

# ARGOSY RESEARCH BRIEF: XERISCAPING

## ABSTRACT

01.09.2008

While over half of the water consumed by American households is used for landscaping, consumption by households is only about seven percent of total consumption (agriculture consumes about 85 percent). Xeriscaping is a landscaping technique that uses indigenous plants, reduced or no turf, and careful planning to reduce landscape water usage. A review of multiple empirical studies finds that xeriscaping can, often substantially, reduce landscaping water usage. Some well-regarded xeriscaping incentive programs are described in this brief; typically these programs offer financial incentives in return for converting turf to xeriscaping.

## Landscape Water Usage

- Water usage is typically described using one of two measures:<sup>1</sup>
  - Water withdrawals: “water removed from a source and used for human needs; some of this water may be returned to the original source with changes in the quantity and quality of the water”
  - Water consumption: “water withdrawn from a source and made unavailable for reuse in the same basin”
- Only a fraction of water withdrawn is actually consumed (e.g. much of the water used by power plants is often returned to the same source); for example, about 29 percent of freshwater withdrawals were consumed in the U.S in 1995<sup>2</sup>
- There are substantial regional differences in water consumption rates: in 1995, freshwater consumption in the Eastern U.S. was only about 12 percent of freshwater withdrawals, while in the Western U.S. consumption was about 47 percent of withdrawals due to more agricultural irrigation<sup>3</sup>
- The biggest water consumers in the United States in 1995 were agricultural irrigation/livestock (84.6 percent), domestic (6.7 percent), industrial/mining (4.1 percent), thermoelectric (3.3 percent), and commercial (1.3 percent); landscaping is part of domestic, i.e. household usage<sup>4</sup> (see Figure 1)
- In 1995, the biggest water consumer in five southwestern states (Nevada, Utah, Colorado, Arizona, and New Mexico) was agriculture/livestock (88.3 percent) followed by domestic including landscaping (5.7 percent)<sup>5</sup>
- The portion of domestic/household water that is used for landscaping varies by region and season; typically studies estimate landscape water usage by subtracting average usage in winter from average summer usage, but this may lead to inaccurate estimates<sup>6</sup>
- Relying on very accurate estimates of indoor and total water usage, one recent study estimated that roughly 59 percent of household withdrawals are used outdoors, mostly for landscaping (see Figure 2)<sup>7</sup>

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<sup>1</sup> Peter Gleick. 2003. “Water Use.” *Annual Review of Environmental Resources*, p. 278.

<sup>2</sup> Although water usage data exists for 2000, the data is not broken down into as many categories and consequently it is not possible to obtain household usage. Data from 2005 has not yet been released. Wayne Solley, Robert Pierce, and Howard Perlman. 1998. “Estimated Use of Water in the United States in 1995.” U.S. Geological Survey.

<sup>3</sup> Wayne Solley, Robert Pierce, and Howard Perlman. 1998. “Estimated Use of Water in the United States in 1995.” U.S. Geological Survey, p. 6.

<sup>4</sup> “Domestic” water is basically water consumed by households. Agriculture/livestock also includes water used to irrigate recreational space (e.g. golf courses). Wayne Solley, Robert Pierce, and Howard Perlman. 1998. “Estimated Use of Water in the United States in 1995.” U.S. Geological Survey, pp. 19, 27, and 31.

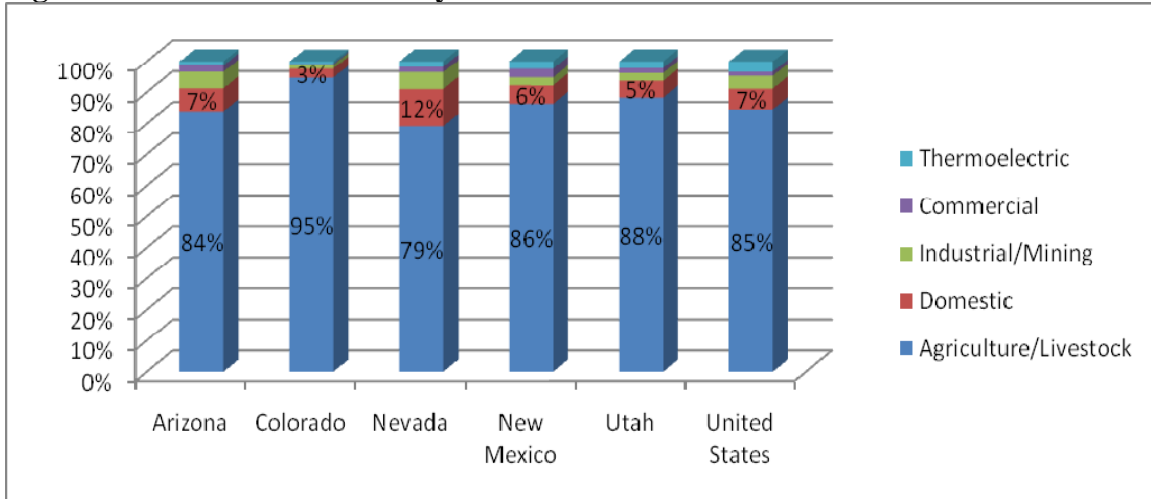
<sup>5</sup> Wayne Solley, Robert Pierce, and Howard Perlman. 1998. “Estimated Use of Water in the United States in 1995.” U.S. Geological Survey, pp. 11 and 23.

<sup>6</sup> Many households regularly water their landscapes in the winter, and thus this method underestimates the amount of water used in landscaping.

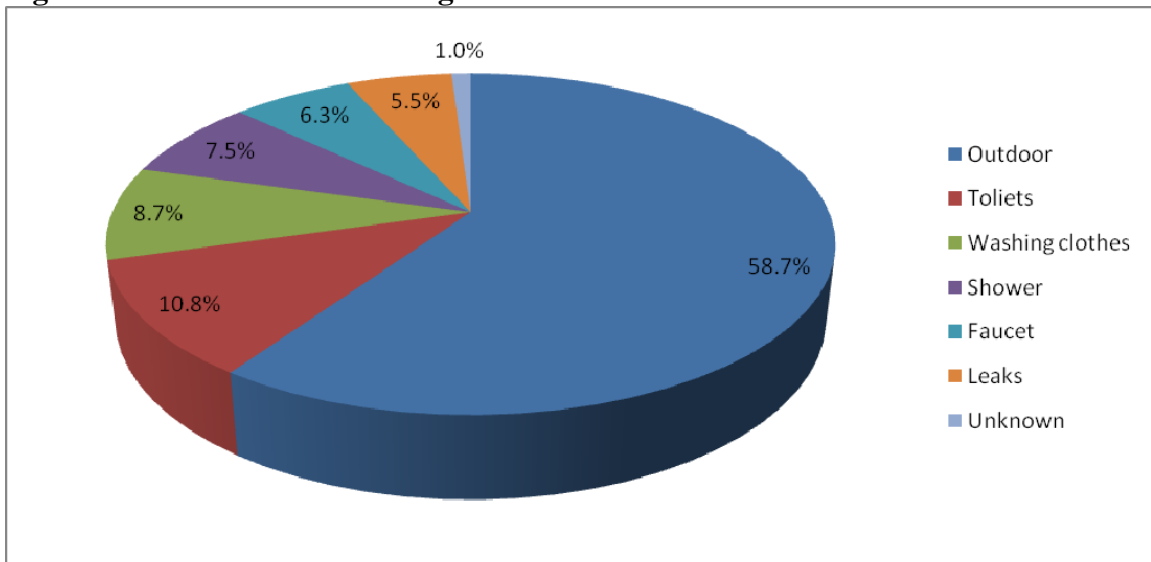
<sup>7</sup> The sample from this study was drawn from 12 North American sites, 9 of them located in the American West. The data was collected from about 1200 single-family homes between 1996 and 1998. The study measured indoor water usage using compact data loggers and total usage using water meters. Although the study did measure outdoor usage, the data was collected over a period

