Legislative Report

Recommendations for Water Efficiency Standards for In-ground Irrigation Systems

As Required by North Carolina House Bill 2499 /S.L. 2008-143

Prepared by the N.C. Department of Environment and Natural Resources
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Executive Summary

Population growth coupled with cyclical drought conditions has caused many public water supply systems to experience limited raw water availability. The population is expected to grow from 8.5 million in 2004 to 12 million in 2030. Water consumption is expected to increase from 241 billion gallons per year for all households to 335 billion gallons if current consumption continues. Water efficient in-ground irrigation systems are one way to decrease household and commercial water consumption to help meet future demands.

S.L. 2008-143, Section 18, mandated the N.C. Department of Environment and Natural Resources develop recommendations regarding water efficiency standards for in-ground irrigation systems. This report makes recommendations for water efficiency standards for in-ground irrigation systems in residential and commercial settings, identifies best management practices for proper installation and use of such systems, and identifies voluntary approaches to decrease water use for irrigation purposes.

DENR makes the following recommendations:

1) Inclusion of rain sensing technology in all new and existing irrigation system use;
2) Mandate annual irrigation system performance audits;
3) Encourage the North Carolina Irrigation Contractors' Licensing Board to consider adopting best management practices such as those listed in this report; and
4) Encourage voluntary approaches to decrease water use for irrigation purposes.

Table of Contents **Page**

Acknowledgements

This document was developed under the guidance and review of stakeholders in the field of irrigation, from both the industrial and academic sectors. DENR would like to recognize the following organizations that have contributed to this document:

N.C. Division of Pollution Prevention and Environmental Assistance
N.C. Division of Water Resources
N.C. Green Industry Council
N.C. State University
The Irrigation Association
EcoIrrigation
Turfgrass Council of North Carolina

I. Background

As the state's population continues to grow, North Carolina is beginning to face the reality that water resources are limited. North Carolina has already experienced ground water depletion in the central coastal plain and serious drought conditions affecting both surface and groundwater supplies.

To date there are no regulations, standards or licensing requirements related to in-ground irrigations systems in North Carolina. Last year, S.L. 2008-177 established the North Carolina Irrigation Contractors' Licensing Board, tasked to adopt and publish a code of professional conduct and practice for all individuals licensed under this Chapter. This code will establish minimum standards for water conservation in the practice of irrigation construction and contracting. The board will also be required to publish a list of best management practices to be followed by licensed irrigation contractors.

On a residential or commercial site, water used for landscape irrigation can range from 25 to 50 percent of total site water usage. With such a large percentage of total water usage devoted to irrigation, there is an opportunity for water conservation through efficient irrigation practices. Excessive water use and inefficiencies arise from improperly designed, installed, maintained and operated irrigation systems.

Proper irrigation reduces water usage, aids in erosion control and lessens energy consumption while adding to aesthetics and environmental quality. The following sections outline practical recommendations to decrease water usage for in-ground irrigation systems. Since operation and management of the system is just as important as the technical standards, this report includes discussion of best management practices for in-ground irrigation systems. Additionally, this report will discuss voluntary approaches to reduce water usage for irrigation purposes.

II. Introduction

This report is in response to S.L. 2008-143, Section18, which mandated the N.C. Department of Environment and Natural Resources to develop recommendations regarding water efficiency standards for in-ground irrigation systems in collaboration with a technical working group.

For the purpose of this report, an irrigation system is defined as: all piping, fittings, sprinklers, drip tubing, valves, control wiring of 30 volts or less, and associated components installed for the delivery and application of water for the purpose of irrigation. Surface water, potable water or groundwater sources, water taps, utility piping, water service lines, water meters, backflow prevention assemblies, storm water systems that service only the interior of a structure, and sanitary drainage systems are not part of an irrigation system (NC S.L. 2008-177).

III. Water Efficiency Standards

Recommending standards for individual in-ground irrigation systems is a complicated task due to vast variability within system parameters, such as: size, grade, plant types, soil conditions and climatic environments.

