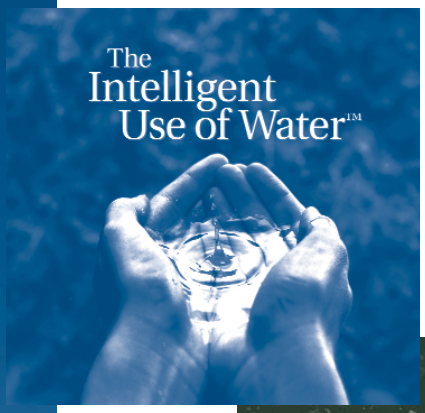

A Homeowner's Guide to Water-Efficient Landscapes

RAIN BIRD®

Since Rain Bird's beginnings in 1933, we have focused on developing products and technologies that use water in the most efficient manner possible. At Rain Bird, we feel it is our responsibility to take the lead on water conservation by promoting it through not only efficient irrigation management, but also through education, training and services for our industry and our communities. We call this The Intelligent Use of Water™.

We participate in a variety of initiatives aimed at educating the public on water conservation. We've developed environmental education curriculums in conjunction with California State Polytechnic University, Pomona, aimed at helping teachers and students better understand the vital role water plays in various types of ecosystems. Through our annual participation in the Tournament of Roses® Parade, we have used our floats to draw attention to animal species and natural habitats that have been adversely impacted by water shortages. And we authored the white paper *Irrigation for a Growing World*, which discusses both causes and potential solutions to the growing global water crisis.

A Homeowner's Guide to Water-Efficient Landscapes continues our discussion of the important issues raised in our first white paper with a focus on the role homeowners can play in conserving this most precious resource through efficient irrigation.

The need to conserve water has never been greater. We want to do even more, and together we can.

Anthony La Fetra
President

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Table of Contents

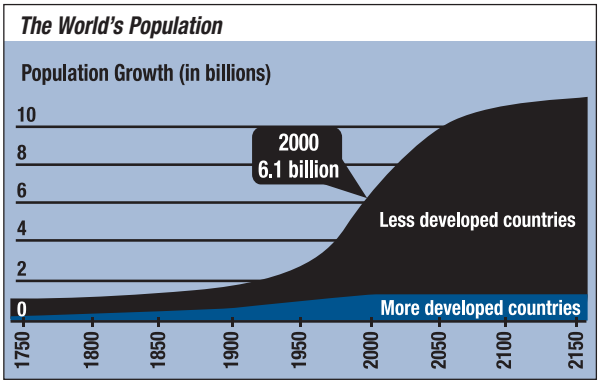
OVERVIEW: THE WORLD'S WATER CRISIS

At first glance, water seems to be the most abundant resource on Earth. The reality, though, is that 99% of all water is tied up in the form of saltwater, snow and icebergs, leaving a mere 1% available for use by humans.[1] And, while the supply is fixed, the demand for fresh water is exploding as the rapidly growing global population taps into the Earth's supply at exponentially increasing consumption rates.

The problem is not limited to developing countries either. Even in the less densely populated United States, pressures are mounting, in part due to demand generated by the U.S. lifestyle.

Since 1900, the United States population has doubled, but per capita water use has increased eightfold, as technology and lifestyle improvements have led to the doubling of water consumption every 20 years.[2] Today, Americans use an average of 101 gallons (382 liters) of water per day, far exceeding the estimated 20.5 gallons (78 liters) per day minimum necessary to maintain life, hygiene and food production.[3]

As outlined in Rain Bird's *Irrigation For A Growing World* white paper, options such as desalination, water re-pricing, water recycling and infrastructure and water delivery system improvements require mobilization of governments and international organizations. In many cases, these technologies are not yet fully developed for effective use today. Conservation through water-efficient irrigation, however, is a practical and cost-effective solution that can be implemented today to help address this growing global crisis.



Source: Population Reference Bureau (PRB), available at www.prb.org

Per Capita Water Usage/Day

Location	Water (gallons/liters)
Las Vegas, NV, USA	307 g/1162 l
United States - Average	101/382
Bangkok, Thailand	55/208
United Kingdom – All Urban Users	40/151
Cairo, Egypt	35/132
Estimated Minimum Needed	20.5/77

Source: Vickers, Handbook of Water Use and Conservation, *WaterPlow Press, June 2002.*

RESIDENTIAL WATER CONSERVATION: PART OF THE SOLUTION

In the beginning, residential water-saving initiatives focused on water-saving practices inside the home, such as toilet redesign in the 1960s, when studies revealed that toilets consumed up to 50% of household water budgets.[4] A decade later, nationwide urban sprawl and resulting water shortages prompted further indoor water conservation measures and massive education campaigns by public utilities.[5]

