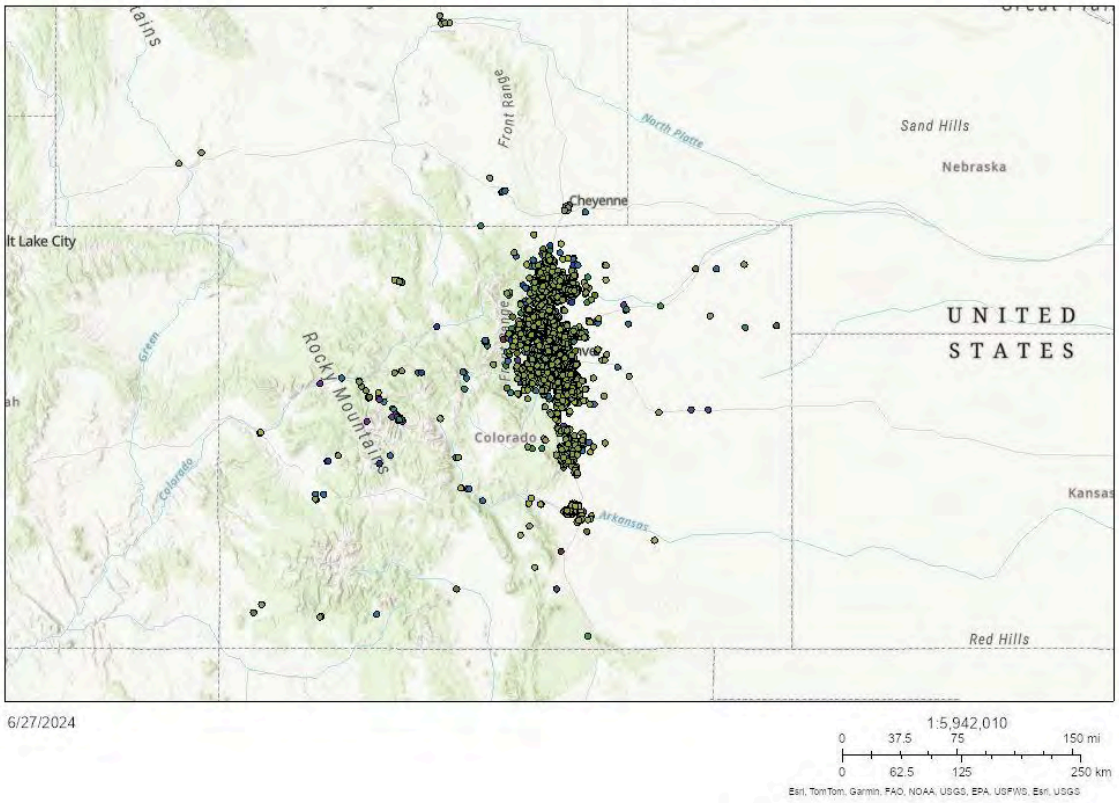
The differences among age groups in the survey may be due to older age groups already having established landscapes, and more experience and knowledge on how to create and maintain their landscapes. Younger people may just be getting their yards established and require more guidance on how to plant or create a landscape, but are more likely to do it themselves.