Therefore, DENR makes two standard recommendations:

1. Rain Sensing Technology - All new and existing in-ground irrigation systems should be equipped with rain sensing technology to override the irrigation cycle of the system during rain events. Rain sensors use an internal cork disk that swells when it becomes wet and automatically signals the irrigation controller to turn off. Requiring rain sensing technology is a financially feasible standard for system owners to achieve, with such equipment available at the cost of around $50.

2. Irrigation System Auditing - All components of an in-ground irrigation system should be inspected and tested annually to ensure proper operation and absence of water leaks. Auditing should also include an evaluation of sprinkler settings, watering schedules, rain sensing mechanisms and back flow prevention devices. Annual audits, although an up-front expense to system owner, may result in yearly operating savings as auditors ensure the system is operating in the most water efficient manner.

IV. Best Management Practices

DENR should work in collaboration with the N.C. Irrigation Contractors' Licensing Board as they develop best management practices for irrigation professionals.

The achievement of water conservation through efficient irrigation requires the consideration of six critical components: appropriate plant selection, system design, system products/equipment, proper installation, efficient operation and routine maintenance. The following best management practices are sensible, easy to implement options that can result in water savings and increase irrigation system efficiency.

A. Appropriate Plant Selection:

Select plant species appropriate to local conditions in which individual systems will be located. Species recommendations are available through the N.C. Cooperative Extension Service, particularly via local county extension agents.

B. System Design:

In-ground irrigation systems should be designed to facilitate uniform water distribution. System design must take into account the following parameters: soil type, grade, sun exposure, wind, plant type and water source. The selection of appropriate irrigation components such as piping, valves, sprinkler heads and control devices are also vital to the design process of any in-ground irrigation system. The oversight of a qualified irrigation designer or consultant is recommended to ensure proper design. Best management practices that advocate water efficiency in the irrigation system design process are summarized below.

- Group or select plants for a given zone that have similar water requirements and root depths.
- Separate severe slope areas into zones to minimize runoff and erosion.
- Place plants with similar sun exposure levels in the same zone.
- Assure that the design will match precipitation rates of sprinklers within a controlled group or zone.
- Use the same sprinkler heads, drip emitters and nozzles within any given zone of plant material.
- Incorporate head-to-head coverage in the placement and spacing of sprinkler heads where radius equals the spacing dimension between sprinkler heads.
- Place sprinkler heads to take into account possible obstructions.
- Use drip irrigation for trees, shrubs and flowerbeds to apply water to root zones to minimize run off and water drift onto impervious surfaces.
- Use pressure-compensating devices where necessary to achieve optimum sprinkler performance and efficiency.
- Determine the recommended operating pressure at the maximum design flow rate of the system.
- Incorporate appropriate pipe sizing throughout the entire system.

C. System Equipment:

The installation of equipment designed for water efficiency significantly reduces total water usage. Whenever possible, purchase water saving products recognized by WaterSense, EPA's partnership program to promote the use of products certified as water efficient. Products promoted by the National Irrigation Associations' Smart Water Application Technologies initiative are also recognized as water efficient.

The best management practices below feature water conserving products used within the irrigation sector:

- Use "smart" irrigation system controllers to reduce water use. Traditional controllers require manual adjustments every time the weather changes. "Smart"

controllers are programmed to automatically adjust irrigation schedules by monitoring and using information about local weather and site conditions such as soil type, rain, wind, slope, soil and plant type. "Smart" controllers receive the weather data they need from various sources, depending on the make and model. Some models use data from local weather stations or on-site sensors, while other models gather information from weather stations linked to match the ZIP code and address of the installation site.