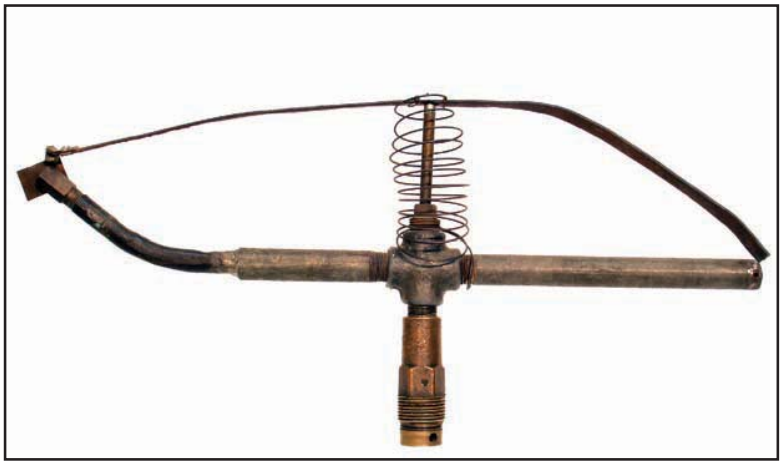
It was not until more recently that the public took notice of the need to conserve water outdoors and water agencies implemented outdoor water-saving awareness campaigns. Even now, most homeowners are more familiar with "best practices" for reducing water use inside the home – using low-flush toilets, low-flow showerheads and water-saving washing machines and dishwashers – than they are with outdoor water efficiency.

Considering that landscape needs may account for 20% to 50%[6] of the 95,000 gallons[7] (359,614 liters) of water consumed by the average U.S. household yearly, conserving water used on landscape is an important part of the overall solution to the water scarcity problem.

That said, today's homeowner often struggles to achieve the delicate balance between conserving water and enjoying the many benefits that a beautiful landscape provides. For most, a water-efficient landscape conjures up images of yards filled with rocks, sand and cacti, or even concrete. While this minimalist view of landscaping is undoubtedly the epitome of water-efficient landscaping, it is just not a practical option for most homeowners due to climate or personal preferences.

Irrigation for A Growing World: A Homeowner's Guide to Water-efficient Landscapes provides homeowners with practical information on how to conserve water through the use of water-efficient irrigation. By addressing every aspect of water-efficient landscapes – from the best times and amounts to water, to the use of efficient irrigation equipment – it becomes clear that water-efficient irrigation methods have the potential to significantly decrease the amount of water used in landscape applications without sacrificing any of the benefits.

A BRIEF HISTORY



Orton Englehart's original impact sprinkler. ©2006 Rain Bird

The earliest forms of irrigation, such as those used for centuries in Egypt's Nile River Basin, simply followed river cycles. Farmers planted crops and waited for river flooding. They dug channels and used gravity to transport river water to where it was needed most. Soil was saturated, allowed to dry out until plants nearly wilted, and then soaked again.

In 1933, Orton Englehart, a Southern California citrus grower, invented the impact sprinkler and in doing so ushered in a new era in irrigation worldwide. His novel watering device, described as a "spring-activated, horizontal, impact arm-driven sprinkler," was durable and distributed water farther, more evenly and more efficiently than existing sprinklers of that time. Clem and Mary La Fetra, neighbors of the inventor, recognized the potential of Englehart's device and began marketing it. Subsequently, the La Fetras set up a manufacturing facility in the family barn, which evolved into today's Rain Bird Corporation.[8]

Seven decades later, the function of modern day sprinklers remains more or less the same, but their operation and efficiency has changed dramatically. Advances in technology and engineering have led to the development of irrigation devices that deliver water in a more precise and uniform manner, in any space, regardless of shape. They range from low-volume drip and microspray irrigation to small pop-up spray head sprinklers used in a typical backyard and garden to rotating sprinklers for large commercial applications.

Perhaps the most significant advance in residential landscaping, automatic irrigation systems enable users to save time and irrigate more efficiently, precisely and evenly based on the specific needs of the plants.

BENEFITS OF A WATER-CONSERVING LANDSCAPE

Beyond saving water, a properly designed, well-maintained, water-efficient landscape is an asset in any neighborhood and brings the homeowner many benefits:

- **Increased real estate values** – Home values can rise by up to 20% and the length of time to sell a property can be cut by six weeks.[9]

- **Lowered home-energy costs** – Air conditioning costs can be reduced by as much as 50% when trees and vegetation provide cooling shade. During winter, the impact of cold winds can be significantly reduced when healthy plants act as a buffer.[10]
- **More pleasant outdoor environment** – Trees and surrounding vegetation can lower outdoor temperatures by up to 10 degrees and act as sound barriers to street noise.[11]
- **Fire-safety** – A 100-foot buffer zone that incorporates low-lying ground cover, clustered plants, succulents and regularly-mown short grasses can prevent brush fires from reaching the home.[12]
- **Erosion control** – Healthy landscapes are less prone to water runoff, helping prevent site and structure damage.[13]
- **Environmental contributions** – Trees and plants absorb carbon dioxide from the air and return it to the environment as oxygen.[14]
- **Numerous emotional benefits:**
  - Beauty and relaxation
  - Pride in home
  - Safe, high-quality play and exercise areas

An irrigation system that is well thought out and properly designed will enable homeowners to enjoy the benefits of a healthy landscape while using less water. The most efficient irrigation systems begin with a design that takes into account climate, plant selection and water-conserving landscaping principles.