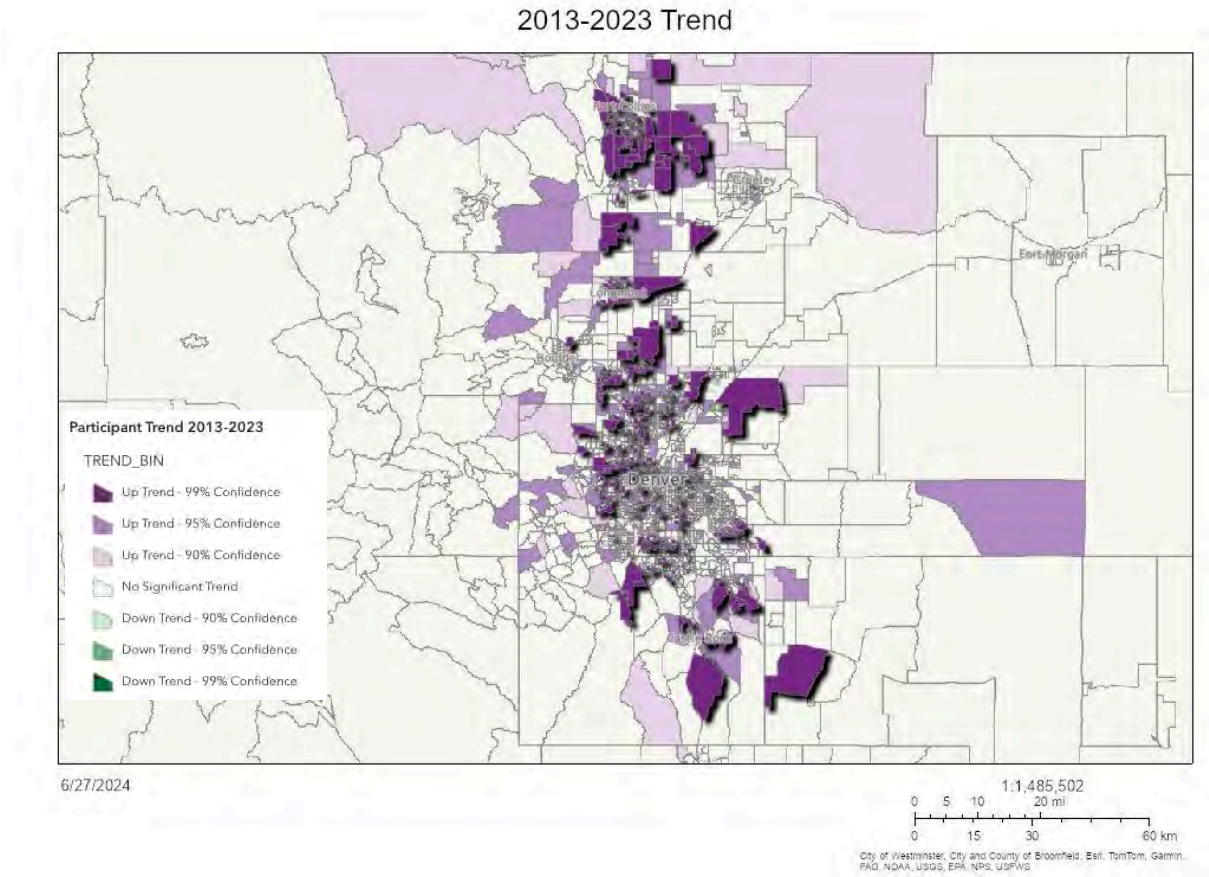
GIS and Mapping

The GIS analyses generated a number of maps showing how Garden In a Box participation has changed over time.