- Multiplying the percentage of water consumed by households nationally (6.7 percent) by the percentage of household use that occurs outdoors (59 percent) leads to an estimate that about 4 percent of consumed water is used by landscaping; obviously this is a rough approximation and the actual percentage will vary significantly by region

**Figure 1: Water Withdrawals by Sector in 1995**



**Figure 2: Household Water Usage**



of four weeks (two summer/winter) and as outdoor usage can vary significantly, this was too short a period to provide accurate estimates. Outdoor usage in this study includes lawns, gardens, and other uses (e.g. pools). Peter Mayer, et al. 1999. "Residential End Uses of Water."

## Background

- Lawns originated in the 17<sup>th</sup> and 18<sup>th</sup> centuries in France and especially Great Britain where they were well-suited to the climate; cultivating lawns around houses did not become common in the United States until after the Civil War<sup>8</sup>
- The word “xeriscape” (created by combining xeros, Greek for "dry," with landscape) and the xeriscape logo were created by Denver Water in 1981, and are registered trademarks of Denver’s water department<sup>9</sup>
- The water-conserving techniques underlying xeriscaping are and have been well-known; xeriscaping did not invent any techniques but instead provided an easy, comprehensive landscaping method that utilizes less water
- Basically, xeriscaping is a type of landscaping that aims to conserve water and protect the environment using: planning, adaptation to the local environment, mulch, indigenous plants, and efficient irrigation; unlike some other water-efficient landscapes, xeriscaping also heavily emphasizes aesthetics<sup>10</sup>
- Water conserving landscapes often go by names such as SmartScape, etc., and in practice these methods are very similar to xeriscape; however, xeriscaping is different from:
  - *Natural Landscaping*: reduces or eliminates watering<sup>11</sup> by only using indigenous plants and trees that have adapted to local climate (xeriscaping encourages, but does not require, the use of native plants, and xeriscape allows some turf); natural landscaping also prohibits pesticides and fertilizer (both can be used under xeriscaping, although they need not be)<sup>12</sup>
  - *Zeroscaping*: a landscaping method that uses more rocks, gravel and sculptures and fewer plants; the plants that are used are native or drought resistant and thus this landscaping uses very little water, but critics claim that zeroscaping is not aesthetically practical for many homes<sup>13</sup>

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<sup>8</sup> Herbert Bormann, Diana Balmori, and Gordon Geballe. 1993. *Redesigning the American Lawn: A Search for Environmental Harmony*. The authors conclude that in the United States the lawn was “able to overcome naturally occurring environmental barriers” through “entrepreneurialism” and “commercialism,” p. 31.

<sup>9</sup> It should be noted that xeriscaping can be used throughout the United States. “In nearly every region of the country there is a need for xeriscape...most of the country may be subject to at least the occasional drought... This contradicts a common misperception about xeriscape landscaping—that it is necessary only in the arid West.” Connie Ellefson, Tom Stephens, and Doug Welsh. 1992. *Xeriscape Gardening: Water Conservation for the American Landscape*, p. 5.

<sup>10</sup> For example, one book states “if it isn’t beautiful, it isn’t a xeriscape landscape.” Connie Ellefson, Tom Stephens, and Doug Welsh. 1992. *Xeriscape Gardening: Water Conservation for the American Landscape*, p. 4.

<sup>11</sup> Some watering may be needed due to urban environment (e.g. shade from buildings) or because even plants that are indigenous to a region may not grow well in all areas within that region.

<sup>12</sup> “There are those who now consider Xeriscape to be outdated or not ecologically sustainable, in part because its principles accept a reliance on supplemental irrigation, the use of landscape chemicals, and the establishment of non-native plants.” Amy Vickers. 2001. *Handbook of Water Use and Conservation*, p. 147.

<sup>13</sup> This concept is not well established. In fact, it is apparently often used either by people who mean xeriscaping (since xeriscaping is actually pronounced “zeriscaping”) or by xeriscapers who want to establish that xeriscaping is not bland or just artfully arranged rocks and gravel.

## Seven Principles of Xeriscaping<sup>14</sup>

1. *Planning and Design*: adapt plantings to different sun and water exposures and existing structures
2. *Soil Improvements*: often not necessary with native plants
3. *Efficient Irrigation*: optimally including rain-shutoff device and drip irrigation
4. *Zoning of Plants*: group together plants with similar light and water requirements, and locate them in areas that match these requirements
5. *Mulches*: typically organic mulches (e.g. wood chips); gravel should be limited as it can retain and radiate heat
6. *Turf Alternatives*: turf is minimized (some turf is allowed for recreational or aesthetic reasons) and the use of native grasses is encouraged
7. *Appropriate Maintenance*: amount usually declines after first and/or second year

## Xeriscaping's Impact on Water Usage

- A review of the relevant literature was conducted; results are summarized below (see Appendix for search procedure and summaries of individual studies)
- All identified studies found that landscapes converted to xeriscaping required less water or that xeriscaping was associated with lower water consumption; the studies either evaluated the effect of converting turf to xeriscaping or correlated water use with landscaping type<sup>15</sup>
- The most methodologically rigorous study found that conversion to xeriscaping lowered landscaping water use by up to 76 percent and that significant savings persisted three years after conversion; the best correlational study found that xeriscape is associated with up to a 30 percent reduction in water consumption<sup>16</sup>
- Unfortunately, none of these studies randomly assigned participants to use xeriscaping or traditional landscaping, and thus while the studies provide some

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<sup>14</sup> In practice, xeriscaping will vary dramatically depending on the local climate, i.e. plants that are ideal for Arizona may not grow well in Georgia and vice versa. The list of principles was obtained from: [http://www.denverwater.org/cons\\_xeriscape/xeriscape/xeriscapeprinciples.html](http://www.denverwater.org/cons_xeriscape/xeriscape/xeriscapeprinciples.html)

<sup>15</sup> A defender of turf might argue that these differences result from a poor choice of turf species, inappropriate landscaping, and overwatering (i.e. lawns per se are not the problem, but certain lawn practices are problematic). For example, during drought or hot periods in the summer, turf should be allowed to go dormant and turn "tan to golden brown" which will substantially decrease water usage. James Beard and Robert Green. 1994. "The Role of Turfgrasses in Environmental Protection and their Benefits to Humans." *Journal of Environmental Quality*. While this strategy may mitigate such differences, experience seems to indicate that many homeowners would be reluctant to allow their grass to turn brown in the summer. However, even critics of what they label the "industrial lawn" believe that the environmental impact of some turf can be overwhelmingly mitigated in the form of a "freedom lawn" that encompasses multiple species including weeds and is not always green or mowed. Herbert Bormann, Diana, Balmori, and Gordon Geballe. 1993. *Redesigning the American Lawn: A Search for Environmental Harmony*.

<sup>16</sup> The 76 percent figure refers to a Nevada program, and these amounts should not be used to extrapolate to xeriscaping programs in different climates or with different types of xeriscaping.