LANDSCAPE ANALYSIS

Proper design depends largely on a proper analysis of the different areas of the landscape. The most efficient irrigation systems divide the landscape into separate irrigation zones to accommodate different watering needs of plants. For example, many landscapes include turfgrass, flowers, shrubs, trees and even potted plants. Each of these plant types has different watering needs and should be treated as a separate zone. In addition, variations in sun exposure in a landscape (full sun versus shade) will also affect irrigation needs.

Thirsty plants and grasses, such as turfgrass, generally require more water than established shrubs and trees to stay healthy. By dividing the landscape into watering zones, the watering schedule will not be dictated by the needs of grass, preventing shrubs and trees from being over-watered and reducing overall landscape water use.

Many homeowners overlook natural and existing landscape characteristics such as areas with poor drainage, clay, sandy or rocky soil and natural slopes. By taking into account the absorption rate and the way that water naturally flows across the landscape, watering zones can be designed to compensate for poor drainage areas.

It is also important to take note of the effect of wind on the landscape. High winds increase the rate of evaporation and can cause spray drift. In areas more prone to windy conditions, such as canyons or open plains, the irrigation system should be designed to compensate for increased rates of evaporation and drift. The effects of wind can also be countered with proper water pressure, which will be discussed later.

Finally, homeowners should take into account the wear and tear caused by heavy foot traffic on the landscape. Irrigation can be tailored to apply adequate irrigation to areas prone to wear and stress.

By dividing the landscape into watering zones, the watering schedule will not be dictated by the needs of the grass.

LANDSCAPE PLANNING

The information garnered from a detailed landscape analysis allows for the development of a landscape plan that best suits the types of plants most likely to thrive in the given conditions and ultimately provides a foundation for a more water-efficient irrigation system.

An important component of any landscape plan is the creation of a to-scale map of the entire landscape area. Detailed maps should include the lawn, sidewalks, driveways, and walkways, as well as the exterior of the house and all corresponding measurements. As the blueprint for a water-efficient irrigation system, the map allows for easy division of the landscape into watering zones that group similar types of plants, like shrubs and ground cover, together to ensure that specific watering needs are met.

Plant Selection: Plants should be selected according to the water zones. The use of drought-tolerant and water conserving native plants will increase the water efficiency of an irrigation system. Spacing each plant far enough apart to account for its size at full maturity levels will contribute to optimum water efficiency.

It is not necessary to renovate an entire landscape all at once. Many homeowners address specific problem areas by replacing plants or lawns that need a lot of water with drought-tolerant natives, or by eliminating areas prone to runoff and erosion by planting groundcover, vines or plant beds.

In this do-it-yourself era, there are many professional resources such as books, online tutorials and nursery professionals to assist homeowners in creating a detailed landscape map. Today's licensed landscape professionals typically also design "hardscape" – patios, walkways, fences and other structures – in addition to working with plant materials. Their design work can include grading, drainage, erosion control, irrigation systems, lighting and other features.

Landscape architects and designers oversee installation of their plans by landscape contractors and gardeners. As with any professional, each will have varying levels of skills and expertise.

Not all are adept at incorporating water-efficient principles, so those qualifications may need to be actively sought out.

XERISCAPE™ LANDSCAPING

The practice of replacing thirsty turfgrasses and other exotic, non-native plants with low-water-use grasses, wildflowers and plants native to the local environment is gaining popularity with many water districts in the United States. In some areas, this practice of Xeriscaping has resulted in a decrease in outdoor water usage of up to 60%.[15]

In order for Xeriscaping to truly succeed in decreasing a landscape's water needs, the design must incorporate only native plants or plants with low water needs and must group plants with similar watering needs together so that different zones can be created to apply different amounts of water. When a landscape's overall water needs are decreased, incorporating low-volume, or drip, irrigation – either by installing a new drip irrigation system or by retrofitting an existing underground irrigation system to include drip components – can lead to significant water savings.

Case Study[16]

RECOGNIZING THE NEED for more precise (and locally applicable) savings estimates, Southern Nevada Water Authority (SNWA) conducted a Xeriscape Conversion Study in 2001 to determine the "Real World" savings of Xeriscape conversion. The experimental study recruited hundreds of participants willing to convert their existing landscape into a Xeriscape and installed meters to collect per-unit area application data. Results showed that Xeriscape can take advantage of some plants' reduced water needs to justify the switch to a low-volume irrigation system, thereby saving vast quantities of water at single-family residences. Overall, homes in this study saved an average of 30% in total annual consumption.

