An Introduction to

Landscape Irrigation Simplified

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Problem

Figure 1
Typical Over-Irrigation of a Landscape

Over-irrigation of landscapes is common where lush, green landscapes are sustained by irrigation. Estimates of the amount of water used for landscape irrigation typically range from 50 to 70 percent of the water used for urban purposes. In the state of Utah, nearly two thirds of residential water is used to maintain landscapes.[1] Preliminary results of numerous water audits conducted by Utah State University Extension in several metropolitan areas of Utah suggest that the typical homeowner applies about twice as much water as is needed each growing season.[2] On many commercial or institutional landscapes, three or four times as much water is applied as is needed. Nearly one third of the urban water supply is wasted by over-irrigating landscapes.[3] Anecdotal information suggests that this problem is relatively typical in many areas where landscapes are sustained by irrigation.

Consequences of over-irrigation can have far-reaching effects. Existing urban water supplies are being depleted sooner than expected. Existing distribution system capacity is or will be over-taxed during the summer irrigation season resulting in possible system failure. As a result, new water supplies and/or increased system capacity will be expensive to obtain. Over-irrigation can also contribute to groundwater and surface water contamination as excessive runoff and deep percolation carry fertilizers, pesticides, and other chemicals into these water supplies. Prolonged runoff from over-irrigation can weaken the foundation materials supporting concrete and asphalt pavement resulting in expensive repairs. Further, many plant problems can be linked to improper irrigation.

Experience shows the major factors that, individually or in combination, result in over-irrigating landscapes include:

1. Irrigation systems that are poorly designed, maintained, and inefficient with sprinklers improperly placed, out of adjustment, or in need of repair;

2. Irrigations that run off or soak past the depth of the plant roots;

3. Irrigations that occur more frequently than required by the landscape.

Informal surveys of homeowners and landscape managers participating in the Bureau of Reclamation's landscape irrigation workshops suggest that only about 10 percent of those in attendance know how much water is being applied by their irrigation systems. These informal observations have since been validated by a survey conducted for the Utah Division of Water Resources. The survey found that about 96 percent of the individuals surveyed lacked adequate information to irrigate their landscapes correctly.

Many homeowners think all sprinklers apply the same amount of water. Most know how long the system runs but not how much water is applied. Further, the lack of understanding the concept of uniform application results in the homeowner increasing run times rather than properly addressing the causes of dry spots in the turf. By watering to the needs of the dry spots, the rest of the turf is over watered.

Need

In evaluating the problems and causes of over-irrigation, three requirements, referred to as the "Three S's," have been identified for achieving efficient landscape irrigation. These requirements are:

1. The **S**ystem must apply water as evenly to the landscape as is practical.

2. The **S**etting of the irrigation run time should allow the sprinkler to eliminate runoff while applying the correct amount of water.

3. The **S**chedule of each irrigation should meet actual plant water needs throughout the growing season.

Unless all three S's are satisfied to the greatest degree practical, inefficient irrigations will continue. Contemporary efforts to promote more efficient landscape irrigation have usually only focused on one or two of the S's. Further, much of the water conservation advice provided has missed its intended audience. As mentioned above, only about 10 percent of the homeowners and landscape managers know how much water their irrigation systems are applying. For the other 90 percent, recommendations like "water deeper less frequently" and "apply 1 inch of water every 4 days" have little or no meaning. Thus, a different approach is needed to promote more efficient landscape irrigation.

The Bureau of Reclamation (Reclamation), an agency of the U.S. Department of the Interior that supplies water to farmers and communities throughout the West, is committed to making sure scarce water resources are used as efficiently as possible. The Upper Colorado Region of the Bureau of Reclamation recognized the need for more tools and techniques to improve landscape irrigation efficiency in the major urban areas served by its projects. Reclamation identified four basic needs:

1. A simple process to determine the irrigation system performance.

2. A simple, non-technical process for irrigating correctly that can be understood by the majority of the homeowners who have been missed in previous campaigns.