- good evidence that xeriscaping reduces water consumption, the evidence is not conclusive<sup>17</sup>
- Estimates about the maintenance cost of converted xeriscaping were mixed; one study estimated that the annual household cost of maintaining xeriscaping was about \$200 less than traditional landscaping, but another study found annual xeriscaping maintenance costs were over \$300 more than traditional landscapes
  - Surveys found that strong majorities of the participating households “very much” liked their xeriscape
  - The importance of rebates varied: 56 to 83 percent of respondents in Colorado stated that they would have installed their xeriscape without a rebate, while only 22 percent of the North Dakota respondents responded the same
  - To attract xeriscaping participants, governments had to extensively promote xeriscaping (e.g. mailings and flyers, newspaper and television advertisements, an informational video, etc.)
  - One study concludes that xeriscaping incentives are relatively expensive, with the cost of saving one acre-foot of water estimated to be between \$512-\$1,834 depending on the program;<sup>18</sup> however, these estimates are likely very sensitive to the assumptions of the model and the amounts might be very different with slightly different, and equally reasonable, assumptions
  - Overall, with proper education and maintenance, the current data indicates that a xeriscaping program could be expected to provide communities with a relatively effective method of reducing landscaping water use; obviously, the magnitude of the reduction will depend on the program parameters and implementation

### **Other Impacts from Xeriscaping**

- Xeriscape obviously would not be able to replace turf on athletic fields, golf courses, and other areas that require a soft surface that provides traction
- Turf can have many positive impacts such as controlling erosion, reducing runoff, firebreak, and dissipating urban heat;<sup>19</sup> appropriately designed, xeriscaping can fulfill similar roles

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<sup>17</sup> The conversion studies provide good evidence of xeriscaping’s potential, although it is possible that households that chose to adopt xeriscaping could have simultaneously adopted other water conservation measures that caused most of the reduction in water usage. However, this seems unlikely as one study found that post-conversion indoor water use among xeriscaped and non-xeriscaped households was almost the same. The correlational studies are more problematic because it seems likely that households that would voluntarily chose to xeriscape would also be more conservation-minded households and thus this tendency, rather than xeriscaping itself, could cause the correlation between xeriscaping and water savings. With both types of studies it is possible that xeriscaping causes individuals to pay closer attention to the amount of water used in landscaping, and if this closer attention was paid to turf landscaping water usage (turf is often overwatered), the differences between xeriscaping and turf might be smaller or nonexistent.

<sup>18</sup> An acre-foot is the amount of water it takes to fill one acre one foot deep. It does not appear that this article was peer-reviewed and there is not other validation of these estimates. Sylvan Addink. “Cash for Grass’—A Cost Effective Method to Conserve Landscape Water.”

<sup>19</sup> James Beard and Robert Green. 1994. “The Role of Turfgrasses in Environmental Protection and their Benefits to Humans.” *Journal of Environmental Quality*.

- Xeriscaping uses plants that are indigenous and appropriately zoned, and can thus reduce or eliminate the use of pesticides<sup>20</sup> and fertilizers<sup>21</sup>
  - In 2002, one survey estimated that 31.5 million U.S. households purchased “weed and feed” (fertilizer plus herbicide ) for their lawns<sup>22</sup>
  - In 2001, the EPA estimated that 102 million pounds of herbicides, insecticides, fungicides, and other pesticides were used in the “home and garden” category<sup>23</sup>
  - In 2002, one survey estimated that 51 million households purchased pesticides, herbicides, and fungicides for their lawns and gardens<sup>24</sup>

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<sup>20</sup> Another benefit of decreasing turf is that xeriscaping can provide a better habitat for indigenous species. Some cities, Toronto for example, have banned the use of pesticides on lawns. [http://www.toronto.ca/health/pesticides/bylaw\\_qa.htm](http://www.toronto.ca/health/pesticides/bylaw_qa.htm). One study found that individuals and pets can track lawn pesticides indoors, although not at levels that are considered hazardous. Marcia Nishioka, et al. 2001. “Distribution of 2,4-D in Air and on Surfaces Inside Residences after Lawn Application: Comparing Exposure Estimates from Various Media for Young Children.” *Environmental Health Perspectives*.

<sup>21</sup> Most lawn fertilizers contain nitrogen, and often in lesser quantities phosphorus and potassium. Fertilizer that is excessively applied can lead to nitrogen runoff/leaching and subsequent environmental problems (e.g. algae blooms, polluted groundwater, etc.). Many studies have concluded that, properly applied, nitrogen leaching from lawns poses little threat to the environment, with the precise amount of nitrogen leaching depending on factors like type of fertilizer, type of turf, irrigation amount, when irrigation occurs, etc. However, high nitrogen fertilization can lead to leaching in excess of EPA standards. Kevin Frank, Kevin O’Reilly, James Crum, and Ronald Calhoun. 2006. “The Fate if Nitrogen Applied to Mature Kentucky Bluegrass Turf.” *Crop Science*. D. Bowman, C. Cherney, and T. Ruffy. 2002. “Fate and Transport of Nitrogen Applied to Six Warm-Season Turfgrasses.” *Crop Science*. See also, James Beard and Robert Green. 1994. “The Role of Turfgrasses in Environmental Protection and their Benefits to Humans.” *Journal of Environmental Quality*. One experimental study compared nitrogen leaching/runoff in landscapes planted with St. Augustine to landscapes planted with a mixed-species landscape including indigenous plants. The study found no significant nitrogen runoff from either landscape but that the mixed-species landscape had significantly more nitrogen leaching. J. Erikson, J. Cisar, J. Volin, and G. Snyder. 2001. “Comparing Nitrogen Runoff and Leaching between Newly Established St. Augustine Turf and an Alternative Residential Landscape.” *Crop Science*.

<sup>22</sup> The survey did not distinguish between fertilizer purchased for lawns or purchased for gardens, however, “weed and feed” is typically used for lawns. The survey also measured other types of fertilizer purchases and estimated that: 22.9 million households bought dry chemical fertilizer, 22.1 million bought water soluble fertilizer, 11 million purchased manure, 7.7 million purchased natural/organic fertilizer, and 6.8 million purchased blood/bone meal/rock power. An unknown portion of these fertilizers would be used on lawns. National Gardening Association. 2003. *National Gardening Survey: 2002*, p. 85.

<sup>23</sup> Obviously, this category encompasses much more than just landscapes, and includes indoor and garden use. The weights refer to the active ingredient in the pesticides. The 102 million can be broke down into used a total of 71 million pounds of herbicides, 17 million pounds of insecticides, 12 million pounds of fungicides, with the remainder in “other.” Timothy Kiely, David Donaldson, and Arthur Grube. 2004. “Pesticides Industry Sales and Usage: 2000 and 2001 Market Estimates.” U.S. Environmental Protection Agency.