WATER PRESSURE

Efficient operation of an automatic irrigation system is largely dependent on water pressure. The water pressure must be high enough to compensate for the loss of pressure incurred as the water travels through the entire system. Simply put, sprinkler heads located at the far end of the system require the same water pressure to operate as those at the beginning of the system. If the water pressure decreases substantially before the water makes it through the system, the efficiency of the system can be severely compromised.

Proper pressure can also minimize wind effects. Excessively high water pressure can cause misting and fogging, which leads to wasted water due to wind drift and evaporation. In these cases, water pressure should be decreased to help create larger spray droplets that minimize drift and evaporation and allow water to be distributed efficiently and accurately.

While most homes have adequate water pressure to run an irrigation system, it is recommended that homeowners check their existing water pressure prior to installing an irrigation system.

Checking water pressure: The easiest way to measure pressure is to screw a pressure gauge on to the faucet nearest to the water meter. Make sure no water is running anywhere inside or outside your house. Turn on the faucet with the gauge attached. The gauge shows your water pressure in pounds per square inch (PSI) or bars. You may also call your local water company to find out your water pressure.

AUTOMATIC IRRIGATION SYSTEMS

Automatic irrigation systems are a convenient tool for homeowners in that when they are set up properly, they will deliver the right amount of water to the right place with minimal effort by the homeowner. Most automatic systems utilize multiple types of water delivery methods, with two of the most common being "pop-up" sprinklers that retract into the ground when the watering cycle is completed and drip irrigation, which uses micro-components to deliver water at a slower rate, precisely where the plant needs it most – at the soil above its roots.

Although many homeowners still water by hand using hose-end sprinklers and soaker hoses, hand watering does not allow for an accurate measurement of the application rate based on the soil's ability

Case Study[17]

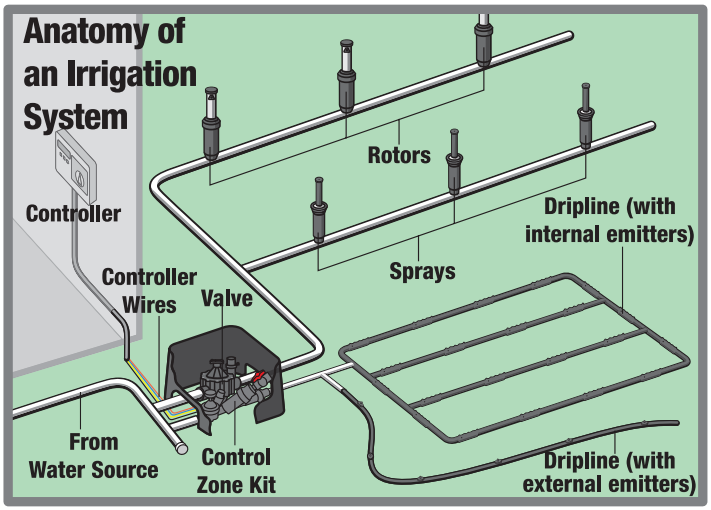
A Dallas, Texas, estate was converted from predominately turf landscape to a four-acre English cottage garden, with a variety of trees, ferns, flowers, tropical and exotic plants and ground cover, alternating with native plant areas. The tremendous scope and variety of plant life presented a challenge for the irrigation system, and watering manually would result in wasted water and potentially unhealthy plants. Since the garden was a mix of newly planted native plants and already developed areas, the challenge was separating the zones for watering. To water the varied landscape accurately, two automatic controller systems were used, each with four independent programs and eight start times. The controllers provided the system-wide management needed to precisely irrigate the wide variety of plant types.

GENERAL WATERING GUIDE

	More Frequent Watering	*Less Frequent Watering*
Weather		
Temperature	Hot	Cool
Humidity	Low	High
Season	Summer	Winter
Wind	Windy	Calm
Plant Maturity/Type		
Maturity	Newly Planted	Established
Growth Rate	Fast	Slow
Leaves	Large	Small, narrow, resinous, fuzzy, succulent or leathery
Soil		
Texture	Sandy	Clay
Mulch	Bare	Mulched

Source: The University of Arizona, Arizona Cooperative Extension, College of Agriculture.

to absorb water. When using soaker hoses, many homeowners turn the water volume up too high and end up wasting water by applying too much. The excess, which is not absorbed, becomes runoff and is lost to the gutters and storm drains. Watering by hand or by soaker hose will both likely result in overwatering of the landscape area, wasting water through evaporation or runoff or by simply applying more water than is necessary to maintain the health of the plant.



©2006 Rain Bird Corp.

One of the greatest benefits of an automatic irrigation system is the ability to provide differing amounts of water to differing plants at a rate at which it can be absorbed. The most efficient systems may include both underground components and drip components – this is especially true for systems with multiple zones. For example, flower beds would be on a zone that receives less water than a turf grass zone and might, therefore, be best served by landscape dripline with low-volume emitters, while the turf areas might be better served by sprays or rotors.

