

Energy Efficient Homes: The Irrigation System¹

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Did you know that the typical homeowner uses up to 50% of a home's total water consumption for irrigation, and often over-irrigating?

If you have a 5,000 square-foot yard and use an in-ground sprinkler system, you may be spending \$5 to \$25 every time you irrigate. Overwatering the lawn and landscape is a common mistake many homeowners make. Keep in mind that, like most homeowners using public water, you are charged twice for the water you use—once for fresh water coming in, and a second time for the estimated wastewater that you discharge.

Quick Facts

- Automated, in-ground irrigation systems have been shown to use 47% more water than non-automated, above ground systems. (Mayer *et al.*)
- Many irrigation systems leave “dead spots” in the lawn due to poor design resulting in over-irrigation efforts to keep the entire lawn healthy.

- Using an irrigation schedule based on the seasonal water needs of the landscape reduces water use without compromising plant quality.
- Rain shutoff devices such as rain sensors and soil moisture sensors reduce the number of unnecessary irrigation events.
- An irrigation schedule based on real-time water needs of the landscape can be determined automatically by using an evapotranspiration (ET) controller instead of a typical time clock.

Terms to Help You Get Started

- **Application Rate** Total volume of water applied in a given time period over an area; expressed as a depth per hour, also sometimes called precipitation rate
- **Effective Rainfall** The rainfall that is stored in the root zone of the lawn/landscape and should be considered before supplementing with irrigation; this does not include rainfall that contributes to runoff or drainage

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- **Evapotranspiration (ET)** The total water lost from the soil (evaporation) and from the plant surface (transpiration) over some period
- **Efficiency, Irrigation Water Use** Ratio of the amount of water actually required by plants to the amount of water extracted from a water source for irrigation
- **Efficiency, Irrigation System** Ratio of the amount of water dispersed to the amount of water actually received by the target area
- **ET (Weather-based) Controllers** Irrigation controllers that calculate ET from on-site weather data by the controller (Stand-Alone) or from a “nearby” weather station and sent by signal to the controller (Signal-Based)
- **Drip Irrigation** Micro-irrigation system (low pressure and low volume) where water is applied on or below the soil surface as drops or small streams through emitters
- **Field Capacity (FC)** Maximum amount of water a soil may hold before draining (measured as percentage or inches per foot of soil)
- **Hydro-Zone** Plants grouped by water needs, organized into one irrigation zone.
- **Irrigation Controller or Timer** An automatic timing device that operates irrigation zones for a predetermined time and frequency (days per week)
- **Irrigation Scheduling** Determining when and how much to irrigate, based on factors such as soil type, root zone depth and local weather conditions
- **Irrigation Zone** Area of an irrigation system operated by one control valve
- **Micro-irrigation** Application of small quantities of water directly to or below the soil surface; includes drip, bubblers, and low-volume spray irrigation (micro-sprinkler)
- **Potable Water** Water fit for drinking
- **Rain Sensor (RS)** Device that can bypass the irrigation controller settings when a specific amount of rainfall has occurred
- **Rain Shut-off Device** Any device designed to bypass an irrigation event after an adequate amount of precipitation has occurred
- **Riser** Length of pipe usually affixed to a lateral line or sub-main pipe to support a sprinkler
- **Reclaimed Water** Used water that is reused after receiving at least secondary treatment from a wastewater treatment facility
- **Runoff** Rainfall or irrigation water that is not absorbed by the soil, but flows off the lawn/landscape area
- **Run time** Length of time a single irrigation zone operates
- **Smart Controller** Technological device (includes Rain Sensors, Soil Moisture Sensors, and ET Controllers) that uses weather data or soil moisture readings as feedback from the irrigated system to schedule irrigation
- **Soil Moisture Sensor (SMS)** Sensor buried in the root zone that measures soil water content
- **Soil Moisture Based Irrigation Controller (Bypass configuration)** Device that connects the SMS to the irrigation timer and bypasses the automatic irrigation when the soil moisture content is adequate for plant needs
- **Soil Moisture Based Irrigation Controller (On-demand configuration)** A controller that uses SMSs to regulate water content in the plant root zone between low and high moisture thresholds
- **Solenoid Valve** Electric valve connected to a timer that facilitates the operation of the irrigation zones
- **Timer** See *Irrigation Controller*
- **Uniformity** The evenness of water application to a target irrigation area

- **Valve** Irrigation device that opens and closes to allow or not allow water into specific pipes; can be either manual or electric
- **Water Meter** Measures water volume (typically in gallons)

Why does irrigation water conservation matter?