<sup>24</sup> This can be broken down into the following categories (some household purchased more than one category): 30.6 million households bought ready-to-use pesticides, 15.3 million households

- By reducing turf area, xeriscaping would almost certainly result in less air pollution,<sup>25</sup> noise pollution, and injuries<sup>26</sup> from lawn mowing

### **Xeriscape Incentive Programs<sup>27</sup>**

*Southern Nevada Water Authority Water Smart Landscapes (Las Vegas)*<sup>28</sup>

- SNWA awards check for converting grass to xeriscape; customers receive \$2 per square foot of grass removed and replaced with xeriscape for the first 1,500 square feet and \$1 per additional square foot
- Homeowners submit an online application, and an inspector does a pre-conversion site visit; homeowners have six months from the date of the site visit to complete the conversion and schedule a post-conversion site visit
- About 25,000 xeriscape conversions have been completed since program inception,<sup>29</sup> and in 2007 there have been over 9,000 conversions through October; roughly 70-80 percent of the applicants complete the process<sup>30</sup>
- In terms of scale, this is a very large and successful program;<sup>31</sup> since 2000, the program has converted about 33.3 million residential square feet and 61 million commercial square feet for a total rebate cost of about \$97.9 million<sup>32</sup>

bought water-soluble pesticides, 11.9 million bought chemical-dust pesticides, 13.6 million bought herbicides, 7.7 million bought fungicides, and 11 million bought natural and less toxic pest control. An unknown portion of these pesticides/herbicides/fungicides would be used on lawns. National Gardening Association. 2003. "National Gardening Survey: 2002," p. 87.

<sup>25</sup> In proposing recent new regulations for lawnmowers, the EPA found that they are a "significant source of mobile source air pollution" including volatile organic compounds, particulate matter smaller than 2.5 micrometers, nitrogen oxide, and other air toxics. U.S. Environmental Protection Agency. 2007. "Control of Emissions from Marine SI and Small SI Engines, Vessels, and Equipment." Draft Regulatory Impact Analysis, 8.1. It is estimated that turf does reduce the amount of carbon in the atmosphere, but in a very water intensive manner. One study estimated that turf in the lower 48 states had a net ecosystem exchange of 5.9-16.7 teragrams of carbon a year (a teragram is 10,000,000,000 kg). However, this beneficial impact requires tremendous water usage, and the authors mention xeriscaping as a possible water-efficient replacement. Cristina Milesi, Christopher Elvidge, John Dietz, Benjamin Tuttle, and Ramakrishna Remani. 2005. "Mapping and Modeling the Biogeochemical Cycling of Turf Grasses in the United States." *Environmental Management*.

<sup>26</sup> One study finds that about 74,000 people annually seek treatment in emergency rooms for lawnmower injuries. Vanessa Costilla and David Bishai. 2006. "Lawnmower Injuries in the United States: 1996 to 2004." *Annals of Emergency Medicine*.

<sup>27</sup> All these programs provide free information on xeriscaping. Other programs provide some non-financial incentives. For example, Olivenhain Municipal Water District (CA) sponsored a "landscape makeover contest" where households applied to have their xeriscape paid for by the District in return for having their house featured in advertisements and allowing visitors.

<sup>28</sup> [http://www.snwa.com/html/cons\\_wsl.html](http://www.snwa.com/html/cons_wsl.html)

<sup>29</sup> The rate of turf conversion increased dramatically in January 2003 when the SNWA: increased the incentive from 40 cents to \$1 per square foot of turf removed, increased outreach, and provided a cash incentive rather than crediting water bill. Participation declined in 2005 and 2006, although it was still at higher level than prior to 2003. Participation increased again in 2006. Heather Colley, Taryn Hutchins-Cabibi, Michael Cohen, Peter Gleick, and Matthew Heberger. 2007. "Hidden Oasis: Water Conservation and Efficiency in Las Vegas."

<sup>30</sup> Based on data provided by Doug Bennett, SNWA Conservation Manager.

### *Albuquerque/Bernalillo County Water Xeriscape Rebate Program*<sup>33</sup>

- An inspector visits the property and verifies that xeriscape plan meets certain requirements (e.g. plants must be from pre-approved list, no spray sprinklers, etc.); once the conversion has taken place, an inspector verifies that the landscape meets program requirements and the homeowner then receives a rebate on their water bill
- Single-family homeowners are eligible to receive a credit on their water bill of 60 cents for each qualifying square foot up to 2,000 square feet (minimum of 500 square feet must be converted); plans that include a rainwater collection system and use native or xeric plants that are adapted to live on the natural rainfall that occurs in Albuquerque are eligible to receive a \$1.20 per square foot rebate
- Multi-family homes and commercial property are eligible to receive a water credit of 60 cents for each qualifying square foot up to 12,500 square feet (minimum of 500 square feet must be converted)
- The program has helped fund 3,594 conversions since 1996<sup>34</sup> and over 5 million square feet of turf have been converted to xeriscape<sup>35</sup>

### *San Antonio Water System*<sup>36</sup>

- Applicants are visited by a landscape consultant who evaluates the irrigation system and whether the landscape meets program requirements (e.g. no more than 50 percent of the landscape may be planted in turf, etc.); there is no site evaluation to determine whether the xeriscaping is preexisting (i.e. do not need to convert landscape to get incentive)
- Currently, rebates are paid as a credit on water bill with amount based on: landscape size, whether or not there is an irrigation system, and whether or not

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<sup>31</sup> Doug Bennett described some aspects of the program that have been effective. First, good data management systems allow for paperless record keeping (e.g. inspectors all use tablet PCs) and really advance administrative efficiency. Second, the name xeriscape was somewhat confusing, so they changed to “water-smart.” Third, incentives are important to converting old landscaping, but the development code should be changed to keep more water-intensive landscaping from being created (e.g. currently, homeowners associations and commercial businesses cannot use turf for decorative purposes). Fourth, xeriscaping can be portrayed as “upgrading” the property and not just a water conservation tool. Fifth, studies of the impact of xeriscaping are useful as they can be used to convince households of the effectiveness and potential savings from xeriscaping.

<sup>32</sup> It is estimated that the program has saved about 4.5 *billion* gallons of water since 2000. Data provided by Doug Bennett. One recent evaluation of the program concluded: “Despite the initial success of the program, Las Vegas homeowners continue to use a large proportion of their water outdoors... Water utilities can and should expand incentives and education efforts to further reduce outdoor water use.” Heather Colley, Taryn Hutchins-Cabibi, Michael Cohen, Peter Gleick, and Matthew Heberger. 2007. “Hidden Oasis: Water Conservation and Efficiency in Las Vegas.”

<sup>33</sup> <http://www.abcwua.org/waterconservation/xericrebate.html>

<sup>34</sup> The original incentive was 25 cents per square foot. According to program staff, the most effective aspect of the program is an information campaign with a very effective evangelist who not only explains xeriscape but also convinces people that they can xeriscape. Phone call with Katherine Yuhas of ABCWUA Conservation.

<sup>35</sup> Martin Heinrich. November 16, 2007. “Commentary: Flush with Success.” *The Albuquerque Tribune*.

<sup>36</sup> <http://www.saws.org/conservation/h2ome/landscape/>

native landscaping is preserved (for example, a 5,000 square foot lot with no irrigation system would receive a \$225 rebate); if the household reduces water usage over the following year there is also a post-rebate bonus (a gift certificate, between \$38-\$350, to local plant nurseries)

- Since 2003, the program has had a total of 567 participants, of which 341 participants saved enough water to qualify for the bonus<sup>37</sup>
- Beginning in 2008, homeowners will receive a \$100 gift certificate to a local nursery when they apply, with the rebate paid at the end of the year if the household has actually reduced water usage; this change is being made because SAWS has discovered that households that convert to xeriscaping often use excessive water<sup>38</sup>

#### *Other Incentives*

- The most common incentives appear to be financial rewards for converting, along with providing free information through classes or books
- Social pressure can also be extremely effective, for example, turf lawns were originally created on English manors and then, as in many things, the middle class followed the aristocracy; since wealthy people often set trends, it might be productive to begin by encouraging them to xeriscape their landscapes
- Homeowners associations can require xeriscaping<sup>39</sup> and could use xeriscaping in new developments; many cities have implemented regulations to discourage water intensive landscaping

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<sup>37</sup> Email from Dana Nichols, SAWS Conservation.