Still, no matter how efficient the design of an irrigation system, the amount of realized water savings depends largely on the proper installation and management of an efficient watering system. Inefficient irrigation systems and incorrect watering schedules are estimated to waste as much as 30% of the water applied to plants and lawns.[18]

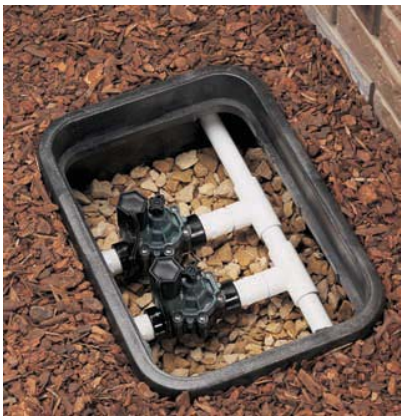
An efficient automatic irrigation system – be it underground, drip or a combination – will ensure that the right amount of water is applied to each area in a landscape. A variety of components make up an efficient automatic system.

CONTROLLERS

The brain of an automatic irrigation system, an automatic controller is programmed to control exactly how often and for how long each area of a landscape is watered. Controllers work by sending an electrical signal to each valve in a system, turning it off and on according to a predetermined schedule. With the ability to control multiple zones, controllers are capable of providing precise amounts of water to each area.

Programming a controller.
©2006 Rain Bird Corp.

Technological advances continue to bring new controller features that give the homeowner additional flexibility and water-savings benefits. To combat one of the greatest sources of water waste – over watering – many controllers feature automatic shut-off devices that turn off the controller and thus the entire system when it's raining, windy or there is sufficient moisture in the soil. The following section will discuss some of these innovations in greater detail.

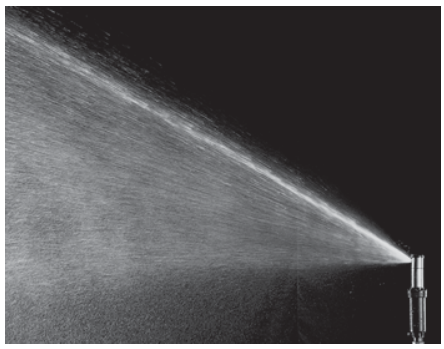


Two valves in a valve box.
©2006 Rain Bird Corp.

VALVES

Irrigation valves allow water to enter an automatic irrigation system and flow to the emission devices (spray heads, rotors, drip components). While valves can be manual or electric, valves in an automatic irrigation system are opened and closed by the use of electricity. When an automatic controller sends an electric current to the valve, it opens to allow water to flow through a system. When the controller shuts off the flow of electrical current to the valve, it closes and shuts off water flow. Each zone in an irrigation system needs to have one valve.

Some valves provide additional water-efficiency features and benefits. For example, certain valves automatically close when there is a problem, such as a leaking diaphragm, which helps prevent flooding, water waste and landscape damage. There are also valves specifically designed for low-flow applications like drip irrigation and valves created for use with reclaimed water. In addition, pressure-regulating devices can help maintain constant optimal water pressure to prevent misting and evaporation of water that can result from high pressure. In cases where there is excessive pressure, a 5 PSI (0.35 bar) reduction in pressure can reduce water waste by 6 to 8%.



Rain Curtain.™ ©2006 Rain Bird Corp.

ROTORS

Rotors (or rotating sprinklers) shoot a single stream of water from a rotating head. While some rotors used on sports fields and golf courses can throw water more than 100 feet (30.5 meters), rotors most commonly used in residential applications have radii of between 20 and 50 feet (6-15 meters).

Rotors are almost exclusively used on turf areas. Many have water-savings features like adjustable watering patterns and radii to keep the spray where it should be and away from sidewalks and buildings. Some rotors have additional benefits such as matched precipitation rates – which ensure that the same amount of water is applied regardless of the nozzle used, reducing water waste by ensuring uniform distribution over a large area. Low-precipitation-rate rotors can help avoid runoff by applying water at a slower rate and thereby allow the water to penetrate the soil. Finally, special nozzles that create larger droplets, such as Rain Curtain™, ensure that the rotors' spray is not blown off course, preventing further potential water loss.

SPRAY HEADS

Pop-up spray heads rise between two and six inches (5-15 cm) above the ground to water turf areas and up to 12 inches (30 cm) to water beds with taller plants. Like rotors, spray heads are available with different spray patterns (full or part-circle) to ensure that water is delivered where it is needed. Additional water-saving features may include pressure regulation to avoid misting – mist is more likely to be blown off course than are large water droplets. Some spray heads have built-in devices, such as wiper seals and check valves, which prevent water from draining out of the lowest head in a system, thereby eliminating puddling, erosion and runoff. Nozzles with an undercut spray, such as U-Series™ nozzles, prevent additional potential water loss by ensuring uniform distribution of water and eliminating over-spray, reducing water usage by up to 30%.[19] And as is the case with rotors, low-precipitation-rate spray heads apply less water over a given time to allow for better soil penetration.