Garden In A Box Participants 2003-2023

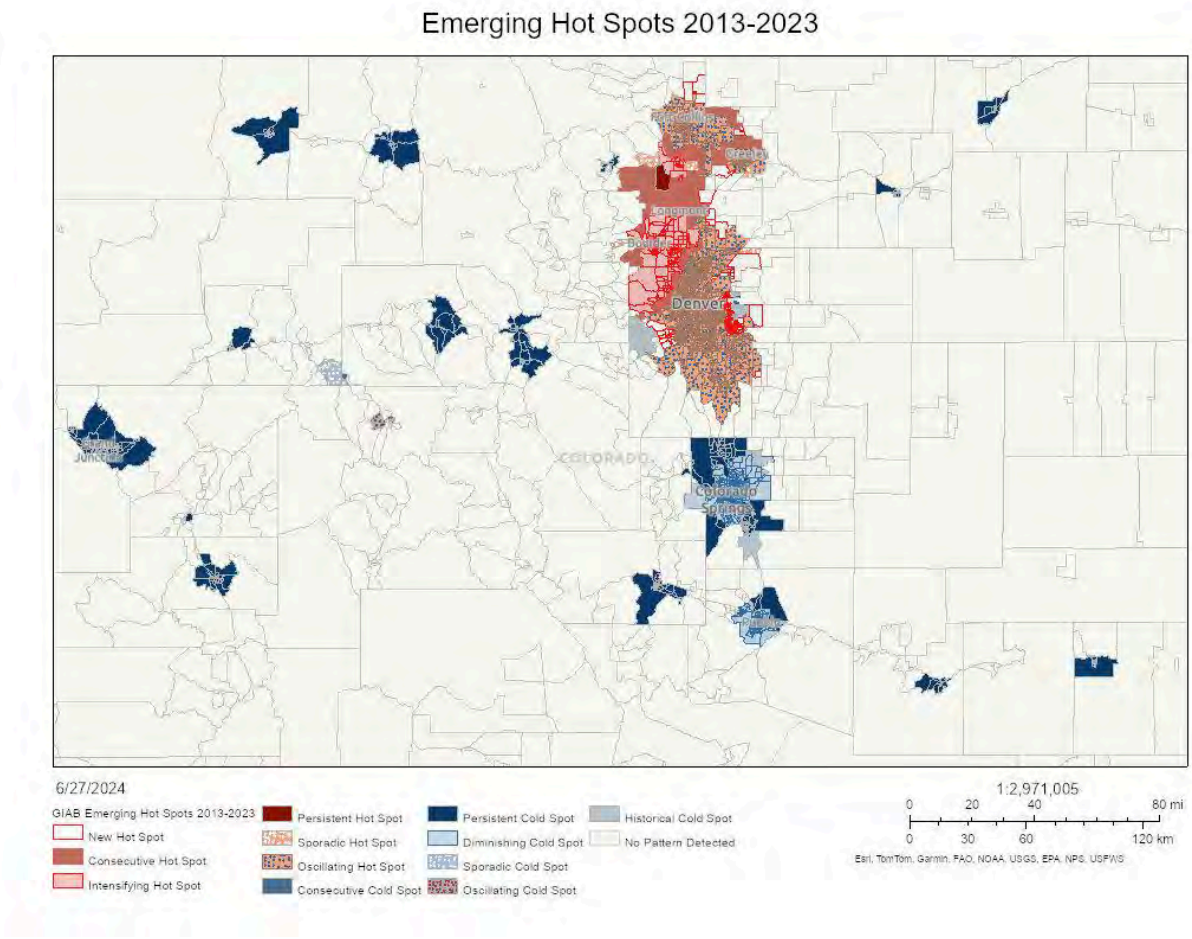


All Participants 2003-2023



Up or Down Trend by Census Block Group 2013-2023

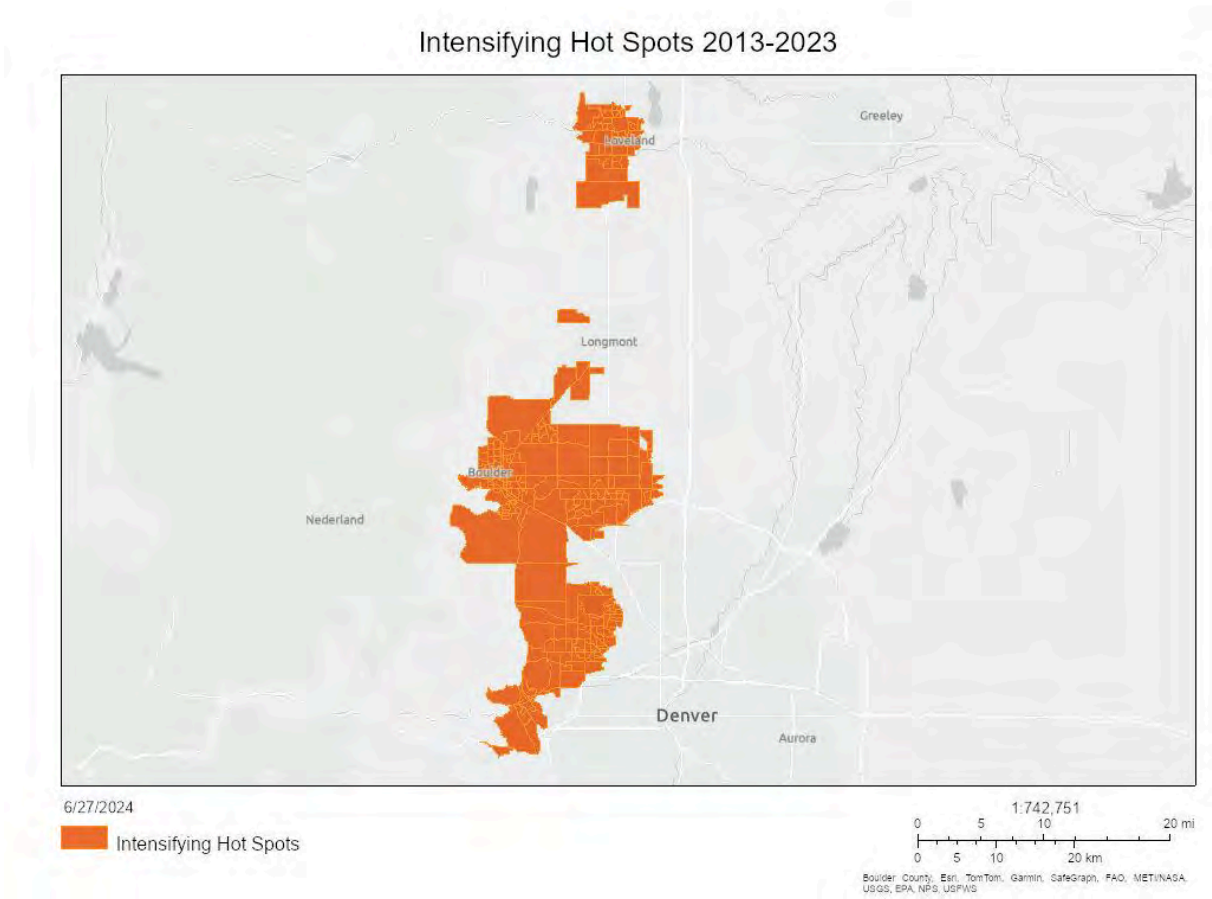
An Emerging Hot Spot Analysis was run to show which CBGs showed increased, sustained, decreased, or no participation from 2013-2023.



Emerging Hot Spot & Cold Spot

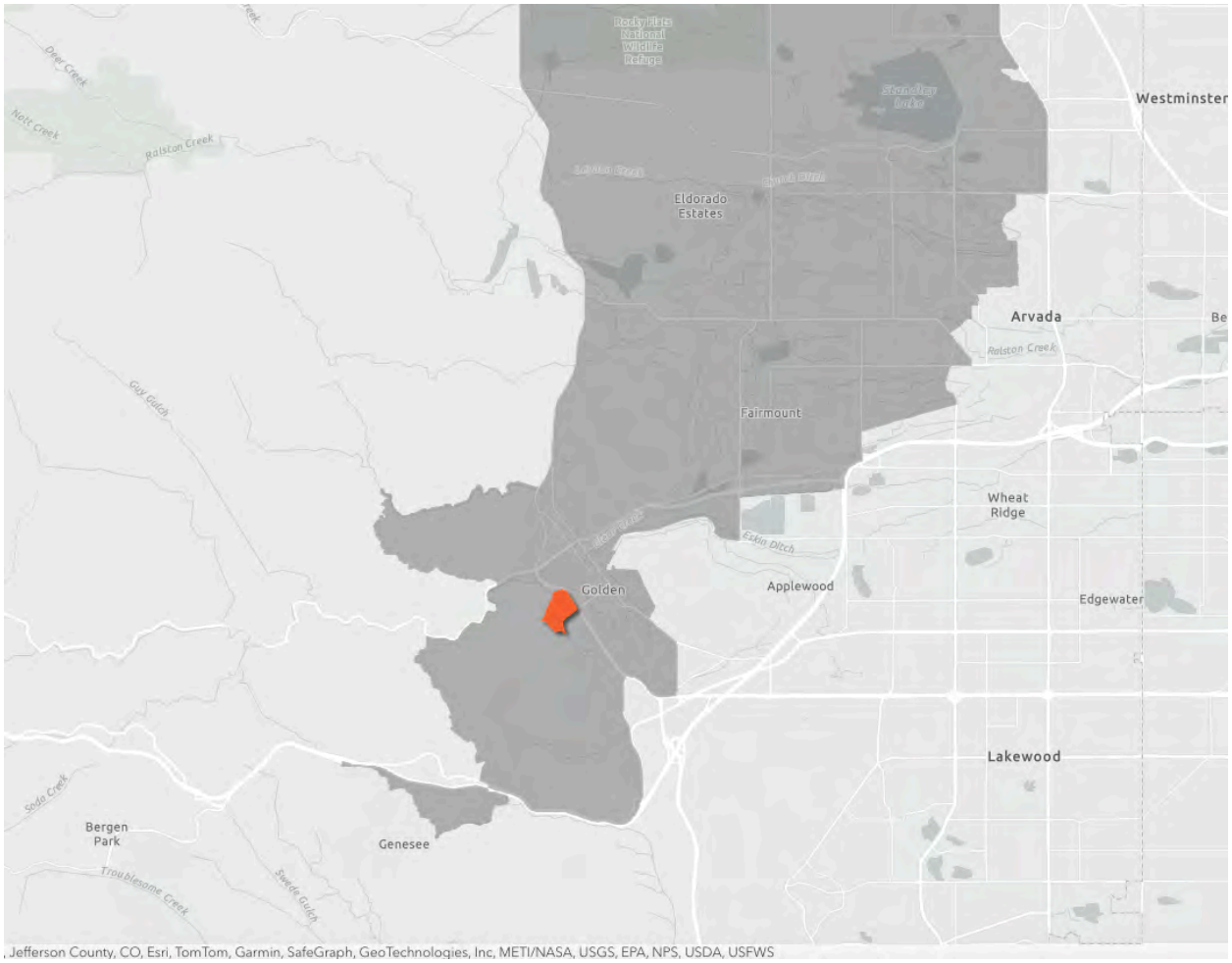
This analysis provides information on where the program is growing, holding steady, and what areas may need to be targeted to increase participation in the future.