Although Florida has a humid climate (the average annual precipitation rate is greater than the evapotranspiration rate), spring, fall, and winter are normally dry. The average annual precipitation in Florida is approximately 52 inches with most rainfall occurring in the summer months (June through August). The spring months (March through May) are typically the hottest and driest (USDA, 1981). This region is also characterized by sandy soils with a low water-holding capacity; therefore, storage of water is minimal. These characteristics (dry and hot spring weather and sporadic large rain events in the summer, coupled with the low water-holding capacity of the soil) make irrigation necessary for the high-quality landscapes desired by homeowners.

Water used in a residential setting comprises 61% of the potable water used by the public. This public supply category is responsible for the largest single portion (43%) of all groundwater withdrawal in Florida (Marella, 1999). This amount of groundwater use is even larger than the agriculture or industrial categories! For more discussion of this concept, see *Florida's Water: Supply, Use, and Public Policy* at <http://edis.ifas.ufl.edu/FE207>.

Water used by the residential sector will continue to increase with increased population in the state. Florida has the largest net gain in population with an inflow of approximately 1,100 people per day and is fourth in overall population (USCB, 2005). New home construction has increased to accommodate such a large influx of people. Florida ranked first in the construction of single family residential homes, totaling 209,162 units in 2005 (USCB, 2007), and most new homes included in-ground automatic irrigation systems. As urban areas grow throughout the country, limited water resources will be stretched to fulfill urban, agricultural, recreational, and other needs.

A landscape and irrigation study in the Central Florida Ridge found that, on average, 62% of potable water was used for landscape irrigation (Haley et al., 2007). Other recent research in Florida has indicated that homeowners irrigated too much in the late fall and winter due to the inconvenience of changing the time clock, or a general misunderstanding of how much water to apply during the year.

The average residential irrigation cycle consumes several thousand gallons of water during each irrigation event. Water conservation has become a major concern for Florida, as the water demand increases, while the limited available supply per capita decreases.

How can I save water and money, yet still have an irrigation system?

- Check to see if there is an operating rain sensor and/or “smart” controller device on the irrigation system. These devices ensure that the landscape is watered only when needed, and that the system will shut-off during/after a rainfall event, or when the soil has sufficient water content. In 1991, the Florida Legislature passed a Bill (HB91), which required any person installing an “automatic lawn sprinkler system” to install a rain sensor device or switch (also referred to as a rain shutoff switch)—see Florida law (section 373.62, Florida Statutes) for full wording. In some municipalities, this is also required on all existing automatic irrigation systems (i.e., including systems installed prior to 1991). For more information about sustainable landscapes and communities see *Policies that Address Sustainable Landscaping Practices* at <http://edis.ifas.ufl.edu/UW253>, and *Evaluating Green Communities: Top Eleven Questions to Ask* at <http://edis.ifas.ufl.edu/UW247>.
- Design the irrigation system so that irrigation zones for turfgrass are separate from other landscape plants. In general, turfgrass needs more frequent irrigation than established shrubs and trees. Therefore, if you have the same irrigation zone for both, you could water the turf correctly while over-watering the shrubs and trees. In fact, once established, most shrubs and

trees do not require additional irrigation unless there is a drought.

- Schedule irrigation appropriately, this means answering:
 - (1) How much water should be applied?
 - (2) When should it be applied?
- The answers to these two questions should be based on water needs of particular plants in the landscape, as influenced by the environment (such as local weather conditions) and site-specific factors (such as soil and root zone).
- Significant reductions in water used for irrigation purposes can be achieved by properly scheduling irrigation and making landscape changes. Recommendations for run times are available from UF/IFAS Extension. The run times are listed by month for geographic location, application rate, and sprinkler type; assuming head-to-head coverage and weather conditions that are characteristic to Florida.
- The Florida Automated Weather Network has an Urban Irrigation Scheduler that can make scheduling very easy (see Web site http://fawn.ifas.ufl.edu/tools/urban_irrigation/). For other EDIS documents that will help you with irrigation scheduling see *Turf Irrigation for the Home* at <http://edis.ifas.ufl.edu/AE144> , *Operation of Residential Irrigation Controllers* at <http://edis.ifas.ufl.edu/AE220> , *Irrigating Landscape Plants During Establishment* at <http://edis.ifas.ufl.edu/AE287> , *Home Irrigation and Landscape Combinations for Water Conservation in Florida* at <http://edis.ifas.ufl.edu/EP113> .