Low-volume pop-up spray heads are also available. Installed on the same line as regular spray heads, these spray heads can be equipped with drip emission devices to provide the benefits of low-volume irrigation in a shrub area or narrow space without the installation of a separate drip irrigation line.

Case Study[21]

THE HRUBY & VACCARELLA residence in Naples, Florida, avoided the typical vast expanse of turf common in upscale, estate homes and instead opted for a decorative landscape planted with an array of tropical plants. The homeowners knew that the densely planted garden featuring tropical flora of all shapes, sizes and water requirements would necessitate a well-conceived irrigation plan with the ability to deliver differing amounts of water to each different plant zone. The use of a multi-zone controller allowed for a broad selection of emission devices with differing flow volumes to provide uniform coverage for the large, dense plantings and the accuracy needed for the estate's seven microclimates and five types of soil conditions, without overspray or water waste. And, by enabling plants with different water requirements to remain side by side, the landscape design creativity was not hindered by limited flexibility of irrigation. The residence expects to recoup their investment through water savings in 5 to 10 years.

Spray heads come in various pop-up heights to water different types of plants. ©2006 Rain Bird Corp.

DRIP IRRIGATION

Drip irrigation, also called micro-irrigation or Xerigation™, uses tubing and emitters to apply a slow, steady trickle of water directly to the soil above the plant's root structure. Through gravity and capillary action, water spreads slowly down to plant roots, reducing water lost to surface evaporation.

Drip can often be a more efficient way to water trees, shrubs, flower beds, ground cover or borders. A drip system can be 30% to 50% more efficient than traditional sprinkler irrigation on landscapes for which drip is appropriate.[20] Drip can also reduce runoff and plant disease, which can result from over-watering.

Dripline with internal emitters.
©2006 Rain Bird Corp.

Case Study[22]

IN AN EFFORT TO ENCOURAGE homeowners to install drip irrigation in appropriate landscape applications, cities have begun to offer drip-irrigation conversion incentives. The city of Albuquerque, New Mexico, pays up to $250, provides seminars, manuals and training videos to homeowners who install drip irrigation. Boulder, Colorado, offers a 50% rebate on the cost of drip irrigation materials. Meanwhile, other areas such as Clark County, Nevada, and Las Vegas mandate drip irrigation for all non-turf vegetation.

Chapter Three: **Advances in Water Savings**

A TREND TOWARD GREATER WATER SAVINGS

In the last decade, significant advances in technology have made irrigation systems even more water-efficient. While public perception may have once been that automated systems used more water than traditional hand watering or soaker hose methods, modern systems can be set to use the minimum amount necessary to maintain the health of the plant.

Many recent innovations are the result of a growing demand for water-efficient irrigation products among municipalities and homeowners. A growing number of cities now offer incentives such as cash rebates to homeowners who install water-saving products as part of their automatic irrigation systems. And, as was mentioned in the previous section, some cities encourage homeowners to replace high water use plants with appropriate native species that need less water.

Below are some innovations that can increase the efficiency of an automatic irrigation system.

- **Rain Sensors** – Rain sensors detect a set level of rainfall to shut off a system during a rainstorm and resume when the sensor dries out, indicating deficient soil moisture. Rain sensors should be mounted away from landscaped areas in a spot that receives unobstructed rainfall, such as the roofline of the house. Avoid placement under a tree or in predominately sunny or shady spots.
- **Moisture sensors** – These devices are placed in the landscape to measure soil moisture and suspend watering until the ground moisture level is dry enough to require more water. Two types exist: tensiometers, a sealed, water-filled tube with a porous ceramic tip; and gypsum blocks. Both measure electrical resistance, which increases as soil dries out.
- **Wind and freeze sensors** – Freeze sensors are used to shut off irrigation systems in climates where seasons are not well-defined but temperatures dip to freezing and below. Freeze sensors prevent water from being circulated through frozen pipes, a situation that could lead to cracked pipes and resulting water loss. Wind sensors stop watering during high-velocity winds and resume when the wind speed lowers. They are used in windy climates where spray from a sprinkler would be blown away.

Case Study[23, 25]

A 1992 STUDY IN GAINESVILLE, FLORIDA, examined and determined that if rain sensors had been in place from 1977 to 1991, up to 25% of all automatic watering in the Gainesville area would have been stopped.

An increasing number of municipalities throughout the country have mandates and cost-savings programs for the use of sensors, particularly rain sensors, on new and existing residential and commercial projects. Currently, there are mandates for rain-sensor use either statewide or in various municipalities in New Jersey, North and South Carolina, Florida, Texas, Georgia, Minnesota and Connecticut.

In Albuquerque, New Mexico, the threat of fines being levied for runoff and overspray have resulted in an increase in installations of pressure regulating valves and multiple-cycle, digital controllers. Albuquerque's Water Conservation Office has also implemented a WaterWatch program that provides daily watering guides through a system of color-coded symbols that are seen as part of the daily weathercast on all local news stations between April 1st and September 30th.