Of particular interest in this study were intensifying hot spots. These are areas that have been considered a “statistically significant hot spot for 90% of the time-step intervals” (ESRI), in this case years. For a more specific description of intensifying hot spots see the appendix.



Intensifying Hot Spots

Three CBGs identified as intensifying hot spots were pulled out for further analysis. Using ESRI Tapestry Segmentation to investigate what kind of participants reside in these CBGs.

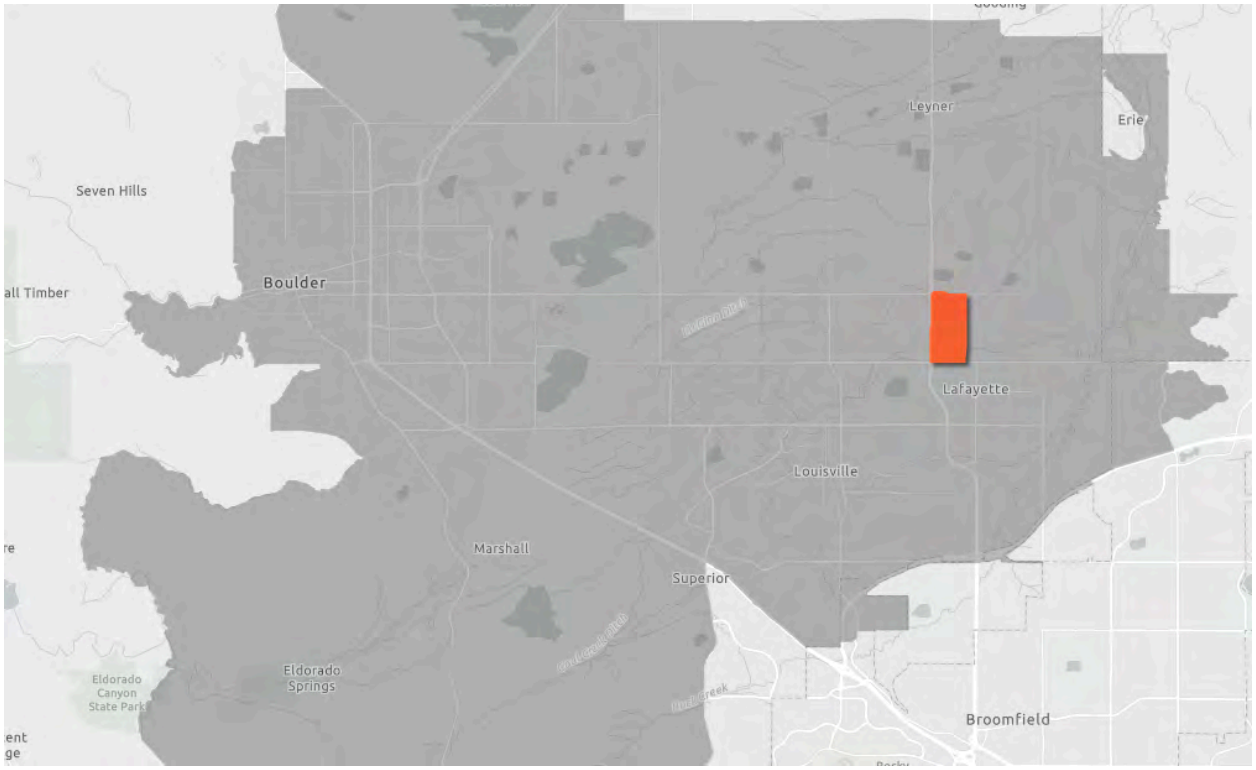


LifeMode Group 1E Exurbanites

Characteristics of this LifeModeGroup include established neighborhoods (1970-1990) on the suburban periphery of large metro areas. Expansive single family homes with larger properties. This population is approaching retirement, and are usually empty nesters or married couples without children. Gardening and home improvement are priorities. They take pride in their homes, and quality is a higher concern than price. In the survey, 45% of program participants cited curb appeal/beautification as a reason why they purchased a Garden In A Box.