<sup>38</sup> The program also includes weekly emails that tell households how much to water based on predicted temperatures. Conversation with Dana Nichols, SAWS Conservation.

<sup>39</sup> In 2003, the Colorado legislature passed a resolution urging cities, homeowners associations and subdivision developers to review and change existing laws and covenants that make xeriscaping difficult, as well as a law (HB 03-1001) that prohibits future restrictive covenants limiting the use of xeriscaping. Other jurisdictions, such as Florida and many localities in Nevada, have also passed laws that prohibit homeowners' associations from banning xeriscape. One evaluation finds that active enforcement of regulations is necessary for effectiveness: Western Policy Research. 2001. "Water Efficient Landscape Ordinance: A Statewide Implementation Review."

## **Appendix**

### **Identifying Xeriscaping Studies<sup>40</sup>**

The criteria for including study in literature review are that the study evaluated whether xeriscape conserved water and was conducted in the United States.

#### **Search #1**

*Databases:* Google and Google Scholar,

*Keywords searched:* xeriscape, xeriscaping, xeriscaped, xeriscape conversion, xeriscape conservation, xeriscape study, xeriscape studies, xeriscape benefit, and xeriscape landscaping

#### **Search #2**

*Databases:* UWM Libraries Online Database Meta Search

*Keywords searched:* xeriscape, xeriscaping, xeriscaped, xeriscape water use, xeriscape water conservation, xeriscape study, phoenix xeriscape, conserv 93, awwa proceedings 1993, residential landscape comparison, and landscape rebate program

#### **Search #3**

*Source:* Water departments of Phoenix, Denver, Las Vegas, Austin, and state of Colorado

*Contact Method:* Emailed to find additional xeriscape reports

#### **Search #4**

*Database:* American Water Works Association – The Water Library

*Keywords searched:* xeriscape, xeriscape conservation, and xeriscape study

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<sup>40</sup> A search was also conducted for studies that evaluated whether natural landscaping could reduce water consumption. ISI Web of Science, Google, and Google Scholar were searched using the following keywords: “natural landscape”, “natural landscaping”, “native landscape”, or “native landscaping” combined with one of “water”, “conservation”, “water conservation”, “water use”, “irrigation”, or “water consumption.” In Harmony Sustainable Landscapes, Seattle Tilth, and North American Native Plant Society were contacted to see if they know of any studies. No studies were identified.

## **Appendix**

### **Xeriscaping in California (Study 1)**

#### *Background*

- Conducted by the North Marin Water District in the summer of 1993
- Tested whether homes with xeriscape use significantly less water than homes with traditional landscape

#### *Methods*

- 250 xeriscaped homes<sup>41</sup> were randomly selected by observing houses while driving in neighborhood
- 226 traditionally landscaped homes<sup>42</sup> were identified by matching characteristics to a nearby xeriscaped home, bringing the sample size to 452
- 70 homes were excluded after screening the data,<sup>43</sup> bringing the sample to 382 homes, of which 192 were xeriscaped and 190 were traditionally landscaped<sup>44</sup>
- Measurement
  - Initial water meter readings were taken on July 2 for all 452 homes, and follow-up meter readings were taken on August 9, which provided summer use data for those 38 days
  - A survey was mailed to each home to determine information about the home's backyard landscape and occupants' information; phone calls were made to the homes that did not respond to the mail survey (87 percent overall response rate)
  - Water use for each home during the previous 12 months (July 1992-June 1993) was calculated using water bills; January usage was used to approximate indoor water use

#### *Results*

- Xeriscaped homes used significantly less water, 158 gallons per day (19 percent), in the summer and significantly less water annually, 81 gallons of water per day (17 percent), than the traditionally landscaped homes
- Each additional 100 square feet of irrigated turf area was significantly associated with an increased use of 11.7 gallons of water per day in the summer and 6.0 gallons of water per day annually

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<sup>41</sup> Xeriscaped homes had to meet these criteria: irrigated lawn area made up less than 15 percent of the front yard, vegetation (not necessarily xeriscape), other than turf, had to dominate the landscape, and the landscape appeared to be well maintained

<sup>42</sup> Traditionally landscaped homes had to meet these criteria: irrigated lawn area made up at least 70 percent of the front yard, the home was either next door or within a block of its matching xeriscaped home, and was similar in lot size to the xeriscaped home

<sup>43</sup> These homes were deleted because one house was vacant in January 1993, three houses had a private well, eight houses had incomplete or incorrect water consumption data, and survey data for 58 houses was incomplete.

<sup>44</sup> Of the 192 xeriscaped homes, only 164 xeriscaped homes had a nearby matching traditional home, resulting in 328 pairs.

## **Appendix**

### **Xeriscaping in California (Study 1)**

#### *Comments*

- The study finds that xeriscaping can conserve water, although conversion to xeriscape cannot be evaluated using these results
- The homeowners in the xeriscape group may have been more environmentally conscious, likely since they chose to xeriscape, and that characteristic, not the actual xeriscaping, could explain the lower water consumption in the xeriscaped homes
- The explanatory model was somewhat weak, with adjusted R-squared values of 0.40 and 0.37 for annual water use and summer water use, respectively

*Source:* J. Nelson and J. Kruta, 1994. *Water Saved By Single Family Residences*. 1994 AWWA Annual Conference Proceedings, June. 335-347.

## **Appendix**

### **Xeriscaping in California (Study 2)**

#### *Background*

- Conducted in the East Bay Municipal Utility District (EBMUD) by their Water Conservation Unit (WCU) between June and August 1992
- Designed to compare amount of water used by water-conserving landscapes versus traditional landscapes

#### *Methods*

- 520 homes with water-conserving landscapes<sup>45</sup> were randomly selected by observing houses while driving in neighborhood
- 520 homes with traditional landscapes<sup>46</sup> were individually matched with a conserving home by being located within one or two blocks of the home and having the same lot size as the home
- Measurement
  - While driving throughout the service area, field data was collected on front yard turf area percentage, irrigation system, and lot size for each home
  - July daily water consumption data was collected from customer billing information

#### *Results*

- Homes with water conserving landscapes consumed an average of 286 gallons of water per day, while homes with traditional landscapes consumed an average of 495 gallons of water per day, resulting in a significant savings of 209 gallons per day (42.2 percent)

#### *Comments*

- This study finds that homes with water conserving landscapes are associated with lower water consumption
- The homeowners who had xeriscape could have been more environmentally conscious than those without (a likely possibility, since they chose to xeriscape), which could explain their lower water consumption
- The analysis of water consumption only compared means of the two groups, so it does not account for any other factors that could be associated with differences in water consumption, such as irrigation method or income level

*Source:* D. Bennett, 1993. "Residential Landscape Comparison Study." AWWA *Proceedings of Conserv '93*, December. 1725-1732.

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<sup>45</sup> These homes met the following criteria: 15 or less percent of total yard area was turf, water conserving area composed of well-maintained vegetation, and lot size must be regular and measurable (square or rectangular).

<sup>46</sup> These homes met the following criteria: 70 or more percent of total yard area was turf, turf was well-maintained, and lot size must be regular and measurable.