MEASUREMENT TOOLS

To help homeowners better gauge how much water should be applied to certain plants at certain times in certain climates, there are several useful measurement tools that calculate likely soil moisture deficiencies. Their use can make an already efficient irrigation system all the more water-saving.

Source: "The Zoo Fence, A Commentary on Life and Living," at www.zoofence.org

- **Water budget/watering index** – A water budget is the quantity of water needed to irrigate a landscape based on the driest season and on lot size, type of vegetation and soil. Controllers are then set to disperse an appropriate amount of water based on this budget, with percentage adjustments up or down depending on the seasons and actual rainfall. Some water utilities, such as the Metropolitan Water District of Southern California, post an online watering index, indicating the percentage setting based on data from weather stations.[24]
- **ET rates** – Evapotranspiration, the measurement of the combined water loss from plants through evaporation and transpiration, is combined with precipitation, temperature, humidity, and wind speed and direction to determine total soil moisture deficit. These measurements, taken from various weather sites, are often posted online (such as local water purveyors' or municipal government websites) for a given time period so that homeowners can set their controllers. Some controllers can be programmed to receive this data and automatically interrupt watering schedules as necessary.
- **Rain Gauges** – Because the amount of rain a yard receives may vary from that reported by county weather stations, a simple rain gauge in the landscape can provide a more accurate local reading and help in water management.

Case Study[29]

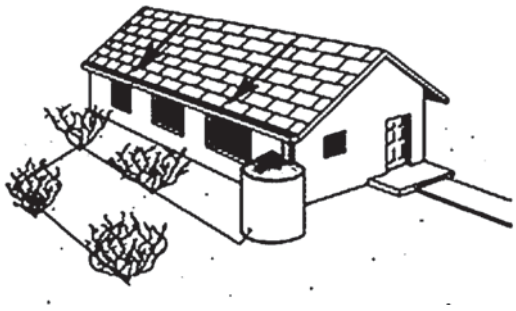
A 1992-1998 SURVEY of Salt Lake City residential water use revealed that automatic watering systems averaged only a 54% efficiency rate, meaning nearly half of water applied to landscaping was wasted because these systems were either not properly maintained or not properly adjusted to use appropriate amounts of water. If Salt Lake residents watered according to need, water savings of 18%, or 25,000 gallons (94,635 liters) per household annually, would occur, the survey concluded.

GRAYWATER REUSE & RAINWATER HARVESTING

Some homeowners save even more water by incorporating graywater and rainwater into their watering options.

Graywater comes from baths, showers, washing machines, kitchen sinks and dishwashers. Methods to retrieve it range from simply draining the water directly on to outside vegetation to installing a complex system of cisterns, filters, pumps and pipes at costs of $1,500 to $3,000. Because graywater contains bacteria and organic waste, some local health departments may regulate its use.[26]

Rainwater harvesting is less controversial but restrictions also may exist, so homeowners should check before installing a system. Water from roof downspouts, walkways or other surfaces and air conditioning evaporation can be channeled into a barrel and funneled on to landscaping.



Water harvesting system with roof catchment, gutter, downspout, storage and drip distribution system. Source: Arizona Department of Water Resources. ©1998

LEED[28]

LEED (Leadership in Energy and Environmental Design) is a program developed by the U.S. Green Building Council to promote the sustainable design and construction of both new and existing commercial buildings. It is currently being expanded through a new pilot program – LEED Homes. This voluntary initiative promotes the transformation of the home building industry toward more sustainable practices by awarding LEED certification to those homes that meet a certain number of criteria across a range of categories. The program's water-efficiency category, for example, has an irrigation component that encourages the separate zoning of plants with varying water needs, the use of drip irrigation, the installation of rain sensors and the use of rainwater and graywater for irrigation.

Case Study[27]

There is a long established tradition of rainwater collection in some parts of Alaska and Hawaii. The city of Austin, Texas, offers rebates for using rainwater for some household uses. In some areas of the Caribbean, new houses are required to have rainwater capture systems. Rainwater offers advantages in water quality for both irrigation and domestic use. Unlike well water, rainwater contains hardly any dissolved minerals or salts, is free of chemical treatment, and is a relatively reliable source of water for households.

MANAGEMENT

With a water-efficient irrigation system in place, increased water savings and simplified landscape maintenance should soon follow. But these systems are not "set it and forget it." Unfortunately, it's too common to see broken sprinkler heads gushing water, systems running during a downpour or spray heads and rotors watering sidewalks and streets. Poor management of automatic systems can lead to a variety of landscape problems, including fungal disease, brown spots and other signs of plant stress.

Ongoing maintenance is an important component to The Intelligent Use of Water™ in water-efficient landscapes.

MAINTENANCE TASKS

Besides using automatic controllers, sensors and measurement tools to regulate watering, routine maintenance tasks should be performed. Like all other equipment, irrigation systems eventually wear out and need replacing. Also, as plants and trees grow, they require regular care. Below are some suggested "best practice" maintenance tasks.