LifeMode Group 5B GenXurban

Typically single family homes in older neighborhoods (built before 1980). Professional couples who focus on their homes and interests by investing in home remodeling, either DIY or hire, and like growing their own vegetables. They are attentive to price, and like to use coupons. 56% of program participants cited reducing their bill/conserving water as a reason why they participated in Garden In A Box on the survey. Only 8% of non-participants cited the program as being too expensive.



LifeMode Group 2E Enterprising Professionals

A mixture of single-family homes and multi-unit dwellings in lower-density urban neighborhoods, 25% of homes were built in 2000 or later. Characterized by a fast growing tech-savvy population focused on convenience when shopping (Amazon, Target pharmacy etc.). 40% of program participants cited ease/convenience of program as a reason why they purchased a Garden In A Box in our survey.

Statistical Analyses

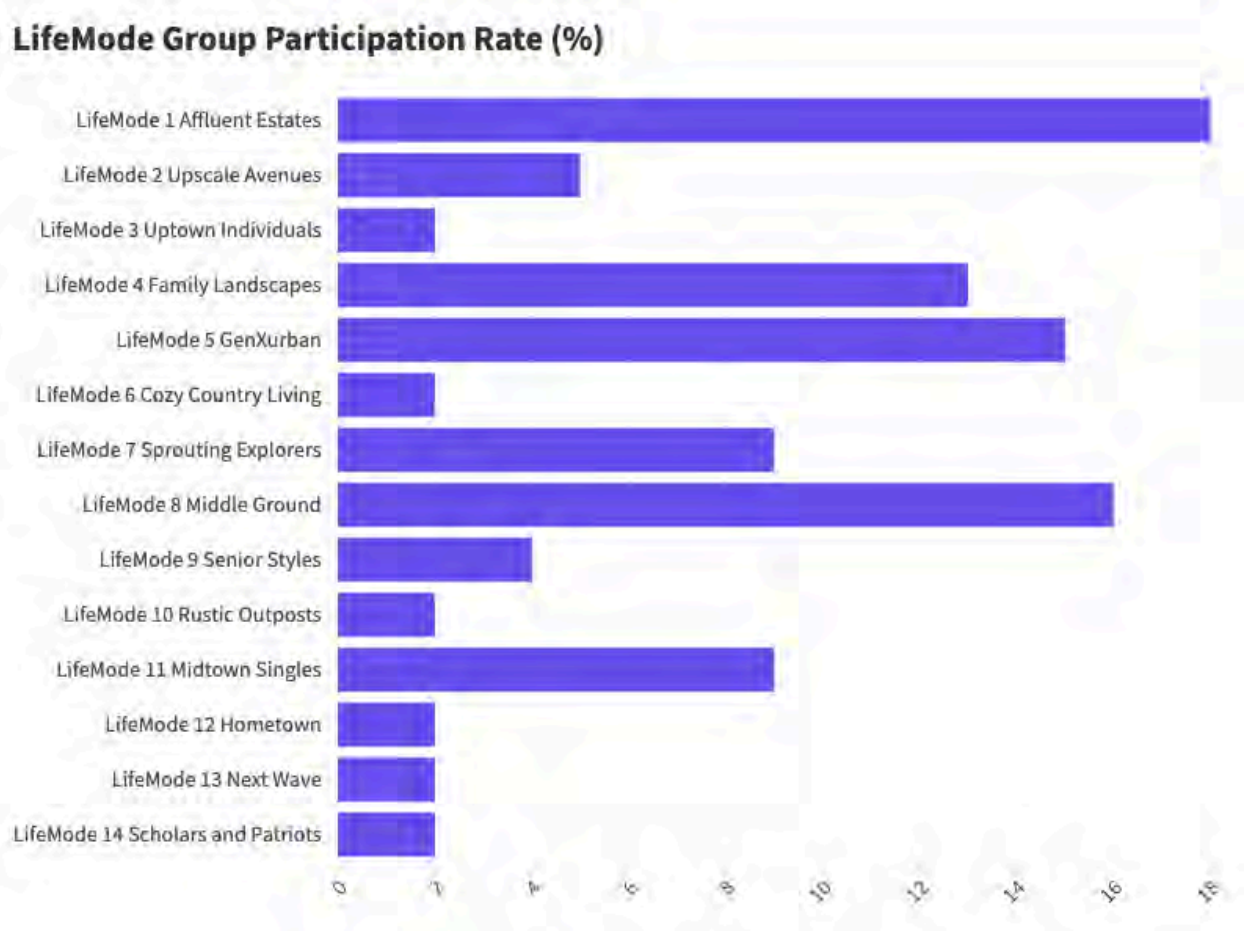
After running the ANOVA, the strongest differences among groups was observed in Denver, which was expected given it had the largest sample size and smallest p-value. The Tukey test showed no significant difference among specific LifeMode Groups in Westminster. The p-values of the other water providers were not enough to create a signal, and thus did not provide any significant trends for us to examine.

ANOVA Results

Provider	Sample Size (CBG)	Average Adoption Rate	Median Adoption Rate	F- Value	p-value
Boulder	74	1.48	1.08	1.90	p > .05
Denver	447	1.26	.97	4.8	p < .05
Lafayette	32	2.9	2.1	1.2	p > .05

Longmont	62	1.62	1.47	.42	p > .05
Westminster	95	1.29	1.1	2.14	p < .05 (.03)
All by LM Group	707	1.39	1.07	5.56	p < .05
All by Provider	707	1.39	1.07	12.2	p < .05

There were no significant differences among LifeMode Groups in the persistent cold, historic cold, diminishing cold spots or the intensifying hot, consecutive hot, and new hot spots. Instead the LifeMode Groups that had the most participants and the least amount of participants were identified. See graph below:



Participation (or lack of participation) in Garden In A Box may be due to mobile populations, no access or awareness of the program (not on front range), people without yards or spaces to

landscape, higher numbers of renters, or unable to afford to participate in Garden In A Box. These factors are of great interest and warrant more study in the future.

