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LANDSCAPE IRRIGATION EVALUATION AS A WATER CONSERVATION PRACTICE

JANET BARGAR
University of Florida, IFAS
Indian River County Extension Service
Vero Beach, FL 32960

DANIEL F. CULBERT[1]
University of Florida, IFAS
Okeechobee County Extension Service
Okeechobee, FL 34972

ELWOOD HOLZWORTH
USDA, Natural Resources Conservation Service
Mobile Irrigation Laboratory
Vero Beach, FL 32960

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Abstract. **In 2001, Indian River County's Orchid Island Golf and Beach Resort was unable to continue new home construction because its irrigation water use exceeded their consumptive use permit. An evaluation of its irrigation systems and landscapes was conducted by a team of the local USDA/NRCS Mobile Irrigation Lab technician and UF/IFAS County Extension Agents. The analysis revealed that time clocks were set at initial landscape installation rates, and irrigation systems had continued to operate at these levels for several years. Recommendations were developed for this community that included the use of the following key irrigation practices: calibrating irrigation equipment, correcting distribution problems, cleaning and adjusting sprinkler heads, and installing or repairing automatic rainfall shut-off devices. Recommendations were implemented during the late spring high water demand period, and resulted in a 57% drop in annual water use. Presentations were made to the property owners and landscapers. A follow-up of practice adoption and water consumption rates shows that an on-going community education program is necessary to impact water conservation.**

Mobile Irrigation Labs (MIL) were developed to help people conserve water and protect water quality, two top priorities in Florida. They are particularly useful where regulations and consumptive use restrictions continue to increase. The MIL technicians provide on-site evaluations of individual irrigation systems and work with property owners to develop irrigation water management plans. The plans include recommendations to improve system performance and teaching irrigation managers how to operate their irrigation systems more effectively (Holzworth, 2004). A partnership between the UF/IFAS Extension programs in Water Quality and Environmental Horticulture and the Urban MILs can demonstrate a team approach in teaching Floridians how to use their water resources wisely.

According to the South Florida Water Management District, in the last four years MILs in south Florida have saved over 3.3 billion gallons per year (SFWMD, 2003). Individual homeowners receiving urban MIL evaluations reportedly saved over 4,500 gal of water per month and $7.00 in water costs (SFWMD, 2003). When recommendations to modify the irrigation systems are made, retrofitting costs of $200 are paid back in 29 months.

Irrigation Water Management (IWM) as defined by the USDA MILs is applying water according to crop needs in an amount that can be stored in the plant root zone. Irrigation is applied when available soil moisture is depleted 30-50%, depending on time of year. The length of irrigation time is the time it takes to refill the root-zone. The amount of water to be applied is generally ¼"-½" on turf grass, depending on depth of root-zone. The frequency of irrigation is 1-2 times per week depending on time of year, age of planting and long-term behavior of the irrigated turf (Culbert et al., 2001).

Proper IWM considers available water capacity (AWC) as the portion of water in a soil that can be readily absorbed by plant roots of a crop. Soil moisture depletion is the amount of water required to raise the content of the crop root-zone to field capacity. Field capacity is the amount of water a well-drained soil holds after free water has drained because of gravity. For a coarse textured soil, drainage occurs soon after irrigation (or rain) because of relatively large pores and low soil particle surface tension; for a fine textured soil, drainage takes much longer because of smaller pores (Culbert et al., 2001).

Major soil properties that affect the field capacity are texture, structure, bulk density and the strata within the profile that restrict water movement. Generally fine textured soils can hold more water than course textured soils, while soils with large amounts of organic matter hold water longer than sandy soils. Compaction increases soil density, reduces pore space and decreases permeability. Restrictive layers can restrict root development and water movement lower in the soil (Culbert et al., 2001).

With rapid development of residential areas continuing in Florida, water management districts are scrutinizing the use of landscape irrigation water. Developers must apply for a consumptive use permit (CUP) to allow them to use either surface or groundwater resources in landscapes or for potable water. Water management districts, the Florida Department of Environmental Protection and local governments have embraced programs such as the Florida Yards & Neighborhoods Program as a way to reduce landscape irrigation water use and stormwater runoff.