- Use rain sensing devices in all new and existing in-ground irrigation systems. Rain sensors use an internal cork disk that swells when it becomes wet and automatically signals the irrigation controller to turn off.
- Install an emergency shut-off device, which automatically turns the irrigation system off when a component malfunction is detected. These devices use a flow sensor to measure water flow rates, if an abnormal rate is detected the master valve closes stopping water flow.
- Use soil moisture sensors to reduce water use. These sensors are wired to a central computerized control system that can be programmed to trigger and curtail irrigation when soil water content reaches specific levels. To consistently achieve water efficiency and maintain a healthy landscape through the use of soil moisture sensors, an extensive understanding of the relationships between soil moisture readings, temperature, depth of sensor placement, root depth and soil moisture thresholds suitable for specific plant types is required. Additional considerations must also be given to the potential for sensors to be damaged during soil aeration and the accuracy of soil moisture sensors in areas where heavy foot traffic can lead to soil compaction.
- Use low flow volume systems (micro-sprays and drip lines) where applicable to increase water efficiency by reducing evaporative losses through the direct application of water to root zones.
- Use pressure regulators to achieve optimal spray pressure that reduce evaporative losses and uneven water distribution.
- Choose proper nozzles to match the precipitation rate throughout each zone of the system.

D. Proper Installation:

After the irrigation system has been designed and water saving products have been selected, proper installation is essential to achieve the most efficient use of water. The system should be installed according to the irrigation design specifications, equipment manufacturer's specifications, both state and local code requirements, and by a qualified irrigation professional.

When installing an irrigation system the following best management practices should be considered:

- Install a dedicated water meter to facilitate monitoring and measurement of overall irrigation system water usage as required by S.L. 2008-143 Section 9.
- Install irrigation systems to operate at the optimal water pressure to reduce evaporative losses or uneven water distribution.
- Provide the owner with an accurate drawing depicting irrigation system installation.
- If a design does not exist, encourage property owner to have a qualified irrigation designer provide a design.
- The irrigation installer should test the completed system to verify its operation according to the design criteria.

E. Efficient Operation:

Even a properly installed system has the potential to use excessive water, if operated incorrectly. The following best management practices for efficient irrigation system operation include:

- When scheduling watering cycles, consider the infiltration rate of the soil, plant type, root depth and evapotranspiration rate.
- When possible, water during times of low wind and when evapotranspiration losses are low.
- Water during the coolest portion of the day to reduce evaporative losses.
- Adjust watering frequencies to meet seasonal need changes. Savings can be realized by watering less frequently in the spring when it is cooler and by tapering watering frequency in the fall.

F. Routine Maintenance:

An irrigation system should be regularly maintained to ensure the performance of the system as designed. The following best management practices for routine maintenance will sustain an efficient and uniform distribution of water.

- Establish a seasonal maintenance schedule to flush all lines and check spray heads, nozzles and valves for proper operating functions.
- Routinely adjust spray sprinkler heads to reduce the possibility of watering impervious surfaces.
- Examine filters and clean filtration elements.
- Periodically check and repair any water leaks.

- In colder climates, prevent future water leaks and irrigation system damage by adequately draining valves, pipes and spray heads or by purging the system with compressed air.
- Annually inspect and test all components of in-ground irrigation system to ensure proper operation.

V. Voluntary Approaches

Along with the adoption of the best management practices listed above, a number of other voluntary approaches have been successfully used throughout the U.S. to promote the installation and operation of water efficient in-ground irrigation systems.

- ***Rebates and Incentives*** – Local governments can implement rebate and incentive programs for installing water efficient equipment in new and existing in-ground irrigation systems in residential and commercial settings. For example, local governments may offer cash rebates or water bill credits for the installation of approved water saving equipment such as a Smart Controller or soil sensor.

> The city of Austin, TX, offers rebates up to $375 for approved upgrades of existing irrigation systems. The city offers a free irrigation audit to any water customer who has an in-ground irrigation system and uses more than 25,000 gallons of water per month in the summer. Rebates are only available to customers who undergo an irrigation audit performed by city and make all recommended improvements. Eligible customers may receive the following rebates: $100 on a new approved controller, $100 on new sprinkler heads, $100 on a pressure reducing valve, $25 on other valves, $25 on a rain shut-off device, and $50 on a wireless rain shut-off device.