Discussion

This study answered the questions:

1. Does Garden In A Box save water?

   Garden In A Box participants save 5,000 gallons on average per year. Participants use 8 gallons per square foot on their entire landscape per year, exceeding Denver Water's estimate of 12 gallons per square foot needed for xeric landscapes. Compared to turf grass estimations that use 19 gallons per square foot, Garden In A Box participants save 11 gallons of water per square foot.This analysis also showed that participants who purchased more gardens, and those who purchased more than one year during the study period showed an upward trend in water savings.

2. What does a typical Garden In A Box customer look like, and what are their opinions, preferences, and values when it comes to landscapes?

   Garden In A Box appeals to a wide variety of participants in various age groups and LifeMode Groups. It aligns with people's values and aligns with shifts in perceptions and preferences away from fully turf landscapes. This is shown through the survey results and the intensifying hot spot analysis. Participants want a convenient program that beautifies their landscape, creates habitat for pollinators, is easy to install themselves, and reduces the need for chemical treatments. The program continues to grow year over year.

3. What other benefits (if any) does Garden In A Box provide?

   Garden In A Box provides benefits in other ways than just reducing outdoor water use. It helps create and connect fragmented pollinator habitats, and contributes to lower chemical usage on landscapes. It is helping participants conserve across their entire landscape, and change how people think about and interact with their landscapes. Almost 20% of survey respondents heard about Garden In A Box through word of mouth. People are talking about Garden In A Box.

   "A benefit of Garden In A Box is that it gets people in conversation about saving water and planting pollinator habitat and that effect has a positive impact on an ecosystem." (Interview with Andrea Montoya of Pollinator Advocate Program)

It should be noted not all water savings can be explained by Garden In A Box, other factors such as turf removal, type of irrigation systems, reactions to weather, etc. may also affect the

amount of water saved. The water usage records were limited to 5 cities on the front range, but the methodology can be applied to other cities and is a good estimate of water savings.

The year 2020 is included in this analysis. 2020 was an exceptionally hot and dry year which, compounded with COVID-19 stay at home orders, may have led to some participants increasing their water use and reducing savings. It is widely recognized within the industry that higher than average water use across Colorado in 2020 can be attributed to a combination of these factors and our analysis reflects this perception.

While Garden In A Box may not be the sole reason for water savings, it is a catalyst for landscape transformation and helps contribute to more awareness of outdoor water use, while conserving across the entire landscape and changing landscape practices and preferences. Garden In A Box provides benefits to the community beyond water savings by creating pollinator habitat, initiating conversations about climate and landscape transformation, and reducing chemical treatments on landscapes.

Conclusion

Garden In A Box participants save water, create habitat for pollinators and other wildlife, reduce the application of chemicals, and are leading the way in what waterwise landscaping looks like in Colorado, and the program keeps growing.

Resource Central is well situated to continue to be a leader in landscape transformation programs in Colorado, expanding into other areas of the state to reach more participants outside of just the Front Range.

Directions for future research include:

- Turf removal at residential scale combined w/ Garden In A Box
- Type and number of pollinators that Garden In A Box attracts.
- High water use households, and more potential for savings.
- Spillover effect, if one person purchases a Garden In A Box, how likely are others to purchase one?
- Water budgets and effects on water bills.
- Income of participants and access to income dependent discounts.
- Landscape breakdown,(turf, rock, patio, garden) type of Garden In A Box installed.

Appendix

The full survey can be viewed here.

Survey Question 10

Number	Question	Ranking/Weight							
		SD	D	N	A	SA	N/A		
		-2	-1	0	1	2		Total Responses	Rating Average
1	My neighborhood has mostly turf grass landscapes.	156	192	215	1057	1253	21	2894	1.06
2	I know how to maintain turf grass (mowing, fertilizing, etc.).	99	229	378	1252	860	74	2892	0.90
3	I know how to plant and maintain perennial plants (weeding, trimming, etc.).	33	218	361	1348	925	7	2888	1.01
4	I know how to navigate my HOA's landscape policies.	42	95	202	400	366	1783	2888	0.86
5	I prefer to hire someone else to maintain/plant	1021	1012	422	244	95	94	2888	-0.94

	my landscape.								
6	I know how to remove or change my current landscape myself.	144	457	513	1089	646	39	2888	0.57
7	I prefer to hire someone else to remove or change my current landscape.	621	703	536	647	282	99	2888	-0.26
8	I regularly use chemical treatments on my landscape (pest deterrent, fertilization, etc.)	1206	740	404	430	82	32	2894	-0.89

LifeMode Groups (ESRI Tapestry Segmentation):

- LifeMode 1 Affluent Estates
- LifeMode 2 Upscale Avenues
- LifeMode 3 Uptown Individuals
- LifeMode 4 Family Landscapes
- LifeMode 5 GenXurban
- LifeMode 6 Cozy Country Living
- LifeMode 7 Sprouting Explorers
- LifeMode 8 Middle Ground
- LifeMode 9 Senior Styles
- LifeMode 10 Rustic Outposts
- LifeMode 11 Midtown Singles
- LifeMode 12 Hometown
- LifeMode 13 Next Wave
- LifeMode 14 Scholars and Patriots

Emerging Hot Spot Definitions (learn more here):

- Persistent Cold- A location that has been a statistically significant cold spot for 90 percent of the time-step intervals with no discernible trend in the intensity of clustering of counts over time.