Micro-irrigation in bedded areas (Figure 1) results in more efficient water application, because it targets the root zone of the plants, irrigating 50% or less area. Combining both proper irrigation scheduling and design can improve irrigation water conservation. For further information on the topic of micro-irrigation and how to incorporate this into your landscape see *Microirrigation in The Landscape* at <http://edis.ifas.ufl.edu/AE076> and *Retrofitting a*

Traditional In-ground Sprinkler Irrigation System for Microirrigation of Landscape Plants at <http://edis.ifas.ufl.edu/AE222>.



Figure 1. Example of micro-irrigation Credits: Michael Dukes

- An irrigation system evaluation can help you save water by improving the irrigation systems efficiency through maintenance. System evaluations (or audits) can be performed by a state Mobile Irrigation Lab (http://fawn.ifas.ufl.edu/focus/topic.php/mobile_irrigation), or by the homeowner. If you are interested in performing your own system evaluation a good place to start would be with *How to Calibrate Your Sprinkler System* at <http://edis.ifas.ufl.edu/LH026>.
- As part of an irrigation evaluation, the uniformity of water volume applied to the lawn is measured with catch-can tests (Figure 2). Uniformity is increased with proper head-to-head coverage. Good uniformity combined with proper scheduling will result in reduced pest and weed invasion, and less “dry spots.” Although a system can have sufficiently good uniformity, that does not mean that the irrigation event will necessarily be efficient.



Figure 2. Irrigation uniformity bucket test Credits: Melissa B. Haley

Efficiency vs. Uniformity

The terms efficiency and uniformity are often confused when discussing irrigation. It is a common mistake to use them synonymously. Efficiency refers to how much of the water applied to the plants is finally used by them; while uniformity refers to how evenly the water is applied to the plants. Figure 3 illustrates this concept. For a more in depth discussion of the concept, see *Understanding the Concepts of Uniformity and Efficiency in Irrigation* at <http://edis.ifas.ufl.edu/AE364> and *Lawn Sprinkler Selection and Layout for Uniform Water Application* at <http://edis.ifas.ufl.edu/AE084>.

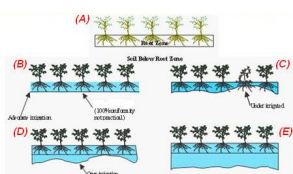


Figure 3. Efficiency versus uniformity in landscape irrigation (A)Top picture shows the soil reservoir or root zone. (B)Middle left is uniform and efficient (the goal). (C)Middle right is non-uniform and while efficient in terms of conservative water use results in plant quality decline. (D)Bottom left is non-uniform and inefficient due to over watering some areas. (E)Bottom right is uniform but inefficient due to over-watering resulting in drainage below the root zone (which, with time, can result in plant loss as well as the transport of excess nutrients, fertilizers and pesticides that harm the environment.) Credits: Michaela Dukas

Checklist for Efficient Irrigation

- Perform regular maintenance by turning on all irrigation zones. Check for leaks and that all irrigation heads are operating properly.
- Avoid the six most common irrigation errors:
 1. *Broken or misdirected sprinklers*
 2. *Sprinklers application obstructed by plant parts or grass blades.* These include branches, trunks, or leaves that can cause the spray pattern to be uneven.
 3. *Mixed sprinkler types.* For example, having spray heads and rotors in the same zone. These two sprinkler types have different application rates, and each is generally intended to irrigate different types of plants. When stationary

shrub spray heads and rotating turf sprinklers are used in the same irrigation zone, the shrubs usually end up being overwatered.