3. A more technical approach to proper irrigation that may be required by a limited number of homeowners, the typical landscape manager, and other irrigation professionals. This would be the group for whom the Irrigation Association’s Certified Landscape Irrigation Audit is too complex or too expensive for normal use.

4. A simple to use, inexpensive tool for determining sprinkler system performance.

<u>Solution</u>

Reclamation has developed a simple process called “Landscape Irrigation Simplified” or “LIS.” LIS addresses all three S’s. LIS provides procedures for determining system performance, a non-technical process for irrigating home landscapes, and an intermediate approach to fill the gap between the homeowner’s process and the Irrigation Association’s Certified Landscape Irrigation Audits.

LIS concepts have been validated by specialists from the Utah State University (USU) Center for Water Efficient Landscapes and the USU Extension Service. The USU Extension Service County Offices now provide Reclamation-prepared LIS handout materials (See Figure 2) as the basis for irrigation recommendations to local homeowners. Several local water purveyors are also using Reclamation’s LIS handouts as part of their water conservation campaigns.

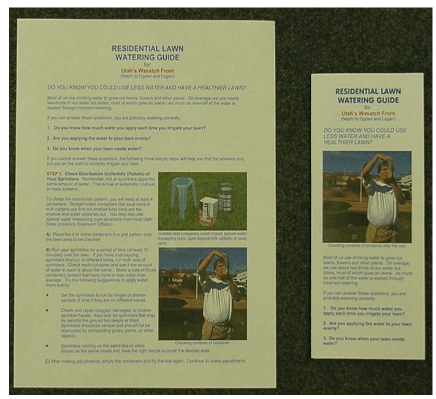

Figure 2
Sample LIS Handouts

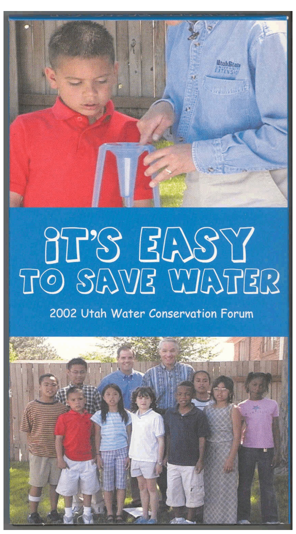

Figure 3
LIS Video

Reclamation partnered with USU Extension Service, The Utah Water Conservation Forum, and several local organizations to prepare an 8-minute video entitled “It’s Easy to Save Water” that describes how homeowners can efficiently irrigate their yards (Figure 3). The video features weather personalities from two local TV stations and a turf expert from the USU Extension Service. The Utah Water Conservation Forum has distributed the video to most municipalities and school libraries through out the state.

Two major water conservancy districts, the Jordan Valley Water Conservancy District and the Central Utah Water Conservancy District, sponsor a program of providing water checks (simplified water audits) for home, commercial, and institutional landscapes. The water checks are performed by USU Extension Service interns and follow LIS procedures. Reclamation has helped train the interns for the past three years. The LIS processes are described briefly below.

<u>The **S**ystem</u>. As previously mentioned, the sprinkler system, whether permanently installed or hand moved, must apply the water as evenly as practical. The design, installation, and maintenance of the sprinkler system all affect how evenly the sprinklers apply water. Sprinklers often appear to be applying water evenly but looks can be deceiving. The frequently appearing dry spots illustrate this problem. Figure 4 shows an example of this problem. A sprinkler system with typical uniformity applied the desired seasonal application of 30-inches but some areas only received 12-inches of water while other areas received 42-inches of water.

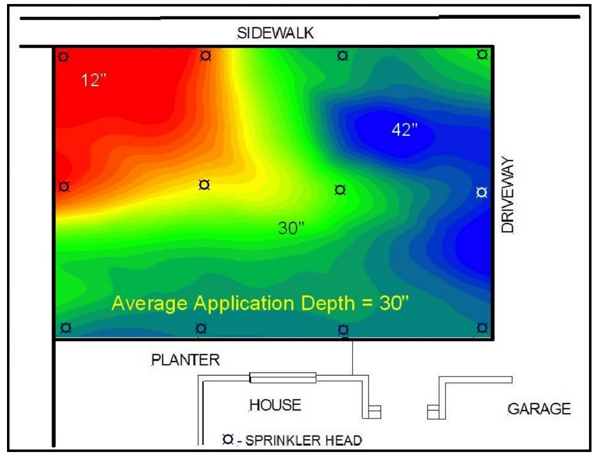

Figure 4
Distribution pattern for a sprinkler system applying an annual application averaging 30-inches in depth.