PLANT MAINTENANCE AND WATERING TIPS	*IRRIGATION SYSTEM MAINTENANCE TASKS*
Water before 10 a.m., when less wind, lower temperatures and less sunlight reduce water loss from evaporation.	Examine your system while in operation. Look for puddles, wilted or fallen leaves, leaking spray heads and clogged emitters.
Water deep enough to reach the root zone and water less frequently to encourage deep root growth.	Adjust your watering schedule monthly or, at minimum, when seasons change.
Mow regularly but keep lawn grasses long (up to 3 inches or 7.6 cm) to better shade the ground and conserve water.	Flush salt build-up from the root zone twice a year by watering more deeply, if heavy rainfall fails to do the job for you.
Check moisture levels regularly. Make sure root zones are saturated: Typically six to 12 inches (15-30 cm) deep for lawns, flowers and vegetables; one to two feet (60 cm) for shrubs and groundcovers; two to three feet (90 cm) for trees. Saturation below the root zone is not effective.	Clean the filter twice a year in drip systems.
Aerate soils, especially clay, once a year to relieve surface compaction and allow for better water penetration.	Remove end caps and flush drip systems twice a year.
Mulch plants, bushes and trees to retain soil moisture, discourage weeds, provide nutrients and prevent soil compaction.	Add, delete or move drip emitters annually to accommodate new growth.
Fertilize twice yearly, once in spring with a slow-release nitrogen and in the fall with a quick-release.	Follow watering schedules and restrictions mandated by your water utility or local government.

Source: American Water Works Association; T. E. Bilderback and M. A. Powell, Efficient Irrigation; Montana State University, Water-Conserving Landscaping Involves More Than Plant Selection; Water Conservation Alliance of Southern Arizona (Water CASA), Water Saving Tips, DRIP IRRIGATION: Now That You Have It, What Do You Do With It; Douglas F. Welsh, William C. Welch and Richard L. Duble, Landscape Water Conservation . . . Xeriscape™

Using controllers and measurement tools, plus performing routine maintenance, can help ensure that irrigation systems perform at their best, keeping landscapes in top shape while using as little water as possible.

In a freezing climate homeowners must also winterize their sprinkler system in order to avoid damage. Special attention should be given to removing water from the pipes, valves, and sprinkler heads before freezing occurs. This may be accomplished using three techniques: the manual drain valve method, the automatic drain valve system, or the air blow-out practice. Incorrect winterization could result in damage to the irrigation system and it is therefore advised that homeowners consult an expert before beginning the process.

LANDSCAPE CONTRACTORS AND GARDENERS

Although water-efficient landscapes and irrigation systems are increasingly in demand, not every landscape and yard care professional is an expert in designing, installing and maintaining a water-efficient system. Homeowners may need to seek those well-versed in water-efficient principles, native plant gardening, drought-tolerant plants, ecology-based landscaping or sustainable practices in landscaping. Professional directories and local native plant and gardening societies as well as colleges and universities and their extension offerings are good resources.

Training and certification programs are also available for landscape professionals through the Irrigation Association as well as through some manufacturers, and many cities and states require contractors to be licensed. Homeowners should ask contractors and gardeners if they are certified and/or licensed.

LOCAL RETAILERS

Staff at nurseries and gardening supply stores can prove helpful to homeowners interested in implementing efficient irrigation practices, but not all will be knowledgeable about water-conserving irrigation techniques and tools. Homeowners can prepare themselves first and then approach retailers. Some irrigation system manufacturers provide extensive online information about water-conserving systems, detailed product information and instructions that can serve as a primer.

LOCAL WATER AGENCIES

Most water agencies and utilities are on the front lines of water conservation. Many have websites and printed materials with basic information and lists of professionals to use.

ONLINE SOURCES

Online resources are extensive and updated constantly. Websites can be easily found using Internet search tools. Below are some recommended sites:

www.rainbird.com – Rain Bird Corporation

www.h2ouse.org – California Urban Water Conservation Council (CUWCC)

www.usgbc.org – US Green Building Council

www.irrigation.org – The Irrigation Association

www.awwa.org – American Water Works Association

www.diynetwork.com – DIY Network television tutorial.

http://bewaterwise.com/index.html – The Family of Southern California Water Agencies.

www.epa.gov/greenacres/ – Green Landscaping Resources, U.S. EPA

http://aggiehorticulture.tamu.edu/extension/landscape.html – Hortextension, Texas A&M and Texas Cooperative Extension

http://igin.com/Irrigation – Irrigation & Green Industry Network, Official Publication of the Irrigation Association.

www.drought.unl.edu/ – National Drought Mitigation Center, University of Nebraska-Lincoln.

www.epa.gov/owm/water-efficiency/index.htm – Water efficiency, United States Environmental Protection Agency (EPA).

www.xeriscape.org/ – Xeriscape™ Colorado!, Inc.

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