4. *Unmatched precipitation rates.* The flow rate of a sprinkler covering 90 degrees should be half the amount of the same type of sprinkler covering 180 degrees.

5. *Improperly spaced sprinklers.* Space the lawn sprinklers so the water from one head reaches the next surrounding sprinkler head(s), ensuring full coverage.

6. *Irrigation scheduled incorrectly.* Irrigation controllers are often set to run too frequently or for too long per irrigation event.

Consequently, turfgrass and landscape plants are over-irrigated, water is wasted, fertilizers are washed away, and diseases are promoted. Water only as needed.

- Adjust irrigation zones/sprinklers to avoid spraying buildings, driveways, streets, and sidewalks. In addition, be certain that plants or structures do not interfere with irrigation spray patterns.
- Make sure that there is a functioning rain shut-off device placed in an effective location (i.e. rainfall collection will not be impeded).
- Use a dual programmable timer to irrigate different areas of the landscape for different lengths of time.
- Separate the irrigation system into multiple zones to water only those areas that need it.
- Use micro-irrigation systems (sometimes called low-volume irrigation) on ornamental planting areas, which use water more efficiently by dispensing water slowly near the base of the plant, thereby reducing runoff and evaporation.
- Check on the availability and legality of reclaimed water, cistern water (from rainwater harvesting), or other non-potable source for irrigation water.

- Call your water utility company, a local irrigation contractor, county extension office, or your local Natural Resources Conservation Service (USDA/NRCS) to see if they can provide an irrigation system evaluation through the Mobile Irrigation Laboratory or some other method.

What is Evapotranspiration?

Evapotranspiration (ET) is the rate at which water may be removed from soil and plant surfaces to the atmosphere by a combination of evaporation and transpiration. Evaporation (E) is the conversion of water into its vapor phase. The main factors influencing evaporation are the supply of energy by solar radiation (from the sun) and the transport of vapor away from the surface (e.g., by wind). Transpiration (T) refers to the water used by plants and is affected by plant physiology and environmental factors. The evapotranspiration process is climate controlled. To learn about controlling for evaporative losses during irrigation, see *Evaporation Loss During Sprinkler Irrigation* <http://edis.ifas.ufl.edu/AE048> as well as the Florida Automated Weather Network (FAWN) at <http://fawn.ifas.ufl.edu> to determine the ET for your area. Finally, the concept is described in further detail in *Evapotranspiration: Potential or Reference?* at <http://edis.ifas.ufl.edu/AE256>, and *Atmospheric Parameters Which Affect Evapotranspiration* at <http://edis.ifas.ufl.edu/AE037>.

How an irrigation system is set up, including conservation devices

Figures 4 through 10 pictorially depict how automatic irrigation will function when wired with conservation devices such as rain sensors, soil moisture sensors, and ET controllers.

Other documents that will help you understand how your irrigation system and controllers are set up include *Irrigation System Controllers* <http://edis.ifas.ufl.edu/AE077>, *Using the Irrigation Controller for a Better Lawn on Less Water* <http://edis.ifas.ufl.edu/EP235>, and *Selection and Use of Water Meters for Irrigation Water Measurement* <http://edis.ifas.ufl.edu/AE106>.

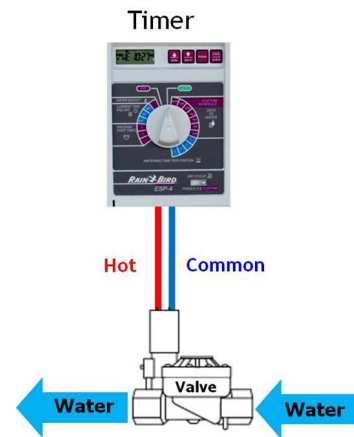


Figure 4. Irrigation timers are wired to valves in the ground that allow irrigation to occur when scheduled Credits: Haley et al