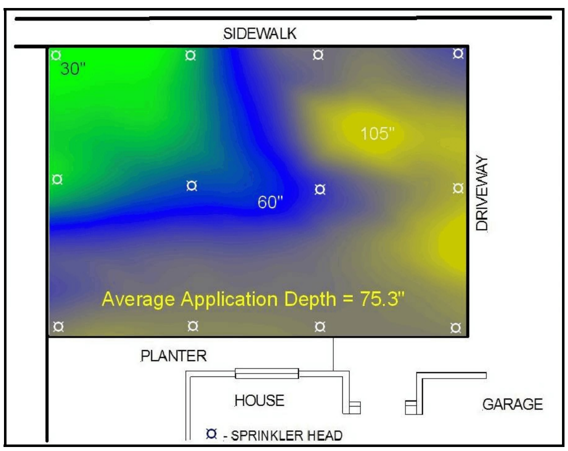

Figure 5
Distribution pattern for a typical sprinkler system applying 30-inches to the “dry” spot.

The typical “correction” for the problem is to repeatedly increase the sprinkler run time until the dry spots disappear. Figure 5 shows that with the same sprinkler system, the dry spot received the desired 30-inches of water but some areas received as much as 105-inches of water. The average application jumped from 30-inches to over 75-inches. The only way to know if the sprinkler is performing properly is to measure its performance.

LIS provides a process for determining sprinkler performance. Containers are placed in a grid pattern on the turf. The containers should be at least 3-feet from any sprinkler. The sprinklers are run for a known amount of time. A typical sprinkler performance test is shown in Figure 6. The sprinkler run time may be just a few minutes or for the duration of the entire irrigation event, depending upon the containers used. After the test, the depth of water in each container is observed. Significant differences in depth of water indicates either too much or too little water was applied in

Figure 6
Sprinkler system performance test in progress

some areas. This indicates some repair work is needed before the sprinklers will apply water evenly.

A more precise approach to determining sprinkler performance requires knowing the measured depth of water in each container. The measured depths in the containers are used to calculate the "Distribution Uniformity or DU" of the sprinkler system. A DU of less than about 0.65 to 0.70 indicates problems with the sprinkler system.

LIS helps locate and identify sprinkler problems and suggests methods for correcting the problems. Surprisingly, most repairs are quite inexpensive and easy to fix. After repairs have been made, the test should be re-run to verify that all problems have been fixed.

The **S**ettings. The settings of the sprinkler controller or timer should allow the sprinklers to apply the proper amount of water while minimizing or eliminating runoff. The root zone depth, soil water holding capacity, allowable soil moisture depletion, sprinkler water application rate, soil water infiltration rate, and the ground slope all combine to affect how long the sprinklers should be run. A typical irrigation event would apply about ½-inch of water. This depth, however, might vary depending upon the daily consumptive use of the plant during the hottest part of the summer.

LIS suggests three methods for determining the correct run time. In Method #1, containers are placed in a grid on the turf prior to a normal irrigation event. After the irrigation has been completed, the amount of water collected in each container is measured and compared with the appropriate amount of water, for example ½-inch. If the amount is not correct, the run time is adjusted and the test repeated during the next irrigation event. Adjustments may be required over the next two or three irrigation events to get the correct application depth.

Method #2 involves marking the desired depth on the containers and placing them in a grid pattern on the turf. The sprinklers are then started and timed to determine the number of minutes required to fill the containers to the desired level. The run times would be recorded or set on the sprinkler controller.