- ***Reclaimed Water*** – Local governments should be incentivized to offer reclaimed water to customers for irrigation and other non-potable uses through loans or grants from the Drinking Water Reserve or Wastewater Reserve listed in NCGS 159G-23 (3). These grants or loans could be used to install a permanent second pipe (purple pipe) water distribution system for reclaimed water in new housing or commercial development. Reclaimed water may also be distributed by bulk truck delivery. Reclaimed water must meet the standards found in 15A NCAC 02T .0900, *Reclaimed Water Systems* (N.C. Administrative Code, 2006).

The town of Cary was the first in the state to pump treated wastewater to local residents and businesses for irrigation and cooling. Cary currently operates two reclaimed water distribution systems. Each facility provides reclaimed water to nearby residential and commercial properties through the purple pipe distribution system as well as a truck filling facility to provide bulk reclaimed water to customers that come to the facility. One facility supplies an average of 58 million gallons per year to approximately 300 residential and commercial customers and a second facility supplies an average of 6.5 million gallons per year to a school and park facilities. The town is currently in the design phase for a third

- ***Rain Water*** – Using rain water irrigation systems will reduce demands on potable water supplies. Incentivize the installation of rain water harvesting systems in residential and commercial settings by providing tax credits for a portion of the cost of water harvesting systems including cisterns, pumps, filters and piping. The purchase of rain barrels for residential rain water harvesting could be encouraged through municipal rebates or coupons, or through "make your own" clinics in partnership with local home improvement stores.

The University of North Carolina at Chapel Hill installed a 70,000-gallon underground cistern and gravel storage field at a sports field on campus. The cistern system captures rainwater from the roofs of nearby buildings, and stores the water until it is used to irrigate the sports field. Other cistern systems on UNC-CH's campus can be used for both irrigation and flushing toilets.

- ***Water Efficiency Partnerships*** – In addition to working with the N.C. Irrigation Contractors' Licensing Board to develop best management practices, DENR should work with the following organizations to improve interagency communication and further promote water efficient irrigation: N.C. Green Industry Council, Carolina Irrigation Association, N.C. Department of Agriculture, N.C. Cooperative Extension and N.C. Irrigation Society.

- ***Education and Outreach*** – DENR should work with the partners listed above to develop educational training and guidance material on how to design, install, retrofit and maintain an in-ground irrigation system for residential and commercial users. In

addition, DENR and partners should develop online educational materials on reclaimed water, rain water harvesting, available rebates and incentives, and other related issues. This information should be easily accessible to local governments and commercial and residential consumers.

VI. Recommendations

DENR makes the following recommendations to promote water efficient in-ground irrigation systems:

1) All new and existing in-ground irrigation systems should be equipped with rain sensing technology to override the irrigation cycle of the system during rain events.
2) All components of an in-ground irrigation system should be inspected and tested annually to ensure proper operation and absence of water leaks. Auditing should also include an evaluation of sprinkler settings, watering schedules, rain sensing mechanisms and back flow prevention devices.
3) The N.C. Irrigation Contractors' Licensing Board should consider the best management practices listed in this report when establishing minimum standards for water conservation in the practice of irrigation construction and contracting.
4) Encourage non-regulatory approaches to increase the installation and usage of water efficient in-ground irrigation system through:
    - Offering rebates and incentives for the installation of water efficient in-ground irrigation system equipment,
    - Incentivizing the development of reclaimed water distribution systems to make reclaimed water available for irrigation and other non-potable uses,
    - Developing water efficiency partnerships to improve interagency communication and further promote water efficient irrigation, and
    - Providing statewide education and outreach to local governments, residential and commercial users, including training and guidance material on how to design, install, retrofit and maintain in-ground irrigation systems and on non-potable water use options for irrigation.