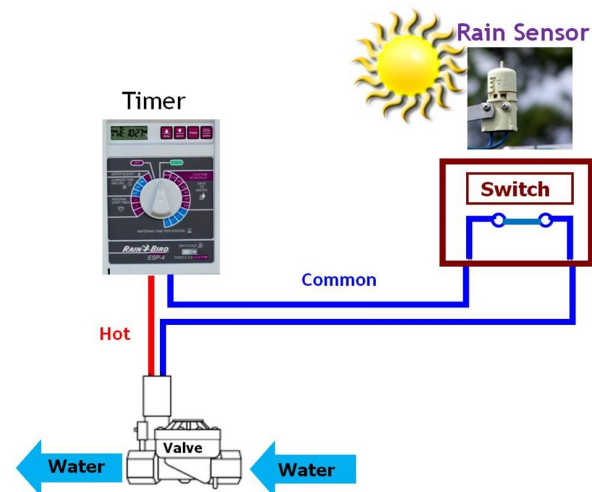


Figure 5. Irrigation timers connected to rain sensors allow irrigation events when the sensor is dry Credits: Haley et al

The EDIS document *Irrigation of Lawns and Gardens* <http://edis.ifas.ufl.edu/WI003> will help you understand how to design the irrigation system properly, differences in water sources, sprinkler types, and scheduling.

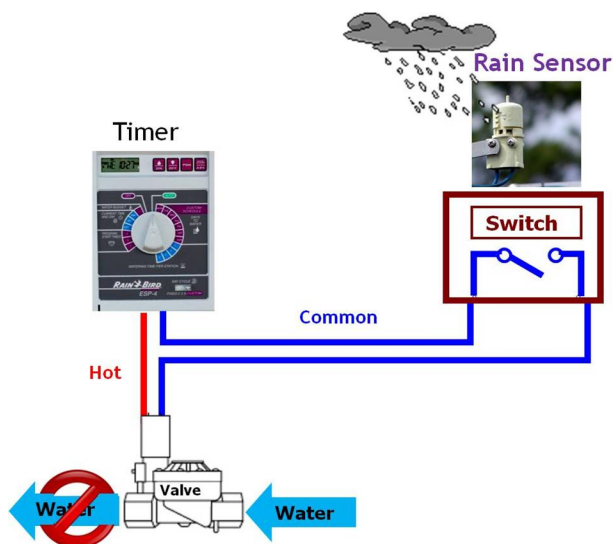


Figure 6. Irrigation timers connected to rain sensors bypass irrigation events when the sensor is wet; irrigation events resume as scheduled when the sensor dries out Credits: Haley et al

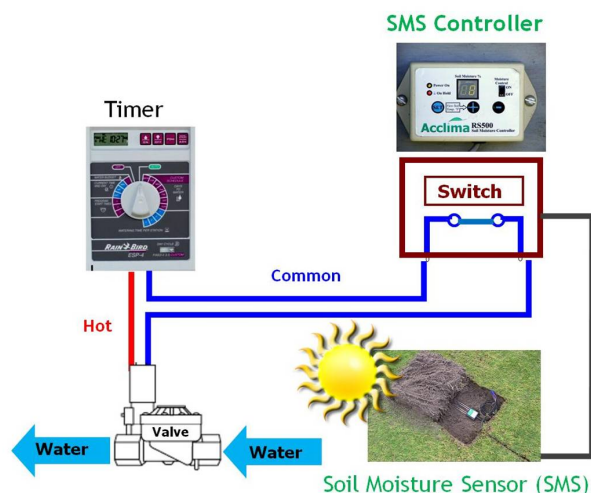


Figure 7. An irrigation timer with soil moisture sensor (SMS) allows irrigation events when the soil is dry Credits: Haley et al

during normal/wet weather (Cardenas-Lailhacar et al., 2008) .

- ET controllers: they are appropriate for California weather conditions, but not for Florida. Initial research has shown that they are also effective for Florida's climate (Davis et al., 2007) .

Rain Sensors

Rain sensors, the simplest rain shut-off device, are designed to bypass a scheduled event from an automatic irrigation system timer after a specific amount of rainfall has occurred. They are small and inexpensive devices that are wired to the irrigation system timer. In order to ensure proper functionality, they should be mounted in an open area where they are exposed to rainfall. For more information see *Residential Irrigation System Rainfall Shutoff Devices* <http://edis.ifas.ufl.edu/AE221>.