One of the many urban developments in Florida is a 412 acre golf and residential community that has also incorporated itself as a municipality in Indian River County. The Orchid Island Golf and Beach Club has 156 acres of golf course and 122 acres of residential and common areas under irrigation. This community constitutes the major portion of the Town of Orchid, located on the barrier island north of Vero Beach, and is an upscale development of single family homes, courtyard homes and condominiums which include many recreational amenities that are attractive to affluent retirees.

The St. Johns River Water Management District regulates irrigation water use in this area of Florida. Their staff recommended that Orchid be issued a CUP in Feb. 2000 in the

[1]Corresponding author.

amount of 258.2 million gallons per year (mgy) of stormwater and non-potable ground water for irrigation of the golf course, residential and common areas (Knight, McGuire and Associates, 2000). Of this amount, 77% (198.8 mgy) was designed to come from stormwater retained in internal lakes. The balance comes from two 10 inch artesian wells that draw from the Florida aquifer from depths of 750 and 800 feet. The permit allows the community's wells to be opened only when needed to maintain pond water levels, especially during periods of drought.

This community installed an irrigation system that is segmented into golf course use and residential/common area systems, each powered by independent pumping stations. The urban landscape use pump has a capacity of 550 gal per minute (gpm), and supplies irrigation water throughout the 283 home sites and 10 beach condos. This irrigation water is not metered, and the system costs are handled through the Property Owners Association (POA). The residents' potable water is supplied by the county utility system through individual meters.

Materials and Methods

In Jan. 2001, the County Extension office was asked to provide assistance to the Orchid Island Golf and Beach Club with their irrigation system. Agents from the local University of Florida County Extension Service invited the local urban MIL technician to an initial meeting with members of the property management team and a POA representative on 15 Jan. 2001. The property managers provided an overview of water use and rainfall statistics in the community (Table 1). The water use values revealed that the community was currently using 207% more water in the urban landscapes than their CUP allowed despite being at only 60% build out and with all common area landscapes installed.

Developers and landscape managers also revealed that the urban irrigation systems were calibrated to be within 2% of the manufacturer's recommended rates at installation. Application decisions were based on the amount of moisture in the ground. The community irrigation system for Orchid's homes and common grounds was independent of golf course irrigation system; the operating pressure for these urban uses was approximately 75 psi in daytime hours, while during night time high-use periods the pressure often dropped below 20 psi.

There was some concern about salinity of the irrigation water, especially during drier months when well water from the Florida aquifer would be used. Prior to 2001, a mysterious clogging of the system was also causing homeowners to run their systems for longer periods of time, further dropping water pressure and encouraging even longer run times, further wasting water.

The major assistance requested of the Extension/MIL team was to develop homeowner recommendations on how long to water their landscapes. From the perspective of the developer, the question was how much water would be needed. A member of the POA board noted that a monthly community newsletter was distributed to all property owners, and might be a way to get an educational message out to the community (Tench, 2001).

It was agreed that coring samples would be to taken to determine soil water-holding capacities. Five basic kinds of landscape plans were found to represent the kinds of homes present in the development, so that only five evaluations would be necessary to develop irrigation schedules for all homes in the community. The amount of water needed to irrigate these five lots was then multiplied by the number of residences of that type to estimate all the water needs of the community.

The team agreed that after evaluations were completed and recommendations developed that the group would meet again to review the recommendations. Recommendations would then be presented at the annual general meeting of the community's POA. It was noted that implementation of these recommendations would be made gradually so that landscape quality would not be affected. Management also felt that implementation of the irrigation schedule could be done during the springtime, which is the season with the highest irrigation water demand.

The following steps and calculations were used to determine run times:

1. The number of irrigation heads of each pattern (¼ round, ½ round, full circle, side spray) was counted. Water was collected for a noted amount of time. The following calculations were then made:

   watering rate for each type of head (ml/sec) × 0.016 = ***n*** gpm.

   number of heads × ***n*** gpm = total gpm for that type of spray pattern.