## Appendix

### Xeriscaping in Colorado

#### *Background*

- Conducted by Metro Water Conservation, Inc. of Denver, Colorado from 1997 to 2002 to estimate the water savings, installation, and annual maintenance costs of xeriscaping; part of the National Xeriscape Demonstration Program
- Seven demonstrations were performed in: Arvada/Wheat Ridge (pre-existing xeriscape<sup>47</sup>, 26 treatments/28 controls), Colorado Springs (retrofit to xeriscape, 27/37), Colorado Springs (new-start xeriscape, 27/32), Denver (retrofit, 34/31), Fort Collins/Loveland (new-start, 34/38), Greeley (retrofit and new-start, 6/4), Highlands Ranch (new-start, 16/17)

#### *Methods*

- Households volunteered to participate in the study and chose whether to xeriscape or retain their current landscaping<sup>48</sup>
  - Xeriscape participants were screened to ensure they would be able to perform their demonstration through the entire study<sup>49</sup>
  - A group of traditional landscape participants was identified after finding out the characteristics of the xeriscape participants and a random sample was contacted to join the control group
  - Participants with similar property and landscape features in each demonstration were paired for comparison
- Measurement
  - Water consumption data was collected by water meter readings provided by the local utilities
  - Outdoor water use was estimated by subtracting the average winter monthly use (January, February, March, November, and December) from water use during the growing season months (April through October)
  - Installation costs were estimated by having the treatment group send in their receipts and keep track of their labor hours (99 percent response rate)
  - Maintenance costs were estimated by having both groups report their maintenance-related expenses and time spent on maintenance, (34 percent response rate)

#### *Results*

- The results indicate, that compared to the control group, households in the xeriscape group significantly reduced their water consumption in five of seven

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<sup>47</sup> The pre-existing xeriscapes were estimated to be at least 5 years older than the landscapes of the other demonstrations.

<sup>48</sup> The study initially intended to randomly assign participants to xeriscaping or not, but this was not possible due to the lack of participants willing to install xeriscape.

<sup>49</sup> These participants had to pay a \$100 commitment fee, and received a \$300 rebate check for a new landscape, or \$600 for a retrofit. They also received design and educational support and discounts on xeriscape plants and materials.

## Appendix

### Xeriscaping in Colorado

- localities, with the reductions ranging from 18 percent in Colorado Springs, to 28 percent in Denver, to 63 percent in Highlands Ranch
- Xeriscaping in Arvada/Wheat Ridge did not yield significant water savings (less than one percent), which suggests savings may decrease with xeriscape aging unless proper maintenance and homeowner education is maintained; Greeley yielded a 54 percent savings, but the small sample size meant there was not enough power to determine whether this result was statistically significant
- Xeriscaping installation costs were estimated to be \$1.36 per square foot and 50 hours of labor per 1,000 square feet for new properties, and \$1.26 per square foot and 59 hours of labor for retrofits
- Maintenance costs tended to be lower for xeriscaping groups in the first three years (\$0.74 per square foot for xeriscape group, \$0.83 per square foot for control group) and lower for control groups in the last three years (\$0.56 per square foot for control group, \$0.71 per square foot for treatment group), suggesting that older xeriscapes may need more maintenance than traditional landscapes

#### *Comments*

- This study finds that xeriscape can conserve water, although it suggests that the water and maintenance cost savings may diminish as landscapes get older
- Difficulties arose in completing sampling needs; Greeley and Highlands Ranch could not obtain an adequate number of participants, and only 58 percent of the xeriscape group completed the study
- The xeriscape group was composed of volunteers, so the water savings in the xeriscape group could be due to those participants being more environmentally conscious
- The study period included 2002, a severe drought year in which the utilities imposed water restrictions, but some still allowed xeriscape owners to water as needed; this caused Colorado Springs xeriscapers to increase their consumption by 50 percent for the new start properties and 34 percent for the retrofit properties, bringing their water savings down from 28 to 18 percent for new-start, and from 32 to 23 percent for retrofitting

*Source:* J. Gumper and J. Medina. 2004. *YARDX: Yield and Reliability Demonstrated in Xeriscape*. Retrieved September 27, 2007 from <http://www.coloradowaterwise.org/documents/YARDXmain.pdf>

## Appendix

### Xeriscaping in North Dakota

#### *Background*

- Conducted by the municipality of Fargo, North Dakota from 1997 to 2002, as part of the National Xeriscape Demonstration Program
- Main goals were to estimate water savings, installation costs, and maintenance costs of xeriscape

#### *Methods*

- Initial sampling plan was to randomly select and assign 70 homeowners from a pool of volunteers into two treatment groups, retrofit<sup>50</sup> and new-start,<sup>51</sup> these homeowners would receive a \$300 rebate check and 2.5 hours of professional landscape design consultation
- There was a low interest in the project, and new-start homeowners were very difficult to find; only 13 participants were enrolled in the new-start treatment group, and 36 retrofit treatment participants were enrolled<sup>52</sup>
- Control group participants were randomly chosen by a computer based on matching characteristics to the treatment participants, and were not informed about the comparison to xeriscape in order to lessen the possibility of influencing water use
- Measurement
  - Monthly main water readings were used to collect data on water usage, and outdoor water use was estimated by subtracting the winter water use (November, December, January, February, and March) from the summer water use (April, May, June, July, August, September, and October)
  - Installation costs were obtained by having treatment participants submit receipts of expenditures related to materials and labor costs (76 percent response rate)
  - Maintenance costs relating to materials and labor were logged by both control and treatment participants over the duration of the study

#### *Results*

- New-start xeriscapes experienced a significant median per month water savings of 0.16 gallons per square foot of landscape (29 percent) compared to the new-start control group
- Retrofit xeriscapes actually significantly increased water use by 0.08 gallons per square foot per month (114 percent) compared to the retrofit control group

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<sup>50</sup> Retrofit group was composed of homeowners who replaced their traditional landscape with xeriscape.

<sup>51</sup> New-start group was composed of homeowners building new houses on their property, and installing xeriscape instead of a traditional landscape.

<sup>52</sup> These participants were not randomly selected. Instead, they volunteered to be part of the treatment group, signed a commitment agreement, and submitted a \$100 participation commitment check.

## Appendix

### Xeriscaping in North Dakota

- New-start average installation cost was \$1.11 per square foot, of which \$0.41 per square foot was attributed to installation of an irrigation system; retrofit average installation cost was \$0.71 per square foot
- Median yearly maintenance costs per property were \$303 more for retrofit xeriscapes than their control counterparts (31 percent higher), and new-start xeriscapes cost \$133 more than their controls (9 percent)

#### *Comments*

- One explanation for the counterintuitive retrofit results is above average rainfall in Fargo during three of the five years; in June 2000, a large storm produced 8 inches of rainfall over 2 hours, which ruined plant beds and this large amount of rainfall is believed to be a major cause of the unexpected water usage numbers, especially in the retrofit groups (due to the abnormally wet climate conditions, the established traditional landscapes could be maintained without additional watering, while the newly retrofitted xeriscapes still needed additional water)
- The homeowners who volunteered to xeriscape may have been more environmentally conscious, likely since they chose to xeriscape, and that characteristic, not the actual xeriscaping, could explain the lower water consumption in the xeriscaped homes
- Difficulties arose in obtaining willing participants to install xeriscape and the rebate had to be raised from \$300 to \$1200, which could have biased the findings
- A final survey found that the xeriscape homeowners tended to be more environmentally conscious than the control homeowners; this disparity, not the act of xeriscaping, could have caused the difference between groups
- Reporting was erratic, with some participants submitting forms at some times and not others, some participants never turning in a report, and very few households turned in every report requested; inaccurate record keeping likely occurred, especially with hours logged spent weeding and thus, the cost calculations were done on only nine of the most commonly answered fields in the maintenance reports