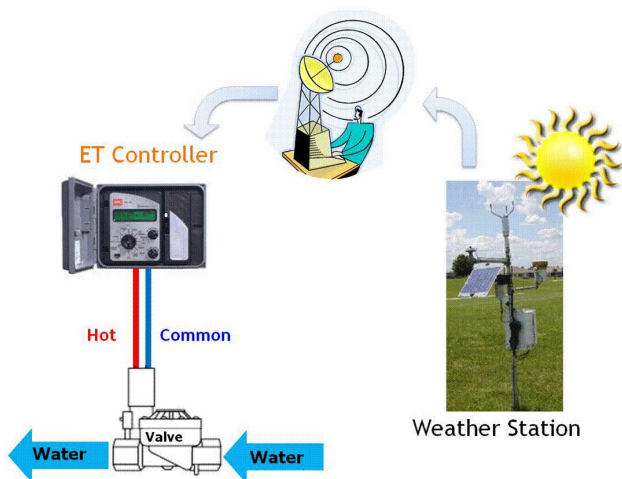


Figure 8. Signal-based ET controllers use local, publicly available weather data to calculate ET used to determine the irrigation schedule Credits: Haley et al

Water Conservation Devices

Debunking Urban Myths

- Rain sensors: everybody knows they dont work so why bother? They actually had resulted in a 34% savings during normal/wet weather conditions (Cardenas-Lailhacar and Dukes, 2008) and 15% savings during dry weather conditions (Haley and Dukes, 2007) .
- Soil moisture sensors: these things are not worth the money. Savings could provide a payback in 1 to 2 years and resulted in 69 to 92% savings

Soil Moisture Controllers

Soil moisture controllers are designed to bypass a scheduled event from an automatic irrigation system timer if the soil water content is above a certain threshold. This threshold is defined and set by the user. The sensor buried within the turfgrass or landscape root zone checks the soil water content. (Dukes et al, 2005)

What does an ET controller do?

ET controllers are irrigation devices that schedule irrigation instead of using run times programmed by the homeowner. These controllers use daily ET and rainfall to determine the landscape water needs. Daily ET amounts will vary with the season, typically being high in the summer and low in the winter, and schedules are gauged for the plants water requirement. This will result in more irrigation applied when less water is available to the plants.

Each controller works differently depending on the manufacturer but typically can be programmed with site-specific conditions such as soil type, plant type, sprinkler type, sun and shade, etc. The controllers are designed to either replace the typical timer or act as an amendment to the timer. In addition, controllers can have accessories that make them more accurate while others come as a complete package and need no additions. Depending on how the controller obtains ET information, yearly signal fees could be necessary.

Conservation devices and day-of-week restrictions

These devices can all be used successfully in conjunction with day-of-week watering restrictions. As shown above, the rain sensors and soil moisture controllers are wired to the standard irrigation time clock. The irrigation timer initiates the irrigation events, and therefore your appropriate watering days can be scheduled. A key concept to remember is that if the rain sensor setting or soil moisture sensor's threshold setting is queued correctly and determines that an irrigation event should be bypassed, overriding the system and irrigating on that day will result in runoff or excess drainage. Likewise, ET controllers allow for the user to program in permissible watering days and hours, and it adjusts the watering schedule accordingly. When these devices are set correctly, not only will you reduce unnecessary irrigation, but also turf quality will not be adversely affected.

Improper Irrigation

There are many potential risks to improper and inefficient irrigation design and water application.

For a detail discussion, see *Potential Impacts of Improper Irrigation System Design* <http://edis.ifas.ufl.edu/AE027> . See examples in Figures 11 through 15 for a few common design related issues.



Figure 9. Over irrigation results in runoff Credits: Michael Dukes



Figure 10. Irrigating this small strip of turfgrass with too large a spray head and excessive radial coverage results in water waste Credits: Michael Dukes



Figure 11. Water pressure that is too low provides uneven watering Credits: Bryan Unruh

Check with your local water management district or public water supply company about potential rebates or other incentives for reducing your irrigation water demand. They may even be able to



Figure 12. Iron stains on the fence show the use of an irrigation radius that is too large for this area Credits: Bryan Unruh



Figure 13. Irrigation spraying side of house Credits: Michael Dukes

refer you to a qualified irrigation specialist who can evaluate your system thoroughly and make recommendations for your particular situation.

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