Method #3 involves calculating the correct run time. The calculation requires knowing the average application depth determined during the evaluation of the sprinkler system along with the length of time the test was run. This is the quickest and most precise method for determining sprinkler run times.

Low soil infiltration rates or excessive ground slopes may cause water to runoff before the irrigation application has finished. LIS provides a process for cycling the irrigations using shorter run times separated with soak cycles. This practice allows the correct amount of water to be applied while minimizing or eliminating runoff.

The **S**chedule. Individual irrigation events should be scheduled to meet local water requirements of the plant. The plant variety, the amount of water applied at the last irrigation, air temperature, relative humidity, wind velocity, and solar radiation all help to control how frequently the plant needs to be irrigated. Typically, temperatures are the coolest in the spring and fall so plant water needs are less during these times. Plants may only need to be irrigated once every 7 to 10 days during the cooler seasons whereas they may require irrigation every two or three days during the heat of the summer. Irrigation schedules often vary from one climate zone to another.

A key component of LIS is the irrigation schedule tailored to local horticultural and climatic conditions. Procedures have been developed for LIS that create daily consumptive use estimates using local, long-term climate and evapotranspiration data for the plants. Daily consumptive use estimates are the basis for developing detailed irrigation schedules. Figure 7 shows a typical detailed irrigation schedule for three different application amounts. The detailed schedule begins at the start of the growing season and shows the recommended number of days between irrigations. It shows the time period during which the recommended number of days applies. As temperatures warm, the recommended number of days between irrigations is reduced by one day. The schedule shows the time period when this new recommended interval applies. The schedule continues to show the changing recommended intervals and the applicable time periods throughout the entire growing season. This schedule provides a high degree of precision in scheduling irrigations throughout the growing season.

The high precision of the detailed irrigation schedule, however, is too complicated for most homeowners and landscape managers. A more simplified schedule has been prepared that shows, on a month-by-month basis, the recommended number of days between irrigations for each month of the growing season. A typical Monthly Irrigation Schedule is shown in Figure 8 for three application rates. This irrigation schedule allows the homeowner to simply reset the number of days between irrigations at the beginning of each month. The recommended intervals, when used in conjunction with a calendar, can tell when to expect the next irrigation for manually operated systems.

The recommended irrigation schedules are based upon long-term, typically 30-year average, climatic and evapotranspiration data. Hotter than normal temperatures could require irrigating sooner than the schedule recommends. Likewise, cool periods or rain could delay or eliminate a recommended irrigation. LIS encourages homeowners and landscape irrigation practitioners to frequently check the conditions of the plants and make any short-term adjustments in the irrigation schedule that might be required. Also, LIS recommends that if dry spots are noted, the sprinkler system should be checked for problems, the soil should be checked for abnormalities, and the plants should be inspected for pests before automatically increasing the frequency of irrigations or increasing the sprinkler run times.