*Source:* A. Lee, and J. Medina. 2006. *Fargo Xeriscape Project*. Retrieved September 28, 2007, from <http://www.cityoffargo.com/attachments/085a3837-2779-406d-8f30-4298f66e43ea/Fargo%20Xeriscape%20Project%20Final%20Report.pdf>

## **Appendix**

### **Xeriscaping in Nevada (Study 1)**

#### *Background*

- Performed by the Southern Nevada Water Authority (SNWA) from 1995 to 2001
- Participants were selected from the water utilities that compose the SNWA: Las Vegas (77 percent of participants in study group), Henderson (12 percent), North Las Vegas (9 percent), and Boulder City (2 percent)

#### *Methods*

- Households volunteered to participate in the study and chose whether to xeriscape or retain their current landscaping
- Three groups were compared: Xeriscape Study Group (XS), Turf Study Group (TS), and Comparison Group (CG)
  - XS Group composed of 472 residents who converted at least 500 square feet of traditional turf grass to xeric landscape or installed new xeric landscaping;<sup>53</sup> average area converted was 2,162 square feet
  - TS Group composed of 253 residents with traditional landscaping; average landscape included 2,462 square feet of traditional turfgrass
  - CG<sup>54</sup> composed of properties in the same neighborhoods and with similar landscape footprints and composition as the TS and pre-conversion XS groups; this non-contacted control group was used to evaluate sampling bias as XS and TS groups were solely homeowners willing to participate
- Measurement
  - XS data was collected by monthly main water meter reading and submeters<sup>55</sup> installed in the xeriscaped portions of lawns
  - TS data was collected by monthly main water meter reading and submeters installed in turf
  - CG data was collected by monthly main water reading
  - Surveys were also sent to participants to measure labor hours and direct costs associated with landscape choices; 300 surveys were returned for a response rate of roughly 41 percent

#### *Results*

- The average annual household savings in the XS group was a statistically significant 96,000 gallons per year (30 percent savings from pre-conversion to post-conversion) and this reduction occurred every year of the study; CG households experienced a much smaller reduction in consumption over the course of the study (13,000 gallons per year or 3 percent)

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<sup>53</sup> These households were given a \$0.45 per square foot incentive to convert, capped at \$900 for 2,000 square feet.

<sup>54</sup> When making comparisons with the XS group, 288 households were included and 179 households were included when comparing with the TS group.

<sup>55</sup> Submeters are devices used to measure water use for a specific purpose; in this study, submeters were installed to measure outdoor water use.

## Appendix

### Xeriscaping in Nevada (Study 1)

- The annual household savings in the TS group was a significant 34,000 gallons per year (10 percent savings from pre-submetering to post-submetering), but the savings only occurred during the first year of the study and then water consumption returned roughly to pre-study levels
- Water consumption for lawn irrigation for the TS group was, on average, 73 gallons per square foot per year, while the XS group used 17.2 gallons per square foot per year, a statistically significant 76.4 percent savings;<sup>56</sup> XS group applied significantly less water every month than the TS group, especially in the summer months
- Xeriscape conversion costs (in 1999 dollars) averaged \$1.55 per square foot
- Compared to properties with 60 percent or more turf landscape, properties with 60 percent or more xeriscaped area experienced, on average, a 2.2 hours per month reduction in labor and a \$206 per year savings on maintenance costs

#### *Comments*

- Participants were volunteers and self-selection bias appeared to be present between XS group and the other groups, since people who already conserved water were more likely to volunteer to convert their landscape<sup>57</sup>
  - This means the effects of a xeriscaping program may not be as large for the general population
  - Self-selection also means that it is possible that the measured differences might not be due to xeriscaping as the XS households may have been more likely to also begin using other water conservation techniques during the study period; however, this seems unlikely to completely account for the large differences given the importance of landscaping in water usage
- The great majority of water consumption in this region goes to outdoor irrigation, and these results should not be extrapolated to regions with different climates or patterns of consumption
- The results are consistent with theory that xeriscaping is especially effective in summer months

*Source:* Kent Sovocool. 2005. *Xeriscape Conversion Study*. Retrieved September 21, 2007 from [http://www.snwa.com/assets/pdf/xeri\\_study\\_final.pdf](http://www.snwa.com/assets/pdf/xeri_study_final.pdf)

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<sup>56</sup> Neither distribution appeared normal. Levene's F-test revealed that there were significant differences in the distributions, which suggested a need to check the findings with a non-parametric test. The Mann-Whitney U test provided supporting evidence for the significance of the percent savings.

<sup>57</sup> XS households, before their conversion, consumed a significant average of 76,000 gallons per year less than CG households; TS households consumed an insignificant average of 12,000 gallons per year less than CG households.

## **Appendix**

### **Xeriscaping in Nevada (Study 2)**

#### *Background*

- Phase II of a study performed as part of the Xeriscape Conversion Study (XCS) by the Southern Nevada Water Authority in February and March of 2000
- XCS Phase I was conducted in the summer of 1998, and found substantial water savings in the xeriscape homes one year after conversion; SNWA wanted to determine whether the savings would be maintained over a longer period
- Main objectives were to collect data on winter water use, analyze water use data on both annual and end use level, and use the results to evaluate longer-term impacts of XCS

#### *Methods*

- A sample of 93 homes was obtained from XCS Phase I (45 xeriscape/48 turf)<sup>58</sup>
- Measurements
  - SNWA provided data on billing information, temperature, precipitation, evapotranspiration, and landscape area measurements; Using portable data loggers,<sup>59</sup> Aquacraft, Inc. collected data on end-use water
  - The flow traces were able to be broken down into individual components of end-uses: toilets, showers, baths, clothes washers, dishwashers, faucets, leaks, other domestic uses, swimming pools, turf irrigation, xeriscape irrigation, and miscellaneous outdoor uses

#### *Results*

- Total outdoor water use was significantly lower in xeriscape homes (135.5 gallons per day) compared to turf homes (208.1 gallons per day), a 35 percent difference
- On average, xeriscaped homes use approximately the same amount of water indoors (157.9 gallons per day) as turf homes (162.7 gallons per day), only a three percent difference
- In 1995,<sup>60</sup> homes in the xeriscape group were found to use slightly less water per year (231,000 gallons) than the turf group (250,000 gallons), although the 7.6 percent difference is insignificant

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<sup>58</sup> Originally, 96 homes were selected (47 xeriscaped/49 turf), but three were dropped. One turf home was before the study since it was vacant; two xeriscaped homes were dropped during data analysis: one was judged as being misrepresentative of typical water consumption in the Las Vegas area and the other had substantially converted xeriscaped areas back to turf.

<sup>59</sup> These data loggers were attached to water meters to collect continuous flow measurements from each home for a two-week period. They would record flow through the meters every ten seconds, which produced the water data log, referred to as a “flow trace”.

<sup>60</sup> 1995 was the year before any xeriscape conversions took place, so it is considered the base year.