2. Measurements for each different kind of spray head pattern produced gpm rates for each zone. These rates were summed, and the total gpm was divided by the square footage of the zone. The product was converted to inches per hour by multiplying by 96.3.

3. The run time for each zone was determined by multiplying the total iph by 60 min to give the minutes of run time.

Table 1. Annual urban water use—Orchid Island Golf & Beach Club, 1999-2003.

Year	Net water use[z]	Permitted water use[z]	Annual use over permitted[z]	Percent of permitted water use	Annual rainfall[yw]	Percent of normal rainfall[x]
1999	160,192,000	110,789,000	49,403,000	5%	47.28	-8.03%
2000	215,818,000	110,789,000	105,029,000	95%	44.33	-13.77%
2001	340,321,000	110,789,000	229,532,000	207%	52.35	1.82%
2002	108,474,000	110,789,000	-2,315,000	-2%	89.15	73.40%
2003	155,822,301	110,789,000	45,033,301	41%	47.97	-6.69%

[z]Water in gallons.
[y]Rainfall in inches.
[x]Based on normal rainfall of 51.51" (NOAA).
[w]Values for 1999-2001 from Bayer Labs, Vero Beach; 2002-03 values from Orchid Island (on-site).

Table 2. Irrigation evaluation tool kit.

Soil core sampling tool
Plastic gallon jug—catch bottle
Stopwatch
Graduated cylinder—measuring device
Calculator
Special hose and saddle
Pressure gauge
Measuring tape or wheel
Laminated worksheet with formulas

After run time and frequency recommendations were developed, it was recognized that implementation of these recommendations would also take the involvement of landscape maintenance professionals. At the time that this project was undertaken seven different landscape maintenance companies operated in Orchid. Representatives of these companies were invited to attend the POA annual meeting, and copies of the irrigation schedule were sent to these service providers.

One of the participants in the POA meeting was the property manager of the adjacent development of Windsor. He indicated that his residents had similar issues with water conservation. In this community, municipal (potable) water was used for landscape irrigation, and homeowners were motivated towards water conservation not by financial considerations, but by the high volumes of water used and recorded on their individual water meters. A second set of irrigation evaluations was conducted by the MIL, and a second set of irrigation run times was recommended to this community's management office on 3 Aug. 2001.

Table 3. Orchid Island irrigation system evaluations.

	Proposed schedule for 5 typical lot sizes			
Zone	Application Rate	Flow (gpm)	Time**	Gallons per event
Caribe				
1	4.15 iph	27.37	8	218.96
2	2.71 iph	16.38	11	180.18
3	2.33 iph	33.62	13	437.06
4	3.26 iph	52.84	9	471.06
5	2.92 iph	30.36	10	303.60
				Total 1610.86
Club House Court				
1	1.36 iph	20.84	22	458.48
2	1.76 iph	28.95	17	492.15
3	2.30 iph	21.63	13	281.19
4	0.86 iph	18.79	36	657.65
				Total 1880.47
Indies				
1	3.60 iph	135.80	8	1086.40
2	2.57 iph	83.50	12	1002.00
3	0.81 iph	26.66	37	986.42
				Total 3074.82
Pembroke				
1	3.70 iph	30.70	8	245.60
2	2.30 iph	20.85	13	271.05
3	4.98 iph	27.95	6	167.70
4	1.92 iph	8.50	16	136.00
5	1.38 iph	24.20	22	532.40
				Total 1352.75
White Pelican Circle				
1	0.85 iph	28.55	35	999.25
2	2.36 iph	32.07	13	416.91
3	0.50 iph	22.90	52	1190.80
4	0.61 iph	13.49	49	661.01
5	0.98 iph	24.90	30	747.00
6	1.15 iph	14.15	26	367.90
7	4.47 iph	16.24	7	113.68
8	1.86 iph	23.14	16	370.24
9	1.00 iph	16.64	30	499.20
10	0.47 iph	18.93	64	1211.52
11	4.15 iph	19.49	8	156.92
				Total 6733.43

**Time—minutes to operate each zone to apply 0.5" of water.

A workshop was planned and held for landscape maintenance personnel on 12 Sept. 2001 at Windsor. Thirteen participants were provided with background information and reference materials on irrigation water management and given hands-on practice in using these irrigation management techniques. A tool kit (Table 2) was assembled by the MIL and given to the property manager's offices for use by landscape management personnel so they could perform these evaluations as needed.