VII. References

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VII. Appendix

Glossary of Terms

- **Backflow prevention-** Measures/efforts to avert the unintended flow of water from a potentially polluted source into a potable water supply. A safety device must be installed to prevent the reverse flow of water, which may contain toxic residue from being siphoned into the drinking water system from the sprinkler heads. Acceptable types include: pressure vacuum breakers, double check valve assemblies and reduced pressure zone assemblies (Peterborough Utilities Group Web page).

- **Controller-** An automatic timing device used to remotely control values or heads according to a set irrigation schedule (Turf and Landscape Best Management Practices, 2005).
- **Cycle- (minutes or hours) -** The operating duration of one or more value for one irrigation start time (Turf and Landscape Best Management Practices, 2005).
- **Efficiency, irrigation system-** the percent of irrigation water that is beneficially used for plant growth (Turf and Landscape Best Management Practices, 2005).
- **Evapotranspiration** -The amount of water lost to the atmosphere by evaporation from the soil and plant surfaces and by transpiration from the plants (Asano, T., Burton, F. L., & Leverenz, H. L. ,2007).
- **Current evapotranspiration-** Actual measured or calculated reference evapotranspiration for a period of time (Turf and Landscape Best Management Practices, 2005).
- **Flow rate-** (gal/min, gpm, gph) Volume of flow per unit of time, such as discharge from an irrigation sprinkler or emitter; or flow into a zone (Turf and Landscape Best Management Practices, 2005).
- **Hardscape-** Impervious surfaces within the landscape, such as a concrete walkways or brick paving (Turf and Landscape Best Management Practices, 2005).
- **Historical evapotranspiration-** A multiple-year average of recorded historical reference evapotransporation data from a weather station or evaporative pan in a given geological location, typically a monthly average (Turf and Landscape Best Management Practices, 2005).
- **Hydrozone-** Grouping of plants with similar water (and environmental) requirements for irrigating with one or more common station/zone values (Turf and Landscape Best Management Practices, 2005).
- **Infiltration rate-** The rate at which water permeates soil, expressed as a depth of water per unit of time in inches per hour or feet per day. The infiltration rate changes with time, both during and between irrigations (Vickers, A., 2001).
- **Irrigation interval-** Number of full days between irrigation applications (Turf and Landscape Best Management Practices, 2005).
- **Irrigation schedule-** Set of data describing when and the amount of irrigation water to be applied to each station/zone (Turf and Landscape Best Management Practices, 2005).
- **Irrigation system-** Set of components that may include the water sources, water distribution network, control components and other general irrigation equipment (RainBird Homeowner's Guide, 2006).
- **Microirrigation**- A method of irrigation in which water is applied directly to the root zone of the plant in small but frequent quantities in such a way as to maintain the most active part of the soil at a quasi-optimum moisture (ex., drip irrigation, trickle irrigation, dribble irrigation or micro irrigation) (Nevada's Division of Water Resources Water Words Dictionary Web page).

- **Matched precipitation rate-** System or zone in which all the heads have similar precipitation rates is said to have matched precipitation rates (Turf and Landscape Best Management Practices, 2005).
- **Moisture sensor-** Device that monitors or measures soil water content or tension (Turf and Landscape Best Management Practices, 2005).
- **Precipitation Rate-** Amount of water applied by an irrigation system measured in inches per area or gallons per area (Turf and Landscape Best Management Practices, 2005).
- **Pressure, dynamic-** (psi) Working or operating pressure at a point within the irrigation system (Turf and Landscape Best Management Practices, 2005).
- **Rain shut-off device, rain sensor, rain switch-** A device that causes the controller to suspend or override an irrigation cycle or that opens the circuit to a valve or set of valves when a preset amount of rain occurs (Turf and Landscape Best Management Practices, 2005).
- **Reclaimed water-** tertiary treated wastewater used in a beneficial manner.
- **Runoff-** Portion of irrigation or rainwater that leaves the target area, primarily due to slope or the precipitation rate exceeding the soil infiltration rate (Turf and Landscape Best Management Practices, 2005).
- **Smart Irrigation Controller-** a controlling device that automatically adjusts irrigation timing and frequency based on environmental or historical conditions.