## **Appendix**

### **Xeriscaping in Nevada (Study 2)**

- Compared to pre-conversion (1995), xeriscape homes were found to significantly, and relatively consistently, lower their annual outdoor water consumption in each of the following years studied (1997: 65,000 gallons, 39 percent; 1998: 67,000 gallons, 40 percent; 1999: 65,000 gallons, 39 percent)
- In contrast, for the turf homes there was no significant change in annual outdoor water use from 1995 to 1997; however, outdoor water use did significantly decrease between 1995 to 1998 (28,000 gallons, 14.5 percent) and between 1995 to 1999 (15,000 gallons, 7.7 percent); the drop in outdoor water use for turf houses might have been caused by behavior responses to the site visits and sub-metering that occurred for the turf group in 1998
- Xeriscape homes were found to apply 2.14 inches of water across their entire landscape, compared to turf homes that applied 3.29 inches of water across their entire landscape (35 percent decrease); however, xeriscaped homes used almost twice as much water (8.96 inches) irrigating their turf portions than did the turf homes (4.50 inches), further indicating that the xeriscape homes' lower outdoor use is due to lower application rates on the xeriscaped portions

#### *Comments*

- This study found that conversion to xeriscape contributes to lower water consumption over a longer-term period
- Although the samples were chosen at random from XCS participants, selection biases could still be present, since the original groups were composed of volunteers
- These results should not be extrapolated to other regions, since the study was conducted in the arid climate of southern Nevada

*Source:* Aquacraft Inc. 2000. "Impacts of Xeriscape on Outdoor Water Use: Data Logger Analysis Determining Water Usage of Maturing Xeriscape Landscapes – Phase II."

## **Appendix**

### **Xeriscaping in Texas (Study 1)**

#### *Background*

- Funded by the Texas Water Development Board to determine the effectiveness of xeriscaping
- Second part of a two-phase study conducted in Austin, Texas; Phase I was designed to find water savings due to xeriscaping, while Phase II was designed to confirm the water savings results and to find whether additional socioeconomic or other landscape factors influence the savings from xeriscaping

#### *Methods*

- Participants were chosen using a cluster sampling method that sampled all households within a randomly selected water meter-reading route (composed of about 200 homes in a three mile radius)
- Final sample consisted of 6,015 households from the original sample of 7,110<sup>61</sup>; a subset of 440 households (150 xeriscaped, 290 traditional or partially-xeriscaped) were mailed questionnaires and there were 270 responses (100 xeriscaped, 170 traditional) for a response rate of 61 percent
- Measurement
  - Information on the households was collected by: a drive-by inspection of landscape characteristics, using the utility's water consumption database, and using the county's tax database

#### *Results*

- Xeriscaped sites were associated with an average savings of approximately 175 gallons per day (30 percent savings) when compared to sites with St. Augustine grass<sup>62</sup>, a significant difference that is consistent with the results from Phase I of the study (40 percent savings)
- No significant interaction terms were found between grass type and irrigation method or geographic location,<sup>63</sup> implying that water consumption savings from xeriscaping appears to be constant over all house values and locations

#### *Comments*

- The study finds that houses with xeriscaping are associated with lower water consumption, but there were several important limitations:
  - The study was based on correlational data about current landscapes, so direct effects of xeriscape conversion are not shown

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<sup>61</sup> About 200 sites were lost to coding errors, about 800 sites were deleted due to change of address, and 35 sites were deleted because of unreasonable values of consumption (less than 1,000 gallons or more than 20,000 gallons per month).

<sup>62</sup> St. Augustine grass is the type grass considered to be traditional turf for this study.

<sup>63</sup> Geographic location refers to eight groups of residential sites defined by similar location and house values.

## **Appendix**

### **Xeriscaping in Texas (Study 1)**

- The study was not able to rule out self-selection bias into xeriscape and traditional landscape groups; households more interested in conserving water could also be more likely to choose xeriscaping
- Xeriscaping was not prevalent in this study: at most six percent of households qualified by the amount of grass (429 sites) and at most four percent qualified by grass type (225 sites)
- The finding that savings do not vary by household type implies that the percentage savings should be higher among low- and middle-income houses without an irrigation system because their base rate of water consumption is lower

*Source:* T. Gregg and J. Curry, 1994. *Xeriscaping: Promises and Pitfalls*. Retrieved September 27, 2007 from [http://www.twdb.state.tx.us/RWPG/rpgm\\_rpts/92483328.pdf](http://www.twdb.state.tx.us/RWPG/rpgm_rpts/92483328.pdf)

## **Appendix**

### **Xeriscaping in Texas (Study 2)**

#### *Background*

- Follow-up study to the Promises and Pitfalls study in Austin, TX during the summer of 1997; part of the National Xeriscape Demonstration Project
- Primary goal of this study was to show how much water can be saved with xeriscaping, and to examine the effects of the Xeriscape It rebate program and the Irrigation Audit program
- The Xeriscape It program, which began in 1993 and ended in 1997, was designed to promote conversion to xeriscape<sup>64</sup>
- Irrigation Audit is a free program offered by the city of Austin to assist customers with using their in-ground irrigation systems as efficiently as possible

#### *Methods*

- Randomly selected 2,016 homes from the Promises and Pitfalls study, referred to as the “drive-by” sample because obtained while driving in neighborhood
  - Sample consisted of both xeriscaped and traditional landscapes
  - Typical house: 3 bedroom, 2 bathroom, 2,000 square foot house built in 1977 that consumes 142,000 gallons of water per year
- Measurement
  - Drive-by sample data was collected on grass type and area, plant bed location and area, tree bed area, presence of irrigation systems, and direction the house was facing
  - Data on actual water consumption was gathered from utility records and lot sizes and property values were gathered from tax databases
  - Surveys were mailed out to all 299 participants of the Irrigation Audit program, 85 were received (response rate of 28 percent) and matched with water consumption data

#### *Results*

- Houses with xeriscaped plant beds were associated with statistically significant water savings of 71 gallons per day compared to houses with non-xeriscaped beds; compared to houses with St. Augustine grass and non-xeriscaped plant beds, xeriscaping provided a significant 214 gallon per day savings of water consumption per house
- The Xeriscape It program resulted in an estimated savings of approximately 133 gallons per day per house, and an estimated total of 34 million gallons saved for the duration of the program; the break-even point of the cost/benefit ratio of the program was estimated to be just less than 13 years

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<sup>64</sup> Rebates were given to participants who installed xeriscaping, at a rate of \$0.08 per square foot converted, with a maximum of \$240

- The Irrigation Audit program successfully changed watering practices of the participants, with 69 percent permanently altering their habits to meet the auditors' recommendations

## **Appendix**

### **Xeriscaping in Texas (Study 2)**

#### *Comments*

- The study finds that xeriscaping can be an effective means of water conservation, but conversion to xeriscaping cannot be considered since the results were based on correlational data on current landscapes
- The homeowners in the xeriscape group may have been more environmentally conscious, likely since they chose to xeriscape, and that characteristic, not the actual xeriscaping, could explain the lower water consumption in the xeriscaped homes
- The Irrigation Audit result is based on information from only 28 percent of the participants and the actual impact could thus be much different from the observed result
- Austin received a very unusual rainfall pattern in 1996, which led the research team to change the months that the study focused to May through July for summer, and November for winter

*Source:* T. Gregg, D. Strub, C. Grigsby, S. Deitz, B. Anderson, W. de Herrera, 1999. *Xeriscaping: Sowing the Seeds for Reducing Water Consumption*. Retrieved September 24, 2007 from <http://www.ci.austin.tx.us/watercon/downloads/Xeriscape.pdf>