Results

On 25, 26 and 29 Jan. 2001 the MIL technician and Horticultural Extension agent worked with the property's irrigation manager to complete evaluations of five typical lots. Soil core samples taken showed that the soils consisted of a coarse yellow sand and slightly finer whiter sand. Cores taken near the beachfront condos indicated that some marly shell rock fill existed approximately six inches below grade. In some cases, soil core samples taken just after irrigation had been applied showed wetness below the root-zone, indicating over-irrigation.

Each irrigation zone was operated, the number of emitters was counted, the operating pressures were measured and the flow rates were calculated. Square footage of each zone was calculated (Culbert et al., 2001). Using this information, irrigation run times for five typical lots were calculated (Table 3).

Frequency of each irrigation event needed was determined by applying irrigation water management (IWM) principles as used by USDA/MIL and University of Florida turfgrass researchers. For this community, a maximum of two irrigations per week was suggested as a compromise that would be easy for landscape managers to implement, yet would maintain available water capacity and allow for CUP levels to be followed.

Observations of the landscape revealed other issues in this community that related to their urban irrigation water use. Timers were originally set from 15 to 30 min per zone and varied from 3 to 5 to 7 d per week. These settings, and interviews with homeowners and landscapers, indicated that most landscapes had been installed with timers set to apply irrigation rates typical for newly established plant materials. It appeared that these delivery rates had not been adjusted as the plants became established. Very little root growth on St. Augustine