- Diminishing Cold - A location that has been a statistically significant cold spot for 90 percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of low counts in each time step is decreasing overall and that decrease is statistically significant.
- Historical Cold- The most recent time-period is not cold, but at least 90 percent of the time-step intervals have been statistically significant cold spots.
- New Hot - A location that is a statistically significant hot spot for the final time step and has never been a statistically significant hot spot before.
- Consecutive Hot - A location with a single uninterrupted run of at least two statistically significant hot spot bins in the final time-step intervals. The location has never been a statistically significant hot spot prior to the final hot spot run and less than 90 percent of all bins are statistically significant hot spots.
- Intensifying Hot - A location that has been a statistically significant hot spot for 90 percent of the time-step intervals, including the final time step. In addition, the intensity of clustering of high counts in each time step is increasing overall and that increase is statistically significant.

Work Cited

Abraham, S., Kammeyer, C., & Cooley, H. (2020). *Sustainable Landscapes in California: A Guidebook for Commercial and Industrial Site Managers*. www.pacinst.org.

Addink, S. (2005). *"Cash for Grass"- A Cost Effective Method to Conserve Landscape Water?*

A&N Technical Services, Maureen Erbeznik & Associates, & Sligo Creek Resources. (2018). *Landscape Transformation Study: 2018 ANALYTICS REPORT*. www.allianceforwaterefficiency.org

Andrade, R., Hondula, D. M., Larson, K. L., & Lerman, S. B. (2021). Landscaping preferences influence neighborhood satisfaction and yard management decisions. *Urban Forestry and Urban Greening*, *59*. https://doi.org/10.1016/j.ufug.2021.126983

Arbués, F., García-Valiñas, M. Á., & Martínez-Espiñeira, R. (2003). Estimation of residential water demand: A state-of-the-art review. *Journal of Socio-Economics*, *32*(1), 81–102. https://doi.org/10.1016/S1053-5357(03)00005-2

Baerenklau, K. A., Schwabe, K. A., & Dinar, A. (2014). The Residential Water Demand Effect of Increasing Block Rate Water Budgets. *Land Economics*, *90*(4), 683–699. https://escholarship.org/uc/item/89r3b05w

Barnett, M. J., Jackson-Smith, D., Endter-Wada, J., & Haeffner, M. (2020). A multilevel analysis of the drivers of household water consumption in a semi-arid region. *Science of the Total Environment*, *712*. https://doi.org/10.1016/j.scitotenv.2019.136489

BBC Research & Consulting. (2024). *Updated 2024 Exploratory Analysis of Potential Water Savings, Costs and Benefits of Turf Replacement in Colorado*. www.bbcresearch.com

Bowen Collins & Associates, & Hansen Allen and Luce Inc. (2018). *State of Utah Water Use Data Collection Program*.

Brelsford, C., & Abbott, J. K. (2017). Growing into Water Conservation? Decomposing the Drivers of Reduced Water Consumption in Las Vegas, NV. *Ecological Economics*, *133*, 99–110. https://doi.org/10.1016/j.ecolecon.2016.10.012

Brelsford, C., & Abbott, J. K. (2021). How smart are 'Water Smart Landscapes'? *Journal of Environmental Economics and Management*, *106*. https://doi.org/10.1016/j.jeem.2020.102402

Brelsford, C., & De Bacco, C. (2018). Are `Water Smart Landscapes' Contagious? An epidemic approach on networks to study peer effects. *Networks and Spatial Economics* , *18*, 577–613. http://arxiv.org/abs/1801.10516

Brent, D. A., Cook, J. H., & Olsen, S. (2015). Social comparisons, household water use, and participation in utility conservation programs: Evidence from three randomized

trials. *Journal of the Association of Environmental and Resource Economists*, *2*(4), 597–627. https://doi.org/10.1086/683427

Breyer, B., & Chang, H. (2014). Urban water consumption and weather variation in the Portland, Oregon metropolitan area. *Urban Climate*, *9*, 1–18. https://doi.org/10.1016/j.uclim.2014.05.001

Brown, O., Wood, D., Gulliver, M., & Graves, A. (2021). *CARBON CARBON FARMING FARMING TOOLKIT*.

Champine, V. M., Jones, M. S., Lischka, S., Vaske, J. J., & Niemiec, R. M. (2022). Understanding individual and diffusion behaviors related to native plant gardening. *Journal of Environmental Psychology*, *81*. https://doi.org/10.1016/j.jenvp.2022.101798

Colorado Water Conservation Board. (2023). *Colorado Water Plan*.

Colorado WaterWise. (2010). *Guidebook of Best Practices for Municipal Water Conservation in Colorado Water Conservation in Colorado Technical Guide*.

DeOreo, W. B., Mayer, P. W., Dziegielewski, B., & Kiefer, J. (2016). *Residential End Uses of Water, Version 2 : Executive Report*. Water Research Foundation .

Dieter, C., Maupin, M., Caldwell, R., Harris, M., Ivahneko, T., Lovelace, J., Barber, N., & Linsey, K. (2018). *Estimated Use of Water in the United States in 2015*.

Diringer, S., & Shimabuku, M. (2021). *Stacked Incentives: Co-Funding Water Customer Incentive Programs*. www.pacinst.org.