Detailed Irrigation Schedule
for
A Typical Location

0.5-inch Application		0.75-inch Application		1.0-inch Application	
Start/End Dates	Interval, days	Start/End Dates	Interval, days	Start/End Dates	Interval, days
04/01 - 04/02	10	04/01 - 04/02	14	04/01	18
04/03 - 04/07	9	04/03 - 04/06	13	04/02 - 04/04	17
04/08 - 04/13	8	04/07 - 04/10	12	04/05 - 04/07	16
04/14 - 04/20	7	04/11 - 04/14	11	04/08 - 04/11	15
04/21 - 04/29	6	04/15 - 04/20	10	04/12 - 04/15	14
04/30 - 05/12	5	04/21 - 04/26	9	04/16 - 04/19	13
05/13 - 06/04	4	04/27 - 05/04	8	04/20 - 04/24	12
06/05 - 08/09	3	05/05 - 05/14	7	04/25 - 04/29	11
08/10 - 08/29	4	05/15 - 05/29	6	04/30 - 05/06	10
08/30 - 09/09	5	05/30 - 08/14	5	05/07 - 05/14	9
09/10 - 09/16	6	08/15 - 08/26	6	05/15 - 05/25	8
09/17 - 09/20	7	08/27 - 09/03	7	05/26 - 06/13	7
09/21 - 09/24	8	09/04 - 09/09	8	06/14 - 07/28	6
09/25 - 09/28	9	09/10 - 09/13	9	07/29 - 08/15	7
09/29 - 09/30	10	09/14 - 09/17	10	08/16 - 08/24	8
10/01 - 10/03	11	09/18 - 09/20	11	08/25 - 08/31	9
10/04 - 10/05	12	09/21 - 09/22	12	09/01 - 09/04	10
10/06	13	09/23 - 09/24	13	09/05 - 09/08	11
10/07 - 10/08	14	09/25 - 09/26	14	09/09 - 09/11	12
10/09 - 10/11	15	09/27 - 09/28	15	09/12 - 09/14	13
10/12 - 10/14	16	09/29	16	09/15 - 09/16	14
10/15 - 10/31	17	09/30	17	09/17 - 09/18	15
		10/01	18	09/19 - 09/20	16
		10/02 - 10/03	19	09/21	17
		10/04	20	09/22 - 09/23	18
		10/05 - 10/06	21	09/24	19
		10/07	22	09/25	20
		10/08 - 10/31	23	09/26	21
				09/27	22
				09/28	23
				09/29	24
				09/30	25
				10/01	26
				10/02	27
				10/03 - 10/31	28

Figure 7
Typical Detailed Irrigation Schedule showing irrigation intervals for three application rates

Monthly Irrigation Schedule for A Typical Location			
Month	Irrigation Intervals		
	1/2" Application	3/4" Application	1" Application
March	---	---	---
April	Once every 6 days	Once every 8 days	Once every 11 days
May	Once every 4 days	Once every 6 days	Once every 8 days
June	Once every 3 days	Once every 5 days	Once every 6 days
July	Once every 3 days	Once every 5 days	Once every 6 days
August	Once every 3 days	Once every 5 days	Once every 7 days
September	Once every 6 days	Once every 8 days	Once every 10 days
October	Once every 10 days	Once every 18 days	Once every 26 days

Figure 8
Typical Monthly Turf Irrigation Schedule for Three Application Rates

Figure 7
Performance evaluation cups - Professional Model and Institutional/Homeowners Model, L-R.

Performance Evaluation Cups. The most difficult part of applying good landscape irrigation practices has been getting good sprinkler system performance information. The Bureau of Reclamation has designed (U.S. Patent No. 6,779,399) two self standing, direct reading, water measuring cups for measuring sprinkler system performance. The cups, made of durable, clarified polypropylene plastic, are designed to simplify the process of assessing sprinkler system performance. Both cups are self-stacking to ease transport and storage of the cups. The self-standing feature provided by the three attached legs simplify deployment and retrieval of the cups during a sprinkler evaluation test. The direct reading of application depths eliminates most of the calculations associated with other measuring devices used to assess sprinkler system performance.

The Professional Model is 6 3/4-inches tall with a 4 1/4-inch diameter opening. It has three attached legs that flare outward to form a 6 1/2-inch diameter base. Ten cups form a stack 12 3/4-inches tall. Each additional cup adds 9/16-inch to the stack. This cup measures sprinkler application depth in inches or centimeters and volume in milliliters. It is a low volume cup with high resolution measuring scales used primarily by landscape irrigation professionals for short duration tests. The three measuring scales accommodate world-wide use of the cups.

The smaller cup (the Institutional/Homeowners Model) is 5-inches tall with a 3-inch opening. Its three attached legs flare out to form a 5-inch diameter base. A stack of ten cups is 9-inches high. Each additional cup adds 1/2-inch to the stack. This cup is a higher volume, lower resolution cup than the Professional Model. However, there is very little practical difference in the resolution of the two cups. This smaller cup is used for measuring the application of a full irrigation event. This cup only reads application depth in inches. It is the choice of the institutional landscape practitioner who is restricted to checking the performance of the sprinkler system during normally scheduled irrigation events and of the homeowner.

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