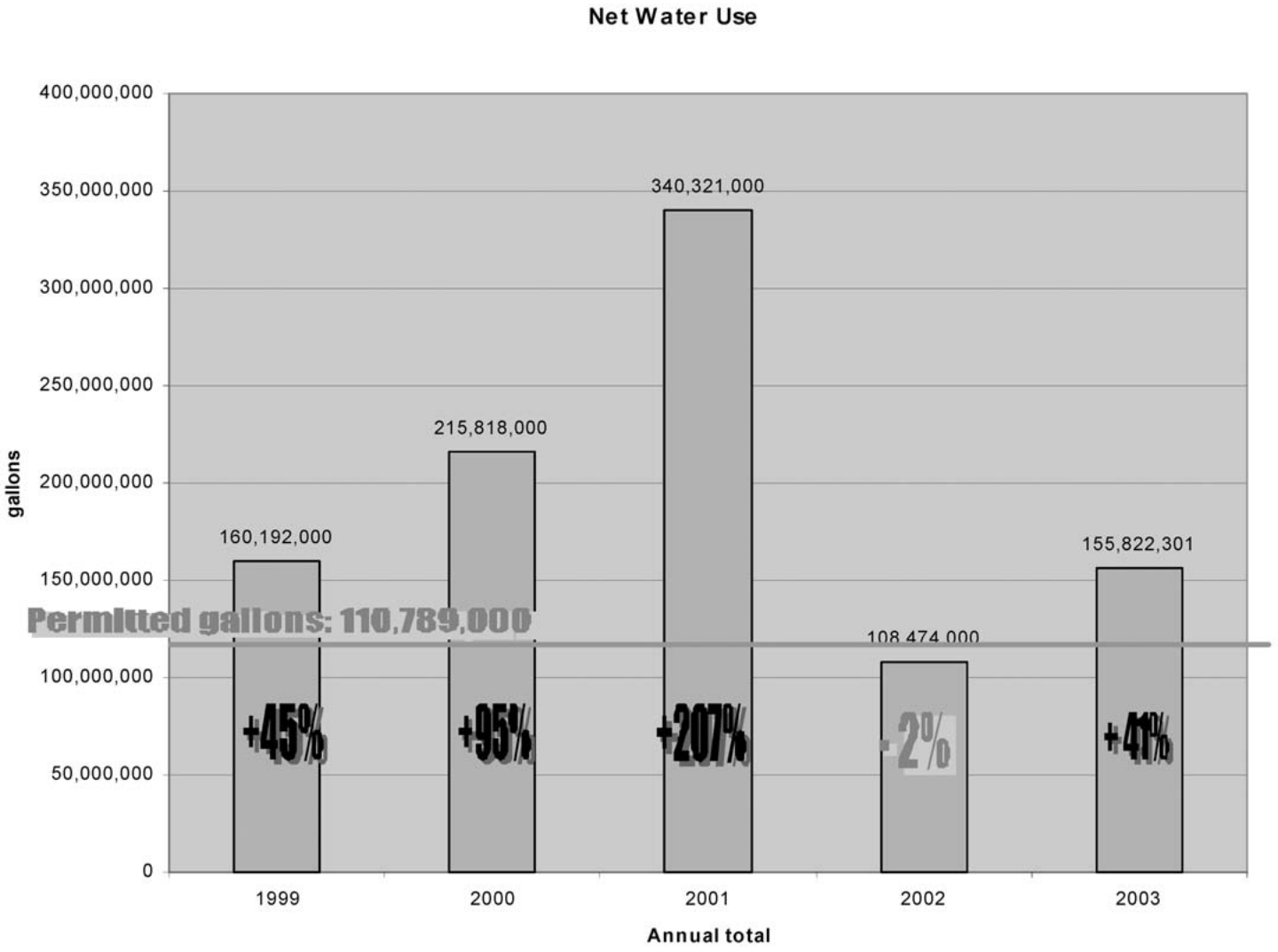

Fig. 1. Net water use.

turf was noted. Sprinklers sometimes were obstructed by shrubs, which caused puddling and runoff onto driveways and roads or resulted in dry spots in the landscape. It was recommended that landscapers and homeowners observe each zone in operation and adjust positioning/heights of sprinklers and/or prune shrubs and grass to avoid obstruction of spray pattern.

Community water use values are summarized in Fig. 1. This figure shows that a drop in consumption of irrigation water occurred between 2001 and 2002, with the amount in 2002 being 2% less than CUP levels. In 2003, consumption climbed 47% above permitted amounts. Climatic records for 2001 showed that the community received nearly normal rainfall levels, while in 2002, levels 73% above normal were recorded in this community. From the information available, it is difficult to determine if the drop in irrigation water use was due to the irrigation recommendations made, or if excessive rainfall was the major factor in the drop in community water use.

A follow-up evaluation of practice adoption was conducted in 2004 (Bargar, 2004). Of the 13 workshop participants, none of those attending were available to respond to questions about how the workshop may have affected their ability to evaluate irrigation systems. Comments received were that companies had gone out of business or that workshop attendees had moved out of the landscape maintenance employment.

Comparing water consumption in Fig. 1 to staffing patterns, it is noted that the during the latter part of 2002 the newly hired Water Quality Extension Agent left the county, and that the County Extension Director/Horticulture Agent left this county in 2003. Without staff support, there was little opportunity for continued training of landscape maintenance personnel in irrigation management, nor was there staff available to monitor and assist these property managers.

Conclusions

Results from this project allowed the team to determine the total community water use levels, and these figures indicated fluctuations in consumption and their relationship to the CUP. The use of these procedures can show water management districts, property developers, and property owners if they are in compliance with these regulations.

Application of these procedures in other communities may reveal opportunities for property managers to act immediately on sudden spikes in water usage. These procedures can provide a method for management to demonstrate compliance with CUPs and request permit modifications.

It is noted that non-continuous staffing of those available to provide irrigation education programs may have played a role in the inability of this community to reduce their landscape irrigation water use. Without on-going programming and evaluation, irrigation efficiency and water conservation may be a function of weather patterns. Communities committed to water conservation will need to provide on-going training programs and support to property management and POAs to conserve water.

Finally, another recommendation would be for property managers to "listen to the technicians". In this case the irrigation specialist indicated to this evaluation team the he had informed management of a problem, but that they were slow to react. The data in this instance came in monthly reports. The CUP together with monthly usage figures can allow management to assess spikes in water use, which can serve to motivate changes in how urban landscape irrigation systems are operated.

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