Donnelly, K., & Cooley, H. (2015). *Water Use Trends in the United States*. http://pacinst.org/publication/water-use-trends-in-the-united-states

Endter-Wada, J., Kurtzman, J., Keenan, S. P., Kjelgren, R. K., & Neale, C. M. U. (2008). Situational waste in landscape watering: Residential and business water use in an urban Utah community. *Journal of the American Water Resources Association*, *44*(4), 902–920. https://doi.org/10.1111/j.1752-1688.2008.00190.x

Farag, F. A., Neale, C. M. U., Kjelgren, R. K., & Endter-Wada, J. (2011). Quantifying urban landscape water conservation potential using high resolution remote sensing and GIS. *Photogrammetric Engineering and Remote Sensing*, *77*(11), 1113–1122. https://doi.org/10.14358/PERS.77.11.1113

Feinglas, S., Gray, C., & Mayer, P. (2013). *Conservation Limits Rate Increases for a Colorado Utility*.

Gillis, A. J., & Swim, J. K. (2020). Adding native plants to home landscapes: The roles of attitudes, social norms, and situational strength. *Journal of Environmental Psychology*, *72*. https://doi.org/10.1016/j.jenvp.2020.101519

Kenney, D. S., Klein, R. A., & Clark, M. P. (2004). Use and effectiveness of municipal water restrictions during drought in Colorado. *Journal of the American Water Resources Association*, *40*(1), 77–87. https://doi.org/10.1111/j.1752-1688.2004.tb01011.x

Kirk, Jessica. Tap. (2019). How Much Water Does Your Landscape Actually Need, Summer Water use reports help customers understand how efficient they are with outdoor watering. www.denverwater.org

Koch, C., Koehler, C., Arling, V., Belanger, L., Berggren, J., & Rogers, L. (2022). *FINANCING THE FUTURE: How to Pay for Turf Replacement in Colorado*.

Larson, K. L., Andrade, R., Nelson, K. C., Wheeler, M. M., Engebreston, J. M., Hall, S. J., Avolio, M. L., Groffman, P. M., Grove, M., Heffernan, J. B., Hobbie, S. E., Lerman, S. B., Locke, D. H., Neill, C., Chowdhury, R. R., & Trammell, T. L. E. (2020). Municipal regulation of residential landscapes across US cities: Patterns and implications for landscape sustainability. *Journal of Environmental Management*, *275*. https://doi.org/10.1016/j.jenvman.2020.111132

Larson, K. L., Hoffman, J., & Ripplinger, J. (2017). Legacy effects and landscape choices in a desert city. *Landscape and Urban Planning*, *165*, 22–29. https://doi.org/10.1016/j.landurbplan.2017.04.014

Neel, R., Sadalla, E., Berlin, A., Ledlow, S., & Neufeld, S. (2014). The social symbolism of water-conserving landscaping. *Journal of Environmental Psychology*, *40*, 49–56. https://doi.org/10.1016/j.jenvp.2014.04.003

Saher, R., Stephen, H., & Ahmad, S. (2022). Role of Urban Landscapes in Changing the Irrigation Water Requirements in Arid Climate. *Geosciences*, *13*(1), 14. https://doi.org/10.3390/geosciences13010014

Saurí, D. (2013). Water conservation: Theory and evidence in urban areas of the developed world. *Annual Review of Environment and Resources*, *38*, 227–248. https://doi.org/10.1146/annurev-environ-013113-142651

Shimabuku, M., Stellar, D., & Mayer, P. (2016). Impact evaluation of residential irrigation audits on water conservation in Colorado. *Journal - American Water Works Association*, *108*(5), E299–E309. https://doi.org/10.5942/jawwa.2016.108.0076

Sovocool, K. A. (2005). *Xeriscape Conversion Study Final Report*.

St Hilaire, R., Arnold, M. A., Wilkerson, D. C., Devitt, D. A., Hurd, B. H., Lesikar, B. J., Martin, C. A., McDonald, G. V, Morris, R. L., Pittenger, D. R., Shaw, D. A., & Zoldoske, D. F. (2008). Efficient Water Use in Residential Urban Landscapes. *HORTSCIENCE*, *43*(7), 2081–2092.

Torpey, H. (2017). *Spatiotemporal Spillover in Turf Replacement Rebate Programs in Long Beach, California* [University of Southern California]. https://doi.org/10.13140/RG.2.2.11111.75685

Tull, C., Schmitt, E., & Atwater, P. (2016). How Much Water Does Turf Removal Save? Applying Bayesian Structural Time-Series to California Residential Water Demand. *KDD Workshop on Data Science for Food, Energy and Water,* 189–190. https://doi.org/10.1145/1235

Urban Landscape Conservation Task Force. (2024). *URBAN LANDSCAPE CONSERVATION TASK FORCE FINAL REPORT*.

Wang, J., & Chermak, J. M. (2021). Is less always more? Conservation, efficiency and water education programs. *Ecological Economics*, *184*. https://doi.org/10.1016/j.ecolecon.2021.106994

Warner, L. A., Lamm, A. J., Rumble, J. N., Martin, E. T., & Cantrell, R. (2016). Classifying Residents who use Landscape Irrigation: Implications for Encouraging Water Conservation Behavior. *Environmental Management*, *58*(2), 238–253. https://doi.org/10.1007/s00267-016-0706-2

Warner, L. A., Lamm, A. J., & Silvert, C. (2020). Diffusion of water-saving irrigation innovations in Florida's urban residential landscapes. *Urban Forestry and Urban Greening*, *47*. https://doi.org/10.1016/j.ufug.2019.126540

Warner, L. A., Rumble, J., Martin, E., Lamm, A. J., & Cantrell, R. (2015). The Effect of Strategic Message Selection on Residents' Intent to Conserve Water in the Landscape. *Journal of Agricultural Education*, *56*(4), 59–74. https://doi.org/10.5032/jae.2015.04059

Western Resource Advocates and Waternow Alliance. (2022). *Enhancing Greeley's Water Efficiency Portfolio through Performance Analysis*.